Structural Patterns and Multi-Path Development of China's Regional Digital Economy

Mengsi Li[1], György Iván Neszmélyi[2]

[1]Budapest University of Economics and Business, Budapest, 1149, Hungary
[2]Milton Friedman University, Budapest, 1039, Hungary

Abstract This research is about the structural characteristics and regional differences of digital economy development in 31 provinces of China from 2014 to 2021. The entropy weight-TOPSIS technique is used to identify the main reasons for regional differences in the digital economy through a four-dimensional evaluation framework of 20 variables. The results show a significant structural variation across regions. The basic sources of regional differentiation are the volume of telecommunication services, the turnover of the technology market, and the revenue from the software business, although indicators of digital finance are relatively modest. The East region has better industrial and innovation capability; the Central mainly depends on the communication-scale expansion; the West region focuses on the technological transformation; and the Northeast provides a hybrid infrastructure-technology framework. The results indicate that the development of China's digital economy has a multi-path structural feature, rather than a simple hierarchical structure.

Keywords Digital economy, Regional heterogeneity, Structural characteristics, Entropy-weighted TOPSIS, Regional development

JEL O18, O33, R11, C44

1. Introduction

1.1. Research Goals and Questions

Current research primarily focuses on the development level and growth effects of the digital economy (Jiao & Sun, 2021), neglecting the regional differences in the internal structure of the digital economy and its development drivers. Regional economic theory posits that the development of different regions depends on their core development factors (Krugman, 1991; Porter, 1998). Development in different regions depends on different development factors, such as more efficient communication networks, digital economy-related investments, and the rate of return brought by innovative technologies (Feng & Qi, 2024). To measure the current state of development of China's digital economy, it is necessary to understand the root causes of its uneven development and its development trajectory.

Therefore, this study will focus on the following questions:

RQ1: Do regional differences in China's digital economy reflect structural heterogeneity rather than only development-level disparities?

RQ2: Which indicators constitute the major structural drivers of regional digital economy development?

RQ3: What role does digital finance play within the regional digital economy structure?

1.2. Theoretical Background

Driven by the rapid development of next-generation technologies such as artificial intelligence, 5G networks, cloud computing, and big data, the digital economy has become a new arena for competition among major economies (Brynjolfsson & McAfee, 2014).

The main driving force behind China's high-quality development is the development of the digital economy (Engineering, 2020). Recently, a series of policies have been put into place, including Made in China 2025, the Plan for Building a Digital China, and the Guiding Opinions on Enhancing the Development of the Industrial Internet through "Internet Plus Advanced Manufacturing" (Arcesati et al., 2020; Engineering, 2020). These policies put digital technology first in the real economy and speed up the process of improving and changing industries (Sturgeon, 2021). The current study shows that improving digital infrastructure and using digital technologies make industries more efficient and regions more competitive (Porter, 1998). However, China is still far behind wealthy countries when it comes to basic technological self-sufficiency, the complexity of its industrial base, and the efficiency of resource use (Simon, 2021).

The development of the digital economy is uneven across regions. Regional economic theory asserts that distinct regions may rely on specific core components for their growth (Krugman, 1991; Porter, 1998). This difference shows that regional digital economies not only have different levels of development, but they may also have very different internal structures and driving forces.

1.3. Research Gap

Currently, there are still some gaps in the discussion of regional development of the digital economy. The primary deficiency is the lack of a structural perspective. Existing research mainly assesses the scale of digital economic development and its impact on economic growth and industrial progress (Bukht & Heeks, 2017), emphasizing the importance of digital infrastructure and technological innovation for economic development (Brynjolfsson & McAfee, 2014). Most of these studies use composite indices or single-dimensional indicators for comparison, failing to consider the different weightings of various variables in the digital economy (Ruan et al., 2024). Secondly, there is a lack of a multi-path framework for the development of the digital economy. Recent studies examining regional disparities in the digital economy predominantly employ either an "east-high, west-low" or "core-periphery" spatial structure framework (Wei, 2025). This single gradient explanation does not elucidate why certain regions excel in innovation-driven development or technology commercialization (Wang et al., 2023).

In short, recent studies show that structural weight analysis, finding driving mechanisms, and making multi-path patterns all have big problems. This study develops a weighting system for regional digital economy indicators using the entropy-weighted TOPSIS method to explores the main driving factors of digital economy development, the various development paths resulting from structural differences, and how the digital economy achieves regional growth within this context.

1.4. Thesis Significance

This study re-examines the development of regional digital economies, expanding the analytical framework of digital economy research from the perspective of weighted differences.

This paper examines regional development disparities and the weighting framework of indicators to explore the primary determinants of regional digital economies and their unique developmental pathways. It is also important to think about the exact role of digital finance in the regional digital economy. This research provides an impartial assessment of the incremental role of digital finance, thereby augmenting the theoretical contributions of investigations into the internal framework of the digital economy (Shan & Liu, 2023). This approach elucidates the internal structural disparities and primary determinants influencing regional digital economies (Novikova & Strogonova, 2020). This provides theoretical support for understanding the different ways that China's digital economy has evolved and sets up a structural basis for improving policies for regional digital economies.

2. Literature Review

2.1. Digital Economy and Regional Development

The digital economy is an economic system that relies on digital technologies, data resources, and network infrastructure (Milskaya & Seeleva, 2019; Williams, 2021). Dahlman et al. (2016) argue that the digital economy encompasses internet activity, the application of digital technologies, and their impact on economic and social structures. Existing research also indicates that the digital economy comprises several fundamental elements: data as a crucial component of production; the importance of modern information networks to operations; and the role of information and communication technologies in improving efficiency and optimizing structure (Berczi, 1981; Hu et al., 2014; Qiang et al., 2004). However, existing concepts only emphasize the multifaceted nature of the digital economy and its macro-level impact, while ignoring the regional differences in the internal structure of the digital economy, such as the varying levels of technological innovation, data acquisition, and digital infrastructure development (He et al., 2024; Sidorov & Senchenko, 2020).

The digital economy has strong effects that spread beyond its immediate impact, as digital technologies help different industries come together and benefit related sectors by creating new ways of doing business through network effects, sharing knowledge, and spreading platforms (Z. Wang et al., 2024; Zou et al., 2024). At the same time, digitalization greatly lowers the costs of copying and sharing information products, which lowers the costs of new ideas and spreading new technologies within an organization. This boosts the driving force in many fields and industries (Polyakov & Kovshun, 2021), leading to increased innovation, improved efficiency, and enhanced competitiveness across various sectors. Regional differences in the digital economy may not grow in a straight line but instead cause structural changes through "key indicators (such as telecommunications service volume, platform and network capacity, and technology transaction activity)" (Hao et al., 2023).

Finally, there is the innovative integration capability of the digital economy. Digital technology is both a tool and an object of innovation, applying its innovative capabilities in organizational structures, governance models, and business practices (Chirkunova et al., 2020; Ding et al., 2025). Therefore, the innovation process in the digital economy often follows a chain path: R&D investment → output → market transformation (Yi et al., 2024). Regional differences in each link are also one of the sources of differentiation in the digital economy (Zhang & Xing, 2025).

So compared with the traditional economy, the digital economy exhibits stronger dependence on data resources, network externalities, platform coordination, and digital infrastructure. These characteristics imply that regional digital economy development may rely on different structural drivers. **Table 1** summarizes the major structural differences between the digital economy and the traditional economy.

Table 1. Characteristics of the Digital Economy vs. the Traditional Economy.

Comparison Dimension	Digital Economy	Traditional Economy
Main Factors of Production	Information, Data.	Labor, Capital, Land.
Dominant Economic Force	In-depth participation of demand, platform collaboration.	Supply-led.
Main Micro Subjects	Platform enterprises, multi-sided market entities.	Single-center or multi-center enterprises.
Form of Economic Organization	Networked and multi-form organizational structure with data and information links at its core.	Hierarchical organizational network based on factor separation and contractual relationships.
Marginal Return	Increasing (driven by network externalities).	Decreasing (law of diminishing marginal returns).
Consumption Pattern	Integration of online and offline.	Offline-oriented.
Infrastructure	New infrastructure such as 5G, big data centers, cloud computing platforms, and computing power centers.	Traditional infrastructure such as transportation, water and electricity, and energy.

Source: The author compiled this information based on relevant literature.

Table 1 compares the digital economy and the traditional economy in terms of production factors, organizational forms, and value creation mechanisms. In more concrete terms, the increasing significance of data resources, network externalities, and platform coordination implies that the development of regional digital economies may exhibit differentiated structural patterns, rather than uniform development paths.

2.2. Regional Heterogeneity and Structural Drivers

Research on the regional imbalance in the development of the digital economy typically begins with the premise that "the spatial distribution of the digital economy is not naturally balanced" (Han et al., 2024). This phenomenon has a relatively straightforward explanation. New economic geography suggests that when economic activities exhibit increasing economies of scale and agglomeration effects, a stable core-to-periphery structure forms, resulting in the concentration of production and innovation resources in a few core areas (Krugman, 1991; McCann & Van Oort, 2019). In the context of the digital economy, the economic attributes of digital products and services reinforce this logic.

Early research on the digital economy primarily focused on its impact on economic growth and productivity, exploring how digital technologies can improve economic efficiency by reducing costs, optimizing resource allocation, and facilitating dissemination (Brynjolfsson & McAfee, 2014; Polyakov & Kovshun, 2021). Later research revealed that the digital economy is not a single factor of production, but a multi-dimensional, complex system encompassing digital infrastructure, digital platforms, data resources, innovation capabilities, and institutional policies (Rong, 2022). These findings suggest that in regions with abundant innovation resources or advanced institutional policy frameworks, the development of the digital economy relies not solely on scale expansion but more on collaborative innovation and information spillover. Evolutionary economic geography proposes that the development paths of different regions are influenced by multiple factors, exhibiting path dependence and multi-path evolution characteristics (Boschma & Frenken, 2006; Sun et al., 2024). Therefore, using comprehensive indicators to assess the development of the digital economy may, to some extent, obscure the fundamental reasons for its differences (He et al., 2024).

3. Methodology

This study constructs a four-dimensional assessment framework comprising 20 indicators, aiming to explore the structural differences and driving patterns of regional digital economies. The study employs the entropy weighting method to validate indicator weights and uses the TOPSIS method to assess the development level of the digital economy in 31 provinces of China. Information entropy of the indicators is used to represent data dispersion, which is then used to assess the relative impact of each indicator on regional differences, while avoiding subjective weight bias (Wu et al., 2022). The TOPSIS technique computes the relative closeness of each region to an optimal solution, producing a detailed ranking that allows for comparability (Çelikbilek & Tüysüz, 2020). Crucially, the weight distribution produced within the entropy-weighting framework inherently signifies the structural importance of various indicators in influencing regional disparities, thus offering a quantitative basis for discerning multi-pathway driving patterns (Wu et al., 2022).

This analytical approach allows the research to investigate gradient disparities in the levels of regional digital economic development and to pinpoint fundamental supporting factors across regions from a structural weight perspective. This makes it easier to figure out if regional digital economies have a "multi-path driven" development pattern and to look at the current structural state of digital finance-related variables. The shift from "horizontal comparison" to "structural identification" addresses the shortcomings of current research in terms of mechanisms. It also provides empirical support for regional differences in the digital economy (Moder, 2017).

3.1. Evaluation Framework and Indicator System

The digital economy is based on data, supported by information and communication technologies, and characterized by its reliance on infrastructure, industrial features, integrated services, and emphasis on innovation (Ouyang et al., 2024). The digital economy is not only reflected in the improvement of information infrastructure, but also in the revenue scale of digital industries, the complexity of digital service systems, and the driving force of innovation capabilities (Williams, 2021). This study aims to explore the contribution of each indicator to regional differentiation.

3.1.1. Digital Economy Indicator System

This study constructs indicators in four dimensions: digital infrastructure, profitability of the digital industry, operational capability of digital services, and operational capability of digital innovation. The system is based on the structural features of the digital economy and the theoretical framework of regional development. This model fully includes the "input foundation," "industrial output," and "innovation support" of the digital economy, making it easier to systematically study regional digital economic systems. As shown in Table 2.

Table 2. Digital Economy Evaluation Index System.

Code	Secondary indicators	Primary indicators
X1	Length of optical fiber cables (km)	Digital infrastructure
X2	Number of broadband internet access ports	
X3	Penetration rate of mobile phones (number of users per hundred people)	
X4	Number of domain names (in ten thousand)	
X5	Capacity of mobile telephone exchanges (in ten thousand)	
X6	Revenue from software business (10,000 RMB)	Revenue from the digital industry
X7	Revenue from information technology services (10,000 RMB)	
X8	Telecom business volume (100 million RMB)	
X9	E-commerce procurement volume (100 million RMB)	
X10	E-commerce sales volume (100 million RMB)	
X11	The breadth of digital financial coverage	Digital service capability
X12	The depth of digital financial usage	
X13	Level of online and mobile payments	
X14	Level of digitalization of inclusive finance	
X15	Number of employed persons in urban units engaged in information transmission, software, and information technology services (in ten thousand)	
X16	Full-time equivalent (FTE) R&D personnel in industrial enterprises above designated size (person-years)	Digital innovation capability
X17	R&D expenses in industrial enterprises above designated size (10,000 RMB)	
X18	Number of R&D projects in industrial enterprises above designated size	
X19	Technology market turnover (100 million RMB)	
X20	Number of domestic patent applications and authorizations	

Source: The Authors' own work.

X1-X5 represent the dimensions of digital infrastructure, which serve as the physical foundation for the functioning of the digital economy (Milskaya & Seeleva, 2019). This dimension aims to assess the network support capabilities and information transmission infrastructure of a region's digital economy.X6–X10 denote the revenue-generating aspect of the digital sector. This dimension assesses the levels of industrialization and marketization within the digital economy. Dimensions X11–X15 denote the digital service capability dimension, characterized by the digital economy's integration with social and financial processes. The first four indicators are derived from the Peking University Digital Inclusive Finance Index(Li & Zhang, 2024), used to assess the penetration and utilization rate of digital finance. This dimension defines the ability of the digital economy to connect with social services and the financial system. X16 - X20 represent the digital innovation capability dimension, reflecting the unique innovation-driven attributes of the digital economy (Chen & Xing, 2025). Five indicators were identified, as shown in Table 2. The first three indicators reflect the scale of R&D investment; technology market transaction volume assesses the transformation capability of technological progress; and patent authorization volume represents intellectual property output. This dimension is used to assess the innovation support capability and technology diffusion potential within the digital economy.

3.1.2. Data Sources and Sample Description

The sample data for this study comes from all 31 provincial-level administrative regions of China (excluding Hong Kong, Macau, and Taiwan) (He et al., 2018). All data are from publicly available statistical resources to ensure reproducibility and verifiability.

All other indicator data were sourced from(China, 2026) except the digital finance indicators :

- National Bureau of Statistics of China (NBS)
- China Statistical Yearbook
- China Information Industry Yearbook
- Provincial statistical yearbooks

Digital finance indicators (X11–X14) were sourced from: Digital Inclusive Finance Index compiled by Peking University Digital Finance Research Center (Series of Digital Finance Indexes, n.d.).

All 20 indicators selected in this study are positive indicators, requiring no inverse transformation. To eliminate the impact of differences in the dimensions of the indicators on the comprehensive evaluation results, all variables were standardized before calculation to ensure data comparability and stability. To ensure data consistency and logical coherence, the statistical definitions and units of measurement for each indicator were uniformly calibrated. For missing values that may exist in specific years or regions, supplementary data published by the National Bureau of Statistics (China, 2026) and relevant authoritative yearbooks were consulted.

3.2. Methods

The overall analytical process of this study involved developing indicators for evaluating the digital technology economy and collecting statistical data from various provinces. Then, the entropy weight method is used to find the indicators' objective weights. After that, the TOPSIS method is used to find out how developed the digital economy is in different areas. Finally, a robustness test is done with the equal-weight method to see how different weight settings affect the results of the study.

3.2.1. Entropy Weight Method

The entropy weight method was employed to objectively determine the contribution of each indicator based on the degree of variation across regions. The entropy weight method assigns weights to indicators based on the extent of data variability (Chen, 2021). Indicators exhibiting greater dispersion encompass more information and hence are assigned higher weights (Wu et al., 2022).

Step 1: Construction of the Original Data Matrix

There are n provinces and m indicators. The original matrix is:

$$(X = (x_{ij})_{n\times m}) \tag{1}$$

where x_{ij} represents the value of indicator j for province i (Wu et al., 2022).

Step 2: Data Normalization

Since all indicators are positively oriented, normalization is conducted to eliminate dimensional differences. Following the mean normalization approach:

$$(z_{ij} = \frac{x_{ij}}{\bar{x}_j}) \tag{2}$$

where $\bar{x}_j$denotes the mean value of indicator j (Wu et al., 2022).

Step 3: Calculation of Proportions

$$(p_{ij} = \frac{z_{ij}}{\sum_{i=1}^{n} z_{ij}}) \tag{3}$$

Step 4: Entropy Value Calculation

$$(e_j = -k\sum_{i=1}^{n} p_{ij}\ln(p_{ij})), \quad \text{where } k = \frac{1}{\ln n}. \tag{4}$$

Step 5: Information Utility Value

$$(d_j = 1 - e_j) \tag{5}$$

Step 6: Determination of Entropy Weights

$$(w_j = \frac{d_j}{\sum_{j=1}^{m} d_j}) \tag{6}$$

The resulting weight w_j reflects the contribution of indicator jto regional differentiation.

Step 7: Weighted Standardized Matrix

$$(v_{ij} = w_j \cdot z_{ij}) \tag{7}$$

The entropy weights derived here are later used in the TOPSIS evaluation process.

3.2.2. TOPSIS Comprehensive Evaluation Method

TOPSIS evaluates each province by calculating its distance from the ideal solution (Çelikbilek & Tüysüz, 2020; Wang & Wang, 2014).

Step 1: Construction of the Weighted Decision Matrix

$$(V = (v_{ij})_{n\times m}) \tag{8}$$

Step 2: Determination of Ideal Solutions

Positive ideal solution (Chen, 2021):

$$(A^+ = \{\max(v_{ij})\}) \tag{9}$$

Negative ideal solution (Chen, 2021):

$$(A^- = \{\min(v_{ij})\}) \tag{10}$$

Step 3: Euclidean Distance Calculation

Distance to positive ideal (Wang & Wang, 2014):

$$(D_i^+ = \sqrt{\sum_{j=1}^{m}(v_{ij} - A_j^+)^2}) \tag{11}$$

Distance to negative ideal (Wang & Wang, 2014):

$$(D_i^- = \sqrt{\sum_{j=1}^{m}(v_{ij} - A_j^-)^2}) \tag{12}$$

Step 4: Relative Closeness Calculation

$$(C_i = \frac{D_i^-}{D_i^+ + D_i^-}) \tag{13}$$

The value $C_i \in [0,1]$ represents the comprehensive development level of province i. A larger value indicates a higher digital economy development level.

Importantly, beyond ranking provinces, the entropy weights allow identification of structural contribution differences across regions, which serves as the foundation for structural heterogeneity and multi-path development analysis(Wu et al., 2022).

3.2.3. Robustness Check: Equal-Weight Comparison

To assess the robustness of the entropic weighting method's results, this study further employs an equal-weighting approach for comparative analysis (Esangbedo & Wei, 2023). Specifically, while maintaining the unchanged indicator system, the standardized contribution values e_{ij} for secondary indicators X1–X20 are assigned equal weights. The comprehensive scores for each province are then calculated using simple averaging:

$$(Score_i = \frac{1}{m}\sum_{j=1}^{m} e_{ij}) \tag{14}$$

Here,$m = 20$ denotes the number of indicators. To verify the impact of different weights on the results. The results of the equal weight calculation are shown in Table 5.

4. Results

4.1. Descriptive Structural Characteristics of China's Digital Economy Development

Based on the construction of the indicator system and measurement model, the weights (W_j) of each evaluation indicator in every region are calculated according to the above formula, as shown in

Table 3 below.

 DOI: 10.26552/tac.C.2026.1.4

Table 3. The weights of each evaluation index in Eastern China from 2014 – 2021.

Region	Wj%	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20
Eastern	Beijing	4.08	2.24	3.05	2.97	7.14	6.94	7.48	9.98	5.36	5.66	4.59	5.07	2.93	2.75	4.02	4.61	5.75	4.17	7.91	3.31
	Tianjing	5.35	4.28	5.70	2.43	4.01	5.55	5.73	11.82	6.81	5.04	4.84	4.47	2.73	2.51	5.21	4.07	4.68	5.69	5.97	3.12
	Hebei	4.10	2.73	3.93	3.55	4.80	6.53	6.75	11.32	4.15	4.32	4.21	4.00	2.67	2.50	4.59	4.10	4.55	7.13	8.12	5.97
	Shanghai	2.64	4.11	5.37	4.00	4.59	4.38	4.77	9.47	5.97	6.19	3.80	4.04	2.29	2.47	5.45	3.29	3.77	3.84	7.29	12.29
	Jiangsu	3.06	2.52	4.92	2.45	7.34	3.70	3.90	10.68	6.36	7.69	4.34	4.21	2.57	2.54	4.91	3.86	4.48	5.87	7.80	6.83
	Zhejiang	3.48	2.09	4.86	4.51	4.36	4.60	5.04	12.04	6.44	5.53	4.50	4.57	2.61	2.69	5.49	3.93	4.59	5.14	7.78	5.77
	Fujian	4.32	2.99	3.33	3.94	4.33	3.29	3.12	12.08	8.00	8.15	5.08	4.37	2.99	3.52	2.69	5.28	3.89	7.66	7.92	3.05
	Shandong	3.16	3.05	3.67	4.32	4.79	5.86	5.23	10.74	4.34	4.34	4.55	4.32	2.75	2.61	5.43	4.09	4.74	6.72	8.16	7.13
	Guangdong	3.97	3.28	3.98	4.25	3.84	4.84	5.50	11.49	4.29	5.63	4.47	4.55	2.87	3.45	5.51	5.51	4.21	5.89	6.80	5.70
	Hainan	3.52	3.11	3.51	6.98	5.38	4.14	4.05	10.74	3.90	4.75	4.07	3.40	2.57	2.33	4.65	3.67	4.30	9.87	6.68	8.38
Central	Shanxi	3.49	2.83	4.37	5.62	6.09	7.07	5.51	10.08	5.04	6.52	3.83	3.49	2.50	1.87	6.75	3.49	4.08	4.94	6.04	6.40
	An'hui	3.13	2.32	3.17	5.47	2.98	4.97	4.94	11.24	6.02	4.71	4.91	4.42	2.83	2.76	4.48	4.51	5.53	7.07	8.61	5.93
	Jiangxi	4.04	1.72	3.96	4.22	4.08	4.48	5.93	8.74	3.16	1.89	3.26	3.08	1.98	1.92	3.73	25.47	3.27	4.81	7.05	3.22
	Henan	2.69	2.44	4.91	4.98	4.47	4.79	4.83	10.30	5.22	2.79	4.25	3.89	2.88	2.35	4.40	3.85	4.70	6.42	14.75	5.10
	Hubei	3.82	2.64	5.07	3.57	10.70	3.74	5.21	10.93	5.68	5.76	4.30	4.21	2.56	2.45	4.20	3.87	4.58	5.07	5.38	6.27
	Hunan	3.62	2.91	4.81	3.62	5.20	6.02	5.49	10.45	5.92	5.45	4.06	3.58	2.41	2.28	4.54	3.58	4.19	6.46	10.09	5.35
Western	Neimenggu	4.21	2.64	3.01	4.11	3.69	13.15	16.59	9.22	3.08	2.87	3.70	3.16	2.30	2.39	3.67	3.35	3.80	3.72	5.61	5.73
	Guangxi	4.31	2.86	4.46	3.84	3.72	8.01	7.62	9.02	3.52	5.68	3.50	3.32	2.21	1.69	4.13	6.02	3.62	6.90	10.86	4.74
	Chongqing	3.43	2.52	3.57	3.71	6.61	4.59	5.72	13.38	4.69	6.97	3.87	3.79	2.35	2.15	7.49	3.59	4.30	4.74	9.51	3.01
	Sichuan	4.60	3.46	4.96	3.50	3.18	5.08	5.82	11.34	6.76	5.91	4.84	4.45	2.77	2.36	4.64	4.28	4.75	5.65	6.32	5.35
	Guizhou	2.95	3.03	4.14	6.91	7.48	7.34	7.36	10.15	4.14	4.73	3.83	3.16	2.51	2.05	5.31	3.61	4.04	5.40	6.11	5.75
	Yunnan	4.62	2.78	5.12	5.47	8.40	5.01	5.34	11.48	4.60	4.17	4.17	3.81	2.58	2.10	4.78	3.78	4.31	3.61	8.65	5.24
	Tibet	2.69	2.69	1.54	2.28	2.04	21.32	21.32	6.46	2.23	2.72	2.71	1.95	1.47	1.31	3.90	1.44	5.34	3.39	9.08	4.13
	Shaanxi	4.35	2.91	4.27	4.59	4.63	4.44	5.42	11.52	6.97	6.81	4.46	4.13	2.96	2.58	4.49	3.99	4.66	5.16	7.19	4.48
	Gansu	4.33	3.15	4.77	5.32	4.07	3.18	3.35	11.54	4.60	8.93	4.59	4.05	3.19	4.44	6.75	4.17	4.61	4.58	5.00	5.41
	Qinghai	4.91	3.13	4.26	4.54	4.77	7.06	6.10	11.19	4.03	5.64	4.53	3.55	2.94	2.58	2.33	4.12	4.68	5.02	8.97	5.68
	Ningxia	3.77	4.34	2.86	4.15	2.99	6.29	6.22	11.96	5.33	5.08	4.50	3.85	2.94	2.97	3.79	4.13	4.92	5.83	7.86	6.24
	Xinjiang	4.13	3.28	4.62	3.56	3.05	3.58	5.11	11.54	5.71	5.14	4.30	3.89	2.70	2.51	7.63	3.86	4.52	6.34	9.00	5.55
Northeastern	Liaoning	3.70	2.05	3.74	4.44	11.13	6.49	4.56	9.71	6.75	5.04	4.45	4.11	2.63	2.66	4.11	4.01	4.60	3.92	5.29	6.63
	Jilin	5.07	2.95	4.92	6.43	5.23	5.06	3.30	11.76	5.26	4.77	4.60	4.12	2.65	2.64	5.10	4.32	4.90	2.56	8.14	6.23
	Heilongjiang	4.61	2.64	5.70	9.81	3.39	5.53	6.34	9.21	3.42	3.87	4.26	3.78	2.50	2.21	3.97	4.04	4.81	4.32	8.77	6.82

Source: The author's own calculation is based on data from the National Bureau of Statistics of China，China Statistical Yearbook, China Information Industry Yearbook, Provincial Statistical Yearbooks, and Digital Inclusive Finance Index.

Table 3 shows the entropy-weighted indicator structure of the digital economy in 31 provinces of China from 2014 to 2021. The results of weight show that China's regional digital economy development presents significant structural heterogeneity, rather than a simple hierarchical gap in the level of development. The various regions are characterized by different combinations of indicators of infrastructure, industrialization, innovation, and transformation that reflect the diversified development mechanisms in the country.

From the perspective of national structure, the volume of telecommunications services (X8) has always been one of the highest weighted indicators in almost all regions, indicating that the scale of communication and the transmission capacity of information are still the most basic driving forces for the development of the regional digital economy. The burden of X8 is generally greater than 9%–12% in the Eastern, Central, and Western regions, respectively, which reflects the strong role of telecommunications infrastructure and communication service development in the formation of regional digital economy differences. This finding indicates that the development foundation of China's digital economy still heavily depends on communication networks.

Furthermore, the technology market turnover (X19) also has a relatively high structural importance in several provinces, in Western and innovation-oriented provinces. The increasing importance of X19 indicates that the commercialization of innovation and the transformation of technology have become increasingly important sources of regional differentiation. The growing importance of technology transaction indicators relative to traditional infrastructure indicators reflects the gradual shift of China's digital economy from infrastructure expansion to innovation-driven development.

Indicators of digital industrialization, especially the indicators of software business revenue (X6) and information technology service revenue (X7), also have relatively high weights in economically developed regions. This phenomenon shows that the income generation of the digital industry has become a significant structural support for the advanced digital economy of the region. The Eastern region is relatively more coordinated between digital industrial revenue, e-commerce activities, and innovation capacity, which reflects a relatively mature digital economic ecosystem.

In contrast, digital finance-related indicators (X11-X14) generally maintain relatively low weights in most provinces and regions, usually between 2% and 5%. The lack of dominant digital finance indicators indicates that digital finance plays a more supportive role than a main driving force in regional digital economic development. Even in the economically developed Eastern provinces, digital finance does not show an absolute structural predominance. This finding suggests that the current stage of the development of China's digital economy is still primarily driven by infrastructure expansion, industrial digitalization, and innovation transformation rather than financial digitalization alone.

The Eastern region exhibits a relatively balanced structure at the regional level, with coordinated development of digital industrial revenue and innovation capacity. Indices such as software business revenue, information service revenue, e-commerce activities, and patent-related innovation indices generally have relatively high weights, which reflects strong industrial synergy and innovation integration.

The Central area shows a communication-scale-supported structure. In most of the Central provinces, the telecommunications service volume level is the most stable and dominant indicator, while the innovation-related indicators show relatively divergent patterns. This implies that the Central region is strongly dependent on the expansion of communication infrastructure while also developing differentiated innovation paths.

The West shows a stronger structural concentration and a higher degree of regional differentiation. Except for the leading role of the telecommunications service volume, the technology market turnover and industrial transformation indicators perform relatively stronger in several provinces. The development trend of "communication scale support + technology transformation enhancement" has been formed, which shows that the commercialization of innovation has become an increasingly important driving mechanism for the development of the digital economy in the Western region.

Northeast China has a multi-core structural pattern with communication support, internet resource differentiation, and technology transaction variation compared with other regions. The region lacks a single dominant structural path, although telecommunication indicators remain important. Rather, different provinces depend on different combinations of internet resources, communication capacity, and technology transformation indicators, which reflect a more heterogeneous development structure.

In general, the analysis of descriptive structure indicates that China's digital economy development is characterized not only by regional disparities in development levels but also by significant differences in structural driving mechanisms. The results indicate that the development of the regional digital economy in China has gradually changed from infrastructure-oriented expansion to diversified paths integrating communication scale, industrial digitalization, and innovation transformation.

4.2. Comparative Analysis of Regional Digital Economy Structures

To more clearly identify the structural differences in regional digital economy development, a comparative analysis was conducted on the indicator weights of provinces in China based on four dimensions: digital infrastructure, digital industry revenue generation, digital service capabilities, and digital innovation capabilities. The results are shown in Table 4.

Table 4 presents the results of the four main dimensions of development of the digital economy in China's eastern, central, western, and northeast areas. The results suggest that the differences in the development of the digital economy among regions are embodied not only in the overall level, but also in the structure of digital infrastructure, the revenue of the digital industry, the competence of digital services, and the capability of digital innovation. This suggests that multiple development trajectories exist for various regions instead of a single linear path.

The digital infrastructure has relatively large structural contributions in the South as well as the northeastern regions. Additionally, some western provinces, including Yunnan, Guizhou, Gansu, and Qinghai, make relatively significant infrastructure contributions, while Heilongjiang, Liaoning, and Jilin also have infrastructure weights exceeding 24%. This means that infrastructure construction remains an important foundation for the development of a digital economy in less developed or geographically remote territories. In contrast, the infrastructure weights of most eastern provinces are 19% to 22%. This indicates that the digital infrastructure of the region is relatively developed and has entered a more stable stage. In other words, the development of the digital economy in the eastern region no longer primarily relies on infrastructure construction. For its development, however, industrial revenue and innovative capacity are becoming more important instead. Anhui and Jiangxi still struggle with poor infrastructure in the central area, while Hubei and Shanxi perform relatively well. This situation indicates that the infrastructure development of the central region is still uneven and has not yet formed a fully balanced digital foundation.

Table 4. Regional Comparative Analysis of Digital Economy Entropy Rights Measured by TOPSIS in China.

Region	Region Index	Digital infrastructure	Revenue from the digital industry	Digital service capability	Digital innovation capability
Eastern	Beijing	19.48	35.42	19.36	25.74
	Tianjing	21.77	34.95	19.76	23.53
	Hebei	19.10	33.07	17.97	29.86
	Shanghai	20.70	30.77	18.05	30.47
	Jiangsu	20.28	32.33	18.56	28.84
	Zhejiang	19.29	33.65	19.85	27.21
	Fujian	18.91	34.64	18.64	27.81
	Shandong	18.99	30.52	19.65	30.85
	Guangdong	19.32	31.74	20.84	28.10
	Hainan	22.50	27.58	17.02	32.90
Central	Shanxi	22.39	34.22	18.43	24.95
	An'hui	17.08	31.88	19.39	31.65
	Jiangxi	18.02	24.21	13.96	43.81
	Henan	19.49	27.92	17.77	34.82
	Hubei	25.80	31.31	17.72	25.17
	Hunan	20.15	33.32	16.87	29.67
Western	Neimenggu	17.66	44.92	15.22	22.20
	Guangxi	19.18	33.84	14.85	32.13
	Chongqing	19.85	35.35	19.65	25.15
	Sichuan	19.69	34.91	19.05	26.34
	Guizhou	24.51	33.72	16.86	24.90
	Yunnan	26.39	30.60	17.43	25.59
	Tibet	11.23	54.04	11.34	23.39
	Shaanxi	20.75	35.17	18.61	25.48
	Gansu	21.64	31.59	23.03	23.75
	Qinghai	21.61	34.01	15.92	28.46
	Ningxia	18.11	34.88	18.04	28.96
	Xinjiang	18.65	31.07	21.02	29.26
Northeastern	Liaoning	25.05	32.55	22.99	24.44
	Jilin	24.60	30.15	23.88	26.14
	Heilongjiang	26.16	28.37	20.58	28.76

Source: The author's own calculation is based on data from the National Bureau of Statistics of China，China Statistical Yearbook, China Information Industry Yearbook, Provincial Statistical Yearbooks, and Digital Inclusive Finance Index.

In most places the most visible structural dimension is digital industry revenue. The digital business is contributing robust and consistent revenues, with most of the provinces contributing more than 30% in the eastern area. The relatively high numbers in Beijing, Tianjin, Fujian, Zhejiang, Jiangsu, and Hebei all show the importance of software revenue, IT services, telecommunications services, and e-commerce to the eastern digital economy. The western area also generates a lot of money from the digital business, but the structure is more concentrated and uneven. Especially for Tibet and Inner Mongolia, the values are high, indicating that a few leading indicators, rather than extensive industrial cooperation, drive the digital industry revenue in some western regions. In contrast, the eastern region's heterogeneous digital industrial ecosystems have a stronger correlation with the revenue generated from the digital sector. The central area has moderate revenue contributions from the digital sector. Jiangxi's performance is much worse than Shanxi and Hunan, which indicates that the central region has yet to form a stable and coordinated digital industry revenue structure. Liaoning is leading Jilin and Heilongjiang in the northeastern region, and this situation indicates that the digital industry sector of the northeast remains heavily reliant on a few industrial and telecommunications foundations instead of a complete digital industrial ecosystem.

The strongest regional structural differentiation is in the ability to innovate digitally. The most obvious differences were in the central region, especially in Jiangxi Province with a comparatively high innovation capacity of 43.81%, whereas Hubei Province only reached 25.17%. This suggests that the distribution of innovation capability in the central region is rather uneven and is strongly influenced by several innovation-related metrics such as R&D spending. Moreover, the eastern region has a relatively large innovation capacity, especially in Shanghai, Shandong, Hainan, and Hebei. However, the eastern innovation is more correlated with the developed industrial system, technological market, and patent output than the central. This indicates that innovation and industrial development in the eastern region are more closely linked, and that there is a greater emphasis on market orientation. In the west, the key measures of innovation capacity are metrics related to technology market turnover and commercialization. The relatively large innovation weights of Guangxi, Xinjiang, Ningxia, and Qinghai indicate that technological transformation has become an important driving force for the growth of the western digital economy. The Northeast, particularly Heilongjiang and Jilin, also has a technology-transaction-oriented innovation pattern, where innovation differences are more correlated to technology market activity than to general R&D expansion.

It is usually the smallest and weakest factor in most areas. However, the weight of this dimension in the total is still lower than the revenue and innovation capability of the digital industry, although some provinces such as Liaoning, Jilin, Gansu, and Xinjiang have relatively higher weights of service capability. The pattern is very much in line with the relatively low weight of digital finance indicators. The digital finance-related variables do not exert a prominent structural impact in any of the four regions. This suggests that other factors, rather than digital finance, now drive the development of the digital economy in various regions of China. Digital finance has not been a major differentiator in the east due to the relative maturity of digital infrastructure and services. The central and western regions' digital finance development is constrained by regional development imbalances and uneven service coverage. Digital finance has not yet replaced the activities of the telecommunications and internet resources and technology market in the northeastern region.

The regional comparison shows four major structural trends in total. The eastern region has higher digital industry revenue and relatively mature innovation capabilities, forming a pattern of "industry revenue + innovation". Second, the middle area shows different innovation paths and is more dependent on the scale of communication. Third, the western region has a mixed structure of technology transition, concentrated revenue from the digital economy, and communication support. Fourth, there is a multi-core structure of the northeastern area based on technological transactions, internet resources, telecommunications size, and infrastructure. Thus, the development of China's regional digital economy is not a simple "east high and west low" pattern. Instead, it is a fundamentally heterogeneous development model, in which different regions depend on different combinations of infrastructure, industry revenue, service competence, and innovation transformation. This result underlines the relevance of a structural comparison rather than a mere ranking for understanding the evolution of regional digital economies.

4.3. Robustness Test: Equal-Weight TOPSIS Comparison

The results of equal-weighted ranking and entropy-weighted TOPSIS show a high degree of consistency: provinces with developed digital economies in the east (such as Beijing, Guangdong, Jiangsu, and Zhejiang) maintain a relatively leading position, while some western and northeastern regions lag. This also proves that the research conclusions do not depend on specific weight settings, and the overall results are robust, as shown in Table 5.

Table 5. Equal-weight robustness comparison based on e_{ij} indicator shares.

Province	Equal-weight score	Rank	Province	Equal-weight score	Rank
Fujian	0.8788	1	Xinjiang	0.85775	17
Jilin	0.8728	2	Jiangsu	0.8577	18
Sichuan	0.87175	3	Henan	0.85745	19
Beijing	0.8715	4	Yunnan	0.8546	20
Guangdong	0.86945	5	Hainan	0.8502	21
Gansu	0.8682	6	Hunan	0.84685	22
Ningxia	0.867	7	Chongqing	0.84425	23
Qinghai	0.8667	8	Shanxi	0.8427	24
An'hui	0.8665	9	Guizhou	0.8404	25
Shandong	0.86565	10	Neimenggu	0.836	26
Heilongjiang	0.86395	11	Guangxi	0.8293	27
Liaoning	0.8629	12	Shanghai	0.81985	28
Hebei	0.8626	13	Jiangxi	0.81055	29
Shaanxi	0.86245	14	Tibet	0.76545	30
Zhejiang	0.8603	15	Tianjing	0.13475	31
Hubei	0.8582	16			

Source: The author's own calculation is based on data from the National Bureau of Statistics of China，China Statistical Yearbook, China Information Industry Yearbook, Provincial Statistical Yearbooks, and Digital Inclusive Finance Index.

Note: Equal-weight scores are calculated as the average of the 20 standardized indicator shares e_{ij}. Provinces with extremely low values reflect structural differences in indicator contributions rather than absolute development levels.

It is important that the results of the equal-weight calculation show that some provinces have numerical characteristics that are very different from the overall distribution. Tibet's composite score is also low, and Tianjin's equal-weight composite score is much lower than that of other areas. An examination of the initial indicator framework reveals that this conclusion primarily results from the uneven distribution of values in certain indicators. From the perspective of the general ranking framework, except for a few outlier instances, the relative standings of most provinces demonstrate considerable alignment with the entropy-weighted TOPSIS results. This evidence indicates that the principal conclusions of this paper are minimally affected by the weighting methodology. As a result, the results of the equal-weight test further support the strength of the empirical study presented here.

5. Discussion

5.1. Structural Heterogeneity and Regional Driving Mechanisms

The weight distribution from the entropy-weighted TOPSIS framework highlights an important fact: the differences in China's digital economy are not simply a ranking of overall performance, but a significant change in how different regions value their indicators. Different development factors have formed different structural compositions both between and within regions.

The analysis results show that digital finance-related variables (X11-X14) have low to medium weights in all four regions, with no region having a particularly high weight. This does not mean that digital finance is unimportant but rather indicates that its current "structural position" is more like a supporting auxiliary variable. This stage-dependent and condition-dependent assessment is consistent with the regional differences and development stages of digital finance(Li & Zhang, 2024). From the perspective of driving structures, digital finance plays a role in all regions but is still in the development stage. The basic structure of regional digital economies is still based on indicators related to communication scale (X8) and industrial profitability and technology sales capabilities (e.g., X6, X7, X19, X20). The results show that the regional differences in digital economy are caused not only by the differences in the level of development but also by the differences in the structural composition and dominant development mechanisms.

5.2. Theoretical and Policy Implications

This paper's theoretical contributions are reflected in three aspects. First, it expands the explanatory framework for regional digital economy disparities from "single-stage development" to "multi-path-driven structural evolution," emphasizing that regional development is influenced by a combination of factors rather than a fixed linear trajectory, including communication scale, platform industry revenue, technology transfer, and R&D investment. Second, it proposes a verification hypothesis of "driving structural heterogeneity" at the regional level: even in regions with similar growth dimensions (e.g., the central and northeastern regions), the combination of key driving indicators can differ significantly. This makes regional disparity research focus on the reasons for the existence of disparities and the structural configurations that support the generation and expansion of these disparities. This study reveals the existence of multiple driving paths and identifies the mechanisms of path combination, providing an analytical framework for regional digital economy research.

The policy implications of this article can be summarized in one sentence: "Customize structural and path-based development measures." First, the policy focus should shift from "whether to build" to "how to build," emphasizing improving marginal efficiency and the spillover effects of network capabilities, especially in terms of "communication scale." For example, in regions with abundant infrastructure like eastern China, efforts should be made to promote the deep integration of network capabilities with industrial applications, thereby further enhancing the role of digital infrastructure in driving service transformation and industrial innovation (Li & Zhang, 2022). In regions with poor infrastructure, efforts should be made to address network capacity and access issues to prevent the digital divide from widening further. Second, regional strategies should not be generalized; different regions have different structural paths, such as "industry revenue-concentrated," "technology transfer-driven," or "R&D-intensive" models. Efforts should be focused on the combination of key indicators based on each region's resource framework. Finally, although digital finance is not currently the most important factor in most regions, its long-term impact should not be ignored. Conversely, digital finance should be viewed as a "fundamental support" dimension, evolving and advancing alongside industrial digitalization, platform construction, and innovative thinking.

6. Conclusion

At the macro-structural level, communication scale indicators (such as telecommunications service volume) have established a stable foundation in most regions. Indicators such as digital industry revenue, e-commerce scale, and technology market transaction volume show different strengthening trends in different regions, thus collectively creating different driving paths, such as industry synergy-driven, technology transfer-driven, and innovation-enhanced-driven. This also demonstrates that the growth of the digital economy in different regions does not follow a single development path but rather exhibits a multi-path coexistence model. Secondly, within regions, provinces with similar development levels may also have significant differences in the weighting of basic indicators. These differences indicate that the main reason for regional differences in the digital economy is "which combination of factors drives development." This finding deepens the understanding of the causes of regional differences in the digital economy. This study's data results reveal the differences in the development trajectories of regional digital economy economies, thus validating the theory of multi-path driven development models. The findings indicate that regional digital economy policies should not be universal growth strategies but rather tailored to the specific needs of each region.

While this study provides a comprehensive overview of the structural differences in regional digital economies, several significant limitations remain. The constructed indicator system covers four basic dimensions but lacks advanced elements such as data governance capabilities, platform ecosystems, and the application of artificial intelligence. This study employs cross-sectional weighted structural analysis but does not delve into the dynamic evolutionary process. Future research could utilize time series or panel data to explore the structural evolution paths and phased transformation processes of regional digital economies. Also, could use dynamic panel data or spatial econometric methods to study how the regional digital economy develops over time and across different areas.

REFERENCES

[1] Arcesati, R., Holzmann, A., Mao, Y., Nyamdorj, M., Shi-Kupfer, K., von Carnap, K., & Wessling, C. (2020). China's digital platform economy: Assessing developments towards industry 4.0. challenges and opportunities for German actors. https://merics.org/en/report/chinas-digital-platform-economy-assessing-developments-towards-industry-40.

[2] Berczi, A. (1981). Information as a factor of production. Business Economics, 14-20. https://www.jstor.org/stable/23482505.

[3] Boschma, R., & Frenken, K. (2006). Why is economic geography not an evolutionar y science. Towards an evolutionary economic geography. https://doi.org/10.1093/jeg/lbi022.

[4] Brynjolfsson, E., & McAfee, A. (2014). The second machine age: Work progress and prosperity in a time of brilliant technologies. WW Norton & company.

[5] Bukht, R., & Heeks, R. (2017). Defining, conceptualising and measuring the digital economy. Development Informatics working paper(68). http://dx.doi.org/10.2139/ssrn.3431732.

[6] Çelikbilek, Y., & Tüysüz, F. (2020). An in-depth review of theory of the TOPSIS method: An experimental analysis. Journal of Management Analytics, 7(2), 281-300. https://doi.org/10.1080/23270012.2020.1748528.

[7] Chen, P. (2021). Effects of the entropy weight on TOPSIS. Expert Systems with Applications, 168, 114186. https://doi.org/10.1016/j.eswa.2020.114186.

[8] Chen, Z., & Xing, R. (2025). Digital economy, green innovation and high-quality economic development. International Review of Economics & Finance, 99, 104029. https://doi.org/10.1016/j.iref.2025.104029.

[9] China, N. B. o. S. o. (2026). National Bureau of Statistics of China. https://www.stats.gov.cn/english/.

[10] Chirkunova, E., Anisimova, V. Y., & Tukavkin, N. (2020). Innovative digital economy of regions: Convergence of knowledge and information. In Current Achievements, Challenges and Digital Chances of Knowledge Based Economy (pp. 123-130). Springer. https://doi.org/10.1007/978-3-030-47458-4_15.

[11] Dahlman, C., Mealy, S., & Wermelinger, M. (2016). Harnessing the digital economy for developing countries. OECD Development Centre Working Papers. https://doi.org/10.1787/4adffb24-en.

[12] Ding, Y., Guo, J., Ji, Y., Guo, K., & Ma, S. (2025). The digital economy and city innovation convergence–an empirical research based on the innovation value chain theory. Technological and Economic Development of Economy, 31(5), 1583-1618. https://doi.org/10.3846/tede.2025.23567.

[13] Engineering, C. A. o. (2020). Development Status in China. In Industrial Internet: Research on the Development of Electronic Information Engineering Technology in China (pp. 15-28). Springer. https://doi.org/10.1007/978-981-15-7490-0_3.

[14] Esangbedo, M. O., & Wei, J. (2023). Grey hybrid normalization with period based entropy weighting and relational analysis for cities rankings. Scientific Reports, 13(1), 13797. https://doi.org/10.1038/s41598-023-40954-4.

[15] Feng, J., & Qi, S. (2024). Digital infrastructure expansion and economic growth in Asian countries. Journal of Business and Economic Options, 7(2), 27-32. https://resdojournals.com/index.php/jbeo/article/view/356.

[16] Han, J., Song, Y., & Chen, J. (2024). Reducing the "digital divide" to reap the "digital dividend": spatial differences and convergence of the digital economy in cities of China. frontiers in Sustainable Cities, 6, 1283604. https://doi.org/10.3389/frsc.2024.1283604.

[17] Hao, X., Wang, X., Wu, H., & Hao, Y. (2023). Path to sustainable development: Does digital economy matter in manufacturing green total factor productivity? Sustainable Development, 31(1), 360-378. https://doi.org/10.1002/sd.2397.

[18] He, H., He, Z., & Nie, X. (2024). Analysis and study of digital economy level measurement index. Journal of Internet and Digital Economics, 4(3), 187-217. https://doi.org/10.1108/JIDE-05-2024-0020.

[19] He, S., Chung, C. K. L., Bayrak, M. M., & Wang, W. (2018). Administrative boundary changes and regional inequality in provincial China. Applied Spatial Analysis and Policy, 11(1), 103-120. https://doi.org/10.1007/s12061-016-9203-5.

[20] Hu, X., Chu, T. H., Leung, V. C., Ngai, E. C.-H., Kruchten, P., & Chan, H. C. (2014). A survey on mobile social networks: Applications, platforms, system architectures, and future research directions. IEEE Communications Surveys & Tutorials, 17(3), 1557-1581. https://ieeexplore.ieee.org/document/6960871.

[21] Jiao, S., & Sun, Q. (2021). Digital economic development and its impact on econimic growth in China: Research based on the prespective of sustainability. Sustainability, 13(18), 10245. https://doi.org/10.3390/su131810245.

[22] Krugman, P. (1991). Increasing returns and economic geography. Journal of political economy, 99(3), 483-499. https://doi.org/10.1086/261763.

[23] Li, B., & Zhang, S. (2022). Research on the development path of China's digital trade under the background of the digital economy. Journal of Internet and Digital Economics, 2(1), 1-14. https://doi.org/10.1108/JIDE-10-2021-0010.

[24] Li, Q., & Zhang, X. (2024). Digital finance development in China: A scientometric review. Heliyon, 10(16). https://doi.org/10.1016/j.heliyon.2024.e36107.

[25] McCann, P., & Van Oort, F. (2019). Theories of agglomeration and regional economic growth: a historical review. In Handbook of regional growth and development theories (pp. 6-23). Edward Elgar Publishing. https://doi.org/10.4337/9781788970020.00007.

[26] Milskaya, E., & Seeleva, O. (2019). Main directions of development of infrastructure in digital economy. IOP conference series: materials science and engineering (Vol. 497, No. 1, p. 012081). IOP Publishing. https://doi.org/10.1088/1757-899X/497/1/012081.

[27] Moder, I. (2017). Spillovers from the ECB's non-standard monetary policy measures on south-eastern Europe. ECB Working Paper. https://data.europa.eu/doi/10.2866/830401.

[28] Novikova, N., & Strogonova, E. (2020). Regional aspects of studying the digital economy in the system of economic growth drivers. Journal of new economy, 21(2), 76-93. https://doi.org/10.29141/2658-5081-2020-21-2-5.

[29] Ouyang, R., Jing, W., Liu, Z., & Tang, A. (2024). Development of China's digital economy: path, advantages and problems. Journal of Internet and Digital Economics, 4(3), 141-160. https://doi.org/10.1108/JIDE-05-2024-0022.

[30] Polyakov, M., & Kovshun, N. (2021). Diffusion of innovations as a key driver of the digital economy development. Baltic Journal of Economic Studies, 7(1), 84-92. https://doi.org/10.30525/2256-0742/2021-7-1-84-92.

[31] Porter, M. E. (1998). Clusters and the new economics of competition (Vol. 76). Harvard Business Review Boston. https://hbr.org/1998/11/clusters-and-the-new-economics-of-competition.

[32] Qiang, C. Z.-W., Pitt, A., & Ayers, S. (2004). Contribution of information and communication technologies to growth (Vol. 41181). World Bank Publications. https://books.google.hu/books?id=jYneJy0km6QC&lpg=PP7&ots=5IPXfhZ5U0&dq=Contribution of information and communication technologies to growth (Vol. 41181).&lr&hl=zh-CN&pg=PP7 - v=onepage&q&f=false.

[33] Rong, K. (2022). Research agenda for the digital economy. Journal of Digital Economy, 1(1), 20-31. https://doi.org/10.1016/j.jdec.2022.08.004.

[34] Ruan, J., Zou, L., Liu, R., & Pan, H. (2024). The impact of digital economy development on regional income gaps: a perspective on multidimensional inequality decomposition and threshold effects. Mathematics, 12(24), 4024. https://doi.org/10.3390/math12244024.

[35] Shan, S., & Liu, C. (2023). Research on the impact of financial deepening on digital economy development: an empirical analysis from China. Sustainability, 15(14), 11358. https://doi.org/10.3390/su151411358.

[36] Sidorov, A., & Senchenko, P. (2020). Regional digital economy: Assessment of development levels. Mathematics, 8(12), 2143. https://doi.org/10.3390/math8122143.

[37] Simon, D. F. (2021). China's international S&T relations: From self-reliance to active global engagement. Innovation and China's global emergence, 128-151. https://epress.nus.edu.sg/innovationandchina/chaptersix/.

[38] Sturgeon, T. J. (2021). Upgrading strategies for the digital economy. Global strategy journal, 11(1), 34-57. https://doi.org/10.1002/gsj.1364.

[39] Sun, H., Ma, L., Jin, F., & Huang, Y. (2024). Path dependence or path creation of mature resource-based cities: A new firm entry perspective. Journal of Geographical Sciences, 34(3), 499-526. https://doi.org/10.1007/s11442-024-2215-1.

[40] Wang, S., Zheng, Y., & Wang, Q. (2023). Technical standardization and total factor productivity in innovation-driven development: Evidence from China. PloS one, 18(10), e0287109. https://doi.org/10.1371/journal.pone.0287109.

[41] Wang, Z., Lin, S., Chen, Y., Lyulyov, O., & Pimonenko, T. (2024). The digital economy and real economy: The dynamic interaction effect and the coupling coordination degree. Sustainability, 16(13), 5769. https://doi.org/10.3390/su16135769.

[42] Wang, Z.-X., & Wang, Y.-Y. (2014). Evaluation of the provincial competitiveness of the Chinese high-tech industry using an improved TOPSIS method. Expert Systems with Applications, 41(6), 2824-2831. https://doi.org/10.1016/j.eswa.2013.10.015.

[43] Wei, Y. (2025). Research on the spatio-temporal dynamic evolution and driving forces of digital inclusive finance in developing countries: A case study of China. International Review of Economics & Finance, 104590. https://doi.org/10.1016/j.iref.2025.104590.

[44] Williams, L. D. (2021). Concepts of Digital Economy and Industry 4.0 in Intelligent and information systems. International Journal of Intelligent Networks, 2, 122-129. https://doi.org/10.1016/j.ijin.2021.09.002.

[45] Wu, R. M., Zhang, Z., Yan, W., Fan, J., Gou, J., Liu, B., Gide, E., Soar, J., Shen, B., & Fazal-e-Hasan, S. (2022). A comparative analysis of the principal component analysis and entropy weight methods to establish the indexing measurement. PloS one, 17(1), e0262261. https://doi.org/10.1371/journal.pone.0262261.

[46] Yi, L., Xuan, Z., & Wei, Y. (2024). Impact of the digital economy on the integration of traditional manufacturing industry chain and innovation chain: an empirical study based on China's provincial experience. Frontiers of Economics in China, 19(2), 203-225. https://doi.org/10.3868/s060-018-024-0009-2.

[47] Zhang, Y., & Xing, M. (2025). Digital Innovation Networks for Regional Sustainability: An Analysis of Evolutionary Characteristics and Driving Mechanisms in China. Sustainability, 17(23), 10835. https://doi.org/10.3390/su172310835.

[48] Zou, S., Liao, Z., & Fan, X. (2024). The impact of the digital economy on urban total factor productivity: mechanisms and spatial spillover effects. Scientific Reports, 14(1), 396. https://doi.org/10.1038/s41598-023-49915-3.