A Brief Discussion on the Value Representation of Digital Assets in Different Periods

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ABSTRACT With the rapid advancement of information technology, digital assets are playing an increasingly crucial role in the global economic system. This paper provides an in-depth analysis of how digital assets manifest their value across different periods, examining their characteristics, driving factors, and challenges during the nascent, developmental, mature, and transformative stages. By offering a comprehensive discussion of each stage, this study reveals the evolution of digital asset value, providing valuable insights for enterprises and investors.

Keywords Digital Assets, Informatization, Artificial Intelligence, Big Data, Value Characteristics.

I.INTRODUCTION

In the current era of rapid digitalization, digital assets have become a core driving force for economic progress and social transformation. Evolving from early-stage electronic data storage to the widespread application of cutting-edge technologies such as blockchain and artificial intelligence, the concept of digital assets has continuously expanded in scope and depth. Their value has also manifested in diverse forms across different periods. A thorough investigation into the value representation of digital assets at various stages is of paramount significance for accurately understanding the development trajectory of the digital economy, capturing investment opportunities, and formulating sound policies.

II.Concept and Classification of Digital Assets

2.1 Definition of Digital Assets

Digital assets refer to resources that exist in digital form and can generate economic benefits or other value for their owners. These assets encompass a wide range of domains, including electronic data, software, digital copyrights, virtual currencies, and digital financial assets. Compared to traditional assets, digital assets exhibit distinct characteristics such as intangibility, replicability, high liquidity, and ease of dissemination.

2.2 Classification of Digital Assets

Based on their nature and applications, digital assets can be categorized into the following types:

（1） Data Assets: This category includes various types of data generated during enterprise operations, such as customer information, sales data, and production data. Through in-depth analysis and mining, these data assets provide critical decision-making support and create substantial value. For instance, Amazon leverages advanced algorithms to analyze vast amounts of user purchase data, enabling personalized product recommendations that significantly enhance conversion rates, thereby demonstrating the immense value of data assets in business operations.

(2) Digital Copyright Assets: This category includes digital copyrights of literary works, music, films, and software. With the widespread adoption of the internet, the market value of digital copyrights has been steadily increasing, making them an essential component of the cultural industry. Digital music platforms such as Spotify collaborate with numerous copyright holders to provide users with vast music resources while generating considerable revenue for rights holders, thereby fostering the prosperity of the digital music industry.

(3) Virtual Currency Assets: Represented by Bitcoin and Ethereum, virtual currencies rely on blockchain technology and are characterized by decentralization and anonymity. They have attracted significant global attention and applications. Bitcoin, as the earliest virtual currency, has sparked extensive discussions in the financial sector since its inception. Its decentralized nature allows transactions to bypass traditional financial institutions, offering users novel payment and investment options in specific scenarios.

(4) Digital Financial Assets: This category includes electronic payment tools, digital currencies, and digital securities, which have significantly driven financial

innovation, enhancing the efficiency and convenience of financial transactions. The widespread adoption of electronic payment platforms such as Alipay and WeChat Pay has fundamentally transformed daily payment methods, greatly improving transaction efficiency and convenience.

III.The Valuation of Digital Assets in Their Emerging Stage

3.1 Time Span and Background of the Emerging Stage

The emerging stage of digital assets can be traced back to the mid-20th century when the advent and gradual development of computer technology enabled the application of electronic data in enterprises and institutions. During this period, computers were primarily used for scientific calculations and data processing. Although the concept of digital assets had not yet been formally established, the groundwork for future developments was already being laid.

3.2 Main Forms and Value Representation of Digital Assets

(1) Early Electronic Data Storage: Enterprises began utilizing computers to store and process basic information such as financial and personnel data. This significantly improved work efficiency and reduced labor costs. For instance, IBM ' s early accounting software systems facilitated the transition from manual bookkeeping to electronic record-keeping, dramatically reducing human calculation errors and enhancing data processing speed. This early adoption highlighted the advantages of digital information management.

(2) Simple Software Programs: Some rudimentary office and business management software began to emerge, such as early word processing and accounting software. The introduction of these applications standardized enterprise workflows and improved operational quality and efficiency. A notable example is Microsoft ' s early release of Word, which revolutionized document processing in offices by significantly improving editing and formatting efficiency.

3.3 Value-Driving Factors

(1) Technological Advancements: Continuous innovations in computer technology enhanced data storage and processing capabilities, providing a solid technical foundation for the generation and application of digital assets. The transition from transistors to integrated circuits led to a significant increase in data storage capacity and processing speed. Meanwhile, advancements in operating systems and database management systems further enhanced computers' ability to handle data, laying the groundwork for digital asset storage and application.

(2) Enterprise Demand: As enterprises expanded and business operations became increasingly complex, the need for efficient information management and workflow optimization grew. This demand accelerated the initial application of digital assets. The expansion of enterprise scale resulted in a surge of information, making traditional manual data processing methods inadequate. To improve operational efficiency and reduce costs, enterprises increasingly relied on computer technology for digital information management, driving the early adoption of digital assets.

3.4 Challenges

(1) High Technological Costs: Early computer equipment was expensive, and software development costs were equally prohibitive, significantly restricting the widespread adoption and application of digital assets. Large-scale computers could cost millions of dollars, making them affordable only to large enterprises and research institutions. Software development required significant investments of manpower and resources, with long development cycles. These high costs prevented many small and medium-sized enterprises from entering the digital domain, limiting the spread of digital assets.

(2) Data Security Issues: Due to the technological limitations of the time, data storage and transmission faced significant security risks, making data leakage and loss common concerns. Early computer networks had weak security protections, leaving data vulnerable to cyberattacks and viruses. Furthermore, data storage media were relatively unreliable—magnetic tape storage, for example, was highly susceptible to physical damage, leading to potential data loss.

IV. The Monetization of Digital Assets in the Growth Phase

4.1 Time Span and Background of the Emerging Stage

From the late 20th century to the early 21st century, the widespread adoption of the Internet and the rapid rise of e-commerce marked the entry of digital assets into a phase of rapid expansion. During this period, both the variety and volume of digital assets experienced exponential growth, and their value gained broader recognition.

4.2 Key Forms of Digital Assets and Their Value Representation

(1) Data Assets of Internet Enterprises: Leading internet companies such as Google, Amazon, and Alibaba accumulated vast amounts of user data. By conducting in-depth analysis and effective utilization of these datasets, businesses could gain precise insights into user demands, enabling personalized marketing and services, thereby generating significant commercial value. Google leveraged user search data to implement targeted advertising through its search engine, with ad revenue comprising a substantial portion of its total income. Amazon analyzed users ' purchase history and browsing behavior to provide personalized product recommendations, significantly boosting conversion rates.

(2) Rise of the Digital Copyright Market: With the advancement of internet technologies, industries such as digital music, film, and gaming witnessed rapid growth. The digital copyright trading market gradually took shape, allowing copyright holders to monetize their intellectual property through licensing and sales. Platforms such as Spotify and Netflix revolutionized traditional business models in the music and film industries. Spotify introduced a subscription-based model, providing music streaming

services to users while paying royalties to copyright holders, fostering the prosperity of the digital music market.

(3) Development of Electronic Payments and Virtual Currencies: The widespread adoption of electronic payment solutions such as Alipay and WeChat Pay significantly transformed traditional payment methods, greatly enhancing efficiency and convenience. Meanwhile, the emergence of virtual currencies like Bitcoin attracted global attention and sparked heated discussions. Despite the high volatility of virtual currencies, they introduced new possibilities for financial innovation. Alipay and WeChat Pay dominated China's mobile payment market, with transaction volumes growing annually. Bitcoin, as a decentralized digital currency, offered alternatives for cross-border transactions and anonymous payments.

4.3 Value-Driving Factors

(1) Internet Proliferation: The extensive application of the Internet enhanced the efficiency and convenience of information dissemination, providing a vast platform for the circulation and exchange of digital assets. The Internet eliminated geographical barriers, enabling digital assets to be distributed and traded globally. Online digital content platforms allowed creators to reach a worldwide audience, expanding market reach and enhancing the value of digital copyright assets.

(2) Evolving Consumer Demand: The growing demand for personalized and convenient products and services drove businesses to leverage digital assets to meet these expectations. As modern lifestyles became increasingly fast-paced, consumers sought products and services tailored to their specific needs. By collecting and analyzing consumer data, businesses could offer customized solutions, enhancing customer satisfaction and loyalty.

(3) Financial Innovation: Financial institutions actively explored digital financial products and services, significantly promoting the development of electronic payments and virtual currencies. To remain competitive, financial institutions continuously innovated financial products and service models. Electronic payment solutions simplified transaction processes and reduced costs, while virtual currencies challenged traditional financial systems, providing new directions for financial innovation.

4.4 Challenges Faced

(1) Data Privacy Issues: As the volume of data surged, concerns over data privacy protection became a major societal issue. Internet companies faced the challenge of balancing data utilization with user privacy protection. The Facebook data breach incident heightened global awareness of data privacy concerns. The unauthorized collection and misuse of user data infringed upon privacy rights, requiring businesses to implement appropriate data policies that ensure compliance while maximizing data-driven value creation.

(2) Digital Copyright Infringement: The ease of copying digital content led to escalating copyright infringement issues, making robust digital copyright protection a critical industry concern. In the online environment, digital music, films, and other works were easily reproduced and distributed illegally. According to the International Federation of the Phonographic Industry (IFPI), global digital copyright infringement results in annual economic losses worth billions of dollars. Strengthening copyright legislation and implementing advanced technical protection measures are essential to addressing digital copyright infringement.

(3) Regulation of Virtual Currencies: The anonymity and decentralization of virtual currencies posed significant challenges for financial regulation, making it imperative for governments to formulate appropriate policies. The lack of effective oversight over virtual currency transactions increased the risks of money laundering, terrorist financing, and other illicit activities. Governments worldwide needed to strike a balance between fostering financial innovation and mitigating risks by establishing suitable regulatory frameworks for virtual currencies.

V. The Value Manifestation of Digital Assets in the Maturity Stage

5.1 Time Span and Background of the Maturity Stage

In recent years, with the growing maturity and widespread application of technologies such as big data, artificial intelligence, and blockchain, digital assets have entered the maturity stage. During this period, digital assets have been deeply integrated into various sectors of the economy and society, with their value being fully realized.

5.2 Major Forms of Digital Assets and Their Value Representation

(1) Deep Application of Big Data Assets: Enterprises leverage big data analytics to achieve precision marketing, intelligent production, and risk prediction. For instance, manufacturers optimize production processes through big data analysis, significantly enhancing efficiency and product quality. Financial institutions use big data for credit risk assessment, reducing non-performing loan rates. General Electric applies industrial big data to optimize equipment maintenance, minimizing downtime and improving operational efficiency. Similarly, financial institutions utilize big data-driven credit evaluation models to more accurately assess customer credit risks and lower default rates.

(2) Value Creation of Artificial Intelligence Assets: The development of artificial intelligence (AI) has given rise to a range of AI-driven assets, such as intelligent algorithms and machine learning models. These assets are widely used across healthcare, transportation, and education, creating substantial social value. In healthcare, AI-powered diagnostic systems assist doctors in making more accurate diagnoses, thereby improving the quality of medical services. IBM Watson for Oncology, for example, provides cancer treatment recommendations for physicians. In the transportation sector, advancements in autonomous driving technology are expected to enhance traffic efficiency and reduce road accidents.

(3) Expansion of Blockchain Asset Applications: Blockchain technology, with its decentralized and tamper-

proof characteristics, has been widely adopted in finance, supply chain management, and public administration. Blockchain-based digital assets, such as digital bills and asset securitization products, enhance transaction transparency and security while reducing transaction costs. In supply chain finance, blockchain facilitates information sharing and traceability, effectively addressing financing difficulties for small and medium-sized enterprises (SMEs). The R3 Corda blockchain platform, for instance, has been successfully applied in the financial sector, improving transaction efficiency and security.

5.3 Value-Driving Factors

(1) Technological Maturity: The advancements in big data, artificial intelligence, and blockchain have provided a solid technical foundation for the deep application of digital assets. Breakthroughs in data processing, analysis, storage, and security have enhanced the efficiency, safety, and intelligence of digital asset applications. For example, deep learning algorithms have been widely applied in image recognition and natural language processing, significantly improving the effectiveness of AI-driven assets.

(2) Policy Support: Governments worldwide have introduced policies to promote the development of the digital economy, creating a favorable regulatory environment for the application and innovation of digital assets. Many countries have established digital economy development strategies and increased support for research and application of big data, artificial intelligence, and blockchain technologies. For instance, China has released the Digital Economy Development Strategy Outline, promoting deep integration between the digital and real economies, thereby accelerating the development of digital assets.

(3) Market Demand: The increasing demand for efficient, intelligent, and secure products and services is a major driver of digital asset value realization. Consumers and businesses are seeking more intelligent and personalized products and services, prompting enterprises to leverage digital assets to enhance their offerings. In smart city development, the growing need for intelligent transportation and security solutions has driven the application and expansion of related digital assets.

5.4 Challenges

(1) Lack of Unified Technical Standards: The application of digital assets varies across enterprises and institutions, leading to inconsistencies in technical standards. This lack of standardization hinders data sharing and system integration. In the big data sector, differences in data formats and interface standards across companies complicate data integration. In the blockchain sector, discrepancies in platform architectures and standards limit cross-chain interoperability. Establishing unified technical standards is crucial for fostering the coordinated development of digital assets.

(2) Talent Shortage: The demand for interdisciplinary professionals in the digital asset sector is rapidly increasing. However, there is a shortage of talent with expertise in both technology and business, which constrains industry growth. Digital asset development requires knowledge spanning multiple disciplines, including computer science, statistics, and economics. Currently, the supply of such interdisciplinary talent is insufficient, restricting enterprise digital transformation and innovation.

(3) Ethical and Moral Issues: The application of AI and other technologies raises ethical concerns, such as algorithmic bias and data misuse, necessitating appropriate regulations and guidelines. AI algorithms may contain biases that impact decision-making fairness, while data misuse could infringe on user rights. Establishing ethical standards and guidelines to ensure responsible technological application is a crucial challenge for the sustainable development of digital assets.

VI. Valuable Manifestations of Digital Assets in the Transformation Period

6.1 Background and Trends of the Transformation Period

With the continuous emergence of new technologies and ongoing changes in the socio-economic environment, digital assets are entering a new transformation period. Looking ahead, digital assets will exhibit more diversified, intelligent, and globalized development trends.

6.2 Emerging Forms of Digital Assets and Value Predictions

(1) Quantum Computing-Related Assets: As quantum computing advances, digital assets based on quantum algorithms may emerge, offering immense application value in fields such as cryptography and computational optimization. With its powerful computational capabilities, quantum computing is expected to revolutionize complex algorithm processing, encryption, and decryption, opening up entirely new application scenarios for digital assets.

(2) Internet of Things (IoT) Assets: The widespread adoption of IoT will generate massive amounts of device data and connected assets. Integrating and utilizing these assets can enable applications in smart homes, intelligent transportation, and smart cities, creating significant economic and social value. For example, smart home systems can integrate various device data to enable intelligent home environment control, enhancing comfort and convenience. Similarly, intelligent transportation systems can leverage vehicle and road sensor data to optimize traffic flow and improve transportation efficiency.

(3) Digital Identity Assets: With the growing digitalization of society, the value of personal digital identities will become increasingly prominent. Digital identity assets can be used for identity verification, credit evaluation, and personalized services, bringing convenience and security to individuals and society. These assets will contribute to building a safer and more efficient digital ecosystem, with broad applications in financial services, e-commerce, and other sectors.

6.3 Value-Driving Factors

(1) Technological Innovation: Ongoing technological advancements will drive the emergence of new forms of digital assets, bringing fresh momentum to economic and

social development. Breakthroughs in fields such as quantum computing, IoT, and artificial intelligence will continue to foster innovative digital asset models, injecting new vitality into the digital economy.

(2) Evolving Social Needs: People's aspirations for a better life, along with increasing demands for fairness, security, and sustainable development, will push digital assets to play a greater role in addressing societal challenges. Digital assets can provide technological support and innovative solutions to promote social equity, enhance public services, and drive sustainable development initiatives.

(3) Global Collaboration and Competition: The global nature of digital assets intensifies international collaboration and competition in the digital economy, accelerating innovation and application. International cooperation facilitates knowledge sharing and technological exchange, fostering the global expansion of digital assets. At the same time, heightened competition drives increased research and development investment, promoting technological innovation and the expansion of digital asset applications.

6.4 Potential Challenges

(1) Technological Risks: Emerging technologies carry uncertainties, including challenges in achieving breakthroughs and potential security vulnerabilities. Quantum computing, still in its developmental stage, faces technical bottlenecks and security risks. IoT devices, due to their sheer volume, present challenges related to data security and privacy protection. Addressing these risks requires substantial R&D investments and enhanced cybersecurity measures.

(2) Legal and Regulatory Gaps: The emergence of new digital asset forms may challenge existing legal frameworks, necessitating timely updates and improvements in relevant regulations. Digital identity assets, for example, involve personal privacy and information security, requiring robust legal safeguards. Additionally, laws governing the trading and regulation of emerging digital assets must be refined to ensure orderly market operations.

(3) Intensified International Competition: Competition among nations in the digital asset sector is becoming increasingly fierce. Securing a competitive advantage in the global digital economy is a key challenge for all countries. Many nations are formulating digital economy strategies and increasing support for digital asset development. Enhancing a country's core competitiveness in digital assets requires a strong focus on technological innovation, talent cultivation, and policy support.

VII. Conclusion

This paper systematically explores the value manifestation of digital assets at different stages of development, revealing their continuous evolution driven by technological advancements and changing societal demands. From the early stage of data storage and software applications to the growth stage marked by the rise of internet data assets and digital copyright markets, and further to the maturity stage characterized by the extensive application of big data, artificial intelligence, and blockchain technologies, the value of digital assets has progressively expanded and become deeply embedded in the economic and social landscape.

Looking ahead to the transformation period, digital assets will diversify further and demonstrate vast potential in emerging fields such as quantum computing, the Internet of Things, and digital identity. However, their development also faces significant challenges, including technological security risks, legal and regulatory gaps, and intensified global competition. To fully realize the value of digital assets, enterprises and investors must adopt a forward-looking approach, actively engage in technological innovation, and enhance risk management. Meanwhile, governments and regulatory bodies should refine legal frameworks to establish a well-regulated digital asset ecosystem, ensuring that innovation progresses alongside security and compliance. Amid the accelerating growth of the digital economy, digital assets are poised to play a pivotal role in global technological innovation, social governance, and economic competition, becoming a fundamental driving force behind the prosperity of the digital economy.

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