

# Comparative Study on Valuation Methods of Data Assets: Based on the Perspective of Data Analysis Applications

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**Abstract.** Although the existing valuation methods are showing a diversified development trend, the differences in theoretical logic and applicable conditions among them have not been systematically compared and examined, especially the special requirements for valuation methods in data analysis application scenarios, which still lack in-depth response in existing research. This article conducts a systematic typological comparative study on data asset valuation methods from the perspective of data analysis applications. Based on the underlying differences in valuation logic, this article divides existing methods into four types: cost oriented method, revenue-oriented method, market-oriented method, and value contribution method. A comparative framework is constructed from six dimensions: valuation logic, core assumptions, key methods, main advantages, main limitations, and applicable scenarios. Furthermore, the applicability of each method in three typical scenarios of descriptive analysis, predictive analysis, and normative analysis is examined, and the differentiated role path of data quality dimension in different methods is analyzed. Research has shown that the cost oriented approach is easy to operate but difficult to capture the value differences brought by data quality. The profit oriented approach has clear economic logic but is subject to subjectivity in parameter estimation. The market-oriented approach has high credibility but faces the reality of underdeveloped trading markets. The value contribution approach has the most prominent fit with application scenarios but has a heavy computational burden. The four methods show significant complementary relationships in terms of advantages and limitations. Method selection should be comprehensively balanced based on the characteristics of the analysis task, data conditions, and valuation objectives. This study can provide an analytical framework for enterprises to choose valuation methods reasonably in different data analysis scenarios.

**Keywords:** Data assets, Valuation methods, Data analysis applications.

## 1. Introduction

With the deepening development of the digital economy, the status of data as a new production factor has gradually shifted from policy consensus to enterprise practice. The research results in the field of data asset value evaluation in China have shown a significant growth trend, with research hotspots focused on topics such as defining the concept of data assets, identifying factors affecting value, and constructing evaluation models. At the same time, the practical operation of evaluating the value of data assets still faces many methodological challenges [1].

The cost method, income method, and market method, as the three classic valuation methods, have been widely transplanted and applied in the field of data assets. Among them, the income method has received more attention because it can reflect the future economic benefits of data assets. The multi-period excess return method has achieved reliable valuation results in empirical research of companies such as Yili Group, and the contribution rate of data assets to the overall value of the enterprise has been calculated to be about 10.16%. However, traditional methods face significant limitations in the data asset scenario: the cost method is difficult to reflect the scale effect and reuse value of data, the market method is limited by the underdeveloped trading market and lacks comparable references, and the income method is too subjective in parameter estimation, such as determining the profit sharing rate and selecting the discount rate [2] [3].

To overcome the limitations of a single method, researchers attempted to construct a comprehensive framework that includes multiple evaluation dimensions. Heckman et al. used a combination of expert surveys and regression analysis to classify the value dimensions of data into

three categories: value-based parameters, quality parameters, and cost-based parameters, identifying key dimensions such as data age, period, volume, and accuracy. Ding et al. integrated quality measurement indicators into data market design and constructed a more comprehensive evaluation framework. This type of model has made some progress in terms of systematicity, but the selection of dimensions and weight settings still has a strong subjective judgment color, and there is insufficient attention to the differences in data analysis task scenarios [1-4].

In recent years, some studies have introduced emerging tools such as the Shapley value method, machine learning frameworks, and meta-learning frameworks from cooperative game theory, attempting to more accurately quantify the marginal contribution of data in specific analysis tasks. These methods have made progress in theoretical refinement, but there is still a long way to go before they can be applied in practice.

This article explores the differences in applicability of different types of data asset valuation methods from the perspective of data analysis applications. Starting from the underlying logic of the methodology, this article divides existing valuation methods into four types: cost-oriented method, revenue-oriented method, market-oriented method, and value contribution method. Using the demand for valuation methods in data analysis tasks as a unified comparative framework, the article systematically analyzes the performance characteristics of various methods in terms of their ability to reflect data quality, adaptability to analysis tasks, and reliability of valuation results.

The comparative analysis in this article can provide a decision-making basis for the selection of valuation methods, helping enterprises make more reasonable method choices in different data analysis scenarios.

## **2. Typological analysis of valuation methods for data assets**

### **2.1. Classification framework for data asset valuation methods**

According to the underlying differences in valuation logic, existing data asset valuation methods can be divided into four basic types.

The cost-oriented approach uses the formation cost of data assets as the basis for value measurement, including data collection costs, processing costs, storage costs, and maintenance costs. The core assumption of this method is that there is a positive correlation between the cost input of assets and their value. The operation is relatively simple and easy to understand, but it often underestimates the actual contribution of data in analytical application scenarios because it fails to reflect the expected returns and demand-side value of the data [5].

The income-oriented method is based on the expected future economic benefits that data assets can bring to value, usually using the income sharing method or excess return method. This method fits well with the ultimate goal of data analysis - to create economic value through data-driven decision-making- but its application is limited by the measurability of expected returns, the determinacy of return periods, and the subjectivity of discount rate selection [6].

The market-oriented approach uses comparable trading prices in an active trading market as a valuation reference, relying on a well-established data trading market and sufficient disclosure of trading information. The current data trading market in China is still in its developmental stage, and there is a lack of comparable trading data. This method faces the dilemma of being "invaluable" in most scenarios [7].

The value contribution method focuses on the marginal contribution of data in specific analysis tasks, using tools such as the Shapley value method and machine learning contribution measurement to quantify the incremental value of data on analysis results. This method is most suitable for data analysis application scenarios and can reflect the "scenario dependency" characteristics of data, but it has high computational complexity and is sensitive to analysis tasks and model settings.

## 2.2. Comparison of Core Features of Four Methods

There are significant differences among the four valuation methods in terms of valuation logic, applicable conditions, data quality reflection ability, and analysis task adaptability. The advantage of the cost oriented approach lies in its transparent operation and verifiable results, but it is difficult to reflect the substantive impact of differences in data quality on value - if high-quality data and low-quality data have similar costs, they will receive similar valuations under the cost approach, which contradicts the value differences in analytical practice. The income oriented approach can reflect the impact of data quality on expected returns, but the quality factor plays a role through indirect paths such as "discount rate adjustment" or "yield term correction", and the reflection mechanism is not direct enough. The market-oriented approach is theoretically the most comprehensive reflection of various value factors, including quality, but the prerequisite is that the market itself has sufficient maturity and transparency. The value contribution method can directly capture the marginal impact of data quality differences on analysis results, but is limited by the setting of the "baseline state" and the stability of contribution calculation.

Table 1 provides a brief comparison of four types of data asset valuation methods from six dimensions: valuation logic, core assumptions, key methods, main advantages, main limitations, and applicable scenarios.

In terms of valuation logic, the four methods use cost, revenue, market, and marginal contribution as the core basis for value measurement, corresponding to four different value perception paths. In terms of core assumptions, the cost-oriented approach requires a positive correlation between cost and value, the income-oriented approach relies on the discounting of future income, the market-oriented approach is based on an efficient market, and the value contribution approach is based on the quantifiability of analytical results.

In terms of advantages and limitations, the four methods show a significant complementary relationship. The ease of operation of the cost oriented approach corresponds to the neglect of demand side value, the economic value orientation of the profit oriented approach is limited by the difficulty in determining the attribution of benefits, the contradiction between the credibility of the market-oriented approach and the insufficient market maturity, and the tension between the scenario fit of the value contribution approach and the high calculation cost, all of which constitute the balance space for method selection.

In terms of applicable scenarios, the cost-oriented approach is suitable for compliance assessments such as internal data entry into tables; the revenue oriented approach is suitable for predictive analysis with clear expected returns; the market-oriented approach mainly undertakes cross-validation functions at the current stage, and the value contribution approach has an advantage in scenarios that require precise quantification of data contribution such as governance benefit evaluation. Overall, method selection should be based on a comprehensive assessment of task characteristics, data availability, and valuation objectives, and there is no universally optimal method [6].

**Table 1.** Comparison of Four Data Asset Valuation Methods

| Dimension            | Cost-Oriented Approach                                  | Income-Oriented Approach                                    | Market-Oriented Approach                                   | Value-Contribution Approach                                          |
|----------------------|---------------------------------------------------------|-------------------------------------------------------------|------------------------------------------------------------|----------------------------------------------------------------------|
| Valuation Logic      | Based on formation cost                                 | Based on expected future earnings                           | Based on comparable market transaction prices              | Based on marginal contribution to analytical outcomes                |
| Core Assumption      | Positive correlation between cost input and value       | Future earnings can be discounted to present value          | Comparable assets can be referenced in an efficient market | Analytical outcomes are quantifiable and contributions are separable |
| Key Methods          | Historical cost method, replacement cost method         | Income split method, excess earnings method                 | Market comparison method, reference transaction method     | Shapley value method, machine learning contribution measurement      |
| Primary Strengths    | Simple operation, data availability, auditable results  | Clear value orientation, linked to economic returns         | Transparent value discovery, market credibility            | High scenario alignment, captures marginal utility                   |
| Primary Limitations  | Ignores demand-side value and expected returns          | Strong parameter subjectivity, difficult profit attribution | Relies on market maturity, lacks comparable data           | High computational cost, sensitive to model specifications           |
| Applicable Scenarios | Internal data capitalization with clear cost structures | Predictive analytics with measurable expected returns       | Cross-validation for data products with active trading     | Precise governance benefit assessment with measurable outcomes       |

### 3. Comparison of the Applicability of Valuation Methods in Data Analysis Application Scenarios

#### 3.1. The demand characteristics of valuation methods in data analysis scenarios

From the perspective of data analysis applications, data asset valuation methods need to meet the following core requirements. Firstly, sensitive reflection of differences in data quality. Data analysis tasks are highly sensitive to quality dimensions such as accuracy, completeness, consistency, and timeliness of data, and valuation methods should be able to convert these quality differences into value differences. Secondly, the ability to adapt to differences in analysis tasks. Different analysis tasks (descriptive analysis, diagnostic analysis, predictive analysis, normative analysis) have different demand structures and value realization paths for data, and valuation methods should be able to reflect this heterogeneity. Thirdly, the ability to respond to changes in data usage patterns. The value of data should vary when it is repeatedly used in the same analysis task or reused between different analysis tasks.

#### 3.2. Performance of various methods in different analysis scenarios

In descriptive analysis scenarios such as data reports and visual dashboards, accuracy and timeliness of data are core quality dimensions. The cost-oriented approach has certain applicability in such scenarios - because data is mainly used for display and monitoring, the value realization path is relatively simple, and the correlation between cost input and value is more direct. However, this method cannot reflect the diminishing effect of data timeliness on value, and it needs to be improved by introducing a timeliness correction coefficient [7].

In predictive analysis scenarios such as sales forecasting and risk warning, data integrity, consistency, and historical span become key value drivers. The profit oriented approach can better adapt to such scenarios, as the value of predictive analysis can ultimately be quantified by the economic benefits brought by improving prediction accuracy. However, determining the attribution of profits remains a challenge - the improvement in prediction accuracy may be attributed to both model improvement and data processing, requiring a reasonable division between the two [8].

In normative analysis scenarios such as precision marketing and intelligent recommendations, the accuracy, timeliness, and completeness of user profiles jointly determine the effectiveness of the

analysis. The value contribution method performs best in such scenarios because the analysis task has clear objectives and quantifiable effects, and methods such as Shapley value can effectively measure the marginal contribution of each data source to the final effect. However, computational complexity is the main obstacle for the application of this type of method in large-scale scenarios [9].

### **3.3. The differential mechanism of data quality dimension in valuation methods**

There are systematic differences in the mechanism of data quality in various valuation methods. In the cost-oriented approach, data quality mainly indirectly affects value through the path of "quality cost" - improving quality requires increasing cost investment in data cleaning, validation, and completion, but it is uncertain whether these investments will bring corresponding value added. Data cleaning techniques have been proven to improve the accuracy, completeness, and consistency of data, but their effectiveness in enhancing the value of data assets varies depending on the scenario.

In the revenue-oriented approach, data quality plays a role by influencing the "expected returns after quality adjustment". Researchers typically incorporate the quality dimension into revenue forecasting models or reflect the quality risk premium in discount rates. The limitation of this mechanism of action is that quality factors are aggregated into comprehensive indicators, making it difficult to demonstrate the differentiated effects of various quality dimensions.

In the value contribution method, the role of data quality is the most direct. The improvement of quality dimensions (such as cleaned data) can directly observe changes in Shapley values or other contribution indicators, which has the advantages of traceability and verifiability. This gives the value contribution method a unique advantage in evaluating the benefits of data governance investments [10].

## **4. Comparative analysis and comprehensive evaluation**

### **4.1. Comparison of advantages and limitations of various methods**

Based on the above analysis, the advantages and disadvantages of the four valuation methods can be summarized as follows. The advantages of the cost oriented approach lie in the availability of data, ease of operation, auditable results, and suitability for compliance scenarios such as data asset reporting; The limitation lies in the difficulty in reflecting the differences in data quality and the value brought by analytical applications. The advantage of the income oriented approach lies in its clear value orientation, direct linkage with economic benefits, and suitability for valuing data products with measurable expected returns; The limitation lies in the strong subjectivity of parameters and the difficulty in handling complex analysis scenarios where the attribution of benefits is ambiguous. The advantage of market-oriented approach lies in its transparent value discovery mechanism and market credibility; The limitation lies in the high demand for market maturity, and the current applicability is limited. The advantage of the value contribution method lies in its high compatibility with analytical application scenarios and the ability to capture marginal value; The limitations lie in high computational costs and sensitivity to analytical model settings [11].

### **4.2. Suggestions for selecting methods based on analyzing scenarios**

In specific analysis scenarios, method selection should comprehensively consider task characteristics and data conditions. For descriptive analysis scenarios with clear value realization paths and complete cost data, the cost-oriented approach can be used as a basic valuation tool after time-sensitive adjustments. For predictive analysis scenarios where expected returns are quantifiable and the attribution of returns is relatively clear, the income-oriented approach is more suitable, but attention should be paid to discounting adjustments in the quality dimension. For normative analysis scenarios with clear goals and measurable effects, although the value contribution method has the highest implementation cost, the valuation results have the best fit with the scenario requirements. The market-oriented approach is more suitable as a reference or cross-validation tool for other methods, rather than an independent valuation tool [12].

## 5. Conclusion

This article systematically compares the applicability differences of four types of data asset valuation methods: cost oriented, revenue-oriented, market-oriented, and value contribution methods, from the perspective of data analysis applications. Research has shown that there are systematic differences in valuation logic, data quality reflection ability, and analysis scenario adaptability among various methods. The cost oriented approach is suitable for scenarios where the cost structure is clear and the value realization path is simple; The income oriented approach is suitable for analytical applications where expected returns are measurable; The market-oriented approach is limited by market conditions and currently has limited applicability; Although the implementation cost of the value contribution method is relatively high, it has the best fit with the application scenarios of data analysis.

Future research can be advanced in the following directions. Firstly, explore the integration path of different valuation methods and construct a hybrid valuation framework that takes into account the advantages of each method. Secondly, deepen empirical research on the relationship between data quality dimensions and valuation results, and establish a quantitative model of the impact of quality dimensions on value. Thirdly, pay attention to the new challenges posed by emerging analytical technologies such as big language models for data asset valuation, and expand the applicability boundaries of valuation methodologies. With the gradual maturity of the data element market and the continuous evolution of analysis technology, the research on data asset valuation methods will usher in richer practical scenarios and theoretical innovation space.

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