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Theoretical Basis and Practical Path for Data Asset Valuation and Pricing

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Abstract: In the digital economy era, data has become a key production factor and strategic asset. However, due to its unique attributes—intangibility, non-competitiveness, dependence on specific scenarios and applications, and complex ownership—data assets face significant challenges in valuation and pricing, becoming a core bottleneck hindering the efficient circulation and value release of data factor markets. This article systematically explores the theoretical basis for data asset valuation and pricing, examining multiple theoretical perspectives and their applicability, including labor value theory, utility value theory, property rights theory, cost theory, and market supply and demand theory. At the practical level, this article deeply analyzes the advantages, limitations, and applicable scenarios of mainstream valuation methods, including the cost approach, market approach, and income approach. It also reveals key bottlenecks in current practice, including unclear data ownership definitions, lack of quality assessment standards, imperfect trading market mechanisms, and difficulty quantifying the value of application scenarios. Based on this, this article proposes a collaborative practical approach encompassing "theoretical support - methodological adaptation - institutional guarantees - and market improvement": deepening fundamental theoretical research to guide the development of data; promoting the integration and innovation of multi-dimensional valuation methods to enhance accuracy; accelerating the improvement of fundamental systems such as data rights registration, quality assessment, and security compliance to reduce transaction costs; and focusing on fostering a multi-tiered data trading market and exploring diversified pricing models to promote efficient circulation. Only through the coordinated advancement of theory, methodologies, institutions, and markets can we address the challenges of data asset valuation and pricing, fully unleash the value of data elements, and empower the high-quality development of the digital economy.

Keywords: Data assets, Valuation and pricing, Theoretical foundation, Practical approach, Data element market, Cost approach, Income approach, Market approach, Data rights.

1. Introduction

Human society is rapidly entering the digital economy. As a new production factor, data's strategic value is increasingly prominent and is widely regarded as the "new oil" driving economic growth and social innovation. From a macroeconomic perspective, the optimal allocation and efficient circulation of data elements are key pillars for improving total factor productivity and building a modern economic system. At the micro level, enterprises are treating data as core assets, managing, operating, and trading them. This has become a core strategy for enhancing competitiveness, innovating business models, and expanding value propositions. Whether it's smart city governance, industrial digital transformation, or the development of cutting-edge technologies like artificial intelligence, they all rely heavily on the aggregation, processing, and application of high-quality data.

However, compared to traditional production factors like land, capital, and labor, data assets exhibit significantly different characteristics: First, they are intangible and non-physical, meaning their value is not tied to physical carriers; second, they are non-rivalrous, meaning the same data can be used simultaneously by multiple parties without mutual exclusion; third, their value is highly dependent and contextualized, meaning their value is highly dependent on specific application scenarios, analytical processing capabilities, and the degree of integration with other data; fourth, they can be infinitely replicated and shared, with marginal costs approaching zero; and fifth, they have complex ownership relationships, involving the rights and interests of multiple parties, including data subjects, collectors, processors, and users, making them difficult to define and protect. These unique attributes present unprecedented theoretical and practical challenges when applying traditional asset valuation theories and methods to pricing data assets.

Currently, the development of data factor markets globally is still in its exploratory and initial stages. The ambiguity, complexity, and lack of unified standards in data asset valuation and pricing have become core bottlenecks hindering the efficient circulation, fair trade, and maximization of data value. Overpricing inhibits trading demand, while underpricing undermines the rights and innovation incentives of data providers and leads to inefficient allocation of market resources. Therefore, systematic and in-depth research on the theoretical foundations of data asset valuation and pricing, as well as the exploration of practical and feasible approaches, is not only of great theoretical significance but also a pressing need to unlock the potential of data elements, improve data element market mechanisms, and promote the healthy and sustainable development of the digital economy. This article aims to review existing theoretical foundations, analyze practical difficulties, and propose collaborative development paths for the future.

2. Unique Attributes and Valuation Challenges of Data Assets

To build an effective data asset valuation system, we must deeply understand its essential characteristics that distinguish it from traditional assets. Intangibility and non-physicality are

primary characteristics: as a stream of bits, data's value is not tied to a physical carrier but rather stems from its information content and decision-making support capabilities. This makes its value difficult to intuitively quantify and relies on professional interpretation. Non-rivalry constitutes a secondary characteristic: the same data can be reused simultaneously by multiple parties without devaluing each other, breaking the exclusive use model of physical assets and rendering traditional pricing models based on scarcity ineffective.

The core challenge is the strong scenario-dependent nature of its value. Data value is highly tied to specific application scenarios and analytical capabilities. For example, user behavior data is significantly more valuable in advertising than basic statistics, and industrial data is particularly valuable in predictive maintenance. This ex-post visibility of value and its cross-scenario volatility make ex ante valuations fraught with uncertainty. Furthermore, data value increases nonlinearly with the depth of analysis and the integration of multiple sources, significantly increasing the complexity of assessment [1].

Near-zero marginal cost replicability overturns traditional perceptions of value. The near-zero cost of data replication and transmission undermines the theoretical basis for the notion that "production cost determines the bottom line of value," making the replacement cost method inapplicable to measuring the value of initial inputs. The combined risks of ambiguous ownership and high compliance pressures: The intertwined interests of multiple parties create unclear legal definitions of derivative data ownership. Transactions must meet multiple compliance requirements, including privacy protection, trade secrets, and national security. High review costs and dynamic oversight directly constrain tradability and value assessment.

The lack of quality assessment further amplifies the risks. Without unified standards for measuring core quality dimensions such as data accuracy, completeness, and timeliness, flawed data not only diminishes value but can also lead to erroneous decisions. These characteristics—scenario binding, nonlinear value-added, low-cost replication, ownership compliance barriers, and quality fluctuations—intertwine to create systemic challenges that traditional valuation frameworks cannot address, forcing the reconstruction of theoretical systems and innovative methods.

3. Theoretical Basis for Data Asset Valuation

Building a data asset valuation system requires the integration of multidisciplinary theoretical support.

The labor theory of value states that value stems from the necessary labor input in the production process. The collection, cleaning, and analysis of data assets condense significant labor and resources, forming the fundamental logic of the cost-based valuation approach—estimating value through historical or replacement costs. However, its limitation lies in its inability to account for data premiums that far exceed costs in specific scenarios.

The utility theory of value emphasizes, from the demand side, that value depends on the ability to meet user needs. Data value is reflected in incremental utility, such as improved decision-making efficiency, optimized processes, or revenue generation. This forms the core basis of the income approach, which aims to quantify the future economic benefits of data applications. While this theory can account for the context-dependent nature of data, it faces challenges in utility prediction and value synergy.

Property rights theory reveals that clear ownership is a prerequisite for transactions. The Coase Theorem demonstrates that clear property rights and low transaction costs lead to optimal resource allocation. The core contradiction in the data sector lies precisely in the ambiguity of ownership and high compliance costs. The "Twenty Articles on Data" proposes a "three-rights separation" mechanism for data resource ownership, processing and use rights, and product operation rights, precisely to clarify rights and interests and reduce transaction barriers. Market supply and demand theory explains that prices are regulated by supply and demand [2]. Scarce data increases in value when demand is high, supporting the market approach. However, the current immaturity of the data market, low transaction transparency, and scarcity of comparable cases severely hinder its application.

Multiple theories offer complementary perspectives on data valuation: labor theory and cost approaches anchor value, utility theory and income approaches highlight future potential, property rights theory lays the foundation for transactions, and market theory reflects supply and demand dynamics. Together, they form a framework for understanding the sources of data value.

4. Analysis of Mainstream Valuation Methods and Their Applicability

Data asset valuation primarily draws on three traditional approaches: the cost approach, the market approach, and the income approach. However, these approaches require specific adjustments to accommodate the unique characteristics of data.

The cost approach calculates value based on the inputs involved in data generation. Its advantage lies in its objectivity, making it suitable for internal management, asset accounting, or new data with unknown value. However, it suffers from a fundamental contradiction: the cost of data replication approaches zero, resulting in high investment not necessarily resulting in high value, while low-cost data may command a significant scenario premium. It ignores non-competitiveness, scenario-dependency, and future returns, making valuations often detached from actual value.

The market approach relies on an active trading market and adjusts pricing based on comparable cases. While theoretically the most fair, it suffers from three major bottlenecks:

Market immaturity: low transaction transparency, limited scale, and a lack of effective price references;

Lack of comparability: significant differences in data granularity, quality, and application limitations make it difficult to identify truly comparable assets;

Value conglomeration: transaction prices often bundle technical services or relationship premiums, making it difficult to isolate the pure value of the data.

Currently, it is only applicable to a small number of highly standardized and frequently traded data products.

The income approach projects future net cash flows from data and discounts them for pricing. Its core advantage is capturing utility value, making it suitable for operational data or data products with clear scenarios and mature business models. Key challenges include:

Revenue forecasts are highly uncertain; the rate of value decay is difficult to quantify; data revenue is difficult to separate from other asset contributions; and discount rates are highly subjective [3].

Practical choices require multi-dimensional adaptation: For raw or specialized data, a cost approach can be emphasized; for mature data products, a revenue approach can be explored; and for comparable market cases, a market approach can be supplemented. Most scenarios require integrated verification—using a cost approach as the baseline, a revenue approach as the upper limit, and a market approach as a reference. This should be combined with metrics such as quality scores and scenario potential for comprehensive calibration, and the assessment assumptions and limitations should be clearly disclosed.

5. Core Bottlenecks and Obstacles in Practice

The implementation of data asset valuation and pricing faces multiple practical constraints. The primary obstacle lies in unclear ownership definitions and high compliance risks. The data rights chain involves multiple entities, and the allocation of ownership of derived and integrated data lacks a clear legal basis. Although local rights registration and confirmation pilots are underway, the lack of a national authoritative system for rights confirmation leads to unclear transaction rights. Furthermore, compliance requirements for privacy protection, national security, and industry regulation are stringent, and the dynamically shifting compliance boundaries complicate cost assessments and significantly raise transaction barriers.

The lack of quality assessment standards and the difficulty in quantifying value pose a secondary obstacle. Data value is strongly correlated with quality dimensions such as accuracy, completeness, and timeliness, but the industry has yet to establish unified, quantifiable assessment standards. Differences in data quality perceptions between suppliers and consumers often lead to misjudgments of value. More importantly, data value is highly dependent on the application scenario and the analytical capabilities of the user. The value of the same dataset can vary significantly across different companies. This strong scenario-dependence makes cash flow forecasts based on the income approach fraught with subjective assumptions, making the valuation of innovative application scenarios particularly unreliable.

Imperfect market mechanisms further hinder scalable pricing. The current data trading market is fragmented: numerous regional exchanges exist but lack interconnection, on-exchange trading is limited, and a large number of over-the-counter transactions lack transparency, making it difficult to establish an effective price discovery mechanism. Low standardization in trading processes drives up transaction costs. A weak professional service ecosystem, insufficient third-party services such as data brokerage, compliance audits, and valuation assessments, and limited market liquidity hinder the application of market-based approaches [4].

Weak internal management capabilities within companies represent a fundamental bottleneck. Most companies have yet to establish a systematic data asset management system, resulting in fragmented data resources, confusing standards, missing asset catalogs, and unclear quality status. This lack of internal governance has led to a breakdown in the data value chain, making it difficult to tap into the potential of internal data and to develop high-quality data products for trading, fundamentally undermining the practical foundation for valuation and pricing. These four bottlenecks intertwine and form a real obstacle to unlocking the value of data.

6. Practical Paths for Collaboratively Promoting Data Asset Valuation and Pricing

Solving the challenges of data asset valuation and pricing requires the development of a coordinated mechanism encompassing theory, methods, institutions, and markets.

Deepening Theoretical and Methodological Innovation: Strengthen interdisciplinary research to explore the origins of data value and new theoretical models. Promote contextualized improvements to cost-based, income-based, and market-based approaches: Refine cost accounting standards, develop dynamic income forecasting tools, and explore reference pricing in inactive markets. Break through the limitations of single methodologies by advocating for the integration and cross-validation of multiple methods. Build comprehensive assessment models based on data characteristics and quality scores. Encourage the development of intelligent valuation platforms to improve efficiency.

Improve the basic institutional framework: Implement the "Twenty Measures for Data," accelerate the development of a "three-rights separation" property rights system, and establish a nationwide unified property rights registration system. Improve data quality standards and third-party certification mechanisms, and develop quantifiable quality metrics and testing methods. Strengthen data security and compliance enforcement, refine classification and grading guidelines, and cross-border security processes. Explore guidance for on-balance sheet accounting of data assets to reduce transaction costs and compliance risks.

Cultivate multi-tiered markets and pricing models: Promote the standardization and interconnection of regional and national data exchanges, and coordinate the development of on- and off-exchange markets. Expand transaction targets to include diverse forms such as data products and API services. Explore scenario-specific pricing models: fixed price, negotiated pricing, usage-based pricing, revenue sharing, and auction bidding [5]. Promote the standardization of transaction contracts and delivery, and develop a professional service ecosystem for data brokerage, compliance auditing, and value assessment.

Strengthening the organizational and talent foundation: Enterprises need to establish a full-lifecycle data governance system, improve asset catalogs, quality control, and responsibilities. Prioritize cultivating interdisciplinary talent with combined capabilities in data technology, economic analysis, legal compliance, and valuation. Governments and industry associations should strengthen the development and certification of professional standards to provide core support for valuation practices.

Only through coordinated advancement across multiple dimensions can a scientific and efficient data asset valuation and pricing system be established to unlock the value of data elements.

7. Conclusion

As a core production factor in the digital economy, the efficient release of data asset value depends on a scientific and

reasonable valuation and pricing mechanism. This article systematically explores the theoretical foundations and practical approaches to data asset valuation and pricing, revealing its profound complexity, which distinguishes it from traditional assets. The intangible nature, non-rivalry, strong context-dependent value, unlimited replicability, and complex ownership and compliance requirements of data assets collectively pose unique challenges to valuation and pricing. Diverse perspectives, such as labor theory of value, utility theory of value, property rights theory, and market supply and demand theory, provide a foundational framework for understanding the source of data value, but they also highlight the limitations of a single theory. In practice, mainstream valuation methods such as the cost approach, market approach, and income approach each have their own applicable scenarios and significant shortcomings: the cost approach is objective but ignores value utility; the market approach is fair but subject to market maturity; and the income approach is future-oriented but difficult to predict. Current practices face multiple bottlenecks, including unclear data ownership definitions, high legal and compliance risks, a lack of data quality assessment standards, difficulty in value measurement, imperfect trading market mechanisms, a weak ecosystem, and insufficient internal data asset management capabilities.

The solution lies in building a coordinated and systematic approach: deepening basic theoretical research and exploring new value models that adapt to the characteristics of data; promoting the integration and innovation of multi-dimensional valuation methods and their contextualized application, and developing comprehensive assessment tools; accelerating the improvement of basic systems such as data ownership registration, quality assessment and certification, and security and compliance to reduce transaction costs and uncertainty; vigorously cultivating a multi-tiered data trading market and a professional service ecosystem, exploring diversified pricing models such as fixed prices, negotiated pricing, usage-based pricing, revenue sharing, and auctions; and focusing on improving organizations' data asset management capabilities and cultivating a team of multidisciplinary professionals.

Data asset valuation and pricing is a systematic project involving theory, technology, law, economics, and market mechanisms. Its development and maturity cannot be achieved overnight; it requires continuous exploration, collaborative innovation, and continuous improvement by multiple stakeholders, including academia, industry, government regulatory agencies, and trading platforms. Only by strengthening theoretical foundations, innovating assessment methods, improving institutional safeguards, thriving trading markets, and enhancing the capabilities of stakeholders can we gradually establish a scientific, reasonable, and efficient data asset valuation and pricing system, effectively address the core bottlenecks in the circulation of data elements, fully unleash the enormous potential of data elements, and provide solid support for building a new paradigm of the digital economy driven by data.

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