

INTEGRATION OF THE DIGITAL ECONOMY AND THE REAL ECONOMY: CONNOTATION, MEASUREMENT, AND EFFECTS—A RESEARCH REVIEW

Ruiwen Liao*

International Chinese College, Panyapiwat Institute of Management
Guangxi University of Finance and Economics, China

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Abstract

The integration of the digital economy and the real economy (digital-real integration) has emerged as a core engine for high-quality economic development and a new focus of global competition. This paper systematically reviews and synthesizes this pivotal topic, with the following key findings. Integrating the digital economy with the real economy leads to higher efficiency in the manufacturing and service sectors, reduces operating costs through the use of IoT, PL, and Big Data, creates new businesses, expands digital employment opportunities, and drives sustainable growth. The concept of digital-real integration is interpreted across multiple dimensions, including technology diffusion and innovation, factor restructuring, economic structure evolution, micro-agent behavior, and systemic synergy. Measurement methods for digital-real integration have been developed in three aspects: Macro-level assessment based on the degree of coupling coordination degree and industrial linkages, meso-level measurement of technological integration using patent citations, and micro-level evaluation of enterprise digital transformation via questionnaires and measurement scales. Research on the effects of digital-real integration mainly covers three aspects: promoting economic growth, driving industrial transformation and upgrading, and empowering enterprises. Finally, this paper proposes future research directions from four perspectives: deepening micro-level mechanism analysis, innovating measurement methods, clarifying complex effects and building integrated governance systems. It aims to provide references for advancing theoretical research and informing policy and practice of digital-real integration.

Keywords: Digital Economy, Real Economy, Industrial Integration, Micro-level Mechanisms, Coupling Coordination

*Corresponding Author

E-mail: lrw@gxufe.edu.cn

Introduction

A new wave of technological revolution and industrial transformation is burgeoning. Digital technologies represented by big data, artificial intelligence, cloud computing, and the Internet of Things are penetrating all areas of the economy and society with unprecedented breadth and depth. Against this backdrop, the digital economy has rapidly emerged as a new economic form and exhibits a trend of deep integration with the traditional real economy. Digital-real integration has become a strategic pivot for major global economies to build new competitive advantages (Yang, 2025). For China, promoting the deep integration of the digital and real economies is not only an inevitable requirement to adapt to technological trends and cultivate new quality productive forces but also a key pathway to addressing imbalanced and inadequate development, achieving highquality economic development, and advancing Chinese modernization.

Digital-real integration, as an important concept in China's policy discourse, has its theoretical origins traceable to the earlier concept of "integration of informatization and industrialization". With the iterative evolution of digital technologies and the increasing prominence of data as a factor of production, the connotation of digital-real integration has continuously expanded and deepened (Chen et al., 2022). Since the Chinese government's 2016 call to vigorously promote the deep integration of the internet and the real economy, digital-real integration has been consistently

elevated to a national strategic level. The 19th National Congresses of the Communist Party of China and subsequent plenary sessions have all made significant deployments in this regard, explicitly setting goals such as "promoting the deep integration of digital technology and the real economy" and "building internationally competitive digital industrial clusters" (Xia, 2023). The establishment of China's National Data Bureau further provides institutional safeguards for the coordinated management of data as a factor of production and for digital-real integration (National Data Bureau [NDB], 2025).

Previous studies have conducted extensive and in-depth research on digital-real integration, yielding fruitful results. Scholars have explored the essential connotation of digital-real integration from various perspectives, attempted to construct diversified measurement systems to quantify the level of digital-real integration, and empirically tested its multifaceted effects at the macro level (economic growth), meso level (industrial upgrading), and micro level (enterprise performance) (Chao, 2022; Huang & Gao, 2023; Shi & Sun, 2023). However, as a rapidly evolving and highly interdisciplinary field, existing literature still has some gaps. First, the understanding of the connotation of digital-real integration is not yet fully unified, with varying definitions from different disciplinary perspectives. Second, measurement methods are diverse but have not yet formed a widely accepted standard system; integration between macro, meso, and

micro-level measurements is needed. Third, while there is substantial research on the effects of digital-real integration, exploration of its internal transmission mechanisms, boundary conditions, and potential risks requires further deepening.

Given this, this paper systematically reviews and critiques existing research on digital-real integration, aiming to clarify the research trajectory, integrate existing knowledge, and provide useful references for subsequent theoretical innovation and empirical research.

The remaining structure of the paper is arranged as follows: Section 2 shows the main contents, systematically explains the rich connotations of digital-real integration from multiple dimensions, summarizes current mainstream methods for measuring digital-real integration, reviews the economic and social effects generated by digital-real integration from macro, meso, and micro levels, and proposes future research directions worth exploring based on the gaps of existing studies. Section 3 concludes.

Content

1. The Connotation of the Integration of the Digital Economy and the Real Economy

Digital-real integration is a composite concept with multi-layered and multi-dimensional connotations. From policy orientation and academic discussion, digital-real integration can be understood as a dynamic process. It takes data as the key factor of production, new-generation information and

communication technology as the core driving force, and is supported by digital infrastructure. It promotes the deep integration of digital technology into all factors, the entire industrial chain, and the entire value chain of the real economy, thereby realizing the digital, networked, and intelligent transformation of the real economy and fostering new industries, new business forms, and new models (Guo & Quan 2022; Chen, 2022). Specifically, scholars have deepened their understanding of the connotation of digital-real integration from the following perspectives.

1.1 The Perspective of Technology Diffusion and Innovation

This perspective emphasizes that the essence of digital-real integration lies in the process of innovation, diffusion, and application of digital technology (Yang, 2024). Digital technologies such as the internet, big data, artificial intelligence, and blockchain act as enabling technologies. By changing the ways of information connection and physical connection, they permeate all links of the real economy: R&D, production, distribution, sales, and service. This process is not merely a one-way application of technology but also involves the interaction and collaborative innovation between technology and specific industrial scenarios. The speed, breadth, and depth of digital technology innovation diffusion directly determine the level and quality of digital-real integration (Chao, 2022). For traditional industrial sectors, adopting and applying digital technology implies fundamental

changes in production processes, management models, business models, and even organizational structures (Hess et al., 2016; Huang et al., 2021).

1.2 The Perspective of Factor of Production Restructuring

The core of this perspective is elevating data to a key factor of production alongside land, labor, capital, and technology (Ouyang, 2022). Digital-real integration is not a simple technological add-on but a process driven by the circulation and value extraction of data as a factor. This process drives the reconfiguration and optimal combination of traditional production factors (such as capital and labor) (Xie & Xiao, 2022). Data, as a factor, possesses characteristics like non-rivalry, replicability, and ease of sharing. Its market-oriented allocation can effectively promote digital-real integration through cost effects, factor allocation effects, and technological innovation effects (Wang et al., 2024). The flow of data guides the flow of technology, capital, talent, and materials, connecting all links of production, distribution, circulation, and consumption. It is a new driver for the growth of the real economy (Jing & Chi, 2023).

1.3 The Perspective of Economic Structural Evolution

From the perspective of industrial economics, digital-real integration corresponds to the interaction between digital industrialization and industrial digitalization within the digital economy (Zhang & Zhang, 2025). Digital industrialization is the foundation,

providing technological, product, and service support for integration. Industrial digitalization is the main battlefield and the direct manifestation of the integration between the digital and real economies. It refers to the comprehensive, multi-angle, and whole-chain transformation and upgrading of traditional industries—agriculture, industry, and services—using digital technology (Yang, 2021). Digital-real integration fosters new business forms such as the platform economy, sharing economy, and intelligent manufacturing, pushing the industrial structure towards higher-level and more modernized stages (Du & Hu, 2023). This process also structurally reflects the transition of the economic form from an industrial economy to a digital economy.

1.4 The Perspective of Micro-level Agent Behavior

Enterprises are the main agents of digital-real integration. Some scholars describe the connotation of digital-real integration from the micro-enterprise perspective. From the micro level, digital-real integration is seen as the process of enterprise digital transformation (Xie et al., 2024). It requires enterprises to deeply embed digital technologies and data resources into their strategy, organization, operations, products, and services to achieve digital operation, business process reengineering, and value creation model innovation (Nambisan et al., 2017; Vial, 2019). This transformation is not merely technological application but also involves comprehensive changes in strategic thinking, organizational structure, corporate culture, and employee skills (Gregory et al.,

2021; Yang et al., 2021). Successful digital-real integration embodies the typical characteristics of innovation-driven, business integration, and data-driven approaches.

1.5 The Perspective of Systemic synergy

Digital-real integration is a complex systemic project and a dynamic process (Hong & Ren, 2023). It emphasizes the two-way interaction and co-evolution between the two systems of the digital economy and the real economy. On the one hand, the digital economy injects vitality and provides empowerment for the real economy. On the other hand, the real economy's actual demand, application scenarios, and industrial base, in turn, drive the innovation and iteration of digital technology (Wang et al., 2023). The integration process involves the synergy of multiple levels, including technology, data, business, market, and institutions. Its essence is the formation of a new techno-economic paradigm, accompanied by the coordinated adjustment of productive forces and production relations (Yang, 2025).

Reviewing existing research, it is evident that the connotation of digital-real integration is rich and multi-dimensional. It is simultaneously a technological process and a factor restructuring process; an industrial structural change process and a micro-organizational transformation process; it is also the penetration of the digital economy into the real economy and the synergistic symbiosis of the two economic forms. Scholars' explorations help deepen the

understanding of the multi-dimensional connotation of digital-real integration from various perspectives.

2. Measurement of the Integration of the Digital Economy and the Real Economy

Recently, accurately measuring the development level of digital-real integration have attracted scholars interests. Due to the complexity of the concept, the academic community has not yet formed a unified measurement standard. Overall, existing research has gradually developed the following types of measurement methods, mainly from macro, meso, and micro levels.

2.1 Macro-level Measurement Methods Based on Coupling Coordination and Industrial Linkage

These methods typically operate at the national or provincial level, treating the digital economy and the real economy as two subsystems. They construct indicator systems and use tools like the coupling coordination degree model, grey relational analysis, and input-output analysis to measure the level of synergistic development between them.

2.1.1 Coupling coordination degree model. This is one of the most widely used methods. Researchers first construct separate indicator subsystems to measure the development level of the digital economy (typically covering dimensions like digital infrastructure, digital industry scale, and digital technology application) and the real economy (typically covering dimensions like industrial scale, economic benefits, and innovation vitality) (Guo & Quan, 2022; Shi & Sun, 2023).

Then, methods like the entropy method or principal component analysis are used to determine indicator weights and calculate the development indices of the two subsystems. Finally, the coupling coordination degree model is introduced to calculate the integration degree.

This method can effectively reflect the degree of interdependence and synergistic development between the two subsystems and allows for staging based on coordination levels. For example, studies have shown that China's overall digital-real integration level is rising, but with significant regional disparities, with coastal eastern regions generally having a higher degree of integration than central and western regions (Guo et al., 2025; Chao et al., 2025).

2.1.2 Input-Output Method. Based on input-output tables, this method calculates the degree of industrial linkage or integration by analyzing the intermediate product input relationships between the digital economy sector and the real economy sector (Wu & Li, 2023). For instance, it might calculate the proportion of digital technology products and services as intermediate inputs in the total input of traditional industries or analyze the consumption coefficients of traditional industries on the output of the digital industry. This method can reveal the structural characteristics of integration from a techno-economic perspective of industrial linkage. However, its limitations include the long update cycle of input-output tables (typically every five years), poor timeliness

of data, and certain difficulties in delineating sectors within the digital economy.

2.1.3 Grey Relational Analysis.

This method is used to analyze the geometric similarity between the indicator sequences of the digital economy and the real economy. A higher degree of relationality indicates more synchronized development trends and a closer integration relationship (Wu & Zhang, 2022). This method does not require large data samples but focuses more on trend correlation analysis, offering less precise depiction of the absolute level of integration compared to the coupling coordination degree model.

2.2 Meso-level Measurement Method of Technological Integration Based on Patent Citations

This method starts from the micro-mechanism of technological integration and uses patent data to measure the degree of blending between digital technology and traditional industrial technology. Its core logic is: if a digital technology patent is cited by a patent from a non-digital industry (i.e., the real economy sector), it indicates that the digital technology has diffused and been applied in the real economy, forming integration at the technological level (Huang & Gao, 2023). Specifically, researchers first need to classify patents by industry, distinguishing between “digital technology patents” and “non-digital technology patents” (usually based on International Patent Classification [IPC] codes or industry correspondence). Then, a patent citation network is constructed, and the

quantity, proportion, or intensity of citations of digital technology patents by non-digital industry patents serves as a proxy variable for digital-real technological integration (Guo et al., 2025; Cao & Yue, 2024). This method can depict the depth and breadth of integration from the source of innovation, offering objectivity and traceability. It is particularly suitable for studying the impact of technological integration on enterprise innovation performance and total factor productivity (Huang & Gao, 2023; Shi et al., 2025). However, its limitation lies in the fact that patents primarily reflect technological activities at the invention level and cannot comprehensively cover the process of technology adoption and diffusion. It also overlooks non-technological dimensions of integration, such as management and business models.

2.3 Micro-level Enterprise Assessment Methods Based on Questionnaires and Scales

Enterprises are the ultimate carriers of digital-real integration, and their level of digital transformation directly reflects the degree of integration at the micro level. Therefore, many studies use enterprise-level digital transformation indicators to measure digital-real integration.

2.3.1 Using textual data as proxy variables. This approach uses relevant indicators from publicly available enterprise data as proxies for digital transformation. Examples include: the proportion of investment related to digital technology in total investment

(Zhang & Zhang, 2025), the proportion of IT personnel, digital-related expenditures in R&D investment, and the frequency of digital-related vocabulary in textual analysis of listed companies' annual reports (Li, 2022). This method facilitates data acquisition and is suitable for large-sample empirical research.

2.3.2 Comprehensive evaluation scale method. This involves designing systematic questionnaires to directly measure an enterprise's digital development level across multiple dimensions. This is often the main method used by official agencies or industry associations for diagnostic evaluation. For example: The "Top 100 Digital-Real Integration Enterprises Development Report" released by the China Enterprise Evaluation Association constructs an evaluation system from three dimensions: entity nature (operation, growth, efficiency), technological nature (integration, innovation), and ecological inclusiveness (technology spillover, supply chain/industrial chain empowerment, corporate social responsibility). The "Evaluation Indicators for the Digitalization Level of Small and Medium-sized Enterprises (2024 Edition)" issued by China's Ministry of Industry and Information Technology sets evaluation indicators across four dimensions for manufacturing: digital foundation, operation, management, and effectiveness to assess the degree of digital-real integration.

Reviewing existing research, it is evident that the established measurement methods for digital-real integration each have their focus and complement each other.

Macro-level measurement methods are convenient for grasping the overall situation and spatial pattern; the meso-level patent method excels at revealing the internal mechanism of technological integration; and micro-level enterprise assessments can deeply analyze integration behaviors and performance. Overall, the current methods for measuring digital-real integration can be categorized into three mainstream types. Their core characteristics are compared in Table 1.

Table 1 A Taxonomy of Mainstream Measurement Methods for Digital-real Integration

Analytical Level	Core Logic & Focus	Typical Methods	Primary Data Sources	Strengths & Limitations
Macro	System Synergy: Measures the overall coordinated development level between the digital and real economic systems.	Coupling Coordination Model Input-Output Analysis Grey Relational Analysis	Regional Statistical Yearbooks Input-Output Tables Composite Indicators	Strengths: Captures overall trends and spatial patterns. Limitations: Struggles to reveal micro-mechanisms; data timeliness can be low.
Meso	Technology Convergence: Measures the blending of digital and traditional industry technologies through knowledge flows.	Patent Citation Network Analysis	Patent Databases	Strengths: Objective, traceable; reveals fusion at the innovation source. Limitations: Scope limited to patenting activity; ignores non-technological fusion.

Table 1 A Taxonomy of Mainstream Measurement Methods for Digital-real Integration (Cont.)

Analytical Level	Core Logic & Focus	Typical Methods	Primary Data Sources	Strengths & Limitations
Micro	Enterprise Transformation: Assesses the digitalization process and level of firms as the primary carriers of integration.	Surveys & Scales Textual Analysis Digital Investment Indicators	Enterprise Survey Data Listed Firms' Reports & Filings Commercial Databases	Strengths: Reveals firm-level behavior-performance links; fine-grained data. Limitations: Large-scale surveys are costly; proxy variables may lack precision.

2.4 The Difference between the Digital Economy and the Real Economy

The digital economy is an economic system driven by digital technology, with key components including digital infrastructure, e-business, and e-commerce. It takes data as a core production factor and relies on Information and Communication Technologies (ICT) such as cloud computing, big data, and artificial intelligence to reshape economic activities (Goldfarb & Tucker, 2019). As defined by the G20, the digital economy uses digitized information as critical input and modern networks as important carriers, featuring high permeability, network effects, and cross-border operation (Luo, 2025).

The real economy, by contrast, refers to actual production that generates goods and services, impacting employment and the well-being of the population. It consists of material and service-producing sectors such as agriculture, manufacturing,

and consumer services, based on physical resources and offline production processes (Yang, 2023). As the material foundation of the national economy, the real economy creates tangible use-value and stabilizes employment and livelihoods (Farooq, 2017).

The two systems differ in production factors, operational carriers, and value creation mechanisms, yet they are complementary: Digital technologies empower the transformation of the real economy, while the real economy provides the practical foundation for the digital economy (Xu et al., 2021).

3. Effects of the Integration of the Digital Economy and the Real Economy

As a key driver of economic development, the economic and social effects generated by digital-real integration have attracted much scholarly attention. From the existing research, this paper synthesizes these effects into three progressive tiers:

macro-economic growth, meso-industrial transformation, and micro-enterprise empowerment (Figure 1). The following

sections will review the specific effects at each of these levels in detail.

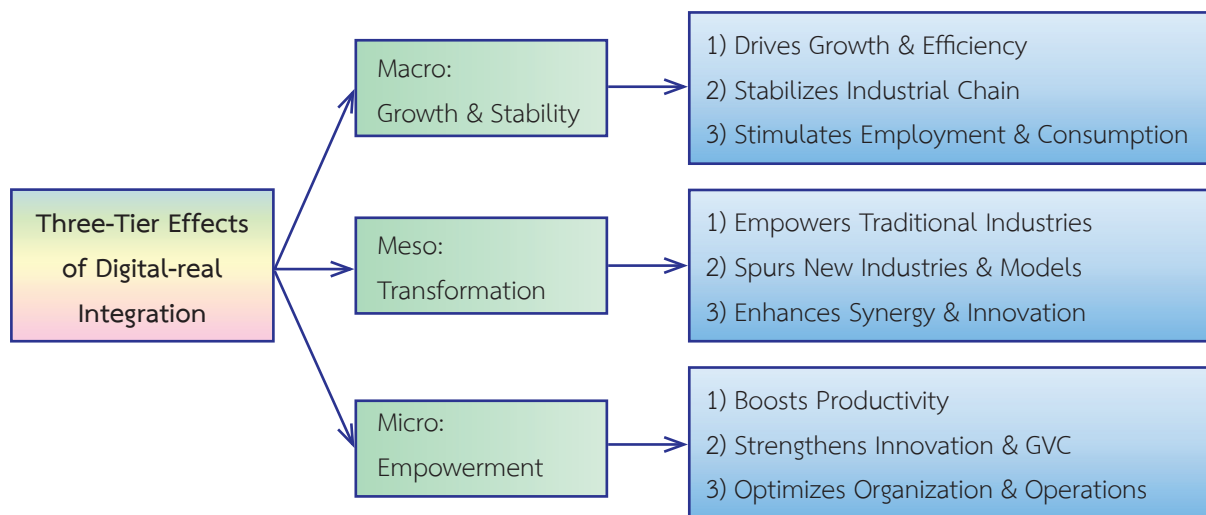


Figure 1 The Multi-level Effects of Digital-real Integration

3.1 Macro-economic Growth Effects

A large body of research confirms that digital-real integration has a significant positive effect on promoting high-quality economic development.

3.1.1 Driving economic growth and efficiency improvement. Digital-real integration injects new momentum into economic growth through channels such as optimizing factor allocation, enhancing Total Factor Productivity (TFP), and stimulating innovation vitality (Qi et al., 2024; Zhang et al., 2024). The deep application of digital technology and data factors can reduce transaction costs, improve matching efficiency, and expand market boundaries, thereby releasing economic growth potential (Ding, 2020).

3.1.2 Stabilizing industrial and supply chains. Integration helps build agile, intelligent, and flexible production networks, enhancing the resilience and security of industrial and supply chains. Supply chain visualization and intelligent management empowered by digital technology can effectively respond to uncertainty shocks (Kuang & Peng, 2020).

3.1.3 Promoting employment and income. Although existing research indicates that the adoption of digital technology impacts the employment structure (e.g., replacing some repetitive labor), most studies believe that digital-real integration, on the whole, creates more high-quality jobs, particularly increasing demand for high-skilled talent, and may indirectly drive wage growth by improving labor productivity (Shi et al., 2025).

3.1.4 Stimulating consumption and expanding domestic demand. New business forms emerging from integration, such as e-commerce platforms, live-streaming commerce, and personalized customization, create new consumption scenarios, improve convenience and experience, and have become an important force in expanding domestic demand.

3.2 Meso-level Industrial Transformation and Upgrading Effects

Digital-real integration is a key force in pushing industries towards the mid-to-high end and successfully achieving transformation and upgrading.

3.2.1 Empowering traditional industries to transform and upgrade. Digital technology enables the comprehensive transformation of manufacturing, agriculture, and services, driving them towards digitalization, networking, intelligence, and greening (Du & Hu, 2023). For instance, in manufacturing, technologies like industrial internet and digital twins promote the transition of production models towards flexible manufacturing, agile manufacturing, and service-oriented manufacturing.

3.2.2 Fostering new industries, business forms, and models. Research indicates that digital-real integration has given rise to emerging industries such as the platform economy, sharing economy, intelligent economy, and data services, as well as new business forms and models like industrial internet platforms, personalized customization, and intelligent operation and maintenance

services. In the cultivation and development of emerging industries, data factors can permeate all stages of reproduction, transforming traditional business models into digital ones, optimizing business processes in the real economy, and promoting the upgrading of the real economy's industrial structure (Zhou & Shi, 2023).

3.2.3 Enhancing industrial synergy and innovation efficiency. Digital platforms promote knowledge sharing and technological collaboration across enterprises and industries, accelerate innovation diffusion, and form networked innovation ecosystems. The circulation and application of data factors enable enterprises to more precisely identify market demand and drive product and service innovation (Ghasemaghahi & Calic, 2019).

3.3 Micro-level Enterprise Empowerment Effects

Digital-real integration profoundly changes enterprises' operational models and competitive capabilities. Understanding its impact on enterprise production and development from a more micro perspective is a key area for scholars studying the effects of integration. Reviewing existing research, from the perspective of enterprise empowerment, scholars have demonstrated and revealed the following three-dimensional effects of digital-real integration.

3.3.1 Improving enterprise total factor productivity and new quality productive forces. Empirical studies show that higher degrees of enterprise digital transformation or technological integration are usually associated

with Higher Total Factor Productivity (TFP) (Huang & Gao, 2023). This is primarily due to benefits from process optimization, refined management, scientific decision-making, and enhanced innovation capabilities (Liu et al., 2025).

3.3.2 Enhancing enterprise innovation capability and position in the value chain. Digitalization empowers enterprises in R&D design, process optimization, and business model innovation, helping them climb to higher value-added segments of the Global Value Chain (GVC) (Zhang et al., 2025). Data-driven precision R&D and rapid iteration have become new sources of core competitiveness.

3.3.3 Optimizing enterprise organization and operational management. Digital-real integration pushes enterprise organizational structures towards flatter, more networked forms, improving internal communication and collaboration efficiency (Li et al., 2022). Real-time analysis and intelligent decision-making based on data significantly enhance the precision and responsiveness of operational management.

Overall, existing research on the effects of digital-real integration has yielded fruitful results, generally affirming its positive value. However, the following aspects still require attention: First, effect heterogeneity. Integration effects may vary significantly across different industries, enterprise sizes, and regions; the underlying conditions and mechanisms need in-depth

analysis. Second, non-linear relationships and threshold effects. The relationship between the level of integration and performance improvement may not be simple and linear; there may thresholds. Third, potential risks and challenges. While emphasizing positive effects, research has paid relatively less attention to potential risks such as the widening digital divide, market monopoly, data security, structural employment contradictions, and shocks on traditional industries.

3.4 Summary of Digital-Real Integration

This involves leveraging technologies such as All-Inclusive, Big Data, IoT, and Cloud to enhance production, marketing, and consumption in the industrial, agricultural, and service sectors. The goal is to increase efficiency, reduce costs, and create added value for businesses. It integrates data as a core factor to reshape industrial chains and optimize resource allocation (Goldfarb & Tucker, 2019). This two-way empowerment drives industrial upgrading and new quality productivity, supporting sustainable economic development (Zhang et al., 2026).

4. Research Outlook

Although current research on digital-real integration has made significant progress, as a burgeoning field, there are still many areas worthy of in-depth exploration. Based on the review of existing literature, this paper believes the following aspects require further deepening in the future.

4.1 Deepening Research on the Micro-level Mechanisms of Digital-Real Integration

There is a need to deeply analyze the internal micro-mechanisms of digital-real integration. Existing research has focused more on the macro effects and meso-level pathways of integration, but exploration of the micro-level intrinsic mechanisms—where integration occurs remains insufficient. Future research should delve into the enterprise, organizational, and even individual levels to dissect the specific mechanisms of action in digital-real integration.

On one hand, research should focus on the organizational change and adaptation mechanisms induced by digital technology. Digital technology is not merely a tool; it triggers profound changes in organizational structure, power relationships, workflows, and corporate culture (Hess et al., 2016). Future research needs to reveal: How does organizational structure evolve from hierarchy to platform-based and networked forms during digital-real integration? How does the digital skills gap between management and employees affect integration outcomes? How do organizational learning mechanisms adapt to rapid technological iteration? On the other hand, attention should be paid to behavioral and cognitive mechanisms at the individual and team levels. Digital-real integration is ultimately realized through human action. Research should focus on employees' acceptance and effective use of digital technologies and their impact on

job satisfaction; collaboration patterns and innovation performance of teams supported by digital tools; and the composition and development path of leaders' digital leadership. Clarifying these micro-mechanisms will help enterprises formulate precise integration strategies and provide a micro-level basis for policy design, thereby solidifying the micro-foundations of digital-real integration.

4.2 Innovating and Integrating the Measurement Method System for Digital-Real Integration

Digital-real integration is a dynamically evolving process, while existing measurements are mostly based on static cross-sections or short panel data. Future efforts should explore the use of high-frequency big data to advance research towards refinement, dynamism and multi-sourcing. First, develop more refined industry and scenario-specific measurement indicators. The patterns of digital-real integration differ greatly across industries (e.g., manufacturing vs. services), necessitating the construction of measurement systems with greater industry specificity. Second, develop high-frequency, dynamic tracking and early warning indicators. Break through the limitations of relying on yearbook data and static cross-sections. Actively utilize high-frequency big data such as enterprise cloud service usage data, platform transaction data, and cloud service API call logs to construct real-time monitoring indicators like the digital-real integration activity index or technology diffusion heat map, enabling dynamic characterization of the integration process and trend warnings.

4.3 Clarifying the Complexity and Boundary Conditions of Digital-Real Integration Effects

Future research should move beyond simple judgments of “whether it is effective” to deeply explore the complexity of the effects. First, strengthen heterogeneity analysis. Systematically study the differences in integration effects across enterprises with different ownership structures, at different lifecycle stages, and with different resource endowments, as well as their manifestations under different regional and industrial policy environments. Second, identify non-linear relationships and threshold effects. Use methods like threshold models and quantile regression to test whether there are optimal intervals or critical points for integration effects. Third, pay attention to potential negative impacts of digital-real integration. Conduct in-depth research on potential negative effects such as the digital divide, technological unemployment, data monopoly, privacy breaches, and industrial chain risk concentration, along with their governance.

4.4 Exploring Governance Systems and Policy Optimization for Digital-Real Integration

The development of digital-real integration is inseparable from effective governance. Future research should focus on: First, the institutional design for the market-oriented allocation of data factors. This includes innovative research on key systems such as data property rights definition,

circulation and transaction rules, benefit distribution mechanisms, and security and privacy protection. Second, new regulatory systems adapted to digital-real integration. Such as, how to implement agile and collaborative regulation on new business forms like the platform economy and algorithm applications, balancing innovation incentives and risk prevention. Third, evaluating the effectiveness of existing industrial policies, science and technology policies, and talent policies in promoting digital-real integration, and proposing targeted, differentiated policy optimization recommendations. Fourth, researching how institutional innovation can guide digital technology to penetrate the real economy, especially key weak links in micro, Small and Medium Enterprises (MSMEs) and traditional industries.

Conclusions

Digital-real integration has emerged as a core engine for high-quality economic development and a new focus of global competition. Integrating the digital economy and real economy leads to higher efficiency in the manufacturing and service sectors, reducing operating costs through the use of IoT, PL, and Big Data, creating new businesses, expanding digital employment opportunities, and driving sustainable growth.

This review has systematically examined the burgeoning field of digital-real economy integration research. By tracing its policy evolution and theoretical underpinnings,

dissecting its multi-faceted connotation, evaluating prevailing measurement approaches, and synthesizing evidence on its macroeconomic, industrial, and micro-enterprise effects, the paper provides a consolidated foundation for understanding this critical domain of contemporary economic transformation.

The analysis reveals that digital-real integration is far more than a simplistic technological overlay. It represents a profound, multi-dimensional process encompassing technological diffusion, factor restructuring (with data as a new key input), structural economic evolution, enterprise-level behavioral transformation, and systemic synergy. This complexity is mirrored in the diverse, yet often siloed, measurement methodologies. While macro-level coupling coordination models map broad spatial patterns, meso-level patent citations uncover technological fusion, and micro-level surveys assess organizational digital maturity, a truly holistic, dynamic, and diagnostic measurement framework remains an urgent scholarly need. The reviewed literature overwhelmingly affirms the positive contributions of integration towards economic growth, industrial upgrading, and enterprise empowerment. However, a more nuanced understanding is required, acknowledging potential heterogeneities, non-linearities, and the significant governance challenges posed by issues like data rights, market concentration, and the digital divide.

Looking ahead, the research agenda must pivot towards greater depth and integration. Future efforts should prioritize unveiling the “black box” of micro-mechanisms—how data flows and creates value within firms, how organizations adapt structurally and culturally, and how individuals and teams interact with new technologies. Concurrently, constructing a next-generation measurement system that is theory-informed, multi-layered, leverages multi-source data, and enables real-time tracking and predictive analysis is paramount. Scholars must also rigorously investigate the conditional boundaries and potential downsides of integration effects, moving beyond blanket assertions of benefit. Finally, designing agile, effective governance frameworks and evidence-based policies will be crucial to steer this integration towards inclusive, sustainable, and secure outcomes. By advancing on these interconnected fronts, academic research can provide the robust insights needed to harness the full potential of digital-real integration for fostering new quality productive forces and achieving high-quality development in China and beyond.

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Name and Surname: Ruiwen Liao

Highest Education: PhD Candidate, Panyapiwat Institute of Management

University or Agency: International Chinese College, Panyapiwat Institute of Management / School of Finance and Insurance, Guangxi University of Finance and Economics, China

Field of Expertise: Business Administration, Enterprise Economics, and Digital Economy