Theoretical Research on the Asset Management of Government Data: Asset Attributes, Data Ownership, and Pricing Methods

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Abstract: In the era of big data, government data resources contain enormous value. How to fully and effectively release this value is still in an exploratory phase both in practice and theory. Currently, it is necessary to establish clear institutional norms and a unified standardized value assessment system, and to conduct research on the asset attributes, ownership positioning, and pricing methods of government data, thereby improving the asset management theory of government data resources. Using literature research method, this paper first clarifies the asset attributes of government data, delineates the scope and classification of government data, and defines the concept of government data assetization. Secondly, it explores the principles for determining the ownership of government data and establishes a property rights model for exercising data usage rights based on the type of government data openness. Finally, it studies data asset valuation methods and proposes insights into flexibly adjusting pricing methods according to the type of government data.

Keywords: Government Data; Asset Management; Asset Attributes; Data Ownership; Pricing Methods

1. Introduction and Literature Review

With the rapid development and deep integration of new-generation information technologies such as big data and artificial intelligence, data has transcended traditional factors of production to become a core engine driving global economic and social development [1]. Against this macro backdrop, government data, as the component with the widest coverage, highest authenticity, and strongest authority within the data resource system, is increasingly revealing its immense socio-economic value. Government data assetization is essentially the process of transforming data from a mere information resource into an asset capable of creating economic benefits [2]. The core of its management lies in the systematic identification, confirmation, valuation, and management of government data to release its potential value [3]. Governments worldwide regard it as key to enhancing national competitiveness, and China has also explicitly proposed strengthening the supply of data factors in its "14th Five-Year Plan for Digital Economy Development".

However, compared to the continuous expansion and deepening of practical application scenarios for government data, the construction of its theoretical support and management framework still lags. Early research primarily focused on the opportunities and challenges that "big data" technology brought to government management, such as improving the efficiency of ICT resource utilization and optimizing personalized e-government services [4]. As theory evolved, scholars began to view data itself as a new asset class [5] and recognized that government data assetization is key to building a digital government [6,7]. Yet, can government data be confirmed as an "asset"? How to define the connotation and boundaries of its asset attributes? This constitutes the logical starting point for management. Theoretically, the concept of data assets also extends beyond tangible assets to include financialized assets and intangible assets [8], but many fundamental issues, such as the preconditions for assetization and the value realization process, remain to be deeply explored [9]. Although some scholars have attempted to define the concept of data assets and construct a basic framework through literature review [10], existing research mostly focuses on enterprise data, and the systematic theorization targeting

government data as a special public asset remains insufficient.

Furthermore, the issue of data ownership—specifically, the ambiguous definition of property rights regarding "who owns, who uses, and who benefits"—has become the most significant institutional bottleneck restricting data sharing, openness, and circulation [11]. This has resulted in vast amounts of high-value data being stranded within departmental "data silos," making it difficult to aggregate, integrate, and leverage their multiplier effect. Additionally, in the value realization phase, there is a lack of a widely accepted value assessment methodology and standard system for scientifically and reasonably pricing government data, which varies greatly in form and sensitivity. Existing research predominantly focuses on enterprise data [12], with insufficient consideration given to the specificities of pricing government data. This leaves the market-oriented allocation of data elements plagued by a lack of clear guidelines. These intertwined theoretical and practical challenges collectively indicate that constructing a systematic theory for the asset management of government data is extremely urgent.

In light of this, this paper aims to systematically respond to the aforementioned theoretical and practical needs, focusing on the three core theoretical issues of government data asset management: asset attributes, data ownership, and pricing methods. This study adopts the literature research method. First, it will deeply analyze the asset attributes of government data from economic and legal perspectives, clarify the confirmation conditions and unique connotations of government data as a "special public asset", and delineate the scope, classification, and assetization concept of government data, laying the theoretical foundation for subsequent research. Secondly, it will explore the basic principles for defining government data ownership and attempt to construct a differentiated property rights exercise and utilization model based on the type of data openness (e.g., unconditional openness, conditional openness, non-openness), to resolve the ownership dilemma. Finally, it will systematically review mainstream data asset valuation methods and propose strategic insights for flexibly selecting and combining pricing methods based on the diverse characteristics of government data, such as data type, application scenario, and openness method, to address the shortcomings of existing research.

The research presented in this paper aims to theoretically enrich and advance interdisciplinary studies in public administration and data economics within the realm of government data value mining, contributing academic insights to the construction of a theoretical framework for government data asset management with Chinese characteristics. On a practical level, it seeks to provide valuable theoretical references and decision-making support for government departments in formulating data asset management policies and establishing market-oriented circulation mechanisms for data elements.

2. Asset Attributes and Scope Classification of Government Data

As a key production factor in the digital economy era, the clear definition of asset attributes and a scientific, reasonable scope classification of government data are important theoretical foundations for achieving asset management of government data. An in-depth understanding and accurate classification of government data asset attributes not only help to better identify, evaluate, and manage their intrinsic value but are also a key prerequisite for promoting digital government construction and public service optimization.

2.1 Asset Attributes of Government Data

Government data possesses multiple asset attributes. Its value is reflected not only in the information itself but also in the huge economic and social benefits generated through systematic processing, standardized circulation, and deep application. These attributes together constitute the theoretical basis for its status as a special type of asset.

2.1.1 Economic value attribute

The core of the data assetization process lies in endowing data with clear economic value through institutional arrangements and technical means [13]. Government data can generate direct and indirect economic benefits through open sharing and market-oriented development and utilization. Direct benefits are reflected in transaction income from data products, value-added fees for data services, etc. Indirect benefits are more profound; for example, open government data can significantly reduce the cost for enterprises and social entities to obtain

high-quality information, promote technological innovation and business model innovation, and thereby effectively drive enterprise intelligent transformation and improve total factor productivity [5]. As a new factor of production, data elements have deeply integrated into the national economic value creation system, and their assetization is an important way to realize the market-oriented allocation and value release of data elements.

2.1.2 Intangible asset attribute

Data assetization is not limited to tangible assets in the traditional sense; more importantly, it reflects the core characteristics of intangible assets. Chiapello (2023) points out that the concept of "assetization" includes not only tangible assets but also financialized assets and intangible assets, and considers "financialized assets" and "intangible assets" to be the core areas of data assetization research [8]. Government data itself has no physical form; its value lies in the information content it contains, the knowledge connotation, and the decision-making support capability and application potential generated through analysis and mining. This is highly consistent with the value logic of intangible assets such as patents, trademarks, and brands. Managing government data as an intangible asset requires establishing corresponding value assessment, registration, and operation maintenance mechanisms.

2.1.3 Coexistence of public good attribute and commodity attribute

Due to its origin in the public sector and its concern for public interests, government data possesses, to a certain extent, the attributes of a public good, namely non-rivalry (one person's use does not affect another's use) and a degree of non-excludability. It should ideally be provided to the public free of charge or at low cost to maximize the level of public services and overall social welfare [14]. However, government data products or services formed through deep processing, integration, and analysis, as they embody additional labor and capital investment, can also be traded and circulated as commodities under specific rules, thereby generating economic returns and demonstrating distinct commodity attributes [9]. The coexistence of these dual attributes necessitates a precise balance between maximizing public interest and sustainably developing commercial value in the asset management of government data, requiring the formulation of differentiated management strategies.

2.1.4 Complexity of rights attribute

The issue of ownership is one of the core challenges in the assetization process of government data [3]. A key characteristic of data circulation and utilization is the separability of rights such as ownership, control, usage, and benefit rights [15]. Government data originates from diverse sources, involving individual citizens, enterprises, other organizations, and the government itself. Clearly defining the rights boundaries of all relevant parties at the legal level, and clarifying the ownership, scope, and manner of data development and utilization while fully protecting citizen privacy and national data security, is a critical institutional step for the successful assetization of government data.

2.1.5 Strategic resource attribute

In the era of big data, data assets have become a core strategic resource that cannot be ignored by nations, societies, and enterprises. For the government, government data is an important foundation for supporting the modernization of the national governance system and governance capacity, and its strategic value is becoming increasingly prominent. High-quality government data resources play an irreplaceable role in precise policy implementation, risk prevention, social governance, and industrial guidance, and are an important component of national competitiveness. Therefore, the asset management of government data must be approached from the height of national strategy, balancing efficiency and security to ensure the effective protection and efficient utilization of this strategic resource.

2.2 Scope and Classification of Government Data

A scientific and systematic classification of government data is a prerequisite for achieving refined and differentiated asset management. Based on management practices, this paper proposes the following multi-dimensional classification framework to facilitate corresponding management measures for different types of data.

2.2.1 Classification by data source and management subject

Internal Government Department Data: Refers to data directly generated and collected by government departments at all levels in the course of performing their statutory duties, such

as administrative approval data, fiscal revenue and expenditure data, population census data, and natural resource registration data [14]. This type of data usually has the highest authority, standardization, and completeness, and is the main body and core of government data assetization.

Public Institution and Enterprise Data: Includes data generated during the operation of public service providers such as water, electricity, gas, public transportation, public healthcare, and education, which are closely related to the public interest. Although not directly produced by government departments, their strong public attributes mean they are usually included in the overall management of government data.

Authorized Socially Sourced Data: Refers to data acquired by the government under specific circumstances through procurement, cooperative development, franchising, etc., from enterprises, industry associations, or other social organizations, to supplement and improve the government data system and enhance the comprehensiveness, precision, and scientific nature of government decision-making.

2.2.2 Classification by degree of openness and sensitivity

Open Data: Refers to data that does not involve state secrets, commercial secrets, or personal privacy and can be directly and unconditionally opened to the public, such as government gazettes, economic statistical yearbooks, real-time public transportation information, and weather forecast data [6]. This type of data is the focus of data opening, easy to circulate and reuse, with significant social benefits.

Authorized Open Data: Refers to data containing certain sensitive information or involving specific interests that can only be opened to qualified entities after going through authorization procedures such as application and approval, for example, some enterprise credit information, de-identified medical research data, etc. The asset management of this type of data requires the establishment of strict security review and usage supervision mechanisms.

Restricted Data / Non-open Data: Refers to data involving national security, national defense, cutting-edge technology, major public interests, highly sensitive personal privacy, etc., which are legally determined as secret or prohibited from disclosure [13]. The focus of asset management for this type of data is to ensure its secure sharing and authorized use within internal networks, emphasizing ultimate privacy protection and security precautions.

2.2.3 Classification by data structure

Structured Data: Refers to data that can be logically expressed and implemented with a unified structure (such as a two-dimensional table structure), stored in traditional relational databases, such as table data in various business system databases. This type of data is the easiest to manage and analyze.

Unstructured data: refers to data without a predefined data model or fixed structure, accounting for a growing proportion of government data. Examples include government-published text reports, policy documents, law enforcement recordings, surveillance videos, geospatial data, etc. [16]. The assetization and utilization of unstructured data face greater technical challenges. For instance, due to its complexity, geospatial data encounters practical issues in governance such as a lack of data culture, insufficient inter-departmental coordination, and unclear infrastructure development.

Semi-structured Data: Data falling between structured and unstructured, possessing some structure but not in a strictly uniform format, such as XML configuration files, JSON-formatted API interface data, and web log data.

2.2.4 Classification by data lifecycle stage

Raw Data: Refers to the initial data collected directly from the source without any processing, which may contain duplicates, errors, or inconsistencies.

Processed Data: Refers to data formed after cleaning, integration, transformation, annotation, anonymization, and other processing of raw data, possessing higher quality, consistency, and usability. It is a key link in data value addition.

Data Products and Services: Refers to standardized data products or customized data services developed based on government data that can meet specific market demands and possess specific functions and application scenarios [3], such as data analysis reports, decision support models, and API call services. These represent the final form of data asset value realization.

The above multi-dimensional classification system demonstrates the high heterogeneity within government data. Therefore, its asset management must follow the principle of "categorized policies", tailoring ownership arrangements, pricing mechanisms, operation

models, and security measures to the characteristics of different data categories, thereby achieving refined management and value maximization.

3. Ownership Definition of Government Data Assets

3.1 Types of Data Asset Ownership

In today's era of information explosion, data has increasingly transcended its original attributes to become a utilizable resource with exchange value, capable of generating economic benefits. However, controversy remains regarding the ownership of these benefits. Therefore, before determining rights ownership of government data, it is necessary to classify data rights, which include the following categories:

(1) Sovereignty. National sovereignty is the supreme power within a country and the independent power in international relations inherent to a state. Data sovereignty is a nation's independence in managing and utilizing its own data, free from interference and infringement by other countries. As data sovereignty involves national interests and the security of data within the territory, China formally promulgated the "Data Security Law of the People's Republic of China" in 2021 at the legislative level. On July 2, 2021, the Cyberspace Administration of China issued a notice initiating a cybersecurity review against DiDi Chuxing. According to Article 9 of the Cybersecurity Law, DiDi Chuxing was suspected of leaking location information overseas, potentially threatening national security. Consequently, DiDi Chuxing, which had just been listed on the U.S. stock market, was subjected to a network review, removed from app stores, and barred from new user registrations. This case involves data sovereignty, demonstrates that data sovereignty is an inseparable part of national sovereignty, and reflects the importance of data security.

(2) Public Power. Public power is a collective power relied upon by the government and other relevant departments to maintain order in public affairs participation using administrative means. Data public power takes public data as the object of power exercise. For instance, the government, as the platform party, can be responsible for managing customer data on the national platform, collecting social data related to government decision-making, uniformly processing data of varying formats and content, and possessing decision-making power over the open management of various databases. However, data public power cannot be abused arbitrarily and must be subject to public supervision and exercised within the scope authorized by law.

(3) Private Rights. Private rights are the property rights and personal rights possessed by citizens, enterprises, social organizations, and even the state in autonomous and equal social and economic life. China's "Civil Code" clarifies two major rights systems: personal rights and property rights. Property rights include not only real rights, creditor's rights, and inheritance rights, but also the property rights within intellectual property. Data possesses the attributes of property rights. However, due to its low replication cost, it does not meet the condition of one object corresponding to one right, making it difficult to categorize under existing property rights systems like real rights or intellectual property. It is more appropriate to classify data property rights as a separate type of property right. In terms of content, if it involves the rights and interests of individuals or other groups, it also possesses corresponding characteristics of personal rights. Regarding the issue of data ownership, China has not yet made clear provisions in law.

3.2 Design of Government Data Ownership

3.2.1 Principles for defining government data ownership

When determining government data ownership, the primary consideration is to effectively ensure that government data resources are more fully accessed and utilized by the broader population, allowing data to play its role as a new factor of production and promoting the digitalization of traditional factors of production. Therefore, the following principles are first established:

First, the principle of public ownership. The public nature of the government itself endows government data with public attributes. The fundamental purpose of establishing government data resource libraries is to better serve the public and generate economic benefits for society. Moreover, both the maintenance and generation of these resources rely on public funding. Therefore, ownership of such data should be collectively owned by the entire populace.

Second, the Openness Principle. As public data, government data resources should be open to the public after clarifying the scope of use and

boundaries. Specifically, they can be divided into three categories: unconditionally open to the public, conditionally open to the public, and prohibited from being open to the public [17]. Due to their replicable and non-excludable nature, data can only fully realize their value through efficient flow.

Third, the Social Public Interest Principle. Government activities are essentially aimed at better serving society. The opening and utilization of data resources formed through these activities should naturally focus on social benefits. A series of policy measures should be taken to promote the development of the digital economy.

Fourth, the Non-exclusivity Principle. In the process of data utilization, no single individual, government, enterprise, or institution can claim exclusive rights to government data resources.

3.2.2 Methods for defining government data ownership

Currently, the definition of data ownership remains ambiguous, as data ownership involves not just one party but a rights system with multiple participants. This also implicates individual privacy rights and data confidentiality issues. Data property rights, as a new form of property rights, can be classified within the property rights system into data source rights, data utilization rights, and public data property rights [18]:

(1) Data Source Rights: Refers to the rights of the initial provider from whom the data originated. The interests of the source right holder are mainly reflected in informed consent, requiring data users to maintain data authenticity, etc.

(2) Data Utilization Rights: Refers to the rights enjoyed by the right holder to control, use, develop, license, and dispose of data elements according to law.

(3) Public Data Property Rights: This includes, first, public data whose source rights cannot be distinguished; and second, government data whose source rights can be distinguished, i.e., data originating from the government and shared by society.

For the above-mentioned government data with distinguishable source rights, the following ownership definition is conducted: For government data collected by government agencies, the natural persons and legal persons who are the handling parties or data providers should be the source right subjects. For data originating from the government itself and data derived during data operation, the state should be the source right subject. The government enjoys data utilization rights over the data it collects and over which it holds source rights. When specifically exercising data utilization rights, management should be carried out according to the different openness categories of the data: For the unconditionally open category, it should be promptly shared openly with society to let data flow, promoting the reuse and secondary development of data elements. This type of opening requires the improvement of government sharing mechanisms and inter-departmental collaboration. For the conditionally open category, it should be openly shared within the limits of the qualifying conditions to avoid waste and idleness of data resources. For the prohibited open category, this data generally involves national security, etc. Data security protection barriers should be established, corresponding confidentiality measures should be taken to prevent data leakage, and the process of data security legislation should be accelerated. Since government data possesses characteristics such as public nature and social benefit, although the government enjoys data utilization rights over it, it must not aim for profit. Instead, it should start from the point of promoting the social utilization of government data resources under the premise of protecting the rights and interests of all parties, clarify the open boundaries of various resources, and open them to the public timely and efficiently.

4. Pricing Methods for Government Data Assets

4.1 Data Pricing Methods

Currently, the valuation of data assets mainly refers to the evaluation models for intangible assets, which are the following three traditional evaluation methods:

4.1.1 Cost approach

The Cost Approach is divided into the Historical Cost Method and the Replacement Cost Method. The data value measured using the Historical Cost Method is equivalent to the cash or cash equivalents paid to acquire the data, providing a true record of the transaction value that occurred in the past. However, this method cannot timely and effectively reflect changes in the value of the data asset, exhibiting a certain lag. The Replacement Cost Method estimates the value of

the asset being appraised by estimating its replacement cost and then deducting various depreciation factors. The Cost Approach is the most basic method in intangible asset appraisal but cannot be fully applied to data asset valuation due to characteristics like low replication cost, which make it difficult to accurately estimate the replacement cost and depreciation amount [19].

Shanghai Deloitte Asset Appraisal Co., Ltd. and AliResearch proposed using the Cost Approach to evaluate data asset value, with the formulas (1) & (2):

Appraised Value = Replacement Cost - Depreciation Factors (1)

Appraised Value = Replacement Cost × Newness Ratio (2)

Since data assets have timeliness characteristics, the main depreciation factor is economic depreciation caused by the loss of timeliness.

4.1.2 Income approach

The Income Approach determines the value of the asset being appraised by estimating its expected future income and discounting it to present value. When applied to data assets, this method has an advantage in measurement because the value of data is considered in terms of future benefits. However, the difficulty in estimating future economic benefits for most assets leads to a deviation between the appraised value and the true value. Moreover, predicting the income that data can generate in the future is subjective, resulting in limited accuracy of the estimated results. The formula for perpetual assets is shown in (3):

$$APV=\sum_{i=1}^{n}\frac{ER_i}{(1+\mathrm{DR})^i}+\frac{Annuity}{DR\times(1+DR)^{pp}} \quad (3)$$

Where APV represents the value of asset appraised , ER_i represents the expected revenue in year i, DR represents the discount rate, pp represents the projection period.

4.1.3 Market approach

When using the Market Approach to evaluate data asset value, it is important to select reference objects recently sold that are close in value to the asset being appraised, and then determine the data asset value through various adjustments. The two prerequisite conditions for using the Market Approach to calculate the value of government data assets are an open and effective government data trading market and the availability of comparable government data transactions close to the data being appraised. However, the domestic data exchange market is still in its early stages, and there is no pricing framework that can reflect the true market value of data. Therefore, the Market Approach is rarely used for asset appraisal in China. Shanghai Deloitte Asset Appraisal Co., Ltd. and AliResearch listed the pricing model using the Market Approach for data assets, as formulas (4):

$$AppraisedValue=ComparableDataAsset\ Transaction\ Amount\times\Sigma\mathrm{Adjustment\ Coefficient} \quad (4)$$

where the adjustment coefficients are influenced by different value factors.

A summary of the advantages and limitations of the three pricing methods mentioned above is shown in Table 1.

Table 1. Advantages and Limitations of the Cost, Income, and Market Approaches

Method	Advantages	Limitations
Cost Approach	*Convenient calculation, easy data collection	* Data characterized by low cost, high benefit * Costs corresponding to data assets are difficult to distinguish
Income Approach	*Conceptually closest to asset's maximum benefit	*Future predicted data income is subjective *Directly generated income from data assets is hard to distinguish
Market Approach	*Can well reflect the asset's current value	*Requires a well-developed trading market *High assessment difficulty

4.2 Analysis of Pricing Methods for Government Data Assets

The "Big Data White Paper (2022)" released by the China Academy of Information and Communications Technology shows that the scale of China's big data industry increased to 1.3 trillion yuan in 2021, the total number of big data market entities exceeded 180,000, and the total investment received by big data-related enterprises exceeded 80 billion yuan.

Amid the rapid advancement of big data, pricing methods for government data assets have become a focal point of discussion. Currently, a fundamentally new logic for data asset valuation and pricing should be constructed around the resourceization and assetization of data. The assessment of data asset value should encompass three components: (1) the measurement of data asset costs, including the cost of the data asset itself and subsequent maintenance input costs; (2) the assessment of data asset income; and (3)

adjustment of the data asset value based on actual market conditions [20].

Since government data resource management is based on the convenience of development and openness, aiming to maximize the social utilization of government data and release the data dividend, the assessment and pricing methods should not focus excessively on expected income. Instead, pricing should be dynamically adjusted based on data categories and purposes, while covering relevant maintenance costs. The evaluation and pricing methods are formulated considering different categories of government data resources:

First, for business data, the cost pricing method can be adopted. Costs include, but are not limited to, hardware facility costs, data integration and storage costs, and software update and maintenance costs required during government operations.

Second, for public opinion data, the main costs involved are labor costs incurred during the data collection process, facility costs invested for data collection, and subsequent data maintenance costs. Therefore, a method of cost plus a moderate market preview price can be adopted.

Third, for environmental data, the "cost plus a moderate market preview price" approach is adopted. The costs of environmental data involve expenses such as automated monitoring equipment and instrumentation. Given that environmental data holds significant social value, the market preview price can be slightly adjusted based on market demand conditions to establish a dynamic pricing mechanism.

Fourth, for decentralized data (acquired from external sources), the price is directly based on its procurement cost and subsequent data maintenance and development costs.

5. Conclusion

This paper has conducted a systematic theoretical discussion focusing on the three core theoretical issues in the asset management of government data: asset attributes, data ownership, and pricing methods. Firstly, the research clarified that government data is a special public asset possessing economic value, intangible asset characteristics, dual attributes of public good and commodity, complexity of rights, and strategic resource attributes. On this basis, a multi-dimensional classification system for government data was constructed, laying the foundation for differentiated and refined asset management. Secondly, addressing the challenge of ownership definition, this paper proposes an ownership arrangement based on the principles of public ownership, openness, social benefit, and non-exclusivity. It innovatively establishes a property rights model for exercising data utilization rights according to data openness categories (unconditional openness, conditional openness, and prohibited openness), thereby providing a theoretical pathway to resolve "data silos" and ownership disputes. Finally, regarding pricing methods, this paper critically reviewed traditional evaluation methods such as the Cost Approach, Income Approach, and Market Approach, pointing out their respective applicability and limitations. It further proposed that different pricing methods should be flexibly selected and combined according to the specific type, application scenario, and openness strategy of government data to achieve a balance between social benefits and cost compensation.

In summary, this paper has preliminarily constructed a theoretical framework for government data asset management covering attribute identification, ownership design, and pricing operations. This framework not only helps deepen the theoretical understanding of government data as a key factor of production and promotes the interdisciplinary integration of public administration, law, and economics in the field of data governance, but also provides practical references for governments at all levels in advancing the registration, valuation, circulation, and supervision of data assets.

Future research can further integrate empirical data to conduct in-depth exploration of the actual pricing mechanisms for various types of government data assets, the institutional guarantees for the implementation of ownership, and cross-departmental collaborative governance models, in order to continuously improve the government data asset management system suited to China's national conditions.

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