Research on Data Asset Valuation and Income Distribution Method

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Abstract-Data are the basic resources and strategic resources, data value is more and more attention. However, due to the complexity and uniqueness of data assets, it is sometimes difficult to measure the fair value of data assets evaluation, and its value-added income distribution lacks research and practical application. Based on the current data asset evaluation methods, this paper proposes a data asset evaluation method based on subjective and objective combination and a data asset value-added income distribution model, which provides a convenient reference for data asset transactions and data income distribution system construction.

Keywords-data; assets; valuation; income; model

1 INTRODUCTION

So far, the digital economy with information technology and data as the key elements is booming and has grown up to be an influential force in facilitating national economic growth. Incorporating data into production factors [1] to enter the market for transaction and circulation, it is urgent to solve the related strategic problems such as the confirmation of data assets and value estimation. For the value of data assets, traditional asset evaluation methods such as cost method, income method, market method [2] and the combination method of the three methods [3-5] are always used in theoretical research to value and price data assets. In terms of the application of data market transactions, the major data exchanges still remain in the mode of transaction by matching and value by experience [6]. The fairness and objectivity of data asset value not reach a market consensus, hindering the circulation. Development and application value of data assets[7].At the same time, as data owners, data asset operators have not obtained the expected data gains in data transactions and data asset appreciation, to some extent, it also limits the socio-economic value driving force of data as a factor of production and becomes a ' stumbling block ' to the development of big data industry and digital economy[8-10].To this end, addressing the fundamental issues of data assets from asset recognition to asset valuation

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and the consensus and implementation mechanisms of income distribution is part of the current research priorities.

2 RESEARCH ON VALUATION OF DATA ASSETS

Data assets assessment is a quantitative and qualitative assessment of the status, quality and value of data assets in the organization [11]. The goal of data asset evaluation is to fully tap the value of data and promote data asset. Guide data to figure out, provide reference for determining data value. Guiding data pricing, supporting the development of data trading market. In 2019,China Asset Assessment Association will issue the ' No.9 expert guidance ' for data asset assessment, which provides cost method, income method and market method for assessment agencies and evaluators[12-13].

2.1 A recognized pricing model

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2.1.1 Cost valuation pricing

$$AV = Rc \times Cd \times Ec \tag{1}$$

The replacement cost (*Rc*) is the sum of storage, processing and maintenance costs: Storage cost: the cost of infrastructure occupied by data storage is converted into the value according to data capacity. Processing cost: Material and manpower involved in data processing. Operation and maintenance costs: material resources and manpower required to ensure normal and reliable data services.

The depreciation factor(*Cd*) is the timeliness factor multiplied by the lifetime factor: Timeliness coefficient: determined by the timeliness of data processing/updating,the coefficients between 0 and 1 are taken.

Life period coefficient: the proportional adjustment coefficient of the time period of data from the end of life to the total life period.

Expected return coefficient(*Ec*):It is the extra income that the data want to obtain in internal accounting and external transactions,and the coefficient is greater than or equal to 1.

2.1.2 Income valuation pricing

Income pricing formula:

$$AV = \sum_{1}^{N} \frac{Er}{(1+i)^N} + Am \tag{2}$$

Business excess return (*Er*): the excess return of data assets is the increase in income or the decrease in cost caused by holding the data assets.

Discount rate (*i*): the necessary return required by the holder of data assets.

Duration of use (*n*): Duration available for data assets.

Income tax amortization income (*Am*): tax amortization income generated by data assets. For the time being, the data assets are not included in the table and cannot be recorded.

2.1.3 Market valuation pricing, Market method pricing formula, as in (3).

$$AV = At \times Cf \tag{3}$$

Comparable data assets turnover (*At*): turnover of the same or similar data assets on the open market.

Correction coefficient (*Cf*): used to correct the difference between underlying data assets and comparable cases.

The above three pricing models has advantages and disadvantages, and the relevant subjects can choose according to the actual situation and their own needs. In addition to these three pricing models, the industry is also exploring different pricing methods, including the use of intellectual property valuation model. The above three valuation methods has their own benefits and disadvantages. Costing is simply and easy to understand. The disadvantage is that replacement costs are hard to measure accurately and do not reflect the value-added by data generated directly or indirectly. The income method can basically reflect the impact of data assets to the value added benefits of data income, which is intuitive and easy to understand. But there are still excess returns tricky to measure, and the excess returns are very dissimilar in different application scenarios. Market method is the most tangible reflection of the market situation of data assets. However, there is the absence of sufficient market transaction basis, and the comparability of data asset value in discrete transaction scenarios is doubtful. In general, involving virtual accounting of internal data assets sharing, external data exchange or transaction and the pricing of data products, the expected income is reasonably, and the cost method is suitable. Involving the contribution of industry evaluation data assets, the income pricing method should be adopted.

2.2 Applicability analysis of pricing model

The value of data assets should follow the constraints of market transactions and value regression. Value pricing is iteratively determined in the market under the constraints of cost factors and income factors. The price of any asset is value-driven.

Built on the data asset application is the underlying logic of data income. Data transaction and data value transfer, we choose the appropriate valuation method depending on the actual transaction and data application of data assets. That is, the application of data assets is calculated by the income method. Data assets are traded and the value price is calculated by the market method. Data assets have not been traded, no application, utilising the cost method.

2.3 Valuation model research

Data assets as a new type of assets, there is no recognized data assets evaluation system. According to the characteristics of data assets such as no consumption, value-added, dependence and value variability, considering the cost of data generation, data quality and data application scenarios and other factors, this paper attempts to introduce the analytic hierarchy process to construct the evaluation index system of data assets. In the aspect of index weight design, in order to avoid the subjective deviation of AHP expert scoring and improve the rationality of entropy weight method in determining the weight of index variability, the combination weight method combined with two methods is used, and the consistency test of index weight is carried out to objectively assign weight. The applicability of the three pricing and valuation methods mentioned in Section *A* of data assets builds a complete, general, subjective and objective data asset evaluation consensus model, and realizes the quantitative analysis of the evaluation results.

2.3.1 Indicator system of data asset value evaluation

Depending on the attributes and characteristics of data assets, it is preliminaries divided into two dimensions of data asset quality and income. Among them, evaluation indexes of data asset quality include integrity, correctness, consistency and repeatability. Evaluation indexes of data revenue include scarcity, timeliness, multidimensionality and scenic value. The specific explanation of each index is shown in table 1:

TABLE 1. HIERARCHY TABLE OF DATA ASSET EVALUATION INDICATORS

Table Head	**Table Column Head**		
	Target layer	**Middle layer**	**Index layer**
Data asset evaluation		Quality index	Integrality
		Quality index	Consistency
		Quality index	Accuracy
		Quality index	Identity
		Income index	Rareness
		Income index	Timeliness
		Income index	Multi-dimensional
		Income index	Scenarized

2.3.2 Weight determination of data asset value evaluation index by hierarchical method

- Construction of judgement matrices

The relative importance between two factors of n indicators at the same level was scored by experts. The scale of relative importance is between 1 and 9,The experimental data are shown in Table 2.

TABLE 2. EXPERIMENTAL PARAMETER TABLE

Table Head	Table Column Head	
	Scale	**Comparison of two factors A and B**
Data asset evaluation		Two factors i,j are equally important.
		Factor i is slightly more important than factor j.
		Factor i is more important than factor j.
		Factor i is more important than factor j evidently.
		Factor i is more important than factor j strongly.
		The intermediate value of the above adjacent judgment.
		If the ratio of importance of i to j is aij,then the ratio of importance of j to i=aji=1/aij。
		Two factors i,j are equally important.

The judgment matrix A (orthogonal matrix) is constructed,and a_{ij} is used to represent the comparison results of the first factor relative to the *j* factor:

$$A = (a_{ij})_{n\times n} = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix}$$

- Calculation of weights

Each row vector of matrix *A* is geometrically averaged (root mean square method),and then normalized to obtain the weight of each evaluation index and feature vector *W*:

- Consistency testing

Calculate the maximum eigenvalue λmax:The consistency index *CI* (Consistency Index),random consistency index *RI* (Random Index,The *RI* experimental data are shown in Table 3) and consistency ratio *CR*(Consistency Ratio) are calculated:

$$CI = \frac{\lambda \max - n}{n-1} \tag{4}$$

TABLE 3. *RI* EXPERIMENTAL PARAMETER TABLE

Table Head	Table Column Head		
		Degree	**RI**
Data asset evaluation		3	0.5149
		4	0.8931
		5	1.1185
		6	1.2494
		7	1.3450
		8	1.4200
		9	1.4616
		10	1.4900

$$CR = \frac{CI}{RI} \tag{5}$$

In general,when CR<0.1,the matrix is considered to have satisfactory consistency,otherwise the judgment matrix needs to be adjusted.

- Data assets indicator score

The value of data assets is jointly determined by the value of data quality and the value of data to return,and the evaluation score of data assets is obtained by multiplying the two.

$$VS = \frac{(V_{sq} \times V_{sm})}{100} \tag{6}$$

Which:

$$Vsq = \sum_{1}^{n} (Q_{wi} \times S_{qi}) \quad V_{sm} = \sum_{1}^{n} (M_{wi} \times S_{mi})$$

Q_{wi} is The weight of data asset quality index i,S_{qi} is the subjective score value of data asset quality index i.M_{wi} is The weight of data asset income index i,S_{mi} is the subjective score value of data asset income index i.

2.3.3 Determination of weights of data asset valuation indicators by entropy weight method

Information entropy is the basic unit of the disorder degree in the information theory measurement system. The smaller the information entropy of an index, the greater the information provided by the index, the higher the degree of variation variance) of the index, and the greater the role played in the comprehensive evaluation, the higher the weight. The elementary principle of entropy weight method is to determine the quantitative weight according to the size of index variability. The process is as following:

- Data standardization

The data of each index are standardized. Suppose k indicators are given$X_1,X_2,X_3,...,X_k$,where $X_i=\{x_1,x_2,x_3,...,x_n\}$.Assuming that the standardized values for each indicator data are $Y_1, Y_2, Y_3,..., Y_k$,then

$$Y_{ij} = \frac{X_{ij} - \min X_i}{\max X_i - \min X_i} \tag{7}$$

- Information entropy of indicators

According to the definition of information entropy in information theory,the information entropy of a group of data is calculated as :

$$E_j = -\ln(n)^{-1} \sum_{i=1}^{n} p_{ij} \ln p_{ij}, \quad p_{ij} = \frac{Y_{ij}}{\sum_{i=1}^{n} Y_{ij}} \tag{8}$$

- Determination of weights for indicators

According to the calculation formula of information entropy,the information entropy of each index is calculated $E_1,E_2,E_3,...,E_k$.The weight of each index is calculated by information entropy:

$$W_i = \frac{1 - E_i}{k - \sum E_i}, \quad (i=1,2,3,...,k) \tag{9}$$

- Data assets indicator score

The value of data assets is jointly determined by the value of data quality and the value of data to return,and the evaluation score of data assets is obtained by multiplying the two.

$$Vo = \frac{(V_{oq} \times V_{om})}{100} \tag{10}$$

Which: $V_{oq} = \sum_{1}^{n} (Q_{wi} \times S_{qi})$, $V_{om} = \sum_{1}^{n} (M_{wi} \times S_{mi})$ Q_{wi} is the weight of data asset quality index i,S_{qi} is the subjective

score value of data asset quality index i.M_{wi} is the weight of data asset income index i,S_{mi} is the subjective score value of data asset income index i.

2.3.4 Comprehensive score of data asset value evaluation index

Confirm index weight and data asset value score,the hierarchical method score corresponds to the subjective score,the entropy weight method corresponds to the objective score.

$$V = Vs * \alpha + Vo * \beta \tag{11}$$

Vs: Subjective ratings of data assets.

Vo: Data assets objective ratings. Which α,β represent subjective weight and objective weight coefficient respectively.$0 \leq \alpha \leq 1, 0 \leq \beta \leq 1, 0 \leq \alpha + \beta \leq 1$.

3 DATA ASSET INCOME MODEL

3.1 Data assets income

Data asset income is mainly derived from its direct or indirect business income [14]. Data income can be generated by the data owner authorizes the data processor to collect, process, process and use the data, so as to realize the value creation, data appreciation and monetization of fiscal benefits. It can also be the data owner authorizes the data processor or data operator to realize data value-added in the way of data transaction, and its income is pecuniary profit after the monetization value of data value-added is removed from the operating cost. Data assets are profitable and worthy embodiment of data commercial value. Data income right refers to the right of data owners to obtain income taken into account their data. Data owners have the income right of their data assets. Data income belongs to the category of incremental property, which can be granted to individuals. Proceeds of data assets should not be classed as public resources or public assets. Where non-owned data are used for commercial purposes,' countervailing ' should be given to the subject of data income rights and not used free of charge.

3.2 Data Asset Income Distribution Model

At present, there is not any mature data asset income model. That can be utilized to reference. Data asset income depends on the value pricing of data assets and the operating income of data assets. Pricing of data assets can be identified according to the pricing model of data assets in the fourth part. Operating income of data assets refers to the net profit on the aggregate income of data minus the processing and operating costs. Built on the transaction or increment of data assets, the basic framework of data income model is suggested.

- When data assets are traded, the return of assets is the cash value after the transaction price deducting transaction cost.

According to the principles of income settlement and income sharing, income distribution completes income payment through blockchain intelligent contract technology [15]. That is,

$$F_{mi} = \frac{Rp - Ta - Ci}{N} \tag{12}$$

F_{mi}:Data assets i income.R_p: Data assets i transaction price.

T_a:Data assets i original price.C_i: Management costs for data assets i.

- Data assets are not traded. asset income is the discounted value of value-added income realized by data assets through the operation of data operators. Income is made available according to the converted value of income and the income is shared. Income is paid through block chain intelligent contract technology.

$$F_{ai} = \frac{Ip - Ia - Ci}{N} \times \frac{1}{(1+r)^t} \tag{13}$$

F_{ai}: Data assets i income.I_p: Currency price of data assets i value-added income.I_a: Data assets i Last term end price.C_i: Management costs for data assets i.r: discount rate.t: Income cycle.

- In order to guarantee the security and transparency of data asset returns, smart contract technology is introduced as data income distribution and payment transfer. Its main functions are: I,to help multi-participants deal with transactions and settlement transactions in accordance with pre-agreed rules, thus completing the delivery and transfer of digital assets. II, Blockchain consensus mechanism and intelligent contract construct a rule protocol for data generation, transmission, calculation and storage in a decentralized environment, which creates the conditions for the safe flow of digital content work and asset value based on data. Thus, the basic agreement of value transfer can be realized, which is convenient for digital copyright trading, consumption and circulation. The specific process is shown in Figure 1:

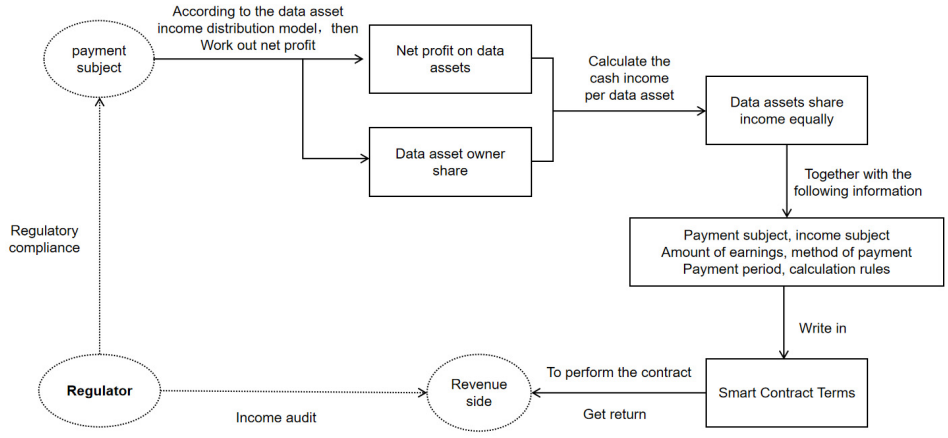

FIG.1 EXPERIMENTAL PARAMETER TABLE DATA ASSET INCOME DISTRIBUTION FRAMEWORK FLOW CHART

Individuals have personal data ownership, including data income rights. The data platform obtains data processing rights through personal authorization, providing information collection, data storage, data processing, data use, data security protection and data output value. Regularly compile and publish data balance sheets, cash flow statements and data profit statements according to data regulatory requirements. Through personal data income payment rules, calculate user income, pay user income. Depending on the "Civil Code", "Anti-monopoly law" and other data compliance legal provision, the data regulatory agencies supervise all aspects of data processing on the data platform. Since then, initially trained by data, individuals, platforms and regulators composed of data authorization, data migration, data use, data value-added, data revenue, data supervision as one of the ecological model of data assets, as showed in Figure 2.

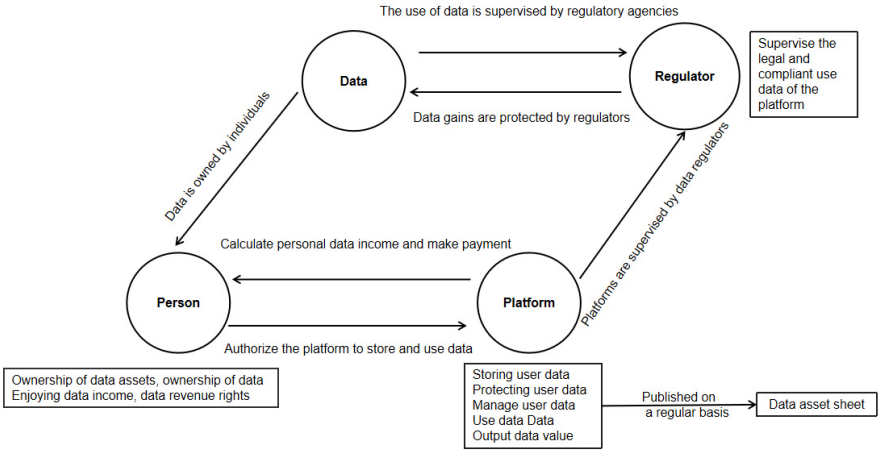

FIG.2 DATA ASSET INCOME ECOLOGICAL MODEL DIAGRAM

4 CONCLUSION

Under the continuous trial and error and iteration of the data trading market, blockchain, private computing, multi-party secure computing and other technologies have established the technical application foundation in data validation, value assessment, data migration and data for use in data from trading. At present, they are undergoing market inspection. However, there the field of data income distribution, there is poorly discussion of the institutional and technical levels. The biggest problem is that the direction of data use is not clear, and no tracking record is carried out. Data income is not separated from business income, so it is difficult for each data owner to benefit from it. Therefore, the establishment of a tracking tool for the use of data for assets and a reasonable data revenue stripping rule is an essential work worthy of further research and practice in the future.

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