Pricing Mechanism of Power Grid Data Asset

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Abstract. As a pillar industry of the national economy, the electric power industry has a large number of high-value data. It is of great significance to study how to transform these data resources into data assets and promote efficient utilization. A scientific data asset pricing mechanism is needed to speed up the circulation of data assets and lead to the positive development of the data asset market. This paper reviews the current status of data asset pricing and pricing principles, concludes the characteristics of power grid data, and summarizes the influencing factors of power grid data asset pricing. Based on this, we put forward a Bilateral data asset Pricing Mechanism.

Keywords: Power Grid Data; Data Asset Pricing; Data Asset Pricing Mechanism.

1 Introduction

With the rapid development of big data technology and the digital economy, data is gradually becoming a new factor of production driving economic and social development. To fully mine the value of the data, we first transform disordered data into ordered and useable data resources through data collection, aggregation, and analysis. Then we turn the data resources into data assets that can be traded and circulated through value assessment. The transaction of data assets can break the information silos and gather massive high-value data, which is an important way to maximize the value of data assets.

The digital economy will become the core of economic form, and data assets will be the core element of the digital economy. To improve the core competitiveness of the digital economy, we need to build an efficient circulation system of the data asset market around all aspects of digital assets, such as production, distribution, circulation, and consumption. The central link in the circulation system of the data asset market is circulation. The large-scale, sustainable, and efficient circulation of data assets depends on the establishment of a data asset market transaction mechanism, which in turn needs a fair and efficient pricing system of data assets as the core support [1]. Therefore, the establishment and improvement of a data asset pricing mechanism is an important topic in the construction of the data trading market. The pricing mechanism of data assets is an institutional arrangement of data pricing based on scenarios, with the data value as

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the core [2]. It includes but is not limited to the pricing method, strategy, and model to determine the price [3].

As a pillar industry of the national economy, the electric power industry has a large number of high-value data. These power data can not only be used in enterprises to better improve their benefits but also can be applied to the upstream and downstream of the industrial chain, financial industry, manufacturing industry, government, and other related parties to provide more comprehensive analysis, more accurate prediction and more valuable decision support. At present, the power grid data asset market is in the stage of unbalanced development, and some small-scale data asset transactions appear. Some pricing technologies and models for power grid data have been preliminarily applied in the existing transactions. But overall, the pricing mechanism of power data assets is still unclear, which makes it difficult for the market to play the role of resource allocation and hinders the efficient circulation of data elements. To meet the needs of digital transformation management of electric power enterprises and promote the development of the digital economy in the electric power industry, it is necessary to study the power grid data asset pricing mechanism. A good data asset pricing mechanism is very necessary to guide market innovation and stimulate market vitality [3]. In this paper, we establish a Bilateral data assets pricing mechanism. This mechanism realizes the value goal of the supply side and satisfies the use value goal of the demand side, which considers the benefits of both buyers and sellers.

The rest of the article is organized as follows. In Section 2, We classify the existing pricing methods and elaborate on the current research status of the data asset pricing mechanism. In Section 3, We summarize the characteristics of power grid data and give the principle of power grid data pricing. In Section 4, We summarize the factors affecting power grid data pricing and give a specific power grid data asset pricing mechanism. Last, in Section 5, we discuss challenges and future directions.

2 Related Work

2.1 Summary of the current situation of data pricing

Many studies have summarized the pricing of the data assets. For example, J. Pei examines the various motivations behind data pricing, understands the economics of data pricing, and reviews the development and evolution of pricing models based on a set of fundamental principles [4]. Zhang et al comprehensively review the state of the art of existing data pricing methods, Also, it proposes a novel classification of data pricing methods in which the methods are grouped according to the fundamental properties of data to be priced [5]. Liu et al compare the advantages and disadvantages of the six mainstream pricing methods: cost method, agreement pricing, market method, income method, quality-based, and query-based pricing. Reveal the characteristics of the different pricing methods and forecast the data pricing direction [6]. Wang et al propose five transaction pricing strategies and a few suggestions to improve data transactions and the big data market [7].

These review articles have made a comprehensive summary of existing data pricing methods. Therefore, this article only briefly summarizes the principles of data pricing and the classification of data pricing methods. We focus more on the power industry, summarize the characteristics of power grid data and summarize the factors that affect the pricing of power grid data. The title is set 17 point Times Bold, flush left, unjustified. The first letter of the title should be capitalized with the rest in lowercase. It should not be indented. Leave 28 mm of space above the title and 10 mm after the title.

2.2 Specific pricing mechanism or method

There are also many studies on specific pricing mechanisms and methods of data pricing. For example, Soumya et al present a bi-level mathematical programming model for the data-pricing problem that considers both data quality and data versioning strategies [8]. Koutris P et al propose a framework for pricing data on the Internet that, given the price of a few views, allows the price of any query to be derived automatically. We call this capability query-based pricing [9]. Kakkar R et al propose a blockchain and coalition game theory-based secure and reliable optimal data pricing scheme for ride-sharing [10]. Zou et al propose a data asset pricing method based on two-stage modified costing by analyzing the common data asset evaluation methods and the data asset value affecting factors [11]. Lu et al designed and construct a scientific and efficient data asset valuation and pricing management system and operation mechanism whose core subject is the "2+1" function system based on the primary market, secondary market, and data asset exchange of data asset [1]. Xiong et al propose a new data products pricing mechanism based on customer perceived value, and the pricing model is constructed from the five dimensions of price value, functional value, competitive value, emotional value, and social value [12].

At present, there is much research on data asset pricing. However, people usually studied data pricing from the perspective of pricing methods or pricing models rather than the mechanism in it. Some scholars have called for the establishment of a unified and standardized data asset pricing mechanism, but there are few studies on the design and further explanations of the specific pricing mechanism of the data assets. We propose a pricing mechanism for grid data assets to fill this gap.

3 The Current State of Data Asset Pricing

3.1 Data Pricing Principles

The pricing of data assets should follow certain pricing principles.

(1) Dynamic pricing based on the transaction. Data products are different from general industrial products. The pricing process of data products is a dynamic process that changes continuously with the application scenarios, users, transaction regulations, and other factors of the products. It is not fixed, unique, and static. The purpose of data products is to dig deeper into the value of data and obtain the maximum economic benefits. Dynamic pricing can help us achieve the goal by repricing the data products before each transaction, which can estimate the value of present data products more accurately.

(2) Compositionality of data asset costs. The production cost of data assets is an important reference for data producers to evaluate data assets, which often determines the lower limit of the price. The cost of data assets includes all the expenses of data planning, data acquisition, and verification, data storage, construction and operation of the data management system, data analysis, API development, etc, which are very complicated. To calculate the entire cost of data assets accurately, we should divide the production process of data assets into basic component units that can calculate the cost, and then gradually summarize each unit.

(3) Diversity of pricing methods. The pricing scenarios of data products are different, and no pricing method can be applied to any pricing scenario, which determines that the pricing process has the characteristics of method diversity. There is no fixed pricing method for data products, and the appropriate pricing method should be flexibly selected according to the specific situation.

3.2 Current Pricing of Data Assets

A data asset is an information-based resource. A data asset may be a system or application output file, database, document, or web page [13]

The existing pricing methods of data assets can be divided into five categories:

(1) Cost-oriented, this type of pricing method is based on the cost of data asset formation, such as the cost approach in data assets [14][15].

(2) Customer-oriented, this type of pricing method is based on consumers' understanding and demand for product value, such as utility-based pricing method and income approach in data assets [16][17][18].

(3) Market-oriented, pricing method based on the price of the same type of commodity in the market, suitable for the more mature and active trading market. Typical examples in game-theoretic pricing model and market approach in data assets [19].

(4) Profit-oriented, a pricing method that aims at maximizing the profit of an enterprise. It mainly manifests in the implementation of differentiated pricing based on customer preference and willingness to pay to maximize the value of consumer surplus. Typical examples are query-based pricing, version-based pricing, and bundled pricing [20][21][22][23].

(5) Based on the life cycle, dynamic pricing is carried out according to different characteristics of data in the life cycle, such as lifecycle-based pricing and real options approach in data assets [24].

4 Data Pricing in Power Grid

4.1 Characteristics of Power Grid Data

Grid data fall into three categories: One is power grid operation and monitoring data, mainly including energy management system, distribution network management system, wide-area measurement system, production management system, grid scheduling system, fault management system, image monitoring system, etc; The second is the marketing data of electric power enterprises, such as electricity transaction price, electricity sales, electricity customers and other data, mainly including sales and marketing information systems, customer service system, electricity energy metering system, electricity information collection system, etc; Third, electric power enterprise data, mainly including collaborative office system, enterprise resource planning system, E-commerce system, etc; Big data of power grid involves all aspects of power generation, transmission, transformation, distribution, consumption and dispatching, and is cross-unit, cross-professional and cross-business. The rapid development of the smart grid makes the rapid integration of information technology, communication technology, and production management of electric power enterprises, and power grid enterprises have formed a big data environment.

Power grid data is mainly generated in real-time with power production and consumption, which can truly reflect macroeconomic operation, industrial development, residents' living conditions, and consumption structure. Power grid companies have a high level of automation and information, as well as complete infrastructure for data collection, transmission, and application, so they can obtain data in a timely and efficient manner. Overall, power grid data have the following characteristics in addition to the general characteristics of data assets:

First, power grid data covers wide areas and has a strong space-time correlation. Power grid data includes power generation data, power grid operation data, user electricity consumption data, and so on. With the gradual construction and application of smart substations, smart electricity meters, and power equipment online monitoring systems, the scale and types of data generated by energy and power systems will continue to grow rapidly and the volume will surge. In addition, the geographical location of the power data acquisition terminal is fixed. Not only the positioning accuracy of geographical location is high, but also the period time is as long as several years or even decades, with strong spatiality and temporality.

Second, power grid data is good at real-time performance and has high credibility. The data acquisition terminal has a high degree of automation and complete infrastructure for data acquisition, transmission, and application. There are also many data collection points so the collection speed is fast. The frequency of some collected data reaches the level of minutes and seconds, which makes the data have strong real-time performance. In addition, with less manual intervention in the process of data collection, power grid data is easy to verify, difficult to tamper with, and has high reliability.

Third, power grid data has high-value density and high application value. Power data contains rich information about regional economic development and enterprise operation, which can fully reflect the operation of the macroeconomy, the development of various industries, residents' living conditions, and consumption structure. Power grid data is convenient to be aggregated with meteorological, communications, social economy, public utilities, geographic information, and other data, which has high application value in serving national governance. Sections should be numbered with a dot following the number and then separated by a single space:

4.2 Influencing Factors in Power Grid Data Pricing

4.2.1 Cost.

Cost is the key factor for data producers to determine the price of data assets. The cost of power grid data assets includes all direct and indirect costs from data generation to data asset formation, which can be divided into acquisition cost, development cost, and circulation cost by stages.

Acquisition cost refers to the total cost of obtaining data from data sources through automatic tools. It can be further divided into tool construction of data acquisition and implementation of data acquisition.

Development cost refers to the total cost of cleaning, processing, modeling, calculation, and statistical analysis of the collected data to release data value. It can be divided into tool construction of data development and implementation of data development.

Circulation cost refers to all the costs of marketing, data security, and trade circulation to achieve the purpose of circulation and transaction of data assets. It can be divided into the tool construction of data circulation and the implementation of data circulation.

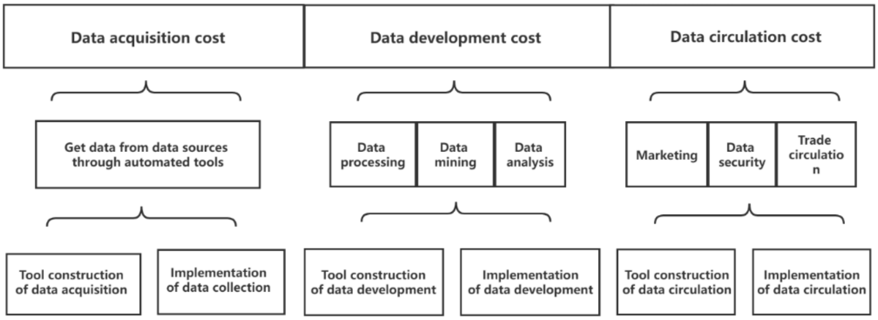

Fig. 1. Cost composition of grid data.

4.2.2 Data Value.

Data value is an important factor affecting data asset pricing. According to the current situation of power grid data assets and the factors that affect the evaluation of data assets, this paper obtains four main factors that affect the value of power grid data assets, including data quality factor, data flow factor, data scarcity factor, and data value realization risk factor.

- Data quality factors

The quality value of electric power data assets reflects the intrinsic value of data and is the nature and value of data itself. Data quality can be evaluated by quantifiable indicators from the aspects of data integrity, accuracy, timeliness, consistency, standardization, and accessibility.

- Data flow factor

Data flow refers to the behavior that takes data as the object between the data supplier and the data demander according to certain flow rules. Data assets can be divided into open data, public data, shared data, and non-shared data by circulation type.

- Data scarcity factor

The scarcity of a data asset is determined by the proportion of the amount of data held by the data asset to the total amount of data of that type. The data scarcity factor can be measured by the proportion of a certain category of data in one or more industry areas, that is, by comparing the total amount of similar data.

- Data value realization risk factors

There are risks affecting the realization of the data value in every link of the data value chain. Data value realization risk is divided into four first-level indicators: data management risk, data circulation risk, value-added development risk, and data security risk, and eight second-level indicators: equipment failure, improper description of data, the incompatibility of system, policy impact, demand for an application, data development level, data leakage, and data corruption.

4.2.3 Scenario and Consumer Willingness to Pay.
The scene refers to a series of elements including behavioral context, the spatial environment, and the emotional context involved in the process of value creation and value realization [3]. The scenario is a unique factor in data pricing, which affects data utility and then data product pricing. The most important feature of the data assets pricing mechanism is the high correlation between data assets pricing and scene. The value of data is highly situational and pricing must be scenario-based. Willingness to pay (WTP), the highest price consumers can offer for a product, also plays an important role in pricing data.

5 Bilateral Pricing Mechanism

5.1 Bilateral Pricing Mechanism

Given the current pricing status of power grid data assets and the demand for market development, we need to establish a universal power grid data assets pricing mechanism. A reasonable and orderly data asset pricing mechanism framework is helpful to reduce the waste of resources caused by disorderly and repeated development. A unified pricing mechanism will produce the maximum development force, break the phenomenon of 'information island' and make the grid data assets flow. In this paper, we establish a Bilateral pricing mechanism. The specific design is as follows.

Overall module design: Bilateral Pricing Mechanism. This mechanism concludes with two dimensions, the value dimension, and the demand dimension. The value dimension is used to realize the value goal of the supply side and the demand dimension is used to meet the use value goal of the demand side. This pricing mechanism considers the benefits of both buyers and sellers. We can integrate these two dimensions into the data trading platform for unified management.

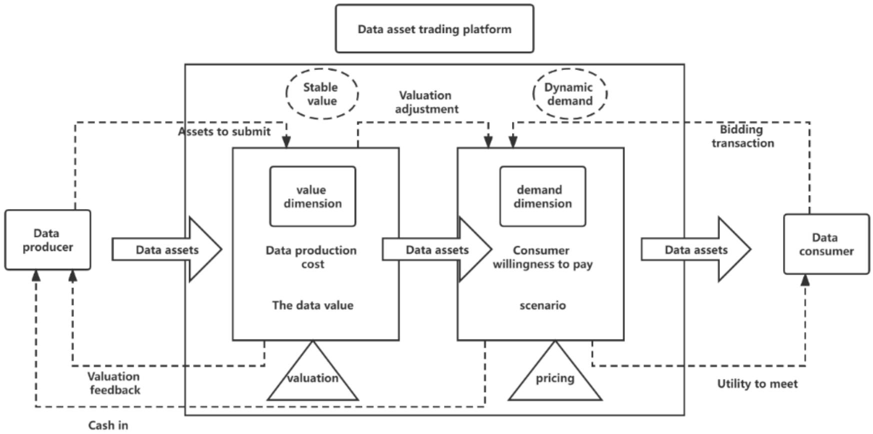

Fig. 2. Bilateral Pricing Mechanism

The value dimension is the dimension associated with the value and characteristics of the data itself. It is the more 'static' part of the pricing process. The demand dimension is from the perspective of the scene and consumer. It includes the more 'dynamic' part of the pricing process and varies with each pricing scenario and consumers' value perception and demand for data. The value dimension determines the lower limit of price while the demand dimension determines the upper limit of price. We first give a preliminary appraisal of the data asset from the value dimension according to the production cost and data value of the data. Then from the demand dimension, according to the changes in the scene and the degree of demand of consumers, the valuation of the value dimension is adjusted, and a final price is given for the combination of the data asset with the specific scene and demand of customers.

- dimension of value

The value of a data asset is fixed over some time. Therefore, the asset valuation of the value dimension can be regarded as the 'stable' part of data pricing. It is determined by the characteristics of the data itself, such as the production cost of data and data value, which also includes the data quality, data scarcity, data circulation, and data value realization risk mentioned in the previous section. The data producer submits the data asset to the trading platform, and the platform puts the data asset into the value dimension for preliminary valuation and feeds the valuation back to the data producer. It should be noted that the valuation of data in the value dimension will change over time. This is because, over time, the cost of data storage and some factors to measure the value of data, such as the degree of data circulation, and policy impact, will change, which leads to changes in the cost of data generation and value of data. Therefore, we need to update the valuation of data in the value dimension after a while to ensure the validity of the valuation of the value dimension.

- dimension of demand

When pricing data, willingness to pay (WTP), the highest price a consumer can offer to obtain a product, plays an important role in setting the price. Different consumers have different degrees of value cognition and demand for the same data assets, leading to changes in the price they will pay. The price of the same data asset may also vary greatly in different application scenarios. The demand dimension considers the more 'dynamic' part of data asset pricing, which changes with the pricing scenario and consumer demand in each transaction. When the data assets are put into the value dimension and have a preliminary valuation, we put the data assets into the demand dimension for a further price adjustment to get the final transaction price. This price not only allows data producers to realize the value of data assets but also meets the utility of data consumers.

- Trading platform

A common trading platform is indispensable in the construction of a data asset pricing mechanism. With the asset trading platform as the carrier, the data producer and data consumer are connected to realize the Bilateral pricing mechanism of data assets. The trading platform combines the value dimension with the demand dimension. After the production of data assets is completed, enterprises can connect with the management interface of the trading platform, and the trading platform will arrange data assets to form a preliminary valuation from the value dimension. Then, from the demand dimension, different scenarios and consumer demands are combined to form a price satisfactory to both buyers and sellers, so that the transaction process of data assets can be carried out efficiently. Each figure should have a brief caption describing it and, if necessary, a key to interpreting the various lines and symbols on the figure.

5.2 An Example

We give an example of a pricing model that conforms to this pricing mechanism.

First of all, in the value dimension, we give a preliminary valuation P_c of the data price. The P_c is obtained based on cost and combined with various factors that affect the value of data assets. The calculation formula is as follows:

$$P_c = C \times \alpha \times \beta \times (1 + l) \times (1\text{-r}) \quad (1)$$

In the formula: C is the cost, α is the data quality factor, β is the data flow factor, l is the data scarcity factor, and r is the data value realization risk factor. These are mentioned in chapter 4.2 of the paper.

Table 1. Cost Estimation Methods for Data Assets

cost item	definition	formula
Acquisition	Acquisition cost refers to the total cost of obtaining data from data sources through automatic tools.	Acquisition cost = The workload of tool construction of data acquisition ×Unit price for R&D personnel + The workload of implementation of data acquisition ×Implementer unit price
Development	Development cost refers to the total cost of cleaning, processing, modeling, calculation, and statistical analysis of the collected data to release data value.	Development cost = The workload of tool construction of data development ×Unit price for R&D personnel + The workload of implementation of data development ×Implementer unit price
Circulation	Circulation cost refers to all the costs of marketing, data security, and trade circulation to achieve the purpose of circulation and transaction of data assets.	Circulation cost = The workload of the tool construction of data circulation ×Unit price for R&D personnel + The workload of the implementation of data circulation ×Implementer unit price

Table 2. Calculation method of data value factors

factor	definition	calculation method
data quality factor	The quality value of electric power data assets reflects the intrinsic value of data and is the nature and value of data itself.	1. Determine the inspection dimensions, mainly data integrity, accuracy, and validity. 2. Establish inspection standards. 3. The proportion of data that passed the inspection was taken as the data quality factor.
data flow factor	Data flow refers to the behavior that takes data as the object between the data supplier and the data demander according to certain flow rules.	Data flow factor = (open data transmission coefficient × open data volume + shared data transmission coefficient × shared data volume) / total data volume.
data scarcity factor	The scarcity of a data asset is determined by the proportion of the amount of data held by the data asset to the total amount of data of that type.	data scarcity factor = System data volume/relevant total data volume
data value realization risk factors	There are risks affecting the realization of the data value in every link of the data value chain.	The risk of data value realization consists of multiple indicators. Experts with professional experience can be invited to fill in the scores and weights, and then aggregated and calculated.

After obtaining the price valuation of the value dimension, we adjust the valuation in combination with the demand dimension to obtain the final price. This is reflected in the correction of prices in combination with market supply and demand factors. Its calculation formula is as follows:

$$P = \begin{cases} P_c, \frac{P_e}{P_c} < \theta \\ P_e, \frac{P_e}{P_c} \geq \theta \end{cases} \quad (2)$$

In the formula: P is the final data pricing of the model, P_c is the price estimate obtained from the value dimension, P_e is the market price, θ is the threshold, and the recommended value of θ is 1.1.

According to the Bilateral Pricing Mechanism, we can also design more specific models according to application scenarios, so that the data pricing problem of the power grid can be better solved.

6 Conclusion

The establishment of a data asset pricing mechanism is inevitable, which is also reflected in national policies in recent years. In this paper, we present a data asset pricing mechanism for the power grid according to the nature of power grid data and the factors affecting power grid data pricing. This mechanism divides the pricing of data into two dimensions: the value dimension and demand dimension, and takes into account the value and uses the value of data, to obtain a price satisfactory to both buyers and sellers. The development of a data asset pricing mechanism still faces many challenges, such as the lack of a mature and active data asset trading market as a reference for the establishment of a pricing mechanism. It is also very difficult to design a common pricing mechanism for most trading scenarios.

This pricing mechanism is still rough at present. In the future, we can further refine this pricing mechanism based on this and give a more specific design of value dimension and demand dimension. And optimize the pricing mechanism to make it more scientific and universal. Based on this, some specific application cases of the pricing mechanism are given.

References

1. Lu Minfeng and Ouyang Wenjie 2021 Research on the system mechanism design and construction of data asset. *J. Social Sciences in Xinjiang*. **01** 43–53+168
2. Ouyang Rihui and Du Qingqing 2022 Research progress on the pricing mechanisms of data. *J. Economic Perspectives*. **02** 124–141
3. Ouyang Rihui and Gong Wei 2022 The pricing mechanism of data elements based on data element value and the contribution of market assessment. *J. REFORM*. **03** 39–54
4. Jian Pei 2020 A Survey on Data Pricing: from Economics to Data Science. *J. IEEE Transactions on Knowledge and Data Engineering*. 1–1
5. Mengxiao Zhang and Fernando Beltrán 2020 A Survey of Data Pricing Methods. *J. SSRN Electronic Journal*
6. Liu Nan, Hao Xuejing and Chen Yuhong 2021 A review and comparative analysis of domestic and foreign research on big data pricing methods. *J. Big Data Research* .**7(06)** 89–102

7. Wang Wenping 2016 Research on big data transaction pricing strategy. *J. Computer Engineering & Software*. **37(10)** 94–97
8. Soumya Sen, Carlee Joe-Wong, Sangtae Ha, and Mung Chiang 2013 A survey of smart data pricing: Past proposals, current plans, and future trends. *J. ACM Computing Surveys*. **46(2)** 1–37
9. Paraschos Koutris, Prasang Upadhyaya, Magdalena Balazinska, Bill Howe and Dan Suciu 2015 Query-Based Data Pricing. *J. Journal of the ACM*. **62(5)** 1–44
10. Riya Kakkar, Rajesh Gupta, Sudeep Tanwar, and Joel J. P. C. Rodrigues 2021 Coalition Game and Blockchain-Based Optimal Data Pricing Scheme for Ride Sharing Beyond 5G. *J. IEEE Systems Journal*. 1–10
11. Zou Guilin, Chen Wen, Wu Liangzheng, Zhang Jigang, Liang Yanni, Yu Zeyuan and Yu Zeyuan 2022 Research on grid power data asset pricing method——analysis based on two-stage modified costing. *J. Price: Theory & Practice*
12. Xiong Li, Liu Mingming and Xu Zhaoran 2018 Research on data products pricing mechanism in china--analysis based on customer perceived value theory. *J. Price: Theory & Practice*
13. K L Dempsey, N S Chawla, L A Johnson, R Johnston, A C Jones, A D Orebaugh, M A Scholl, and K M Stine 2011 *J. Information Security Continuous Monitoring (ISCM) for federal information systems and organizations*
14. Isaac (Dr) Chaneta 2011 Cost-oriented Pricing.Accepted: 2011-05-11T12:47:02Z
15. Yi Kejun and Lei Yuanzhi 1996 Discussion on the operation of cost approach in the evaluation of intellectual property intangible assets. *J. Scientific Management Research*. **06** 47–52
16. David P. Brown and Michael R 1985 A Simple Econometric Approach for Utility-Based Asset Pricing Models. *J. The Journal of Finance*. **40(2)** 359–381
17. Yilong Hui, Zhou Su and Song Guo 2019 Utility Based Data Computing Scheme to Provide Sensing Service in Internet of Things. *J. IEEE Transactions on Emerging Topics in Computing*. **7(2)** 337–348
18. Xu Ziling, Liu Chunxue, Bai Yuying and Wang Ling 2022 A case study of m communication enterprise's data assets——evaluation based on multi-period excess income method. *J. Appraisal Journal of China*. **(03)** 73–81
19. Vladimir Vovk and Glenn Shafer 2008 The game-theoretic capital asset pricing model. *J. International Journal of Approximate Reasoning*. **49(1)** 175–197
20. Shaleen Deep and Paraschos Koutris 2017 QIRANA: A Framework for Scalable Query Pricing. *J. In Proceedings of the 2017 ACM International Conference on Management of Data*. 699–713
21. Paraschos Koutris, Prasang Upadhyaya, Magdalena Balazinska, Bill Howe and Dan Suciu 2015 Query-Based Data Pricing. *J. Journal of the ACM Appl*. **62(5)** 1–44
22. Dusit Niyato, Dinh Thai Hoang, Nguyen Cong Luong, Ping Wang, Dong in Kim and Zhu Han 2016 Smart data pricing models for the internet of things: a bundling strategy approach. *J. IEEE Network*. **30(2)** 18–25
23. Danqin Yang and Juan Bai 2021 Pricing and Versioning Strategy for Information Products with No-Free-Disposal: The Role of Consumers' Expectations Formation. *J. LISS 2020*. 677–693
24. Xumei Zhang, Xiaopeng Han, Xiangyu Liu, Ru Liu and Jinzhong Leng 2015 The pricing of product and value-added service under information asymmetry: a product life cycle perspective. *J. International Journal of Production Research*. **53(1)** 25–40