Data as a Production Factor: A New Engine Driving the Development of the Digital Economy

Cai Xueshu

Shanghai International Studies University，Shanghai ，201620；

Abstract: In the context of global digital transformation, data, as a new production factor, forms the core engine of digital economic development. This paper explains its shift from a resource to a key production factor, analyzing its symbiotic relationship with the digital economy, and explores its multidimensional pathways through which data value is released. It presents practical approaches, highlights real-world challenges such as the dilemma of data ownership rights, and looks forward to its application prospects within industries. The paper emphasizes the role of data in driving high-quality development of the digital economy and in facilitating the economic and social transformation.

Keywords: Data as a Production Factor; Digital Economy; Value Release

DOI:10.69979/3041-0843.25.03.051

1 The Context of the Digital Economy Era

1.1 The Global Wave of Digital Transformation

With the advancement of worldwide digital transformation, many countries have accelerated the development of the digital economy to improve economic quality and foster technological innovation. The digital economy is a new economic form that follows agricultural and industrial economies. The rapid development of the digital economy relies on the widespread application of emerging technologies such as the Internet, big data, artificial intelligence, and the Internet of Things. These technologies are profoundly changing the production methods and business models of traditional industries. The digital economy has increasingly become a new engine for economic growth, driving the global digitalization process through policy support, technological research and development, and infrastructure construction.

1.2 From Resource to Factor: The New Positioning of Data

In the era of the digital economy, akin to oil, the ‘blood’ of industry, data is an indispensable production resource for every enterprise's survival and development. Its multiplier effect in enhancing total factor productivity is becoming increasingly evident. Data has become a core production factor comparable to land in the agricultural economy and to capital and technology in the industrial economy. As a result, data has gradually gained recognition as an important production factor, receiving widespread acknowledgement within the academic community. Data, as a new production factor, possesses characteristics such as non-exclusivity, economies of scale, renewability, and strong pervasiveness.[1] Compared to ordinary goods, data is characterized by non-uniqueness, the ability to be owned immediately after being viewed, and complete replicability with no differentiation.[2] Additionally, data elements are technically dependent, with their production and development closely linked to technology. Technologies such as big data and artificial intelligence provide strong support for the processing and analysis of data.[3]

1.3 The Symbiotic Relationship between the Digital Economy and Data as a Production Factor

The development of the digital economy is closely tied to the deep integration of data as a production factor. Through technological innovation, market mechanisms, and institutional development, the digital economy provides crucial support for the growth of data as a production factor. As the main component of the digital economy, the role of data within it requires precise understanding.

2 Multidimensional Paths for Releasing the Value of Data as a Production Factor

2.1 Empowering Enterprises: Enhancing Efficiency and Continuous Innovation

Data as a production factor primarily releases value by improving production efficiency and optimizing decision-making processes. By collecting, processing, and analyzing internal and external data, enterprises can more accurately understand market demand, optimize production processes, reduce operational costs, and improve resource allocation efficiency. Data-driven applications such as personalized recommendations, precision marketing, and intelligent customer service not only enhance the user experience but also significantly increase enterprise revenue and profits. At the same time, data helps enterprises better identify and manage risks, improving operational stability and resilience to risks. For instance, manufacturing companies can achieve predictive maintenance through data of equipment sensor, reducing downtime, while retail businesses can optimize inventory management using data of consumer behaviors, reducing the risk of unsold stock.

2.2 Reshaping Industries: Unifying the Chain and Promoting Collaborative Development

Data as a production factor releases value by promoting industrial collaboration and ecosystem reconstruction. The flow of data breaks down traditional industry boundaries, facilitating information sharing and business coordination between upstream and downstream enterprises in the industrial chain. Industrial internet platforms connect manufacturers, suppliers, and customers, enabling the circulation and collaborative optimization of data across the entire value chain, thereby improving the operational efficiency of the entire industry. Data as a production factor has also given rise to new business models and industrial forms, such as the platform economy and the shared economy, which redefined traditional industry ecosystems. In industrial clusters, data-sharing platforms help enterprises align production capacities, innovate collaboratively, and share resources, creating economies of scale and network effects that enhance regional industrial competitiveness.

2.3 Driving Society: Stimulating Growth and Optimizing Governance

Data as a production factor releases value by driving economic growth and optimizing social governance. As a new type of production factor, data deeply integrates with traditional factors such as labor, capital, and technology, generating a multiplier effect and improving total factor productivity, making it a new engine for economic growth. The widespread application of data has accelerated both the digitalization of industries and the industrialization of digital technologies, speeding up the transformation and upgrading of economic structures. In the realm of social governance, data empowers government decision-making with scientific precision, enhances public services with targeted accuracy, and facilitates intelligent urban management, thus improving the efficiency and quality of social governance.

3 Data Factor-Driven Pathways for Digital Economy Development

3.1 Enhancing Data Management Capabilities

Data management capabilities serve as the foundational support for the development of the digital economy. In the era of the digital economy, enterprises need to establish a comprehensive data governance system, creating a management framework that covers the entire lifecycle of data—from collection, storing, and processing to analysis and application. By implementing data standardization initiatives and establishing unified data quality standards and management protocols, businesses can ensure the accuracy, completeness, and consistency of data resources. What's more, a data quality monitoring and evaluation mechanism should be established, utilizing data quality probes and intelligent diagnostic tools to monitor data quality metrics in real-time, identifying and rectifying data quality issues promptly. Additionally, there is a need to strengthen the development of data management talent, cultivating professionals who are proficient in both data technology and business requirements, thereby enhancing overall data literacy. Furthermore, it is essential to build an enterprise-level data asset directory, conduct assessments of data asset value, and promote the transformation of data resources into data assets, providing high-quality data support for digital transformation.

3.2 Promoting Technological Innovation Breakthroughs

Technological innovation is a critical engine for the high-quality development of the digital economy. Key technologies such as privacy computing, blockchain, and artificial intelligence must be prioritized to build secure and trustworthy data circulation infrastructures. In the field of privacy computing, efforts should be accelerated to promote the industrial application of technologies like federated learning, secure multi-party computation, and trusted execution environments, enabling 'data availability without visibility'. In the blockchain field, distributed digital identity systems and data provenance platforms should be developed to ensure that the entire data circulation process is traceable and auditable. In the realm of artificial intelligence, technologies such as intelligent data labeling, automated feature engineering, and intelligent data product development should be advanced to improve the efficiency of data development and utilization. At the same time, efforts should be made to develop low-code and modular data intelligence platforms that provide one-stop services for data processing, analysis, and application, lowering the technological barriers for small and medium-sized enterprises.

3.3 Cultivating a Prosperous Market Ecosystem

A prosperous market ecosystem is a key guarantee for the development of the digital economy. Efforts should be made to improve the data factor market system, creating a multi-tiered and diversified network of data trading markets, and fostering a group of industry-influential data trading platforms. Professional service organizations such as data brokerage, data auditing, data quality assessment, and data asset pricing should be developed to form a complete data service industry chain. Innovation applications of data factors should be deepened in key industries, and benchmark application scenarios should be created in fields such as intelligent manufacturing, smart finance, digital healthcare, and intelligent connected vehicles, forming solutions that are replicable and scalable.

3.4 Improving the Institutional and Legal Environment

A sound institutional environment is necessary for the healthy development of the digital economy. Efforts should be made to accelerate the establishment of a data system that is compatible with the development of the digital economy. This includes researching and formulating institutional norms for data property registration, data asset evaluation, and data transaction management, as well as clarifying basic rules regarding data ownership, circulation, transactions, and revenue distribution. It is critical to enforce data security laws and regulations strictly, establish a data classification and grading management system, and improve data security technology protection systems, ensuring a strong safety foundation for the development of the digital economy. Innovation in regulatory approaches should be encouraged by establishing an inclusive and cautious 'regulatory sandbox' mechanism, which provides a testing space and policy exemptions for innovative businesses. Additionally, a data compliance management system should be perfected, including formulating standard contract guidelines for data circulation and establishing a data compliance certification system to reduce institutional transaction costs.

4 The Practical Dilemmas in Releasing the Value of Data Factors

4.1 The Difficulty in Confirming Data Ownership Limits Supply

Unclear data ownership leads to hesitance in providing data. Data is characterized by its replicability and the mixing of rights among multiple parties, and unclear ownership which lead to market participants' rights being unprotected. Participants in data transactions are uncertain about the boundaries of rights, which makes many data-owning enterprises reluctant or unwilling to engage in data transactions, thus hindering the development of the data factor industry in China. Although the 'Twenty Articles on Data' creatively proposed the framework for a data property rights system that separates data ownership, data processing and usage rights, and data product operation rights, the implementation of confirmed data ownership requires comprehensive support in terms of technology, policy, and law.

4.2 Bottleneck in Data Processing Raises Costs

The lack of mechanisms and tools for data processing results in an inability to process data effectively. Data processing primarily includes data cleaning, data labeling, data mining, and product development, which involve the comprehensive

application of technologies such as data modeling, data tagging, blockchain, privacy computing, and AI data security. For most government and enterprise sectors, traditional data processing models rely heavily on manual labor, resulting in challenges such as high technical difficulty, high processing costs, and low development efficiency. Due to the lack of intelligent and efficient data processing tools on the market, although data holders are aware of the value of their data, they struggle to quickly process multiple types of data into standardized data products, thus hindering data-driven business development and innovation.

4.3 Security Concerns Obstruct Data Circulation

The risks to personal privacy and data security are high, leading to reluctance in data circulation. Data security is a key guarantee for the development of the data factor market, as risks associated with the circulation of data factors threaten both the operation of the market and the realization of data value. Additionally, the rapid advancement of information technology, computing power, and algorithms has intensified the pressure on data protection. While the robust data technology industry increases the flexibility and transparency of data circulation, it also presents challenges to the confidentiality, controllability, and integrity of data factors, making the possibility of privacy breaches much higher.

5 Future Trends and Development Directions

5.1 Industrial Sector

The industrial sector will become the core arena for the development of the digital economy. Data elements will play a key role throughout the entire manufacturing chain, driving the transformation of the manufacturing industry towards intelligence and service-oriented models. In the future, industrial internet platforms will be widely adopted, collecting real-time data from production equipment, process parameters, quality data and more, to build digital twin factories that enable visualized management and intelligent control of production processes. Artificial intelligence will be deeply applied in scenarios such as process optimization, predictive maintenance of equipment, and energy consumption management, greatly improving production efficiency and resource utilization. Industrial data elements will propel the manufacturing industry towards new models, such as personalized customization, networked collaboration, and service extension, forming a data-driven intelligent manufacturing paradigm.

5.2 Agricultural Sector

The agricultural sector will embrace significant opportunities for digital transformation. Data elements will profoundly change traditional agricultural production methods, driving the rapid development of precision agriculture and smart farming. In the future, agricultural sensors, IoT devices, and remote sensing technology will be widely used in farmland monitoring, collecting real-time data on soil moisture, weather conditions and crop growth to create agricultural digital twin systems. Big data analytics will provide intelligent decision-making support for agricultural production, enabling precise fertilization, smart irrigation, pest and disease early warning, and other refined management techniques. Agricultural data elements will promote the development of new business models such as rural e-commerce, customized agricultural products, and leisure agriculture, driving the digital transformation of the entire agricultural production, operation, and management process, and supporting the implementation of rural revitalization strategies.

5.3 Service Sector

The service sector will enter a new stage of comprehensive digital upgrading. Data elements will reshape business models and service experiences, driving the service industry towards more personalized and intelligent directions. In the financial sector, big data risk control models will enable real-time risk assessment and early warning, while intelligent advisory services will offer personalized asset allocation plans, and blockchain technology will drive innovations in digital currencies and cross-border payments. In the healthcare sector, electronic personal health records will be established, and big data analytics will enable disease prediction and personalized treatment. Tele-medicine and smart hospitals will become the new norm. In the realm of education, personalized learning platforms will be developed, and data analysis of learning behaviors will facilitate tailored teaching approaches, while virtual classrooms and intelligent teaching assistants will

become widely used. Additionally, data elements will promote innovations in smart retail, digital tourism, intelligent transportation, and other service-oriented sectors, thus significantly enhancing service quality and user experience.

References

[1].Dai Shuangxing. Data Elements: Key Characteristics, Driving Effects, and Development Pathways [J]. Marxism and Reality, 2020, (06): 171-177.
[2].Yang Maojiang. Design of Data Trading Platform Based on Cryptography and Blockchain Technology [J]. Information and Communication Technology, 2016, 10(04): 24-31.
[3].Ma Haiqun, Zhang Tao. The Logical Explanation and "New Quality" Power of Data Productivity [J]. Journal of the Chinese Library Association, 2024(12): 1-16.

Cai Xueshu (born in November 2000), female, Han nationality, from Kaifeng City, Henan Province, is currently a graduate student at Shanghai International Studies University (201620), specializing in Marxist political economy.