Research on the valuation of data assets of internet enterprises based on the improved income approach

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Abstract. This study focuses on the valuation of data resources of Internet companies in the era of digital economy. At present, data has become a key factor of production, yet there is a lack of unified valuation standards in the industr. To address this issue, we propose an optimized income evaluation model. In terms of research methods, first, the principle of discounted excess returns is applied to quantify the value of data resources. Second, a hierarchical weight analysis technique is introduced, and a comparison matrix is constructed to scientifically determine the contribution of data assets to the overall revenue of enterprise. This method combines the forecasting advantages of the traditional income approach with the precision of hierarchical weighting, making the evaluation results more objective and accurate. To verify the practicality of the method, we selected JD.com as the research object and conducted a specific valuation of its data assets. This case study can provide a reference for the data value evaluation work of similar e-commerce platforms.

Keywords: Data assets, Internet firms, income, multi - period returns.

1. Introduction

In light of the digital economy's explosive growth, data technology has been applied in an expanding range of fields, giving rise to many new industries, business forms and models, which have become an important driver of global economic growth. China, as a country with huge data output, attaches great importance to the strategic significance of data in national economic development[1, 2].

Internet enterprises, leveraging their own advantages in data, have accumulated massive amounts of data resources, which contain great potential value. To enhance their core competitiveness, these enterprises continue to explore the value of data resources, convert them into data assets, and gradually shift their business focus to expanding data volume and improving data quality.

In the field of value evaluation of data assets in internet enterprises, a unified and widely applicable evaluation system has not yet been formed so far [3]. For this reason, exploring effective ways of quantitative evaluation for the worth of data assets in specific fields has emerged as a crucial issue that needs to be resolved immediately

Traditional asset evaluation mainly adopts three methods: income approach, cost approach and market approach. However, due to the characteristics of data assets such as non-materiality, replicability and dynamic change of value, traditional evaluation methods have great difficulties in accurately measuring their value. Specifically, the application of the cost approach requires clear measurement of asset costs, however, it is challenging to precisely define the cost of data assets; the implementation of the market approach depends on a sound trading market and sufficient similar asset transaction cases, but at present, the circulation market of data assets is not mature, and relevant transaction cases are relatively scarce; although the income approach can reflect the future income potential of data assets, this method has problems such as prominent subjectivity of parameters such as discount rate and income period, and difficulty in separating the income contributed by data assets alone, which requires optimization and improvement in combination with the own characteristics of internet enterprises [3, 4].

It can be seen that the feasibility of evaluating the worth of data assets by traditional methods is not high. To address this issue, some academics have proposed combining a number of distinct assessment techniques to determine the value of data assets [5].

The core problems faced by The excess of multiple periods return method in the evaluation of Internet assets for data are mainly manifested in the fact that the worth of data assets on the Internet is not presented at one time, and the data assets' value will change dynamically with user behavior, market environment and other factors, and it is difficult to reflect this dynamic value through a single evaluation cycle alone [6, 7].

The innovations of this paper are reflected in two dimensions: one is the industry-innovative analysis of the potential value of data assets, and the other is the innovation of research methods. The reason for choosing the Internet industry for analysis is that data assets play an extremely prominent role in this industry, and can provide a reference for other Internet enterprises to evaluate the value of data assets, which constitutes the innovation in the aspect of potential value characteristic analysis, this paper integrates the approach of multi-period excess earnings with the AHP model to evaluate the overall value of data assets of Internet enterprises [8]. Specifically, the analytic hierarchy process (AHP) is first used to determine the proportion of data assets in the overall contribution value, and then the multi-period excess earnings model is used to evaluate the existing data assets' worth, which is also novel [9, 10]. In practice, combining the analytical hierarchy process (AHP) with the multi-period excess earnings approach, by dividing multiple income periods, measuring and discounting the excess earnings generated by data assets in each stage respectively, this method is more in line with the actual situation of earnings fluctuations of data assets in different life cycles, and can make up for the deficiency of single-period evaluation in capturing their long-term value, thus more accurately reflecting the essence of data assets creating excess earnings. This research result is not only helpful for Internet enterprises to have a deeper understanding of their own asset composition, but also can facilitate the circulation and transaction of data assets [11, 12].

2. Improved Income method model

2.1. Construction of Multi-period Excess Income Model

2.1.1 Calculation of Enterprise's Excess Income in Each Period

The core idea of the multi-period excess income method is that the worth of an enterprise is equivalent to the total of the current values of the part of its anticipated future excess income that exceeds the return required by investors. The excess of multiple periods income method takes the time value factor into account, and determines the current value by discounting the predicted future value of each period [13, 14, 15]. Since this paper evaluates the value of data assets, it is necessary to exclude the impact of other assets except data assets on the enterprise's total worth, so as to determine the data assets' worth. The structure of the suggested data asset valuation model is as follows:

$$V= \sum_{t=1}^{n}(E - Ef - Ec - Ei)t \times (1 - i)^{-t} \times K \quad (1)$$

In the formula:

V represents the worth of the data asset;

E denotes the free cash flow of the enterprise;

Ef is the fixed asset contribution value of the business;

Ec represents the current assets' contribution value to the business;

Ei denotes the contribution value of the enterprise's intangible assets other than data resources;

t represents the income period;

I is the rate of discount;

K denotes the adjustment coefficient for the data asset's worth.

In the research, the overall corporate earnings are measured by the enterprise free cash flow (FCFF). The specific calculation formula is as follows:

Free Cash Flow = Earnings Before Interest and Taxes (EBIT) - Taxes + Depreciation and Amortization - Capital Expenditures - Net Investment in Working Capital (2)

2.2. Establishing the Multi-period Excess Return Model's Parameters

2.2.1 Evaluation of Income Period and Benchmark Date

The so-called income period generally refers to the time period during which an asset has the ability to generate profits. Considering that the data assets' worth is uncertain and time-sensitive, the income period should not be set too long, and this paper assumes it to be 5 years [16, 17]. The determination of the evaluation benchmark date is to clarify the actual status of the asset and the benchmark time point for asset value evaluation.

2.2.2 Discount Rate

The discount rate refers to the minimum rate of return required for an investment, which comprehensively takes into account the time value of money and risk compensation. For the discount rate i, this paper selects the weighted average cost of capital (WACC) as the discount rate. This is because this indicator can comprehensively reflect the capital costs of the enterprise's equity and debt, while taking into account the time value of money and risk premium, which is consistent with the definition of the minimum rate of return. Using this method can relatively accurately reflect the discount rate of enterprise income [18]. The following is the precise calculating formula:

$$i = WACC = K_s \times \frac{E}{D+E} + K_d \times \frac{D}{D+E} \times (1 - T) \quad (3)$$

WACC refers to the average weighted cost of capital; Ks represents the cost of equity capital; Kd stands for the cost of debt capital; E denotes the total amount of equity capital; D is the total amount of debt capital; T indicates the corporate income tax rate. For the cost of equity capital,the capital asset pricing model is widely used, and the formula for calculating it is

$$Re = Rf + \beta \times (ERP + CRP) \quad (4)$$

In the formula,

Rf is the risk-free rate of return;

B is used to measure the systematic risk of a specific asset[3, 9].

2.2.3 Contribution Values of Other Assets

According to Equation (1), to derive the value of data assets, it is necessary to exclude the contributions of all other assets except data assets. Therefore, the contribution values of these other assets must be calculated. Specifically:

Fixed Assets Contribution (Ef): Measured by the sum of the return on fixed asset investment and depreciation compensation, following common industry practices.

Current Assets Contribution (Ec): Determined by multiplying the average annual balance of current assets by their rate of return.

Intangible Assets Contribution (Ei): Calculated as the sum of the investment return from intangible assets (excluding data resources) and amortization compensation.

Note: The formulas for Ef , Ec , and Ei are not explicitly provided in the text but are referenced in Equation (1). Ensure consistency with the original equation when applying these definitions.

2.2.4 Finding the Data Assets' Evaluation Value

Sum the surplus that has been discounted returns of data assets for each period:

Evaluation Value of Data Assets =

$$\sum_{t=1}^{n} \frac{\text{The excess return of data assets in period t}}{(1+r)^t} + \frac{\text{Perpetual income after the nth period}}{r-g} \times \frac{1}{(1+r)^n} \quad (5)$$

(where r is the discount rate, n is the revenue period, and g is the perpetual growth rate)[4, 5, 6, 7, 14, 15]

2.2.5 Constructing a Hierarchical Model with AHP

The role of the Analytic Hierarchy Process (AHP) is that when analyzing the development and operation goals of things involving many factors, these factors are disassembled and a comprehensive evaluation is carried out to find out the factors at different levels under the goal, and then judge the role of each factor on the goal according to the degree of importance, sorting various factors in the order from macro to micro levels, thus forming a three-level structural hierarchy. These three levels are the goal level, the criterion level and the measure level, which are corresponding to the evaluation's object, criteria, and particular components, respectively[19].

2.2.6 Including an Adjustment for Data Asset Value Coefficient(K)

The data assets' worth is not fixed and will be affected by many factors. For example, when the quality of data assets is good, their value tends to rise; if the risk of data assets is high, their value may decline[20]. This paper comprehensively considers various factors affecting the worth of data assets, and then constructs an index system for evaluating the data assets' worth of Internet enterprises[10]. For details, see Table 1.

Table 1. Evaluation Indicator System for Data Asset Valuation

Target Layer	Indicator Layer	Criterion Layer
Index of Data Asset Value	A. Data Asset Quality	A_1Normative
		A_2Accuracy
		A_3Completeness
		A_4Timeliness
		A_5Consistency
		A_6Accessibility
	B. Data Asset Application	B_1Multi-dimensionality
		B_2Scalability
		B_3Usability
	C. Data Asset Risk	C_1Data Impairment Risk
		C_2Data Security Risk

3. Case Study - Taking JD.com Group as an Example

3.1 Company Profile

In the e-commerce sector, JD.com is highly representative, so this article selects it as the subject of case study[20]. JD.com has a wide business scope, covering e-commerce, logistics, industry, technology and health industry, among other fields. It owns several subsidiaries such as JD Retail, JD Logistics, JD Technology and JD Health. JD.com Group has always attached great importance to the research and development of core technologies, striving to build systems like self-operated platforms and logistics, and continuously providing support for its own digital transformation.

3.2 Measurement of Enterprise Excess Income

3.2.1 Measurement of Operating Revenue

To make the prediction results more accurate, this study selects relevant data from the past 5 years as observation samples, uses regression fitting methods to obtain the time-varying function of operating revenue, and then uses this function to estimate the overall income of JD.com Group[7]. According to the data disclosed in the enterprise's annual report, JD.com Group's operating revenues

from 2018 to 2023 are 462 billion yuan, 576.9 billion yuan, 745.8 billion yuan, 951.6 billion yuan, 1046.2 billion yuan and 1084.7 billion yuan in sequence.

In this study, Excel software is used for regression prediction. The linear function (y = 1350.628x + 2720833.03), polynomial function (y = -186.89x2 + 2446.8x + 2516.3) and exponential function (y = 1.197×10?1??) are compared, linear function of JD.com's corporate operating income can be seen in the figure 1, polynomial function of JD.com's corporate operating income can be seen in the figure 2, exponential function fitting graph of JD.com's corporate operating income can be seen in the figure 3, and finally the function form with the best fitting effect is selected to determine the income measurement value. The evaluation of fitting effect is mainly based on the fitting coefficient. The closer the coefficient is to 1, the higher the goodness of fit of the model and the more accurate the data fitting. The measurement results show that the polynomial function has the highest goodness of fit, so this study uses this function for income measurement. By substituting relevant data into the formula y = -186.89x2 + 2446.8x + 2516.3, the operating revenues of JD.com Group from 2024 to 2029 can be obtained, which are 1097.2 billion yuan, 1085.3 billion yuan, 1048.9 billion yuan, 988 billion yuan, 902.5 billion yuan and 792.5 billion yuan respectively.

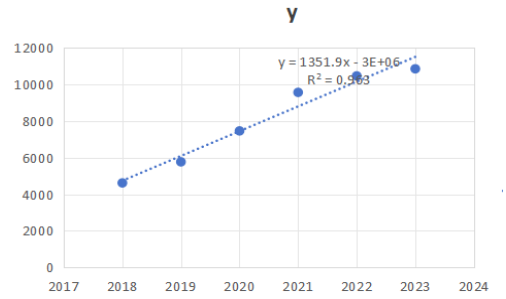

Fig.1 Linear function fitting graph of JD.com's corporate operating income

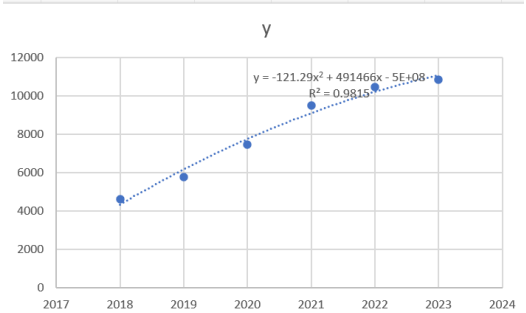

Fig.2 Polynomial function fitting graph of JD.com's corporate operating income

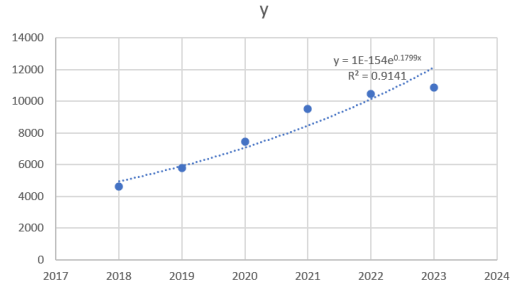

Fig.3 Exponential function fitting graph of JD.com's corporate operating income

3.2.2 Projecting Future Free Cash Flow for the Company

After calculation, during the period from 2018 to 2024, the annual average of the proportion of free cash flow in operating revenue is (10.00% + 9.01% + 9.00% + 9.00% + 9.00% + 9.00% + 9.00%) ÷ 7, and the result is approximately 9.14%. Based on this average, the free cash flow of JD.com Group from 2025 to 2029 is calculated using the formula "Operating Revenue × 9.14%". The specific results are as follows: the projected operating revenue in 2025 is 1085.3 billion yuan, corresponding to a free

cash flow of about 99.2 billion yuan; the projected operating revenue in 2026 is 1048.9 billion yuan, with a corresponding free cash flow of approximately 95.9 billion yuan; the projected operating revenue in 2027 is 988 billion yuan, and the corresponding free cash flow is about 90.3 billion yuan; the projected operating revenue in 2028 is 902.5 billion yuan, with a corresponding free cash flow of around 82.5 billion yuan; the projected operating revenue in 2029 is 792.5 billion yuan, and the corresponding free cash flow is approximately 72.5 billion yuan.

3.2.3 Determining the Evaluation Benchmark Period and Income Period

All original data in this study are derived from JD.com Group's 2023 financial report. The specific calculation process for evaluating the value of JD.com Group's data assets is as follows[20]:
First, define the income period. December 31, 2023 is set as the benchmark date for this evaluation, and the income period is set as 5 years, that is, from 2024 to 2029[5, 14].

3.2.4 Calculating the Discount Rate

The weighted average cost of capital approach is used in this study to calculate the discount rate. Clarifying the weighted average cost of capital (WACC), return on debt capital (Rd), and return on equity capital (Re) is required in order to determine this rate. Every week, the average rate of return is used to compute the risk coefficient, or β.

The country risk premium (CRP) remained relatively stable between 2018 and 2020, staying at 0.8%; from 2021 to 2023, it stabilized around 1.5%. The equity risk premium (ERP) in the Chinese market has long been in a balanced state of about 5.5%[3, 11].

The formula Re = Rf + β × (ERP + CRP) can be used to get the return on equity capital (Re), where the interest rate on a one-year time deposit determines the risk-free rate of return. By entering pertinent data into the calculation, the weighted average cost of capital (WACC) can be calculated with the corporate income tax rate set at 15%.

WACC = Re × E/D + Rd × D/V × (1 - T).

The calculation results of JD.com Group's cost of equity capital from 2019 to 2022 are shown in Table 2; Table 3 displays the weighted average cost of capital calculation findings for 2019–2022.

Table 2. Cost of Equity Capital (Re) of JD.com Group from 2019 to 2022

Cost of Equity Capital (Re) of JD.com Group from 2019 to 2022					
Year	Rf	C	ERP	CRP	Re=Rf+β×(ERP+CRP)
2019	3.15%	1.30	5.5%	0.8%	10.74%
2020	3.15%	1.18	5.5%	0.8%	11.50%
2021	2.80%	1.05	5.5%	1.5%	10.23%
2022	2.85%	0.95	5.5%	1.5%	9.93%
2023	2.60%	0.85	5.5%	1.5%	8.93%

Table 3. Calculation Results of the Cost of Equity Capital of JD Group from 2019 to 2023

Calculation Results of the Cost of Equity Capital of JD Group from 2019 to 2023					
Project	2019	2020	2021	2022	2023
Risk-free rate **Rf**	3.15%	3.15%	2.80%	2.85%	2.60%
Risk coefficient **β**	1.18	1.30	1.05	0.95	0.85
Cost of debt capital **Rd**	4.0%	3.8%	3.5%	4.1%	3.9%
Risk premium	6.3%	6.3%	7.0%	7.0%	7.0%

Return on equity capital **Re**	10.74%	11.50%	10.23%	9.93%	8.93%
Average return on equity capital	9.97%	10.95%	9.22%	8.85%	8.08%

3.3 Calculating the Weighted Average Cost of Capital

The distribution of equity capital and debt capital of JD.com from 2018 to 2023 can be found in the table 3. Over these six years, the proportions of debt capital and equity capital in the total capital of the enterprise remained relatively stable, and on the whole, the proportion of equity capital showed a slight upward trend.

This study selects relevant data from the recent 5 years as the basis for calculation, among which the average proportion of debt capital is 3.86% and the average proportion of equity capital is 10.27%. After calculation, the discount rate for Xiaomi's data assets is established at 8.08% since the weighted average cost of capital in 2023 is 8.08%.

3.4 Determining Other Assets' Contribution Value

Allocation of Asset Contributions Presumptions:Contribution to Fixed Assets:Estimated at 5% of free cash flow (FCF) by referencing industry-average fixed asset return rates. (Note: Actual calculation requires precise inputs of fixed asset depreciation impact + return rate).

Current Assets Contribution: Assumed to be 30% of FCF, based on the logical contribution of working capital turnover to cash flow generation.

Other Intangible Assets Contribution (e.g., patents, trademarks): Allocated at 20% of FCF, derived via the intangible asset revenue-sharing method to isolate non-data-related intangible assets.

The preliminary forecast results of JD.com's data asset value are shown in Table 4.

Table 4. Preliminary Forecast Results of the worth of JD.com's Data Assets

Preliminary Forecast Results of the Worth of JD.com's Data Assets						
Project	2025	2026	2027	2028	2029	Total
Free Cash Flow (billion)	992	959	903	825	725	
Contribution Value of Fixed Assets (billion)	49.6	47.95	45.15	41.25	36.25	
Contribution Value of Current Assets (billion)	297.6	287.7	270.9	247.5	217.5	
Contribution Value of Other Intangible Assets (billion)	198.4	191.8	180.6	165	145	
Excess Earnings (billion)	446.4	431.55	406.35	371.25	326.25	
Present Value (billion)	446.4	399.2876	347.8641	294.0563	239.0942	1726.7022

3.5 Calculation of Data Asset Value Adjustment Coefficient Using Analytic Hierarchy Process (AHP)

Based on the characteristics of data asset value, this paper constructs an index system for evaluating the data asset value of internet enterprises, as shown in Table 1 above. Five experts in the field of data management were invited to score the influencing factors of data asset value. Due to space limitations, the scoring table and scoring basis are omitted. After evaluating the validity, consistency, and correlation of the experts' scoring results, the analytic hierarchy process was used to determine the weight of each index, so as to determine the data asset value adjustment coefficient. It is finally determined that the weight of digital asset quality is 0.7832, the weight of data asset

application is 0.136, and the weight of data asset risk is 0.096,and based on this, the adjustment coefficient K for JD.com's data asset value is calculated as 1.7254. Thus, the final evaluation result of JD.com's data asset value is 172.67022 billion yuan[10, 20].

4. Conclusion

This study addresses the issue of the lack of a unified standard for valuing data assets of internet enterprises and proposes an improved income evaluation model that integrates the multi-period excess income method and the analytic hierarchy process (AHP). The model first quantifies the value of data through the principle of discounting excess income, and then uses AHP to determine the proportion of contribution of data assets, combining the advantages of traditional methods with the accuracy of hierarchical empowerment. Taking JD.com as a case study, with December 31, 2023 as the benchmark date and a 5-year income period, the weighted average cost of capital is used as the discount rate to measure each period's free cash flow. Following the division of the contribution value of other assets to obtain the excess income, and combining with the adjustment coefficient, the final evaluation of JD.com's data asset value is 172.67022 billion yuan. This study provides a feasible paradigm for the valuation of data assets of internet enterprises, helping enterprises clarify their asset composition and facilitate transaction circulation[1, 3, 5, 12].

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