

Research on the digital economy of the Chengdu-Chongqing twin-city economic circle: spatial structure, formation mechanism, and optimization path

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Abstract. Against the backdrop of the "Digital China" strategy and regional coordinated development, the Chengdu-Chongqing Twin-City Economic Circle, China's "fourth pole" of economic growth, sees its digital economy's development trends and spatial patterns profoundly influencing national regional strategy implementation. Based on regional and spatial economics theories, this paper systematically analyzes the spatial structure characteristics and multi-dimensional formation mechanisms of the region's digital economy, and proposes targeted optimization paths. The study finds the digital economy presents an uneven "dual-core leadership, axis expansion, multi-point clustering" structure, with Chengdu and Chongqing's main urban areas as core growth poles and innovation sources. Its formation results from the joint effect of policy drive, market endogeneity, industrial support, and innovation network synergy. To address challenges like solidified "core-periphery" structure and industrial homogeneity, the paper suggests optimizing development through strengthening top-level design, co-building digital infrastructure, and deepening regional collaborative governance, providing support for fostering a high-quality development growth pole.

1 Introduction

The world today is undergoing unprecedented changes not seen in a century. As a key force in reorganizing global resources, reshaping the global economic structure, and altering the global competitive landscape, the digital economy has become a strategic high ground that countries worldwide are actively seeking to occupy. In China, developing the digital economy is a strategic choice to seize new opportunities brought by the latest technological revolution and industrial transformation. The "14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and the Long-Range Objectives Through the Year 2035" explicitly proposes to "create new advantages in the digital economy" and places the construction of the Chengdu-Chongqing

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Economic Circle alongside the Beijing-Tianjin-Hebei, Yangtze River Delta, and Guangdong-Hong Kong-Macao regions, positioning it as an important growth pole and new source of driving force for high-quality national development. Against this backdrop, in-depth research on the spatial structure, evolutionary mechanisms, and optimization paths of the digital economy in the Chengdu-Chongqing Economic Circle is not only a proactive response to the country's major regional development strategies but also a theoretical innovation and practical need for exploring how inland regions can achieve leapfrog development through the digital economy.

As the most densely populated, industrially solid, and innovatively capable region in western China, the Chengdu-Chongqing area possesses unique advantages and enormous potential for digital economic development. On one hand, both Chengdu and Chongqing are key national bases for the electronic information industry, forming strong industrial clusters in integrated circuits, new displays, smart terminals, and software services. On the other hand, the two locations boast abundant universities and research institutes, providing intellectual support for digital technology innovation. However, compared with mature eastern regions such as the Yangtze River Delta and Guangdong-Hong Kong-Macao, the digital economy in the Chengdu-Chongqing area still faces challenges such as internal structural imbalances, limited radiation effect from core cities, insufficient industrial chain collaboration, and a lower degree of market-oriented allocation of data factors.

Existing literature on the digital economy mostly focuses on the national or provincial macro level or the digital transformation and upgrading of specific industries. Systematic research from a regional spatial perspective, especially on the digital economic spatial pattern of the strategically significant Chengdu-Chongqing area, is still relatively lacking. Based on this, this paper seeks to address three core questions: First, what are the characteristics and patterns of the spatial structure of the digital economy in the Chengdu-Chongqing Economic Circle? Second, what are the intrinsic mechanisms shaping this spatial structure, and which key drivers are influencing its evolution? Third, looking to the future, what optimization paths should be adopted to promote the digital economy in the Chengdu-Chongqing area toward a new stage of higher-quality, more sustainable, and more coordinated development? The answers to these questions aim to provide scientific evidence for government decision-making, offer new perspectives for academic research, and provide valuable experiences for the coordinated development of the digital economy in other regions.

2. Spatial Structure Characteristics of the Digital Economy in the Chengdu-Chongqing Twin-City Economic Circle

Based on a comprehensive analysis of multidimensional data, including the distribution of core digital economy industries (such as electronic information manufacturing, software and information technology services, internet and related services), the density of digital infrastructure (such as 5G base stations, data centers, computing power platforms), digital innovation capabilities (such as patents and research papers), and digital consumption levels, it can be observed that the spatial structure of the digital economy in the Chengdu-Chongqing Twin-City Economic Circle exhibits a typical uneven pattern characterized by "dual-core leadership, axis expansion, and multi-point clusters."

2.1 Dual-Core Leadership: Polarization Effects in the Main Urban Areas of Chengdu and Chongqing

The "dual cores" are the absolute core and engine of digital economic development in the

Chengdu-Chongqing region.

Chengdu Core Area: Centered around the Chengdu Hi-tech Zone (particularly Tianfu Software Park and Financial City) and Chengdu Science City, Chengdu has formed a digital economy industry cluster focused on software and information services, artificial intelligence, big data, and cybersecurity. Leveraging its favorable business environment and talent attraction, Chengdu has gathered a large number of research institutes or regional headquarters of domestic and foreign digital giants such as Tencent, Alibaba, Huawei, and ByteDance, leading the region in digital technology and business model innovation.

Chongqing Core Area: Centered around the Liangjiang New Area and Chongqing Hi-tech Zone, the focus is on integrated circuits, intelligent connected vehicles, the Internet of Things, and industrial internet, covering both hardware and industrial internet sectors. Relying on its strong industrial base, Chongqing stands out in digital manufacturing transformation and industrial internet platform construction, with benchmark examples like Changan Automobile and Seres as well as a number of local industrial internet platforms.

These two cores function both complementarily and competitively. Chengdu leans more toward "soft" aspects, such as software development, platform economy, and digital cultural creativity, while Chongqing emphasizes "hard" aspects, such as smart terminal manufacturing, automotive electronics, and instrumentation. However, both cities face noticeable homogenized competition in frontier areas such as artificial intelligence and big data. This "dual-core" structure generates a strong polarization effect, attracting the majority of capital, technology, data, and high-end talent within the region, resulting in a significant "Matthew effect" in digital economic development.

2.2 Axis Expansion: Ribbon-like distribution along major transportation corridors

The elements and activities of the digital economy are not evenly distributed; instead, they tend to expand along the main transportation infrastructure axes. Currently, several key digital economy development corridors have taken shape:

Chengdu-Chongqing Main Axis (Central Axis): Along major transportation routes such as the Chengdu-Chongqing high-speed rail and the Chengdu-Chongqing Expressway, connecting key cities like Ziyang, Neijiang, and Suining. These cities are actively absorbing industrial spillovers from the two core cities of Chengdu and Chongqing, developing supporting industries such as electronic information component manufacturing, data backup, and call center operations, forming a corridor of industrial linkage.

Chengdu-Mianyang-Leshan Development Belt: Centered on Chengdu, extending north to Deyang and Mianyang (China's Science and Technology City) and south to Meishan and Leshan. Mianyang has strong capabilities in electronic information and military electronics, while Deyang is vigorously developing industrial internet-enabled equipment manufacturing. This axis exemplifies the deep integration of the digital economy with advanced manufacturing.

Chongqing-Fuling-Wanzhou Riverside Development Belt: Centered on Chongqing's main urban area, extending east along the Yangtze River to Fuling and Wanzhou. Relying on the Yangtze River, this axis focuses on smart logistics, digital cultural tourism, and riverside electronic information industries.

These axes form the spatial framework of the digital economy in the Chengdu-Chongqing region. They serve as the main channels through which the core cities exert their influence outward and are key areas for cultivating secondary growth centers in the future.

2.3 Multi-point Clusters: Specialized agglomeration of regional nodes

Beyond the "dual-core" cities and main axes, some prefecture-level cities with relatively strong infrastructure have leveraged their resource endowments and industrial foundations to create several specialized digital economy agglomerations, known as "multi-point clusters."

- Yibin, Luzhou: Leveraging their position as upstream Yangtze River shipping hubs, they are actively developing smart ports, digital logistics, and the digital transformation of the liquor industry.

- Mianyang: With national research institutions such as the China Academy of Engineering Physics, it has formed distinctive clusters in civil-military integrated digital technology and BeiDou applications.

- Yongchuan: Leveraging its vocational education advantages, it is vigorously developing service outsourcing and big data industries, aiming to become the "Western Voice Valley."

- Bishan: Next to Chongqing's main urban area, it focuses on developing new energy vehicles and intelligent equipment.

Although these "points" cannot match the economic scale and capacity of the "dual cores," they are indispensable components of the digital economy ecosystem in the Chengdu-Chongqing region. Through specialized divisions of labor, they complement the core cities and help alleviate excessive spatial polarization to a certain extent.

Overall, the spatial structure of the digital economy in the Chengdu-Chongqing twin-city economic circle is a typical "core-periphery" structure manifested under the dual-core model. The current core tasks are to strengthen the "dual cores," ensure smooth "axes," and activate the "points," promoting the evolution of the spatial structure from a "point-axis" model to a more balanced, efficient, and interconnected "networked" model.

3. The Formation Mechanism of the Spatial Structure of the Digital Economy in the Chengdu-Chongqing Twin-City Economic Circle

The formation of the spatial pattern of the digital economy in the Chengdu-Chongqing area is not accidental. It is the result of the intertwined effects and co-evolution of four forces: policy drive, market endogeneity, industrial base support, and innovation network synergy.

3.1 Policy Drive: Strategic Guidance and Institutional Support from Top-Level Design

Strategic planning and policy support from both the national and local governments are the primary external driving forces shaping the spatial structure.

National Strategic Empowerment: The "Outline of the Plan for the Construction of the Chengdu-Chongqing Twin-City Economic Circle" lists "jointly building a nationally influential science and technology innovation center" and "creating a new high ground for the digital industry" as core objectives. At the national level, it clarifies the strategic positioning of the Chengdu-Chongqing region in developing the digital economy, providing top-level legitimacy for factor agglomeration and project layout.

Local Policy Competition and Cooperation: Sichuan Province and Chongqing City have successively introduced a series of special plans and supportive policies for digital economy development, new infrastructure, and talent attraction. For example, Chengdu's "New Policies for the Digital Economy" and Chongqing's "Big Data and Intelligent

Development Strategy." These policies guide digital economy enterprises to aggregate in specific areas (such as high-tech zones and new districts) through fiscal subsidies, land incentives, and tax reductions, directly shaping the "cluster" form of the spatial layout. At the same time, the "competition and cooperation" relationship between the two local governments has not only promoted the rapid development of their respective core areas but also, to some extent, caused industrial homogeneity and resource competition.

3.2 Market Endogeneity: Spontaneous Agglomeration of Economies of Scale and Scope

The market mechanism is a fundamental force driving spatial differentiation in the digital economy.

Pursuit of Returns by Factors: High-level production factors such as capital, talent, and technology naturally tend to flow to regions with high investment returns, a strong innovation atmosphere, and fast information circulation. As regional central cities, Chengdu and Chongqing possess well-developed urban functions, advanced financial services, and abundant consumer markets, creating a strong "siphon effect" for digital economy enterprises and highly skilled talent. This provides the market basis for the formation of the "dual-core" structure.

Industrial Linkages and Agglomeration Economies: The digital economy features significant knowledge spillovers and network effects. Spatial proximity of enterprises allows them to share labor markets, professional service providers, technological information, and critical infrastructure, significantly reducing transaction and innovation costs. The success of platforms such as Tianfu Software Park and Liangjiang Digital Economy Industrial Park illustrates the benefits of agglomeration economies. The presence of leading enterprises (e.g., Huawei, Tencent) attracts upstream and downstream supporting companies, creating a "swarm effect" that further strengthens the status of core areas.

3.3 Industrial Foundation Support: Historical Accumulation and Path Dependence

The existing industrial foundation provides the fertile ground for the growth of the digital economy, with a spatial distribution strongly characterized by path dependence.

Deep Roots in Electronics Manufacturing: The Chengdu-Chongqing region was a major electronics industrial base during the country's "Third Front" construction period, accumulating a large workforce, as well as technical and management experience. This historical heritage provides a solid foundation for the current development of digital core industries such as integrated circuits, new displays, and smart terminals, and determines that these industries are mainly concentrated in Chengdu, Chongqing, and surrounding areas.

Digitalization Demand of Traditional Advantage Industries: The Chengdu-Chongqing region is an important base for China's automobile, equipment manufacturing, defense, and liquor industries. The substantial digital transformation needs of these traditional industries offer a wide local market and application scenarios for the development of characteristic digital industries such as industrial internet, intelligent manufacturing, and smart energy, giving rise to specialized development paths such as industrial internet in Chongqing and defense digitalization in Mianyang.

3.4 Innovative Network Synergy: The Engine of Knowledge Creation and Diffusion

Innovation is the core driving force behind the development of the digital economy, and its spatial distribution is closely linked to the construction of innovation networks.

Uneven spatial distribution of scientific and educational resources: Chengdu and Chongqing concentrate the vast majority of high-level universities in the region (such as Sichuan University, University of Electronic Science and Technology, and Chongqing University) as well as national-level research institutions. These institutions are the sources of knowledge creation, technological R&D, and talent cultivation. Their uneven spatial distribution directly leads to the high concentration of digital technology innovation capabilities in the 'dual cores.'

Construction of collaborative innovation platforms: In recent years, Chengdu and Chongqing have jointly promoted the development of a number of high-level innovation platforms, such as the Western Science City (Chengdu Science City, Chongqing Science City) and the National Digital Economy Innovation and Development Pilot Zones. These platforms aim to break administrative barriers and facilitate the cross-regional flow of innovation elements, serving as key measures to drive the spatial structure from 'isolated dual cores' to 'linked dual cores.' However, the current depth and breadth of collaborative innovation still need to be improved.

In summary, these four forces are interlinked and mutually causal, collectively shaping the current spatial pattern of the digital economy in the Chengdu-Chongqing economic circle. Policy power guides market forces, industrial foundations provide a stage for market and innovation forces, while innovation capabilities, in turn, enhance industrial levels and influence the formulation of subsequent policies.

4. Challenges and Optimization Paths for the Development of the Digital Economy in the Chengdu-Chongqing Twin-City Economic Circle

Despite remarkable achievements, the development of the digital economy in the Chengdu-Chongqing twin-city economic circle still faces a series of deep-seated challenges that urgently need to be addressed through scientific optimization paths.

4.1 Major Challenges

The "core-periphery" structure is solidified, and the digital divide within the region is evident: The polarization effect of the "dual-core" is far stronger than its diffusion effect, leaving surrounding small and medium-sized cities at a disadvantage in accessing digital resources and sharing development dividends. There is a risk of these areas becoming "digital depressions," which restricts the overall competitiveness of the region.

Industrial homogenization is intensifying, and a collaborative and complementary pattern has yet to take shape: Chengdu and Chongqing have very similar layouts in popular fields such as artificial intelligence, big data, and cloud computing, leading to redundant construction and resource internal consumption. There is a lack of a clear roadmap for functional complementarity and differentiated development based on the division of labor along the industrial and value chains.

Reform of the market-oriented allocation of data elements is lagging, and an integrated large market has yet to be established: As a key production factor, data still faces many institutional and technical obstacles in terms of attribution, pricing, trading, and cross-

border flow between Chengdu and Chongqing. The sharing of government data and the openness of public data are not high, limiting the full empowerment of data element value.

Collaborative governance mechanisms are not well-established, and policy "fragmentation" is prominent: The governments of both cities have not yet achieved full coordination in planning alignment, standard mutual recognition, market supervision, and statistical assessment. The phenomenon of "each singing their own tune" still exists, affecting the efficiency and effectiveness of regional integration development.

4.2 Optimization Pathways

To address the challenges mentioned above and promote the Chengdu-Chongqing dual-city economic circle's digital economy toward higher quality, greater efficiency, more fairness, and sustainability, the following optimization pathways are proposed:

① Strengthen top-level design and coordinated governance to create an "integrated chessboard" structure.

- Establish a high-level coordination mechanism: Under the existing cooperation framework, set up the "Chengdu-Chongqing Digital Economy Development Committee" led by national and local senior leaders, responsible for formulating cross-regional medium- and long-term development plans, industrial guidance catalogs, and negative lists for the digital economy.

- Promote policy and standard integration: Unify preferential policies and technical standards in areas such as new infrastructure, data governance, industrial support, and talent recognition between the two cities to eliminate policy barriers. Explore the establishment of a unified digital economy statistical monitoring indicator system for the Chengdu-Chongqing region.

- Implement differentiated assessments: Conduct classified evaluations for core and key cities, guiding Chengdu and Chongqing to focus more on original innovation and high-end services, while directing key cities to concentrate on specialized applications and industrial support, forming a mutually beneficial incentive mechanism.

② Jointly Build and Share New Digital Infrastructure to Strengthen the Foundation for Integrated Development.

- Jointly build a national integrated computing power network with Chengdu-Chongqing as a national hub: Coordinate the layout of data centers and computing centers to avoid redundant construction. Promote the coordination and scheduling of computing power between Chengdu, Chongqing, and other hub cities, creating an important base for the "East Data, West Computing" initiative.

- Jointly build a Chengdu-Chongqing integrated industrial Internet demonstration zone: Support leading enterprises in both regions to jointly create industrial Internet platforms across industries and fields, enable manufacturing enterprises in both areas to "migrate to the cloud, utilize data, and empower with intelligence," and achieve data connectivity and intelligent collaboration across the entire industry chain.

- Collaboratively build a smart city cluster: In public service areas such as transportation, environmental protection, healthcare, and social security, promote data interconnection, application interoperability, and business collaboration, taking the lead in implementing "one-stop online services" and "one-code access," enhancing the digital well-being of local residents.

③ Build a differentiated and collaborative industrial ecosystem to enhance global competitiveness.

- Clarify the functional positioning of the "dual cores": It is suggested that Chengdu focuses more on software, key algorithms, digital cultural and creative industries, fintech, and other areas of "soft strength" and original innovation, while Chongqing concentrates

more on industrial Internet, intelligent connected vehicles, high-end smart equipment, digital warehousing and logistics, and other areas of "hard technology" and integrated innovation. This will form a virtuous cycle of "Chengdu R&D, Chongqing transformation" and "Chengdu software, Chongqing hardware."

- Promote deep integration of industrial and supply chains: Jointly compile a panoramic map of key digital economy industrial chains in Chengdu and Chongqing, work together to fill gaps, strengthen chains, and extend chains. Encourage leading enterprises in the dual cores to prioritize supporting links in hub cities along the axis, and build several cross-regional digital economy industrial cluster belts.

- Co-develop a digital technology open-source ecosystem: Together with universities, research institutes, and enterprises, jointly initiate the establishment of the Chengdu-Chongqing Digital Economy Open Source Foundation, focusing on key areas such as operating systems, databases, and artificial intelligence frameworks, to cultivate open-source communities and projects with international influence.

④ Deepen the market-oriented reform of data elements and stimulate endogenous motivation.

- Jointly build a Western data trading platform: Relying on the foundations of the Chongqing Big Data Exchange and the Chengdu Data Exchange, explore the formation of a unified Chengdu-Chongqing data trading institution, and establish a full-process market system covering data ownership confirmation, pricing, evaluation, settlement, and security auditing.

- Take the lead in exploring data cross-border flow security regulations: Utilize free trade pilot zones and other open platforms to carry out pilot management of cross-border data transmission security under the premise of ensuring safety, creating conditions for the development of digital trade.

- Promote the orderly opening and sharing of government and public data: Develop a public data opening list and standards for the Chengdu-Chongqing region, giving priority to high-frequency, high-value data in transportation, environmental protection, healthcare, credit reporting, etc., for secure and orderly use between governments and for the public.

⑤ Build a hub for digital talent and strengthen the supply of innovation sources.

- Implement the "Chengdu-Chongqing Digital Talent Community" plan: Establish mutual recognition of talent evaluation standards and professional title recognition mechanisms between the two regions, achieving seamless integration of policies regarding talent settlement, children's education, and medical guarantee.

- Co-build and share high-end R&D platforms: Encourage universities such as the University of Electronic Science and Technology of China and Chongqing University to jointly establish cross-regional modern industrial colleges and postdoctoral workstations with enterprises, collaboratively attracting and cultivating strategic scientists, leading industry talents, and high-level innovation teams in the digital economy sector.

- Create an internationally first-class innovation and entrepreneurship environment: Jointly host globally influential digital economy summits, innovation competitions, and project roadshows to attract the world's top digital economy talents and capital to gather in Chengdu-Chongqing.

5. Conclusion and Outlook

The spatial structure of the digital economy in the Chengdu-Chongqing Twin-City Economic Circle is the result of the combined effects of various forces at a particular stage of development. Its distinctive characteristics of "dual-core leadership, axis expansion, and multi-point clusters" not only reflect the significant achievements of regional development but also reveal deep-seated internal imbalances and inconsistencies. The formation

mechanism is rooted in the complex interaction among four major drivers: policy, market, industry, and innovation. Looking ahead, to promote a historic leap for the digital economy in the Chengdu-Chongqing region from "agglomeration" to "coordination" and from "scale" to "quality," it is essential to adopt a systematic approach. Efforts must be continuously made in top-level planning, infrastructure, industrial ecology, factor markets, and talent cultivation and attraction, breaking administrative barriers and enhancing policy coordination to ensure the smooth flow of production factors over a wider area.

Looking to the future, a Chengdu-Chongqing digital economy community with an optimized spatial layout, more rational functional division, a more complete industrial system, and stronger innovation momentum will not only robustly support the Chengdu-Chongqing Twin-City Economic Circle in becoming China's "fourth economic pole," but also pave a replicable and scalable path for inland regions to achieve transformation, upgrading, and high-quality development through digital economy growth. This would contribute a unique "Chengdu-Chongqing plan" to the construction of a "Digital China."

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