Research on the Multi-sided Platform Operational Mechanism for Public Data Authorized Operations: Postprint

Authors: Delia

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Abstract

[Purpose/Significance] The multi-sided platform for authorized operation of public data is an important vehicle for achieving high-quality, high-value transactions of public data, and a necessary condition for promoting the rapid and effective flow of public data elements. [Method/Process] This paper applies a heuristic case study methodology, conducting an in-depth analysis of the operational mechanisms and implications of multi-sided platforms for local government public data authorized operation in China through a comparison of the Beijing Financial Public Data Zone Operation Platform and the Chengdu Public Data Authorized Operation Platform. [Results/Conclusion] It proposes policy recommendations to strengthen data standardization management capabilities on the supply side, construct a risk collaborative supervision mechanism for human "meaningful control" of multi-sided platforms, and enhance the transparency of boundary resources of operational multi-sided platforms.

Full Text

Preamble

This paper, titled "Research on the Operating Mechanism of Multilateral Platforms for Public Data Authorized Operation," appears in the *Journal of Library and Data Science* (Vol. 6, No. 2, June 2024). The author is Di Liya from the School of Humanities and Law at Yanshan University, Qinhuangdao. The research is supported by the National Social Science Fund General Project "Research on the Dynamic Mechanism of Deep Government Data Opening Under the Background of Data Fully Entering the Production Factor System" (Project No. 21BTQ077). The author specializes in government data opening, personal information protection, and e-government, and can be contacted at diyanda@sina.com.

Abstract

[**Purpose/Significance**] The multilateral platform for authorized operation of public data serves as a crucial vehicle for achieving high-quality, high-value transactions of public data and constitutes a necessary condition for promoting the rapid and effective flow of public data as a production factor. [**Method/Process**] This study employs a heuristic case study methodology, comparing the Beijing Financial Public Data Zone Operation Platform and the Chengdu Public Data Authorization Operation Platform to analyze the operational mechanisms and implications of local government public data authorization multilateral platforms in China. [**Result/Conclusion**] The paper proposes recommendations to strengthen data standardization management capabilities on the supply side, construct a risk collaborative supervision mechanism based on human "meaningful control," and enhance the transparency of boundary resources for operating multilateral platforms.

Keywords: Public data; Authorization operation; Multilateral platforms; Operating mechanism

1 The Meaning of Public Data Authorized Operation Multilateral Platforms

Multilateral platforms originated from research on two-sided market platform competition by scholars such as Tirole. Two-sided platforms, as the name suggests, refer to cooperative networks of stakeholders centered on a bilateral platform, primarily comprising the platform company, supplier users, and demand-side users. With the continuous development of the internet platform economy, platforms as intermediaries have evolved beyond being mere bridges between two sides—connecting product suppliers and consumers—to become multilateral entities linking multiple distinct user groups and associated stakeholders.

Public data authorized operation represents a crucial model for China's deep opening and utilization of data and an important stage in enabling public data factor circulation. One of its fundamental purposes is to promote the circulation of public data factors, providing essential pathways, scenarios, and environments for data value realization. This approach not only helps address issues such as uneven distribution of benefits and structural imbalances among stakeholders in China's data factor market but also stimulates the scale effect of data factors, multiplying their value. Based on current local practice cases in China, stakeholder cooperation centered on public data authorized operation platforms has become the main trend. The establishment of multilateral platforms primarily resolves issues related to data supply chain provision, stakeholder interest coordination, public data factor innovation, and security supervision. This paper defines public data authorized operation multilateral platforms as public data supervision and circulation platforms that, to promote high-quality deep opening and circulation utilization of public data factors in China, employ government-authorized enterprise operation. These platforms utilize infrastructure, network

carriers, resources, and governance rules to link diverse interest groups, integrate supply-side data resources, and facilitate supply-demand matching and interactive cooperation to create public value.

2 Literature Review

Although foreign scholars have not specifically studied public data authorized operation multilateral platforms, research on data multilateral platforms is relatively advanced, focusing on several key areas:

First, research on value co-creation in data multilateral platform ecosystems. For instance, Jetzek [1] argues that applying real options theory and two-sided market theory helps provide a more systematic description and analysis of the complex relationship between innovation and value generation in open data ecosystem platforms, better addressing the open data value paradox.

Second, research on data exchange mechanisms in multilateral platforms. Otto et al. [2], using the International Data Spaces as a case study, analyzed the data security and trusted exchange mechanisms of multilateral platforms composed of different stakeholders, concluding that establishing trust and data sovereignty mechanisms constitutes a more effective regulatory tool.

Third, research on constructing operational models for data multilateral platforms. Daniel et al. [3] built a "care coordination model" and "care research model" to achieve cross-sectoral and cross-professional collaboration in patient management, stakeholder learning, and research within digital multilateral platforms in healthcare.

Fourth, research on the impact of information systems in data multilateral platform ecosystems. Tan et al. [4], using Alibaba as a case study, summarized the development process of multilateral platforms from an information systems perspective, revealing that the evolution of multilateral platform information systems capabilities could facilitate the transition from hub-and-spoke multilateral platforms to networked multilateral platforms, ultimately forming symbiotic multilateral platforms.

Fifth, research on business model frameworks for data multilateral platforms. Ardolino et al. [5] argued that data multilateral platforms enable multiple interactions among different users and constructed a three-tier framework operational model for data multilateral platforms to analyze the patterns among framework operational variables.

Since its introduction, public data authorized operation has attracted widespread attention from Chinese academia and industry. Although Chinese scholars have not yet focused on multilateral platform research in this domain, they have made progress in related areas:

First, research on the characteristics and nature of public data authorized operation. For example, Chang Jiang et al. [6] argue that public data authorized

operation emphasizes security, develops specific public data, relies on public data platform operation, and ensures fair competition, with its nature being a public service franchise rather than an administrative license.

Second, research on institutional construction for public data authorized operation. Several scholars have explored this area. Gao Linxin et al. [7] reoriented the public data opening system through typological analysis, constructing a system where public data authorized operation is primary and non-authorized operation is supplementary. Ma Yanxin [8] argues that public data authorized operation is actually a hybrid of different institutional natures, including government procurement and franchise types, and that institutional construction should address objectives, fee collection, benefit distribution, entity access, and administrative supervision according to different types. Feng Yang [9] proposes a competitive authorization-based institutional construction plan aimed at improving the efficiency of public data market allocation, integrating incentive mechanisms into specific rules of authorized operation to fully mobilize the reform enthusiasm of relevant entities.

Third, research on practical pathways for public data authorized operation. Liu Yangyang [10] views authorized operation as a new social and market-oriented approach to utilizing public data, identifying issues such as ambiguous subject system content, loopholes in operational behavior norms, urgent need for improved supervision mechanisms, and suboptimal benefit distribution. Based on this, he proposes adhering to principles of safety and controllability, public-private cooperation, and authorized use, and adopting differentiated regulatory pathways in subject systems, behavior norms, supervision mechanisms, and benefit distribution according to different operation methods.

Fourth, research on the operational mechanisms of public data authorized operation. For example, Lu Zhipeng [11] proposes a public data authorized operation mechanism based on new rights segmentation to achieve refined authorization and constructing a multi-organizational structure to realize coordination among "supervision, management, and operation."

Overall, foreign research primarily focuses on ecological value, models, data exchange mechanisms, and core capability construction of information systems in data multilateral platforms. In contrast, China's public data authorized operation is a new governance model for open data proposed in recent years. Although Chinese scholars have not yet focused on its multilateral platform research, their studies on characteristics, institutional construction, practical pathways, and operational mechanisms provide important references for platform ecological civilization construction.

3 Research Methods

3.1 Method Selection

Since 2020, pilot programs for public data authorized operation have been established successively in Chengdu, Beijing, Shanghai, Guangzhou, and other locations, achieving certain results. This study employs a heuristic case study methodology, analyzing the operational mechanisms and implications of local government public data authorized operation platforms in China through a comparison of the Chengdu model and Beijing model.

The selection of Chengdu and Beijing's public data authorized operation platforms as research objects is based on three reasons: First, **typicality**. Chengdu is among the earliest cities to explore public data authorized operation mechanisms, with its implementation model representing a typical case of comprehensive authorized operation. Beijing's public data authorized operation adopts a multi-center model, using specialized zones as pilots, and has already launched financial zone construction with good results. Second, **guidance**. From the perspective of current pilot platform practices in China, comprehensive and specialized models have exemplary demonstration effects and provide important references for the integration and operational mechanism construction of public data authorized platforms. Third, **data availability**. Due to the typical nature of the Chengdu and Beijing models, abundant relevant materials, news reports, and other literature are available for reference, providing important data for this research.

3.2 Data Collection

Data collection involved three approaches: First, database literature retrieval, primarily using CNKI, Wanfang, and the National Laws and Regulations Database to search for relevant literature as research materials. Second, real-time tracking of relevant news reports and official WeChat accounts to stay informed about practical experiences and cases from public data authorized operation pilots. Third, monitoring official websites such as the Beijing Public Data Open Platform, Beijing Financial Big Data Co., Ltd., Chengdu Data Group, and Chengdu Public Data Open Platform to track and analyze data opening and operational dynamics in real time, obtaining first-hand data materials.

3.3 Evaluation Framework for Multilateral Platform Operation Mechanisms

The evaluation framework comprises four dimensions:

First, **platform structure**. Structure provides an abstract description of a system's components and their interrelationships. According to Chandler's famous proposition that "structure follows strategy," organizational structure must align with strategy to ensure effective implementation [12]. With the de-

velopment of the digital economy, platforms have become a new organizational paradigm and strategic model that invigorates organizations. As operators of public data development and utilization occupy the core link, they play a leading role in platform structure construction, directly influencing how multilateral stakeholders participate. Therefore, this paper analyzes supply-demand matching methods and content from a platform architecture perspective.

Second, **platform boundaries**. Platform boundaries typically refer to the demarcation between the platform and complementors (i.e., data developers, data intermediaries, third-party data users, research institutions, universities, nonprofit organizations, and other enterprises or institutions), encompassing three aspects: (1) the scope or boundary of the platform market, mainly referring to the scope of products and services operated in the market; (2) platform boundary resources, mainly referring to the interfaces where the platform connects with complementors, including transaction protocols, rules, interface requirements, and software tool usage rules (such as APIs and SDKs) [13]; and (3) platform openness, which reflects the access threshold for user participation and directly affects platform visit rates, mainly divided into access-based openness and architecture-based openness according to threshold levels.

Third, **platform knowledge integration capability**. Based on knowledge-based theory, a platform's important core capability is its knowledge integration capacity—the systematic coordination and integration of knowledge and resources required for data utilization [14]. In a sense, public data authorized operation platforms themselves are combinations of knowledge integration and innovation, with their sustainable competitive advantage depending on how to innovate knowledge based on integration, i.e., continuously achieving knowledge internalization, sharing, and sustained innovation during platform development [15].

Fourth, **platform-complementor relationships**. The success potential of digital platform ecosystems lies in complementors' contributions. Complementary activities significantly enhance the production capacity of the entire platform ecosystem, expanding the scope and scale of products and services provided beyond what would be possible within a single organization. Complementors entering the public data authorized operation platform ecosystem jointly participate in value creation with platform operators, and this more complex and novel value creation process fosters differentiated multilateral relationships [16]. Thus, the cooperative relationship formed between platform operators and complementors constitutes an important foundation for platform ecosystem formation and the starting point for complementors' value innovation.

3.4 Case Introductions

Chengdu Model: Chengdu began exploring public data authorized operation mechanisms as early as 2017 and issued the *Chengdu Public Data Authorized Operation Management Measures* in 2018. The authorized operation enterprise is

Chengdu Big Data Group Co., Ltd. (later reorganized as Chengdu Data Group), established in 2021. In 2023, Chengdu's public data authorized operation platform had 46 data cooperation supply units, supported over 40 application scenarios, launched more than 150 data products and services, and connected 570 categories of government data [17].

Beijing Model: In April 2020, Beijing released the *Opinions on Promoting the Construction of Beijing's Financial Public Data Zone*. In September of the same year, the Beijing Municipal Bureau of Economy and Information Technology authorized Beijing Financial Holdings Group to establish the Financial Public Data Zone, with its subsidiary Beijing Financial Big Data Co., Ltd. undertaking financial data utilization and innovation tasks. By 2023, Beijing's Financial Public Data Zone had aggregated over 5 billion public data entries, covering more than 3 million market entities [18].

4 Case Analysis

4.1 Constructing a Four-Sided Platform Structure

Both Chengdu and Beijing models consist of four sides: supply side, demand side, operation side, and supervision side. Due to their different models, they exhibit certain differences in data supply sources and business coverage breadth.

Supply Side: The Chengdu model is comprehensive. While it aggregates data through a big data platform like the Beijing model, its aggregation leading institution differs. Chengdu established a dedicated Office of Network Governance to coordinate business with the operation platform, responsible for aggregating data from various government departments to provide resource guarantees for data operation and for guiding, supervising, and coordinating the advancement of government data authorized operation services [19]. The Beijing model opens a financial public data zone for authorized operation, with the big data platform responsible for public data aggregation and docking.

Demand Side: Public data authorized operation platforms provide services for deep data development and utilization, with complementor demands closely related to the platform institution's positioning. Compared with the Beijing model, Chengdu's data utilization scope is broader, covering agriculture, industry, commerce, and other fields. The Beijing model primarily focuses on credit system construction in banking, insurance, and related fields.

Operation Side: Both Chengdu Data Group and Beijing Financial Big Data Co., Ltd. are state-owned enterprises. In addition to promptly docking user data needs and transmitting data components, operation platforms are primarily responsible for reviewing data demanders' qualifications and bearing main responsibility for data operation security. Both models undergo processes including demand application, review, authorization, agreement signing, data delivery and use, utilization feedback and supervision, and agreement termination. However, they differ in demand confirmation. The Beijing model requires operation

units to submit applications based on specific scenarios, which are evaluated and confirmed by zone supervision departments and reviewed and approved by data providing departments before sharing through the municipal big data platform [20]. The Chengdu model mainly involves complementors and other entities submitting demand applications to the platform, which regularly compiles application lists for review by the Office of Network Governance, with relevant data supply units providing authorization opinions and sharing matters docked through the municipal government information resource sharing platform [21].

Supervision Side: Both models attach great importance to compliance testing for platform security, establishing principles and systems of "data usable but not visible" and employing privacy computing and blockchain technology to ensure data security and full traceability. However, they differ in security system content construction. The Beijing model focuses on credit construction, aggregating personal data from judicial, social security, tax, and other domains, thus imposing higher security requirements. It has built a data platform security governance architecture with three core systems (institutional norms, technical protection, and operation management) and two supporting systems (supervision auditing and emergency response). The Chengdu model has established a data security governance system focusing on data classification and grading, platform security, development security, and operation management.

4.2 Selecting Highly Integrated Platform Boundaries

Both Chengdu and Beijing models adopt highly integrated platform boundary strategies, establishing risk prevention and internal control-integrated platforms to ensure secure output and utilization of data components. However, they differ in market operation: (1) **Focus areas differ**. As mentioned, the Beijing model concentrates on credit reporting, while Chengdu's operation scope is broader, covering agriculture, domestic services, marriage and dating, and other fields. (2) **Operation models differ**. Chengdu primarily provides data component supply services, while Beijing has established a "self-production + data component service" model. Beijing Financial Big Data Co., Ltd. leverages its technical and data advantages to launch the Jingyun Enterprise Credit Platform, overcoming traditional limitations of credit data sources by integrating public data from social security, housing funds, tax, and other domains. Using 118 opened data interfaces, it has provided over 8 million services to 44 financial institutions and more than 20,000 platform users [22]. In addition to self-produced services, the company also provides various data component services.

Nevertheless, both models show high similarity in boundary resources and openness: (1) They have established strict operation gatekeeper systems, adopting the basic principle of "whoever is in charge is responsible, whoever operates is responsible." (2) They employ access-based openness, evaluating complementors based on relevant regulations and policies and reaching cooperation through signed agreements.

4.3 Platform Data Integration Capability Constrained by Supply Units

As an intermediary connecting supply and demand, public data authorized operation platforms must possess data integration capabilities—the ability to acquire, refine, store, apply data, and provide foundational support for complementors' utilization and innovation. This manifests in two aspects: (1) **Network infrastructure support capability**. To ensure secure utilization of public data, operation platforms must at minimum have capabilities in data desensitization processing, data outbound review, and distributed privacy computing to ensure full-process operational auditability and data traceability. Both Beijing and Chengdu models attach great importance to security and controllability of network infrastructure for authorized operation of public data in institutional construction and technical support, achieving good results in practice. (2) **Data sharing capability**. The scope and quality of platform data sharing, in a sense, determine the scope and quality of complementors' processing and integration. Since platforms only serve as supply-demand bridges, the scope of data sharing is determined by data supply departments—that is, by government departments defining, evaluating, and reviewing data opening and utilization. While both Chengdu and Beijing models have achieved certain results in data services and scenario utilization, establishing normalized data supply channels still faces many uncertainties, such as insufficient data opening awareness among data supply departments, obvious risk aversion, and inadequate data classification and grading management capabilities. Particularly, cross-departmental data integration requires strong organizational institutions for long-term continuous coordination to achieve utilization goals.

4.4 Transaction and Innovation Relationships Between Platforms and Complementors

The complementary relationship between platform operators and complementors is a crucial component of multilateral platform ecosystems and the foundation for complementors to develop and serve using data. Generally, two relationships exist: (1) **Transaction complementarity**, where platform operators provide products to complementors. (2) **Innovation complementarity**, where complementors innovate functions, products, and services lacking in the platform operator, such as payment functions or security capabilities.

From the structure and relationships of Beijing and Chengdu's public data authorized operation platforms, authorized operation platforms provide data component services to complementors, while complementors provide computing power, algorithms, and data governance services for productizing and servicing data components. This constitutes a dual complementary relationship of transaction and innovation, with higher complementarity highlighting complementors' importance or compatibility to the platform ecosystem. As shown in Table 1 , in the Beijing model, Beijing Financial Big Data Co., Ltd. collaborates with banks, Beijing Economic-Technological Development Area, and

Peking University Shougang Hospital in Shijingshan District to launch products and services such as credit-based lending, policy intelligent matching engines, and credit-based medical services [23]. In the Chengdu model, to improve platform service capabilities, Chengdu Data Group collaborates with technology providers (e.g., University of Electronic Science and Technology, Yifangjian, Baidu) and application parties (e.g., Xinwang Bank, Zhizhen Data) to promote innovation in "computing power + algorithms + data" [24]. It also partnered with Sichuan Unicom to create the Smart Golden Agriculture Platform, providing various verification information services to Chengdu Shenjia Technology Co., Ltd., Chengdu Xintong Co., Ltd., and Chengdu Branch of Shanghai Pudong Development Bank. In terms of participation, Beijing's Financial Public Data Zone Operation Platform demonstrates higher engagement, having jointly developed innovative services for multiple scenarios with various institutions.

5 Implications and Recommendations

5.1 Implications

The analysis of multilateral operation platform practices in Chengdu and Beijing models yields valuable experiences and lessons for further promoting the construction of China's public data authorized operation multilateral platform mechanisms.

First, these models have pioneered a new public-private cooperation model for deep data utilization. Platform thinking is essentially an open and multi-interactive network cooperation mindset. Both Beijing and Chengdu models center on platforms where government generates, collects, and preserves data, which is further developed and operated by complementors through platform cooperation, forming a public-private cooperative data industry chain. This aims to absorb diverse market entities' data, technology, capital, and other elements to build a multi-level data factor market, form an integrated government and social data circulation system, stimulate enterprise innovation vitality, and release data factor value [26], thereby breaking the long-standing dichotomy of public products being produced solely by government or enterprises. While governance theory has long emphasized multi-party participation, it failed to provide clear frameworks for how to participate and what content to participate in, and its attempts to integrate government, market, and social forces lacked explicit operational systems for implementation [27]. Platform governance theory, inheriting and developing governance theory, provides important mechanisms and operational systems to solve this problem, offering undeniable inspiration and reference for public data authorized operation multilateral platform governance and the practice of multi-supply and collaborative innovation of public data products and cooperative governance of public affairs [28].

Second, these models have promoted the formation of a public data factor circulation ecological chain. The public data authorized operation multilateral platform ecosystem is an economic community formed through interactions

among platform operators, complementors, and product users [16]. Although Beijing and Chengdu models differ in operation scope and content, both have constructed multi-stakeholder collaborative innovation operation mechanisms based on public data supply, circulation, and utilization, solving the challenge of secure public data utilization. They have formed an open and orderly public data utilization ecological chain in the process of transforming data resources from components into final data products and services. In this chain, platforms provide rule systems for realizing data value and scenarios, serving as coordinators to the supply side, collaborators to the demand side, and gatekeepers to the supervision side. They not only coordinate high-quality data matching, enhancing proactivity of data suppliers and responsiveness of data demanders, but also promote efficient data circulation and high-quality development of the data factor market through interactive cooperation among multiple interest subjects.

Third, these models have fostered the formation of a public-private cooperative value network for deep data utilization. Value networks are new value creation network systems formed on the basis of value chains with the development of the digital economy. Their core essence lies in applying platform economy principles to link stakeholders' value chains, forming relationship networks with suppliers and users as main content, integrating and optimizing organizational structures and shared information resources to achieve group competitive advantages [29]. Similarly, a core objective of both Chengdu and Beijing models is to form an orderly value network, treating complementors and their mastered technology, capital, resources, and talent as the source of value creation and innovation. By combining internal process integration with external interaction, they maximize platform ecological value, making the platform both a "catalyst" for deep development and utilization of public data factors and a "binder" for realizing value networks.

5.2 Recommendations

As two typical representatives of "comprehensive" and "specialized" models formed during China's pilot exploration of public data authorized operation, Chengdu and Beijing models have achieved good practical results in secure transaction services and innovative services, providing reference and inspiration for other local governments building public data authorized operation platforms. However, both are still in their initial construction period and face common issues in data standardized supply, collaborative risk supervision, and boundary resource transparency, requiring new institutional supply and further improvement of existing mechanisms [30].

5.2.1 Strengthen Supply-Side Data Standardization Management to Promote High-Quality Data Supply Government departments harbor vast amounts of high-quality, high-value data. Deep opening and utilization of government data constitute important content for promoting China's data factor circulation and utilization, serving as both the supply side of public

data authorized operation multilateral platforms and the starting point of data factor circulation. Since Beijing first established a public data resource open platform in 2012, China's government data opening has a history of over ten years, achieving significant progress in platform coverage with provincial-level platforms basically established in all provinces. However, substantial gaps exist in data opening volume and quality. While establishing public data authorized operation platforms is an important measure to overcome these difficulties and represents an important attempt at innovative utilization of public data at a certain scale oriented toward scenarios, both unconditional opening and authorized opening of government data are severely constrained by public data supply departments, primarily due to insufficient data management maturity, especially weak standardized management capabilities for data opening and utilization.

First, establish specialized data quality standard management institutions. Data quality is the lifeline of data value realization. In public data authorized operation, the quality of original government data directly affects subsequent data utilization effectiveness. Government data quality standard management organizations should be established in supply departments to ensure data integrity, authenticity, and effectiveness. If supply departments' data quality management institutions are not robust, they will seriously affect data output and utilization effectiveness. According to relevant data, the United States loses up to $600 billion annually due to poor-quality data, such as data errors, incompleteness, and inauthenticity [31]. Therefore, government data supply departments need to establish data quality standard management organizations to formulate, implement, supervise, and evaluate data quality standards, promoting high-quality data construction.

Second, unify metadata standards. Metadata refers to data that describes data. Metadata standardization facilitates the operability of data sharing and utilization and forms the foundation of data opening and utilization. However, current local data standard systems show unclear identification of data resources and datasets, with metadata standards not unified. The *China Government Open Data Utilization Report* (2022) surveyed metadata identification in 96 local government open data platforms, finding identification rates for data content names, identifiers, languages, time ranges, spatial ranges, sources, data publishers, data maintainers, media types, byte sizes, and data statuses ranging between 1.2% and 32.6%. Such differences in metadata content identification will affect cross-boundary data fusion and utilization. This necessitates unified metadata standard schemes at the national level, including establishing classified and graded metadata standards based on the characteristics of data resources and datasets.

Third, establish data supply quality foundation standards and evaluation methods. Although some local government data opening policies mention public data quality issues, quality standards and requirements are not unified. For example, Guizhou's *Government Data Opening and Sharing Evaluation Index System* re-

quires data quality to meet standards of accuracy, completeness, timeliness, and accessibility in opening and sharing; Guangzhou's *Digital Economy Promotion Regulations* Article 64 proposes strengthening data quality control to ensure data authenticity, accuracy, completeness, timeliness, and availability; Chongqing's *Data Regulations* Article 12 proposes establishing and improving data quality control systems to ensure data timeliness, accuracy, and completeness. Since China has not formulated data quality standard policies at the national level, local government departments, despite recognizing data quality issues, have basically different quality standards, which will affect data value assessment and utilization. Therefore, it is necessary to issue basic quality standards for data opening by supply departments at the national level, refine evaluation indicators, and construct evaluation methods combining data quality self-assessment and expert assessment. Additionally, actively implementing a "data utilization error correction" feedback mechanism is needed to promote high-quality release of data value.

5.2.2 Construct a Risk Collaborative Supervision Mechanism Based on Human "Meaningful Control" in Multilateral Platforms With the continuous development of artificial intelligence technology, human meaningful control has become an important ethical baseline for data platforms and data products. Although information technology is a technical tool, it is not "technologically neutral." Especially with the widespread application of new-generation technologies like ChatGPT and the metaverse, and the development of algorithmic and technological self-adaptation, they may escape human control and generate significant negative impacts on society and individuals. Therefore, strengthening human meaningful control in public data authorized operation platforms and their products and services is a necessary measure to prevent risks.

First, establish a risk collaborative supervision mechanism for public data authorized operation. Public data authorized operation is a model for deep development and utilization of high-value and high-quality data oriented toward specific scenarios and meeting certain purposes and conditions. It involves supervision of multiple utilization entities during data circulation, including not only supervision of government data resource suppliers and the data lifecycle on government data open platforms but also supervision of complementors regarding data utilization purposes, scope, content, and specific processing results. Supervision subjects also continuously change during business processing cycles.

Currently, China's public data authorized operation supervision subjects mainly include two aspects: departments such as cyberspace administration, public security, national security, and confidentiality and cryptography departments conduct safety supervision and management of public data authorized operation, while departments such as economy and information, development and reform, market supervision, and finance oversee market-oriented supervision of public data products. Circulation means data factors need to pass through dif-

ferent data processing subjects, and if any link fails to maintain strict control, it may trigger chain reactions of associated risks in the next link. Therefore, in the big data era, traditional supervision concepts must be abandoned, and the fragmented supervision model must be broken to construct a "collaborative co-management and co-governance" mechanism among multiple supervision subjects for data factor circulation risks.

Second, establish risk prevention and control measures based on holistic governance. Traditional data utilization processes typically exist in static, fragmented, and independent data risk environments, while large-scale circulation of data factors may bring about and trigger superimposed and systemic risks during circulation. This requires establishing holistic governance thinking in risk prevention and control, not only comprehensively identifying and assessing risks in data factor circulation but also clarifying risk factors and their interrelationships as value attributes change during circulation, mastering characteristics of risk circulation, superimposition, and recombination to improve regulators' overall risk management capabilities.

Third, strengthen the construction of technology-enabled supervision models. Technology is an important guarantee for improving supervision efficiency of data factor circulation and modernizing supervision capabilities. With the development of the digital economy, new industries and models continuously emerge. On one hand, traditional supervision models can no longer keep pace with the times; on the other hand, new risks brought by emerging technologies are difficult to control. Therefore, innovating supervision methods and promoting technology-enabled supervision models based on cloud computing, blockchain, artificial intelligence, privacy computing, and other technologies is imperative. Especially in data factor circulation, vigorous research, development, and application of technologies for credit supervision, anti-monopoly and anti-unfair competition behavior supervision, and online transaction supervision play important roles in enhancing government supervision efficiency and releasing the potential and vitality of the digital economy.

5.2.3 Enhance Transparency of Boundary Resources in Operating Multilateral Platforms Since platform operators typically control or stimulate complementor participation through boundary resources [32], and according to resource dependence theory, if resources controlled by one party are more valuable or less substitutable, it triggers power imbalance—resource advantages bring power advantages [33]. As public data authorized operation entities are closely connected with government data supply parties and typically exercise de facto control over authorized data through exclusive authorization [34], they may occupy a dominant position in relevant markets without effective supervision. This could lead to self-reinforcing data monopoly behavior due to lack of competition, resulting in unfairly high prices that harm consumer rights and severely restricting the development of a fair and orderly digital economy market pattern. The most powerful way to break data monopoly is to enhance the

openness and sharing transparency of platform boundary resources [35].

First, clarify rules. Clarify the responsibilities and obligations of all parties in multilateral platforms for data utilization, enhancing platform resource availability on one hand, and on the other hand, strengthening management of secure and legal utilization of public data throughout its lifecycle based on the principle of "whoever builds is responsible, whoever manages is responsible, whoever uses is responsible."

Second, delineate bottom lines. Ensuring security and fair utilization is the bottom line for public data factor flow. Security and fair utilization must be integrated throughout the entire data governance process, enhancing data availability, trustworthiness, circulation capacity, and traceability, and building a governance model with multi-party collaborative security and fair utilization guarantees from government, enterprises, and society [36].

Third, strengthen interaction. According to the *China Government Open Data Utilization Report* (2022), only 57.47% of local government data open platforms provide user interaction channels [37], indicating that many government data open platforms have not yet prioritized interactive services for data utilization, adhering to government-led data opening principles. As a bridge for China's deep data utilization, public data authorized operation platforms should position themselves not only as channels for dialogue and exchange but also as fundamental carriers for transactions and innovation. Therefore, only through multilateral deep interaction and strengthened integration of government and enterprise data resources can the goal of high-quality data utilization be achieved.

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Note: Figure translations are in progress. See original paper for figures.