Practical Dilemmas and Governance Countermeasures for the Advancement of Digital Economy Driven by Big-data Technologies

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Abstract: The digital economy has emerged as a core growth engine for high-quality economic development in China. As a fundamental production factor and core technological foundation, big data continuously advances industrial digital transformation, fosters new business forms and systems, and reshapes patterns of market division of labor and resource allocation. Based on the current status of China's digital economy, this study sorts out prominent practical challenges arising from big-data-enabled digital economy development. It further analyzes the root causes of such dilemmas with reference to industry statistical data. Systemic governance countermeasures are proposed from four dimensions: factor supply, industrial integration, regulatory frameworks and security governance. The findings aim to fully unlock the value of big-data factors and facilitate the standardized, sound and sustainable growth of the digital economy.

Keywords: Big Data; Digital Economy; Data Factors; Industrial Digitalization

1. Introduction

According to the China Digital Economy Development Report (2025) released by the China Academy of Information and Communications Technology, China's digital economy reached RMB 58.9 trillion in 2025, accounting for 47.2 % of national GDP. The scale of industrial digitalization hit RMB 49.7 trillion, representing 84.4 % of the total digital-economy output. Digital infrastructures including big-data platforms, computing-power centers and data trading markets underpin industrial digitalization. By identifying inherent correlations within massive multi-source datasets, big data supports flexible production in manufacturing, precise matching in service industries and intelligent upgrading of agriculture, amplifying scale effects and innovation effects across the digital economy [1]. Against this backdrop, identifying bottlenecks constraining big-data-driven digital-economy growth and establishing modern governance systems tailored to big-data characteristics carries substantial practical significance for steady economic expansion and the cultivation of new-quality productive forces.

2. Opportunities for Digital-Economy Development in the Big-Data Era

2.1 Data factors Empower Traditional Industries and Advance Substantive Upgrading of Industrial Structures

The primary value of big-data technologies lies not merely in creating digital tools, but in renovating diverse industries with such tools. Integration practices represented by "industrial brains" demonstrate that incorporating data factors into production workflows directly improves factor-allocation efficiency. For instance, one provincial administrative region leverages its comprehensive industrial base covering 41 industrial categories. It feeds process and supply-demand datasets into a provincial capability hub to train vertical large-scale models, enabling "algorithm-guided steelmaking" for iron-and-steel manufacturers and cutting overall operating costs by nearly RMB 200 million per year. The pulp-and-paper industrial brain connects 17 000 suppliers and 22 000 end-user clients, bringing about a 12 % drop in per-ton paper energy consumption and an 8 % reduction in logistics expenses. China's total domestic data output reached 52.26 zettabytes in 2025, marking a 27.28 % year-on-year increase. This statistic indicates that multiplier effects generated by data factors in manufacturing, logistics, agriculture and other sectors have expanded from isolated pilot cases

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toward large-scale implementation [1].

2.2 Big Data Reshapes Decision-Making Systems and Enhances Precision in Economic Operations and Public Governance

Shifting from experience-based to data-driven decision-making constitutes a profound contribution of big-data technologies to the digital economy. The "Data Factor X" Three-Year Action Plan issued by the National Data Administration has rolled out 417 typical cases and 760 scenario-specific guidelines covering 11 industrial sectors, spanning manufacturing, commercial circulation, financial services and other key domains. At the corporate level, big-data-powered intelligent decision-making has lowered inventory costs by 20 % within selected industries, accelerated decision-response speed by 30 %, and pushed price-forecasting accuracy above 70 %. In public-governance contexts, aggregated real-time data monitoring transforms industrial regulation from ex-post statistics into dynamic foresight, mitigating resource misallocation triggered by information asymmetry [2].

2.3 A Fast-Growing Data-Industry Ecosystem Provides Institutional Carriers for Digital-Economy Expansion

China's data-industry scale attained RMB 6.78 trillion in 2025, rising 15.7 % year-on-year. The country hosted 482 000 data-oriented enterprises, representing a 17.9 % annual increase. Data-trading markets have expanded concurrently: 46 sustainably-operational data exchanges are distributed across 21 provincial-level administrative regions. On-site transaction volume through these exchanges approaches RMB 80 billion, while the overall data-trading market exceeds RMB 220 billion [3]. These figures signal that data-factor circulation is evolving from fragmented peer-to-peer transactions toward organized, rule-based market-oriented allocation, laying institutional infrastructure for long-term digital-economy growth.

3. Practical Dilemmas for Digital-Economy Development under Big-Data Technologies

3.1 Prominent Barriers to Data-Factor Circulation and Widespread Data Silos

Free circulation of data factors serves as a prerequisite for big-data-enabled digital-economy development. Nevertheless, cross-departmental, cross-industrial and cross-regional data barriers persist, and data silos remain major obstacles preventing full realization of data-factor value. Within governmental bodies, independent development of business systems across public-security, market-regulation, taxation, housing-and-urban-rural-development departments creates inconsistent data standards and incompatible application interfaces, resulting in fragmented storage of government data. Public-data resources feature limited openness and substandard data quality. Research conducted by the Cyberspace Administration of China suggests that high-value structured datasets suitable for direct modeling and analysis make up less than 22 % of datasets published on provincial-level public-data open platforms. Most publicly available datasets exist as unstructured raw materials, forcing enterprises to incur substantial secondary-processing costs before practical application [4].

Market-side participants also suffer from data monopolies and reluctance toward data sharing. Leading internet platforms hold massive user datasets concerning consumption patterns, web traffic and user behaviors. For competitive reasons, such platforms resist granting small- and medium-sized enterprises access to their datasets. Upstream-and-downstream industry participants show minimal willingness for data sharing, creating disconnections among production, logistics and sales datasets. Manufacturing-sector surveys reveal that merely 16.7 % of large-scale industrial enterprises in China have achieved end-to-end internal data integration. Most small- and medium-sized enterprises possess inadequate digital foundations, lack standardized data-collection systems, adopt divergent data-recording metrics, and face incompatibility among equipment and software systems [5]. Under such constraints, big-data technologies deliver benefits only within localized scenarios and fail to realize value-adding effects across entire industrial chains, as shown in Figure 1.

3.2 Insufficient Deep-Level Industrial Integration of Big Data and Notable Supply-Demand Mismatches in Digital Transformation

High-quality digital-economy growth hinges on deep integration between big data and the real

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economy. Currently, big-data applications concentrate heavily on consumer-oriented internet services, while adoption within manufacturing, agriculture and traditional service sectors remains superficial, accompanied by marked supply-demand mismatches in digital-transformation practices. On the supply side, big-data service providers frequently produce homogeneous products. Most big-data platforms prioritize generic data-analytics modules and visual-reporting tools, with limited tailored solutions for niche industries. Sampling statistics for China's big-data industry show that consumer-focused big-data products account for 63 % of total market output, whereas industry-specific big-data models and industrial-data-analytics platforms for advanced manufacturing and smart agriculture represent less than 25 % of market offerings.

From the demand perspective, traditional enterprises exhibit stratified gaps in digital capabilities. Large corporations possess sufficient capital to build proprietary big-data centers and deploy industrial-internet platforms. By contrast, numerous micro, small and medium-sized enterprises (MSMEs) encounter obstacles described as "incapacity, unaffordability and risk aversion regarding digital transformation" [6]. Surveys released by the Ministry of Industry and Information Technology in 2025 indicate that merely 38.1 % of Chinese MSMEs have completed digital transformation. Many corporate managers associate big-data adoption exclusively with online marketing and order intake, with little awareness of advanced use-cases such as production-process optimization, energy-consumption management and quality traceability.

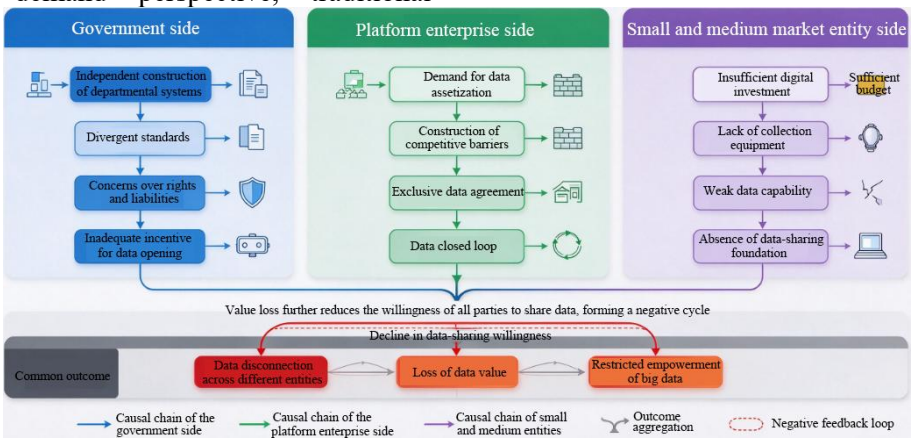


Figure 1. Mechanisms Underlying Data-Silo Formation among Diverse Stakeholders in China

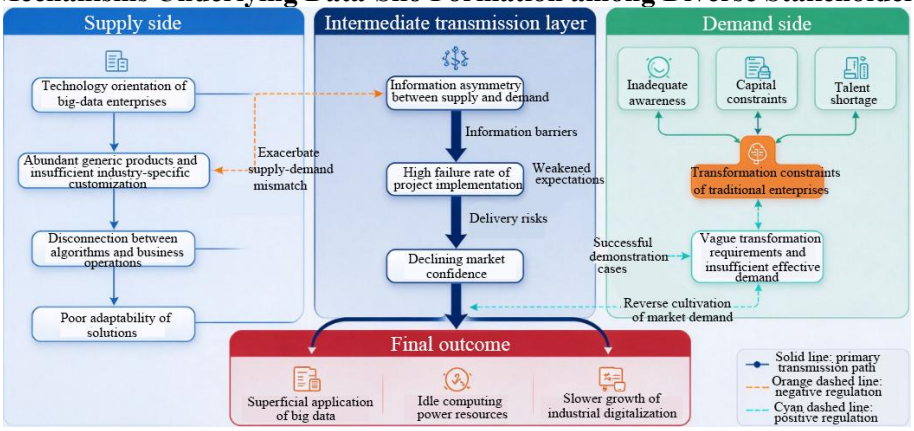


Figure 2. Transmission Pathways of Supply-Demand Mismatches in Big-Data Industrial Integration

Table 1. Distribution of Data-related Dispute Categories in China (2022-2024)

Dispute Category	Case Count (2022)	Percentage	Case Count (2023)	Percentage	Case Count (2024)	Percentage	Average Annual Growth Rate	Core Dispute Focus
Personal-information	1246	41.2 %	1572	42.5 %	1935	43.7 %	24.7 %	Illegal and excessive

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infringement								personal-data collection
Data ownership and revenue allocation	683	22.6 %	841	22.7 %	1107	25.0 %	27.4 %	Ownership demarcation for public and user-generated data
Illegal data trading	571	18.9 %	653	17.6 %	726	16.4 %	12.7 %	Black-market sales of desensitized data, crawler-based data scraping
Algorithm discrimination and platform-related conflicts	314	10.4 %	406	11.0 %	492	11.1 %	25.2 %	Price discrimination via big-data profiling, traffic-allocation bias
Other data-related disputes	210	6.9 %	230	6.2 %	167	3.8 %	-10.7 %	Breach of contract in data-service agreements
Total	3024	100 %	3702	100 %	4427	100 %	21.1 %	—

3.3 Ambiguous Definition of Data Ownership and Fairness Risks Stemming from Inadequate Algorithm Governance

Multiple stakeholders participate in generating big-data resources. Complex ownership divisions emerge throughout data collection, processing and circulation. Existing regulatory frameworks cannot fully accommodate the characteristics of data factors. Raw personal information intertwines with corporate operational datasets and public data, giving rise to growing disputes over data infringements and unauthorized data transactions. Statistics from China Judgements Online demonstrate that the volume of data-related lawsuits rose by 27.4 % year-on-year in 2025. More than 60 % of these litigations revolve around disputes over data ownership and revenue distribution, as shown in Table 1.

Challenges including algorithmic black boxes, algorithmic discrimination and price discrimination via big-data profiling undermine market fairness. Algorithms trained on historical datasets may produce disparate outcomes in credit assessment, job-recommendation systems, platform pricing and traffic-resource allocation. Platform-economy special monitoring data published by the State Administration for Market Regulation in 2025 reveal that 18.3 % of sampled platforms display evidence of differentiated pricing and big-data-driven price discrimination. Furthermore, algorithmic operations remain opaque to ordinary end-users, who cannot interpret underlying decision-making logics [7]. Regulators face substantial difficulties in verifying and tracing complex algorithmic systems, as shown in Figure 3.

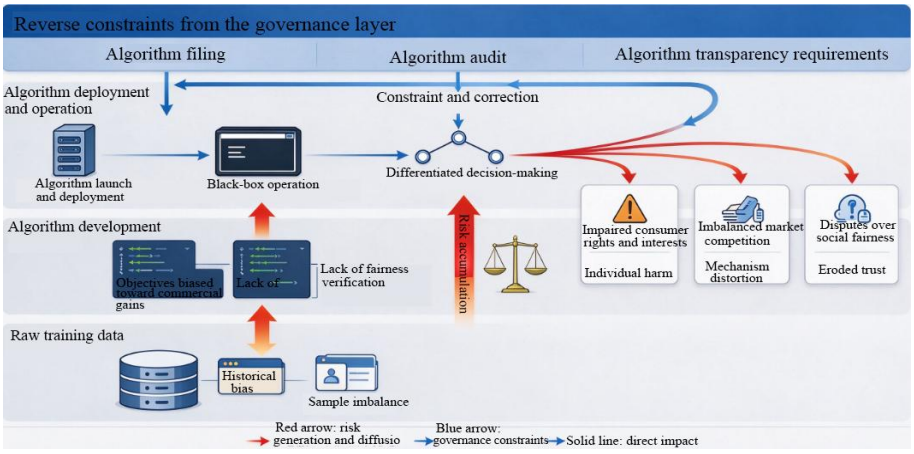


Figure 3. Formation and Diffusion Structure of Algorithmic Risks

3.4 Mounting Data-Security Pressures and Substantial Shortages of Interdisciplinary Digital-Talent Pools

Expansion of computing-power centers and data-trading markets multiplies data-storage nodes and enlarges potential attack surfaces. Data released by the National Vulnerability Database of China shows that high-risk vulnerabilities linked to data security reported throughout 2025 climbed by 19.6 % year-on-year. High-value datasets held within government, healthcare and financial-service institutions constitute primary cyber-attack

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targets. Many small-scale organizations underinvest in data security and lack tiered-and-classified data-management frameworks. Deficiencies persist in data desensitization, access-permission control and security auditing protocols. Unauthorized data export and leakage perpetrated by internal staff occur recurrently [8].

Meanwhile, shortages of interdisciplinary big-data professionals represent a long-standing bottleneck. Big-data governance demands competencies spanning statistics, machine learning and computing-power technologies, paired with familiarity with industrial rules and legal norms. Reports on big-data-industry human resources compiled by the Ministry of Human Resources and Social Security estimate that China faced a talent shortfall exceeding 2.5 million for big-data-related positions in 2025. University curricula prioritize pure computer-science training, with few interdisciplinary programs integrating big-data applications, industry practice and data-related legal governance. Fierce corporate competition for skilled personnel discourages big-data analysts and cybersecurity engineers from taking up positions in smaller cities and traditional industries, as shown in Figure 4.

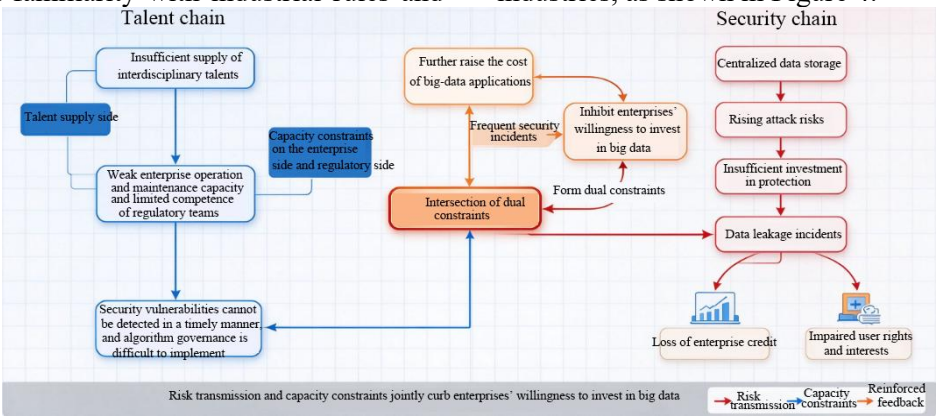


Figure 4. Transmission of Big-data Security Risks and Impacts of Talent Shortages

4. Governance Countermeasures for Big-Data-Driven Digital-Economy Growth

4.1 Optimize Data-Factor Circulation Frameworks and Systematically Dismantle Data Silos

First, national and industry-specific competent authorities ought to accelerate development of unified data standards covering collection, encoding, desensitization and interface specifications for government-administrative, industrial-production and supply-chain datasets. Harmonized standards will enhance format compatibility across heterogeneous business systems and hardware devices. Public data resources should undergo tiered-and-classified opening, whereby datasets are categorized as unconditionally open, open-upon-application or non-disclosable. High-value structured public datasets pertaining to transportation, meteorology, business environments and industrial statistics deserve priority publication to improve the practical usability of open-access data [9].

Second, data-trading markets should receive standardized cultivation. Existing data exchanges shall refine rules governing data-asset registration, valuation, pricing and settlement, prioritizing transactions of data-usage rights while preventing disorderly transfer of data ownership. Leading enterprises within industrial chains should be encouraged to establish industry-wide data-sharing alliances. After adequate desensitization and de-identification procedures, participating firms may share production, logistics and inventory datasets across supply chains.

Third, incentive mechanisms for data sharing should be instituted. Policy subsidies and tax incentives may reward market entities contributing legally compliant datasets, offsetting costs incurred by data providers while generating reasonable returns. Antitrust supervision shall constrain unreasonable data-hoarding behaviors by large platforms and prevent dominant corporations from building exclusionary competitive barriers through control over data resources.

4.2 Deepen Integration Between Big Data and the Real Economy and Mitigate Supply-Demand Mismatches in Digital Transformation

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On the supply side, big-data service providers should be incentivized to cultivate vertical-sector expertise. Collaborative partnerships between big-data enterprises, industry associations, leading manufacturers and research institutes facilitate development of sector-specific big-data models. Lightweight, cost-effective solutions targeting smart manufacturing, precision agriculture, energy-management and supply-chain optimization will alleviate homogeneous competition centered on generic products. Authorities should support industrial-internet-platform construction. Accumulated domain-specific process data can be utilized to train algorithms for quality inspection, energy-consumption optimization and predictive equipment maintenance tailored for real-world production scenarios.

On the demand side, governments should promote digital transformation among MSMEs through tiered, categorized interventions. Digital-transformation subsidies and inclusive computing-power policies ought to be implemented, and lightweight SaaS-based big-data tools popularized to lower technical-adoption thresholds for small businesses. Service providers may deliver free digital-diagnosis services and training workshops to help MSMEs identify feasible digital-upgrade priorities, focusing first on low-cost, fast-return application scenarios. Policymakers shall rationally plan computing-power-infrastructure deployment to curb redundant construction of large-scale computing hubs. Cross-regional computing-power-scheduling platforms should be built to improve overall resource-utilization efficiency [10].

4.3 Clarify Rules Governing Data Ownership and Establish End-to-End Algorithm-Governance Frameworks

Building upon the Data Security Law of the People's Republic of China, Personal Information Protection Law of the People's Republic of China and Interim Measures for the Administration of Generative Artificial Intelligence Services, regulatory authorities shall refine ownership-related provisions distinguishing personal information, corporate operational datasets and public-sector data. Clear boundaries for rights and obligations must be defined for data collection, processing and circulation workflows. Fair revenue-distribution mechanisms should guarantee legitimate interests of data producers, processors and platform operators within data-value-adding scenarios.

Regularized algorithm-supervision mechanisms should be enhanced. Mandatory algorithm filing, safety assessment and algorithm-auditing systems shall be enforced. Large-scale platforms are required to conduct periodic self-inspections for algorithmic fairness and retain algorithm-operation logs to enable regulatory traceability and verification. Dedicated complaint channels for algorithm-related grievances shall be introduced to curb price discrimination via big-data profiling, traffic bias and credit-evaluation prejudice, reinforcing principal responsibilities of platform operators [11]. Public-oriented algorithms should achieve higher transparency: plain-language explanations of core algorithmic logic should be communicated to end-users. Manual review procedures shall be activated for algorithmic outputs that significantly affect stakeholder rights and interests. Regulators should strike a balance between technological innovation and fair oversight. Differentiated regulatory standards for innovative small-scale firms prevent over-regulation from stifling big-data-technology advancement.

4.4 Reinforce Data-Security Safeguards and Build Multi-Layered Interdisciplinary Talent-Development Systems

Tiered-and-classified data-protection mechanisms shall be enforced. Key industries including finance, healthcare, energy and public administration need differentiated protective strategies aligned with data-sensitivity levels. Technical workflows for data desensitization, access-permission administration, operational auditing and backup recovery should be perfected. Enterprises may deploy zero-trust security architectures to monitor internal data-access activities and mitigate insider-driven data-leakage risks. Routine cybersecurity emergency drills and rapid response-and-reporting protocols for data-breach incidents are essential. Law-enforcement agencies must intensify crackdowns on unauthorized web crawling and underground data-trading networks to disrupt illegal-data-transaction value chains.

For talent development, higher-education institutions should revise big-data-related

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curricula by introducing interdisciplinary coursework covering industrial applications, data legislation and cybersecurity. Joint-training internship bases co-developed with industry partners will nurture work-ready specialists. Local governments may roll out talent-attraction subsidies to draw big-data and cybersecurity professionals toward traditional-industry sectors and grassroots digital-governance positions. Administrators and regulatory officials should receive systematic big-data-governance training. Public-awareness campaigns will elevate general-population understanding of data security. Multi-party exchange platforms may foster collaboration among data-technology specialists, industrial practitioners and legal professionals to narrow gaps in interdisciplinary governance talent.

5. Conclusion

To sum up, as a core production factor and technological foundation underpinning the digital economy, big-data technologies deliver powerful impetus for fostering new-quality productive forces and advancing industrial upgrading in China. Nevertheless, data silos, shallow industrial integration, ownership-related ambiguities, algorithm-governance risks and constraints arising from insufficient security capabilities and talent pools jointly hinder big-data-enabled digital-economy advancement . Addressing these practical bottlenecks cannot rely solely on technical iteration. A modern data-governance system characterized by consistent standards, unobstructed data circulation, proportionate regulation and robust security safeguards must be constructed to fully unlock dividends generated by data factors. Moving forward, ongoing refinement of foundational data institutions will facilitate deeper integration of big-data technologies into real-economic activities and propel sustained high-quality development of China's digital economy.

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