



Crossing Boundaries: How the Digital Economy is Reshaping the Innovation Path of the Real Economy — A Literature Review

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Abstract. A purpose of this paper is to explore the enabling role of the digital economy on the development of the real economy, and systematically sort out the conceptual definition of the digital economy, the measurement method and its impact mechanism on the real economy through the literature review method. It is found that the digital economy, as an emerging economic form, significantly promotes the innovation ability of enterprises by improving the supply and use efficiency of R&D funds. In addition, the digital economy also has a profound impact on the real economy by optimizing resource allocation and reshaping traditional industries. The article further analyzes the current situation of the integration of the digital economy and the real economy, pointing out that the integration of the two not only promotes the digital transformation of industries, but also provides impetus for the construction of a new development pattern.

Keywords: digital economy, real economy, digital-substantive fusion, new development paradigm.

1 Introduction

The digital economy, an evolution of the information economy, has emerged as a sustainable model for advancing global economies, attracting significant interest across sectors. As the world's second-largest economy, China is in an advanced stage of industrialization and must expedite its digital transformation. Recognizing the upward trajectory of the digital economy, China has focused on enhancing strategic initiatives. President Xi Jinping has called for accelerating the integration of the digital and real economies and establishing globally competitive digital sector clusters. By the end of 2022, China's digital economy was valued at 50.2 trillion yuan, reflecting a 10.3% annual growth and a 2.22-fold increase since 2016. The convergence of big data, the Internet, 5G, and digital technologies has significantly accelerated industrial digitization, with 2022's industrial digitization reaching 41 trillion yuan. During this period, the share of industrial digitalization in the digital economy rose from 77% to 81.7%, un-

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derscoring the digital industry's role in enhancing the real economy. This paper examines the integration of digital and real economies, focusing on various sectors, including the new energy industry, during the digital transformation. It explores emerging areas and potential risks of the digital economy, summarizing its impacts and pathways for improving the real economy. Furthermore, it proposes rational policies and development strategies for the digital transformation of the real economy to achieve comprehensive economic and social progress and high-quality development, ultimately aiming to enhance the overall efficacy of finances and society.

2 About Digital Economy

2.1 The Concept of the Digital Economy

In 1996, Tapscott coined the term "digital economy." According to Tapscott, this concept demonstrates the knowledge economy, signifies a novel form of economic progress and indicates future trends [1]. Despite its frequent mention in literature and research, the "digital economy" concept has not yet gained widespread recognition in the academic sphere. The academic concept of digital economics can be classified into two significant groups: narrow sense and broad sense.

The Narrow Definition of Digital Economics. The narrow definition of digital economics primarily focuses on information and communication technology (ICT) and specific industries that have been digitized. The growth of digital-related industries due to the evolving Internet has led international organizations and government statistics departments to pay close attention to digital economics. The 2018 paper "Definition and Measurement of the Digital Economy" by the international organization BEA incorporated the conceptual framework of the OECD for the first time. The digital economy is defined by the manufacturing method of the ICT industry and is classified into three groups: digitally facilitated structures, electronic commerce, and online media [2]. In June 2021, China's National Bureau of Statistics (NBS) published the "Statistical Classification of the Digital Economy and its Core Industries (2021)". This article divides the digital economy into five distinct groups: digital production, digital goods and services, technological uses, digital factor-driven businesses, and digital efficiency development [3], these classifications provide an organized structure for analyzing the digital economy. The narrow definition can delineate the scope of the digital economy with a high degree of operability and ensure that the digital economy has a transparent and independent status.

The Broad Definition of Digital Economics. The digital economy is an emerging economic structure that encompasses a wide range of economic activities that arise from the widespread integration of digital technology into the economy and society. At the G20 Hangzhou Summit in 2016, China has implemented the Group of Twenty (G20) Digital Economy Development and Cooperation Initiative. This meeting offers a legal definition of the digital economy as activities that mainly depend on digitized

knowledge and information as the key inputs for production [4]. According to the OECD (2017), the digital economy is defined by a dynamic digital transformation process affecting economic and social development [5]. Subsequently, China made it clear in its 2022 Digital Economy White Paper that digital economy includes digital economization and economic digitization, where digital economization is embodied in the industrialization of the digital, and economic digitization is mainly embodied in the digitalization and transformation of industries [6]. The broad definition of the digital economy has emphasized the importance of digitalization of the economy and the extensive influence of digital technology, as a versatile technology, on all economic operations.

2.2 Quantification of the Digital Economy

Research Conducted by Reputable Organizations. International authorities employ several common ways to evaluate the digital economy, including value-added assessment, comprehensive evaluation index measurement, and integration of the production method with the KLEMS framework.

The value-added measure is mainly utilized in the United States. In 2018, The Bureau of Economic Analysis (BEA) has described the digital economy as technological infrastructure, electronic commerce, and digital media [2]. The objective was to evaluate the magnitude of the U.S. digital economy by examining value-added and net revenue through the analysis of supply-use charts.

The Organization for Economic Co-operation and Development (OECD) has constructed the Digital Sector and Society Index (DESI), a comprehensive evaluation of the digital sector. It includes broadband access, human capital, Internet use, the provision of digital services to the public, digital innovation, and the integration of technical advancements by enterprises[7].

The KLEMS framework measurement method, in conjunction with the manufacturing method, is extensively employed in China. In about 2017, China published a White Paper on the Development of China's Digital Economy [8]. The research study divided the digital economy into digital industrialization and industrial digitization. The digital industrialization component measures the value added by relevant industries by directly aggregating their production. The industrial digitization component estimates the growth in output and efficiency improvement resulting from integration using the KLEMS framework and then calculates the total digital economy of traditional industries.

Academic Research. Furthermore, scholars have methodically developed and enhanced measurement techniques for the digital economy, considering various research viewpoints and adhering to the established measurement procedures of authoritative organizations. Cai Y builds upon previous research and introduces the concept of "contribution degree" to quantify digital economics' substitution effect and penetration effect in the value-added measurement method [9]. However, Zhang T utilizes the input-

output model and adheres to the most recent statistical classification criteria to comprehensively calculate the value added by the digital core industry during the intervening years [10]. Creating indicators to quantify the digital economy follows similar principles, but there are notable variations in data sources and indicator selection.

Satellite Accounts for the Digital Economy. The concept of satellite accounts was introduced by SNA in 1993 to provide a comprehensive overview of specific activities that cannot be fully described within the central framework [11]. In 2003, the Australian Bureau of Statistics (ABS) pioneered the world's first ICT satellite account. In 2018, Nadim Ahmad and Jennifer Ribarsky from the OECD's Statistics Division put up a detailed accounting framework for the digital economy [12]. This framework categorizes digital products, services, and industries and establishes a structure for digital economy satellite accounts. Several experts have analyzed OECD research and explored the creation of digital economy satellite accounts through various core tabulations. In their 2019 study, Xiang S and Wu W developed a framework diagram for China's digital economy accounts, which focuses on digital economy flow accounting and digital economy stock accounting [13]. Luo L studied convergence and developed five tables representing aspects of the digital economy, covering supply, utilization, investment, employment, and free Internet services [14].

3 Advancements in the Study of the Real Economy

3.1 The Notion of the Real Economy

During its initial development phases, Western economics classified the real economy as a conceptual economic system that aligns with the nominal, financial, and monetary economy. Academic research on the real economy is well-funded and similar. In response to the 2008 economic crisis, the Federal Reserve redefined the real economy to exclude real estate and the financial sector. It now refers to the remaining sectors, such as manufacturing, retail trade, agriculture, import, and export. Based on this premise, He Z, Wei W offers a more precise definition, stating that the real economy refers to economic activities that directly participate in and contribute to the production, distribution, exchange, and consumption of physical goods and services. However, it excludes the finance industry and virtual assets [15].

3.2 The Measurement of the Real Economy

When considering earlier empirical studies, it is evident that scholars predominantly utilize direct or indirect measuring methods to assess the economy.

The direct measurement approach relies on assessing the defined measurement range, directly analyzing macroeconomic indicators, or measuring their value-added. It also involves using statistical share ratios and other mathematical methods to estimate the amount of the regional real economy. For example, Xie T utilized the new urban

fixed asset investment (INV) as a metric to gauge the level of development in the real economy [16].

The indirect measuring approach relies on constructing a comprehensive measurement index system. This system calculates the relative level of digital economic progress between regions by weighting pertinent statistical data. For example, Ding S assess the progress of the real economy using four dimensions: economic efficiency, industrial structure, innovation and development, and green ecology [17].

4 Research on the Integration and Advancement of the Digital and Physical Economies

4.1 Quantification of the Integration of Numbers and Reality

During the initial phases of the digital economy's expansion, "digital and real integration" had not yet been introduced. At this point, the academic community primarily focused on examining the transformation and enhancement of the real economy through integrating industrialization and informatization. Gong B developed an evaluation index system which considers the integration level, environment, and economic benefits as critical factors. By using this system, the integration of informatization and industrialization can be effectively evaluated [18]. Zhang Y et al. conducted a detailed analysis of the level of integration using the complex system coordination model [19].

Academics now commonly use the concepts of "digital-real integration" and various measurement models to assess the level of integration and development between the digital economy and the real economy. These models include coupled measurement models [20], gray correlation models [21], and the Input-Output Method [22]. Furthermore, researchers are currently conducting empirical studies to explore the integration of the digital and real economy from many angles. Yang W employed the entropy value method to examine the extent of digital transformation in China's industries, focusing on the economic advantages of industrial digitization and factor input indicators [23].

4.2 The Impact of Digital Economy on the Real Economy

Data is the core component of the digital economy, with the real economy acting as its primary data provider and platform. To realize data value, it must be integrated with the real economy. This study analyzes the impact of the digital economy on the real economy from various perspectives.

Derived from an Analysis Considering Three Different Industries. Agriculture is a primary industry that holds a fundamental and strategic position. It serves as a crucial area for boosting the digital economy. Through the coordination of scholarly study, it has been determined that the digital economy improves the effectiveness of technological advancements in the manufacturing of rural industries [24]. According to Tian X, it enhances the speed at which digital production is created, circulated, distributed, and

consumed [25]. The phenomenon has a substantial influence on the financial earnings of farmers and the alleviation of poverty [26]. It has a beneficial impact on driving progress and has become a powerful force for promoting the agriculture sector.

Manufacturing is a vital element of the secondary sector, plays an important part in advancing technical progress, creating jobs, and enhancing worldwide competitiveness in contemporary industrial countries. The digital economy has a substantial impact on the manufacturing business. It enhances technological complexity [27], optimizes regional capital allocation [28], improves the investment productivity of businesses and upgrades the skill level of the labor force [29]. These factors have positive impacts and contribute to the development and transformation of the manufacturing industry.

As a tertiary sector, the service industry exhibits the highest level of integration with the digital economy. The digital economy can enhance the growth of highly skilled workers, increase the effectiveness of technical advancements [30], and optimize the structure of the service sector [31]. Additionally, it enhances the overall arrangement of new information infrastructure, broadening the growth potential of the digital service sector [32] and thus achieving prolonged expansion of the service industry.

By the Viewpoint of the Emerging Energy Sector. The emerging energy sector, serving as a vital vehicle for the environmentally-friendly revolution of the worldwide economy, is currently at a crucial phase of advancement. Huang G et al. assert that the new energy industry plays a crucial role in the digital era [33]. Information technology, artificial intelligence, and other digital tools have the potential to enhance supply and demand management control and optimize the operational performance of the energy industry [34]. Renewable energy plays a crucial role as a production factor in the energy business. Digital technologies can be used to manage the stock and monitor the consumption of renewable energy [35]. According to the International Energy Agency (IEA) in their World Energy Outlook 2017 report, the text states that digital technology will speed up replacing traditional energy sources with renewable energy by intelligently optimizing system operations, conducting real-time infrastructure testing, and improving the flexibility of energy storage [36].

From a Governmental Standpoint. The government's capacity for macro-control and policy guiding profoundly influences the progress of the actual economy. Driven by the expansion of the digital economy, government has led to the acceleration of demand-based services, intelligent decision-making, social-oriented regulation, and social-oriented regulation and other directions [37]. This integration is beneficial for enhancing the government's macro-control ability and promoting the economy's development of superior quality [38]. Furthermore, from a financial perspective, it has been noted that using digital technology to collect and disseminate information can enhance the social system for disclosing information. It can also address the information imbalance between the supply and demand of credit [39].

The Consumer-based Perspective. Consumption is a vital factor in driving the expansion of China's actual economy. Combined with scholars' research, it has been found

that during the age of the digital economy, marketing methods such as webcasting have come into being, coupled with the information collection and dissemination capabilities of digital technology, are conducive to guiding decision-making on the supply and demand side [40], accelerating the shaping of new market operation and consumption patterns, stimulate the consumption potential of users and help upgrade the consumption structure [41]. Simultaneously, emerging consumption patterns like virtual currencies and inter-period consumption facilitated by digital consumption platforms can give rise to issues such as the unauthorized disclosure of personal information [42], which can dampen users' enthusiasm for consumption and impede the economic progress.

Drawing from Alternative Viewpoints. The real economy has steadily developed, while the digital economy has emerged as a more advanced form, driving reforms in the real sector. However, this growth is constrained by the real economy's primary conditions. Consequently, the interaction and integration between the digital and real economies has become a research hotspot. At the impact level, scholars Jiang S conducted a comprehensive analysis using the cross-sectional threshold model to examine the digital economy exhibits a certain level of crowding out effect while also promoting the progress of the real economy [43]. At the fusion level, Zhang K examines the fundamental requirements for integrating and advancing the digital economy and the real economy. He analyzes the essential factors that contribute to the integration and development of both sectors, as well as the key factors that drive the integration of the two [44].

5 Provide a Concise Overview

Comprehensively examining the current state of research, empirical research on “digital and real integration” to enable high-quality economic development is relatively rich, through the combing and analysis of the existing literature can be concluded:

Academics vary in their interpretation of the digital economy and the methodologies used to account for it. Current digital economy accounting studies are often based on various conceptual frameworks.

The investigation of the digital empowerment engine has garnered considerable interest as a research topic in recent years. The research primarily focuses on studying the effects of the digital economy on economic growth. However, additional improvements are necessary for the studies about the correlation between the digital economy and advancements in the real economy.

The majority of the research concentrates on analyzing certain locations or the overall magnitude. However, the level of investment in the progress of both the digital and physical economies and their integration and coordination in each province and region is comparatively restricted. In future studies, we should provide a more comprehensive understanding of the overall State of China's digital economy development, considering its continuous development and mutual influence.

Today, The digital and physical economies are key drivers of economic progress. The rise of the digital economy aligns with current trends, while revitalizing the physical economy is essential for efficiency. Thus, examining their interdependence and integration is vital for achieving high-quality economic growth.

6 Conclusion

In this literature review, we examine the transformative impact of the digital economy on the innovation pathways of the real economy. A synthesis of existing research indicates that the digital economy acts as a catalyst for innovation, enabling traditional industries within the real economy to adopt new technologies, optimize operations, and enhance competitiveness.

In terms of definition and measurement, the development of definitions and metrics for the real economy is relatively mature, while the delineation of the digital economy remains an evolving concept. Measurement methods for the digital economy include value chain analysis, digitalization indices, and assessments of corporate digital transformation levels. These tools provide a more comprehensive reflection of the impacts of the digital economy. Future research should further investigate the effectiveness of various measurement methods to ensure accurate decision-making support for policymakers and business managers.

An exploration of the mechanisms through which the digital economy influences the real economy reveals that digital tools and platforms not only facilitate the emergence of new products and services but also drive significant changes in business models and processes. The integration of big data analytics, artificial intelligence, and Internet of Things (IoT) technologies is crucial for fostering an innovative culture within traditional enterprises. Furthermore, our analysis highlights the importance of collaborative ecosystems, where partnerships between digital and traditional firms can yield synergistic benefits and accelerate innovation cycles.

However, this transition is not without challenges. Issues such as digital literacy, cybersecurity, and the need for regulatory frameworks remain critical barriers that must be addressed to fully harness the potential of the digital economy. Additionally, disparities in access to digital resources can exacerbate inequalities, underscoring the necessity for inclusive policies that promote equitable innovation.

Overall, this review emphasizes the importance of understanding the interrelationship between the digital economy and the real economy as a holistic construct. Future research should continue to investigate the dynamic relationships between these two domains, focusing on case studies that exemplify successful integration strategies and their long-term implications for sustainable economic growth.

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