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Digital Economy Empowers Corporate Green Productivity: A Literature Review

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Abstract

The ongoing revolution in science and technology has given rise to the digital economy, an innovative economic form that is increasingly vital as a driving force behind the expansion of green productivity. This study seeks to review the current state of research on the digital economy and its relationship with green productivity, thereby offering a foundation and orientation for future investigations in this field. Based on the relevant literature from 2014 to 2024 in the CNKI and Web of Science databases, this study systematically collates the core research results in the fields of the digital economy and green productivity. While substantial research exists on digital economy-green development correlations, scholarly focus on green productivity per se remains underdeveloped, with particularly limited empirical investigation into how digital economic activities specifically influence green productivity metrics. Building on an analysis of contemporary contexts and existing literature, this paper identifies gaps in current scholarly discussions and proposes novel avenues for future research into how the digital economy shapes corporate green productivity.

Keywords

Digital Economy; Green Productivity; Bibliometric Analysis; Citespace.

1. Introduction

The evolving global economic landscape has increasingly positioned sustainable development and environmental stewardship as universally shared objectives. Green transformation is now emerging as a defining trend within the latest wave of technological advancement and industrial restructuring. As a form of sustainable productivity that integrates the ecologicalization of productivity and the productivity of ecologicalization, green productivity is exactly what countries and enterprises strive to pursue and maintain. Within this framework, the digital economy has emerged as a transformative economic paradigm born from the latest technological revolution and industrial evolution, now serving as a crucial catalyst for worldwide industrial development and structural transformation. As the core production factor of the digital economy, data elements, with their unique advantages and innovative technologies, are providing new impetus and paths for the development of green productivity. Therefore, understanding how the digital economy affects corporate green productivity helps enterprises better adapt to the development trend of the times, achieve a win-win situation of economic and ecological benefits, reveals the mechanism through which the digital economy promotes corporate green development, and provides a scientific basis for enterprises to formulate green development strategies.

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2. Research on the Digital Economy

2.1. Research on the Connotation of the Digital Economy

Globally, a standardized definition of the digital economy remains elusive, as scholarly comprehension of its core principles continues to evolve [51]. The concept of the "digital economy" first emerged on the international stage during the 1990s. It was notably advanced by influential thinker Don Tapscott in his 1996 publication, *The Digital Economy: Promise and Peril in the Age of Networked Intelligence*, a contribution that established his reputation as a foundational figure in the field [36]. The U.S. Department of Commerce argued that information technology (IT) has a strong penetrative and integrative effect and should be incorporated into digital industries such as the Internet and e-commerce, thereby expanding the connotation of the "digital economy" [37]. Bhatnagar believed that the digital economy includes two parts in terms of scope: information technology and e-commerce [1]. However, Kling and Lamb held that the digital economy is not defined by specific boundaries; instead, it should cover all services relying on digital technologies, including design, production, supply processes, and commodities [18]. Paul and James similarly contended that conceptualizations of the digital economy should extend beyond e-commerce and technical dimensions, advocating for a more expansive interpretation of its scope [27]. British researcher Kim and colleagues described the digital economy as an emergent economic paradigm distinct from traditional models, fundamentally characterized by the digital transformation of goods and services prior to their exchange[17]. Malecki and Moriset characterized the digital economy as the pervasive integration of information and communication technologies throughout economic activities[26]. Knickrehm et al. conceptualized the digital economy as encompassing all economic value generated through the integrated application of digital competencies, infrastructure, and intermediary goods and services within productive processes [19]. Katzenbach posited an intrinsic connection between the digital economy and the broader concept of a digital society. He emphasized that the infrastructural foundations established by the digital economy serve as essential pillars for building a fully realized digital society [16]. According to Borowiecki, the digital economy represents a synthesis of general-purpose technologies (GPTs), encompassing a broad spectrum of socioeconomic interactions facilitated by network-based technological systems [2].

As international scholars continue to deepen their research on the digital economy, Chinese scholars have also conducted in-depth analyses of its connotation. Wu characterized the digital economy as a modern form of economic activity rooted in internet infrastructure, enabled by information technology, and propelled by knowledge and data-driven processes [40]. Zhao et al. characterized the digital economy as comprising economic operations that can be dynamically represented through binary code (0s and 1s) [60]. Sun and Wang maintained that a fundamental distinction exists between digital and traditional economies, primarily manifested through information transmission paradigms-specifically, productivity enhanced by intelligent systems and digital tools [35]. He conceptualized the digital economy as an economic paradigm emerging from knowledge accumulation, materialized through the implementation of digital technologies across manufacturing, management, and distribution processes [10]. Kang pointed out that the digital economy is an emerging form generated by the rapid development of high and new technologies [15]. Zhao indicated that the digital economy mainly refers to economic activities that use digital technologies to trade digital products, and it is more virtual and rigorous compared with the traditional economy [47]. Li characterized the digital economy as fundamentally relying on digital technologies for economic production, comprising both supply and demand dimensions. His analysis further delineates its evolution through three developmental phases: digitization, networking, and intelligentization [51]. Zhang and Jiao held that the digital economy can digitize various production and daily activities,

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effectively stimulating the development of e-commerce [46].Ding pointed out that as the digital economy penetrates various fields of society, its definition will continue to change with social development, and the boundary between it and the traditional economy is not clear-cut [7]. By virtue of infrastructure and a series of high-tech means, it integrates with various social and economic activities to achieve the goals of improving efficiency and optimizing structure. Guan et al. defined the digital economy as an ecosystem of digitally-enabled applications underpinned by specialized technological infrastructure [9]. Chen conceptualized the digital economy as economic operations centered on digital information assets, utilizing internet-based transmission channels, driving innovation through digital technologies, and ultimately materializing through diverse emerging business paradigms [4].

2.2. Research on the Development of the Digital Economy

To systematically map global research trends concerning the "digital economy," relevant publications from 2014 to 2024 were retrieved from CNKI and Web of Science using this term as the primary search parameter. CiteSpace software was subsequently employed to perform co-occurrence and clustering analyses of keywords. As shown in Figures 1 and 2, the keywords with relatively high occurrence frequencies include: digital economy, data elements, rural revitalization, economic growth, digitalization, innovation, and carbon emissions.



Figure 1. Keyword Co-occurrence Map of Digital Economy Research in CNKI

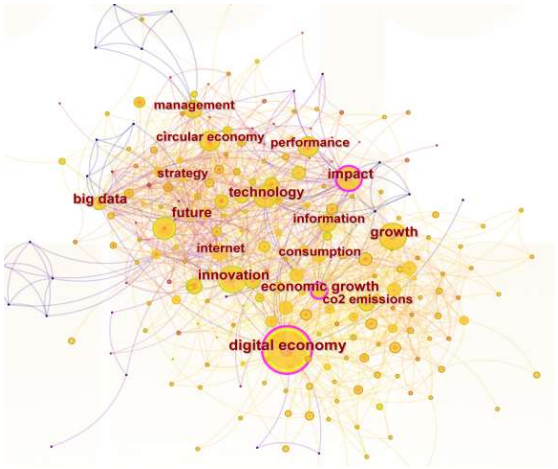


Figure 2. Keyword Co-occurrence Map of Digital Economy Research in Web of Science

Figures 3 and 4 display keyword clustering networks for digital economy research from CNKI and WOS databases respectively. The Modularity Q scores of 0.8685 and 0.8195 indicate highly

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cohesive cluster structures with strong internal thematic relationships. Both figures exhibit Mean Silhouette values (0.9632 and 0.9290) significantly exceeding the 0.5 threshold, confirming that each identified cluster maintains substantial conceptual coherence with core digital economy research themes, thereby validating the clustering effectiveness and analytical precision. Analysis of keyword clustering patterns reveals several dominant research domains within digital economy studies, including digital governance, rural revitalization, sharing economy, green growth, and carbon emissions. Methodologically, mediation analysis and spatial effects examination have emerged as predominant investigative approaches in these fields.

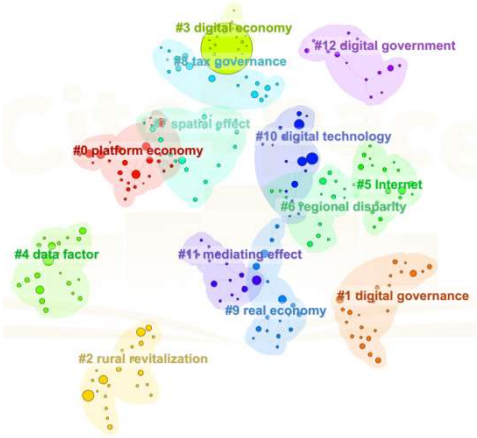


Figure 3. Keyword Clustering Knowledge Map of Digital Economy Research in CNKI

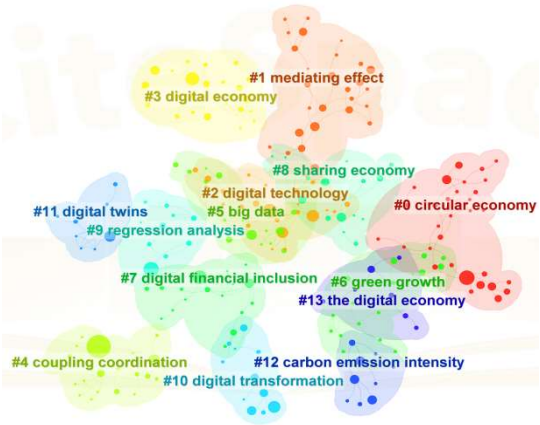


Figure 4. Keyword Clustering Knowledge Map of Digital Economy Research in WOS

Zhang and Bai pioneered an integrated analytical framework combining digital economy and rural revitalization, demonstrating their cross-coupling interaction through key activities operating within internal and external environmental contexts [45]. Yu et al. explored the impact of the digital economy on carbon emissions, the long-term development trend between the digital economy and carbon emissions, the impact of differences in the development level of the digital economy on carbon emission reduction, and the impact of green energy efficiency on the relationship between the digital economy and carbon emissions [43]. Sun and Wang utilized municipal panel data from China to demonstrate that digital economy advancement significantly contributes to reducing carbon emission levels through empirical analysis [59]. Cui et al. discussed how the digital economy affects total factor carbon productivity (TFCP) and its spatial spillover effect [6]. Wei et al. established green technology innovation as their analytical framework, systematically examining how digital economic activities influence urban

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ecological innovation outputs through detailed analysis of municipal panel data, while also uncovering the operational mechanisms behind this relationship [58]. Ren et al. assessed digital economy development and green growth performance across Chinese cities, seeking to systematically examine their interrelationship and underlying mechanisms within a cohesive analytical framework [31].

2.3. Research on Digital Economy Measurement

The ongoing expansion of the digital economy has given rise to numerous novel phenomena and challenges, rendering conventional statistical metrics insufficient for comprehensively evaluating its developmental progress. Consequently, numerous researchers have initiated comprehensive investigations into assessment frameworks for the digital economy, aiming to develop more precise methodologies for capturing its actual conditions and evolutionary trajectory. Xu and Zhang, based on China's actual conditions and drawing on international experience, argued that the evaluation scope of the digital economy should mainly include digital infrastructure, media, transactions, and transaction products [42]. When developing their digital economy assessment framework, Liu et al. utilized the nonlinear normalization-based weighting (NBI) method to assign values to indicators characterized by progressive hierarchical relationships [24]. Starting from informatization development, this system gradually transitions to Internet development and finally focuses on digital transaction development, presenting three progressively hierarchical dimensions. In their comprehensive assessment of the digital economy, Wang et al. established a framework comprising four key dimensions—development infrastructure, institutional environment, digital industrialization, and industrial digitization—which they operationalized through thirty specific tertiary indicators for quantitative measurement [39]. Du and Guan employed principal component analysis to establish a comprehensive framework for evaluating regional digital economy development. Centered on industrial ecosystems and core digital economic activities, they constructed the Shanghai Digital Economy Development Index through three dimensional indicators: infrastructural foundations, industrial integration metrics, and governmental service environments [57]. In developing their assessment framework for the digital economy, Wu and Wang drew upon the most recent industry classification standards issued by China's National Bureau of Statistics. Their model incorporates four key dimensions-digital product manufacturing, digital services, technological application, and factor-driven industries-utilizing eighteen distinct indicators for comprehensive evaluation [41]. Sheng and Liu established an evaluation framework organized around three primary dimensions: digital infrastructure, digital industry, and digital governance. These were further elaborated into 54 specific tertiary indicators. Applying an integrated analytic hierarchy process and coefficient of variation methodology, they quantitatively assessed the digital economy development index across 30 provincial-level regions in China [32].

3. Research on Green Productivity

In the domain of green productivity research, the international scholars Hou et al. employed integrated methodologies combining fuzzy rough set theory and entropy weighting to quantify relevant metrics, thereby reconstructing a comprehensive evaluation framework for assessing green productivity [12]. Employing spatial panel modeling, Zhai et al. conducted an empirical analysis of conditional beta convergence in green productivity, which they had previously quantified along with its constituent elements using specialized measurement techniques [44]. Feng et al. studied the impact of heterogeneous environmental regulations on green productivity and the moderating role of technological change and efficiency change [8]. Compared with international research, there are relatively fewer studies on green productivity in China. Li explored the green productivity effect of enterprises' ESG performance from the

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perspective of green technology innovation [23]. Based on the connotation of green productivity, He et al. constructed an evaluation index system, and used the entropy weight method and clustering method to conduct an in-depth study on the characteristics of regional layout changes of green productivity in China's animal husbandry from 2009 to 2019 and the driving factors behind them [11]. In their research, Shi and Qin stressed that advancing green productivity necessitates increased investment in both the research & development and practical implementation of environmentally sustainable technologies [33]. This process not only requires active investment from enterprises themselves but also relies on the high attention of the government and the broad support of all sectors of society. From a political economy perspective, Ren and Li elaborated on the distinct advantages of green productivity, underscoring its critical role in both safeguarding and advancing productive forces [30].

While there are relatively few global research literatures specifically on green productivity, studies on similar themes such as green production, green transformation, green development, and green total factor productivity (GTFP) are quite abundant. Li et al., in their research on farmers' green production behaviors, conducted an in-depth analysis of the roles of informal institutions and environmental regulations, and the results showed that both played a positive role in promoting farmers' green production behaviors [20].Wang et al. leveraged field survey data to systematically investigate how e-commerce engagement shapes fruit growers' environmentally conscious cultivation practices, while also elucidating the causal pathways governing this relationship [56]. Cheng and Wu demonstrated that green bond issuance substantially accelerates corporate ecological transformation, with particularly marked effects observed in state-owned enterprises, smaller firms, and non-manufacturing sectors [5]. Wan et al. conducted a granular analysis of how environmental technology standards drive manufacturing transformation through technological upgrading mechanisms, specifically examining the dual pathways of pollution abatement and productivity enhancement [55]. From the perspective of informal environmental regulation, Hu et al. found that ESG ratings significantly promote corporate green transformation through market incentive mechanisms and external supervision mechanisms [13]. Li et al. found that the market scale effect caused by the expansion of enterprises' external demand can effectively reduce their own pollution emission intensity [22]. Moreover, the impact of external demand expansion can also spill over to upstream and downstream enterprises, especially downstream ones, along the domestic production network, thereby indirectly reducing the pollution emission intensity of other enterprises and promoting corporate green development. The research by Pei et al. showed that an increase in the degree of embedding in GVCs (Global Value Chains) can effectively reduce enterprises' pollution emission intensity, thereby contributing to corporate green development [29]. Li et al. found that there are significant cross-sectional dependence and cointegration relationships between agricultural insurance, air pollution, and agricultural green total factor productivity [21]. Ji et al.'s investigation reveals an underlying U-shaped correlation between environmental regulatory stringency and green total factor productivity (GTFP). Their analysis positions China's current regulatory intensity along the curve's left segment, suggesting that systematically enhanced policy enforcement remains imperative for transitioning toward optimal GTFP enhancement [14]. Yin et al. demonstrated that green finance's influence on GTFP displays distinct geographical variation, corresponding to China's regional developmental gradient characterized by eastern regions showing superior performance, central areas maintaining intermediate levels, and western zones trailing behind in both green finance development and productivity metrics [54].

Given the relative scarcity of research on green productivity, in terms of measurement, we can draw on the currently widely discussed measurement methods for new quality productive forces to attempt to measure and evaluate the level and development trend of green productivity. This will fill the gap in the field of green productivity research and provide a more

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comprehensive and in-depth perspective to understand and promote the development of green productivity. Chinese scholars Wang and Wang constructed an index system for new quality productive forces from three dimensions: laborers, labor objects, and means of production [38]. Zhu et al. established a comprehensive assessment framework for new-quality productive forces, structured around three fundamental dimensions: labor force quality, means of labor, and objects of labor. Their methodological approach incorporated a projection pursuit clustering model optimized through genetic algorithms for precise measurement [53].Lu et al. divided 18 indicators based on three dimensions (scientific and technological productivity, green productivity, and digital productivity) and adopted the entropy method to measure new quality productive forces [25]. Song et al. developed metrics for assessing new-quality productive forces at the enterprise level, establishing a dual-dimensional framework encompassing both labor capabilities and production instruments [34].

4. Research on the Impact of the Digital Economy on Green Productivity

Zhou et al. identified that while corporate digital transformation and productivity distribution demonstrate spatial equilibrium tendencies, their developmental patterns remain fundamentally uneven [49]. Che et al. demonstrated through empirical investigation that digital economy development substantially enhances productivity within energy sector enterprises [3].Employing data envelopment analysis, Pambekti and Lestari quantified agricultural green total factor productivity, subsequently demonstrating the measurable effect of green financial instruments on ecological efficiency in farming [28]. Chinese scholars Zhou et al. specifically investigated the environmental value of the digital economy. Adopting the perspective of factor allocation distortion, they conducted rigorous empirical analysis to examine both the measurable effects and operational mechanisms through which digital economy development influences green total factor productivity [48]. Zou et al. demonstrated that the digital economy's positive effect on green total factor productivity operates through two key mechanisms: industrial structure upgrading and the reduction of factor allocation distortions, which serve as significant mediating pathways in this relationship [50]. Wei and Hou observed pronounced regional disparities in both digital economy advancement and green development across Chinese prefecture-level cities [52]. Their research indicates that while the digital economy positively influences urban sustainability, this effect manifests with temporal latency rather than immediate impact. Furthermore, they identified significant heterogeneity in this relationship due to variations in regional socioeconomic and cultural contexts, suggesting the magnitude and mechanisms of digital economy's promotional effects differ substantially across geographical areas. However, to date, international academic literature examining the direct influence of the digital economy on green productivity remains limited, with virtually no comprehensive studies dedicated to this specific interdisciplinary domain.

5. Conclusion

The literature review reveals that current methodologies for assessing digital economy development predominantly rely on constructing multi-dimensional evaluation frameworks. Among these approaches, the entropy method has emerged as a principal technique for comprehensive measurement. The integrated development of the digital economy and green development has become a highly noticeable and hot topic. Overall, a substantial number of existing literature have directed their research focus onto the green industrial sector as well as the multi-dimensional impacts that the digital economy exerts on the green field, and have all conducted comprehensive, in-depth, and systematic argumentation and analysis around these aspects. These rich research results have laid a solid foundation for this paper. However, the existing literature also has some shortcomings that cannot be ignored. On the one hand,

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research related to green productivity is relatively scarce, and most studies remain at the theoretical level, lacking empirical analysis based on actual data. Nevertheless, there remains a notable scarcity of empirical studies that systematically investigate the digital economy's concrete effects on green productivity. This gap somewhat constrains a holistic comprehension of their interconnected dynamics.

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