# Data Services Pricing Method Based on Cost and Premium

Jing Su[1, a], Hongyan Yan[2, b, *], Yuan Liu[3, c, *], Yaqing Si[4, d], Zhe Chen[5, e], Yanbin Hu[6, f]

[1]School of Economics and Management, Beijing University of Posts and Telecommunications, Beijing, China
[2]Department of User and Market Research, China Mobile Research Institute, Beijing, China
[3]School of Economics and Management, CCB Fintech, Beijing, China
[4]School of Economics and Management, Beijing University of Posts and Telecommunication, Beijing, China
[5]Department of User and Market Research, China Mobile Research Institute, Beijing, China
[6]Department of User and Market Research, China Mobile Research Institute, Beijing, China

[a]bysj@sina.com
[b*] Corresponding author: yanhongyan@chinamobile.com
[c*] Corresponding author: 15981998214@163.com
[d]siyaqing@bupt.edu.cn
[e]chenzheyh@chinamobile.com
[f]huyanbin@chinamobile.com

**Abstract.** Data services are growing explosively, and the potential scale of the online data service industry is huge. However, the price system of data services is chaotic and the pricing is not standardized, which hinders the healthy development of the online data service industry. Aiming at the pricing problem in the data service market, this paper proposes a data service pricing scheme based on basic cost and premium. According to the analysis of the factors affecting the price of online data services, a data service price index system is constructed, and the data service price composition is divided into two parts: basic cost and premium. Tiered data service pricing mechanism.

**Keywords:** data service pricing; premium; basic cost; fuzzy comprehensive evaluation

## 1 Introduction

In the context of the digital economy era, technologies such as the Internet, big data, and cloud computing have developed rapidly, and the volume of data has also grown exponentially. Mass data from a production factor, after processing and value-added steps such as semanticization [1], cleaning [2], analysis [3], knowledge extraction [4], modeling [5], fusion [6], distribution [7], application [8], which is integrated into "Online Data Service API (referred to as Data Service)" and provided to users [9].

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However, due to the non-physical nature of data services, data service demanders cannot have an intuitive understanding of service quality, application scenarios, effects, etc., and data service is a highly subjective emerging thing, which can be used as a reference data service. Pricing practices have limitations. As the basis of economic operation, price is one of the key contents of data service circulation market research. Scientific pricing is an indispensable factor for the healthy development of data service industry.

This paper takes data service as the research object, conducts research on premium coefficient and data service pricing strategy, and establishes data based on cost calculation and premium level. Explore the use of OWA operator and fuzzy comprehensive evaluation method to study the influencing factors of data service prices and the combination of subjective and objective pricing strategies. It not only builds an indicator system that affects the price of data services, but also develops a dynamic pricing mechanism for data services.

## 2 Research status

Cheng Lin et al. proposed that when the data utility can be quantified, variables such as dynamic cost, margin, and actual profit can be used to analyze the data service price; when the data utility is difficult to quantify, the data can be priced by the value chain and auction [10]. Xiong Qiaoqin and Tang Ke reviewed the transaction, circulation and pricing of data services, indicating that the application scenarios of data services and the heterogeneity of data service consumers have great influence on the transaction mode of data services and the pricing strategies of data service providers. big impact [11]. The price of data services is generally related to the acquisition, storage, and processing of basic data, the application of data services, added value, and comprehensive service quality. The traditional accounting pricing methods in the market include cost method, market method, and income method [12].

Shen and Wen et al. used the Stackelberg game model to analyze the interaction among data providers, service providers and data users, and designed a transaction pricing mechanism to maximize profits for service providers [13]. Sajko et al. proposed a quantitative rating based on the present value of data samples, the characteristics and quality of data services, and the value and importance of multiple dimensions, such as cost, and then combined with qualitative analysis methods such as value matrix and group decision-making to obtain. The value generated by the data in each dimension is obtained, and finally the comprehensive value is obtained by summing up [14].

Based on this idea, this paper first determines the basic cost of data services, and then analyzes the price-influencing factors of data services from seven dimensions, determines the weight of each price -influencing factor, and judges the premium degree of the data service by a fuzzy comprehensive evaluation method. The fuzzy comprehensive evaluation method transforms qualitative analysis into quantitative analysis, and corresponds the degree of premium with fuzzy nature to the numerical range of the

specific premium coefficient, and finally determines the premium coefficient and price according to the pricing analysis of specific services.

## 3 Multi-factor data service pricing system

This paper analyzes the price influencing factors from multiple price influence dimensions of data services, which not only takes into account the data service providers and data service consumers, but also combines the characteristics of the data service itself. By reading a large number of domestic and foreign literature and research materials related to data service prices, combined with the empirical situation of data service transactions at home and abroad, starting from the transaction purposes of data service providers and customers, the author summarizes the following seven factors that affect the price of data services, as shown in Fig.1.


**Fig. 1.** Analysis dimension diagram that affects the price of data services

Dimension of enterprise operation mainly refers to the expenses incurred in the operation of data service providers, including related costs of data acquisition, related costs of technicians, sales expenses, amortized costs of software or hardware facilities, and daily expenses of enterprises, etc. All data service output processes costs incurred.

The basic cost of data service can be calculated according to the cost accounting knowledge in accounting, and the cost subjects are purchase cost, labor cost, sales expense, manufacturing expense, and indirect cost.

**Table 1.** Data service cost composition

| cost account | Symbolic representation | Corresponding price impact factor | Meaning description |
|---|---|---|---|
| purchase cost | PC | data acquisition cost | For data service enterprises, the procurement cost is mostly the cost consumed in the process of obtaining the corresponding data according to customer needs. |
| Labor cost | AC | Technical staff | Costs consumed by professional and technical personnel who process data and output data services in the process of outputting and |

| | | | |
|---|---|---|---|
| | | | operating and maintaining data services, including salary, social insurance, employee benefits, labor insurance premiums, etc. |
| sales expense | SC | sales expense | Various expenses incurred by data service providers in the process of selling data services, including but not limited to sales-person salaries, business promotion fees, advertising fees, etc. |
| Manufacturing costs | MC | Software and hardware facili-ties | Expenses such as depreciation, maintenance or fixed expenses, and consumption of auxiliary materials used in the process of data service storage, output, and optimiza-tion of software and hardware facilities shall be converted according to the data capacity. |
| Indirect cost | IC | Business daily expenses | Including but not limited to water and elec-tricity costs, office supplies costs, which refer to the costs incurred that cannot or are inconvenient to be objectified in the process of data service output. |

According to the cost components of data services in Table 1, the basic cost (TC) o f data services can be obtained:

$$TC = PC + AC + SC + MC + IC \tag{1}$$

From the analysis of the remaining 6 dimensions, the following 21 various factors affecting the price of data services are summarized, and based on this, a data service price index system is constructed, as shown in Table 2.

**Table 2.** Data service price index system

| | Standard Tier A | Substandard Tier B |
|---|---|---|
| Intrinsic price impact indicators of data services | Amount of data $A_1$ | Data breadth $B_1$ |
| | | Data capacity $B_2$ |
| | Data quality $A_2$ | Data accuracy $B_3$ |
| | | Data authenticity $B_4$ |
| | | Data integrity $B_5$ |
| | Data application $A_3$ | Data timeliness $B_6$ |
| | | Data security $B_7$ |
| | | Data scarcity $B_8$ |
| | Data service content $A_4$ | Data quality of service $B_9$ |
| | | Data service efficiency $B_{10}$ |
| | | Diversity of data services $B_{11}$ |
| | | Data service fit $B_{12}$ |
| | | Data service applicability $B_{13}$ |
| | Data service | Technical staff quality $B_{14}$ |

| | | |
|---|---|---|
| | characteristics $A_5$ | Data service life cycle $B_{15}$ |
| | | After-sales service quality $B_{16}$ |
| Data service external Price Impact Indicator | Market factors $A_6$ | Supply and demand $B_{17}$ |
| | | Competitiveness $B_{18}$ |
| | | Customer Loyalty $B_{19}$ |
| | | Market share $B_{20}$ |
| | | Brand effect $B_{21}$ |

In this paper, the OWA operator weighting method is used to calculate the weight of each layer of indicators, which can effectively reduce the subjectivity of experts in the weighting of price indicators, and make the weight W of the evaluation indicators more accurate.

In order to determine the indicator weight of the indicator system, $n$authoritative experts in the data field are invited to score the importance of the sub-standard layer indicators in the price indicator system of a data service. The maximum score is 10 points. The higher the score, the more important it is. the higher the degree. The specific calculation steps are as follows:

The OWA-AP method is selected to determine the weight of each index in the data service price index system. According to existing research, the fuzzy weight vector is set as

$$W = \{W_1, W_2, \dots, W_n\} \tag{2}$$

The number of experts participating in the evaluation $n$ is:

When $n$ an odd number,

$$W_i = \begin{cases} \frac{i}{\left(\frac{n+1}{2}\right)^2}, & i \le \frac{n+1}{2} \\ W_{n-(i-1)}, & i > \frac{n+1}{2} \end{cases} \tag{3}$$

When $n$ an even number,

$$W_i = \begin{cases} \frac{i}{\left(\frac{n}{2}\right)^2 + \frac{n}{2}}, & i \le \frac{n}{2} \\ W_{n-(i-1)}, & i > \frac{n}{2} \end{cases} \tag{4}$$

$i = 1,2, \dots, n$, the parity of the number of experts participating in the evaluation $n$determines the index weight vector; $W_i$ is the first $i$ value in the index weight vector ($W = \{W_1, W_2, \dots, W_n\}$).

Ask $n$an expert to assign weights to the 21 indicators of the sub-standard layer, and the decision matrix for the weights of the indicators can be obtained $A$as follows:

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1,21} \\ a_{21} & \cdots & a_{2,21} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{n,21} \end{bmatrix} \tag{5}$$

Among them, $a_{ij}$ represents the $i$ weight evaluation value of the th expert on the $j$th i ndex. For each indicator, $n$ the results of the weights scored by the experts are $a_{1j}, a_{2j}, \ldots, a_{nj}$ sorted from small to large, and a new sequence is obtained, which is $c_{1j}, c_{2j}, \ldots, c_{nj}$, then assembled with the position weights obtained according to the AP weighting method $W = \{W_1, W_2, \ldots, W_n\}$. Then the $j$weight of the first indicator $c_j$ is:

$$c_j = OWA_\lambda(w_{1j}, w_{2j}, \ldots, w_{nj}) = \sum_{i=1}^{n} w_i \cdot c_{ij} \tag{6}$$

The fuzzy weights of 21 indicators can be obtained by calculating in sequence:

$$\underset{\sim}{C} = (c_1, c_2, \ldots, c_{21}) \tag{7}$$

After normalization, the fuzzy weight vector can be obtained:

$$\underset{\sim}{D} = (d_1, d_2, \ldots, d_{21}) \tag{8}$$

Then the weight of each indicator of the sub- standard layer is obtained.

Different data services have different types, service content, and emphasis, and their data usage costs, monetization capabilities, operating strategies, and data service consumer positioning are different. Therefore, each time a data service is priced, the data service price index system The weights are based on specific circumstances, and are scored and calculated by experts. Of course, the 21 indicators can be appropriately simplified as needed, and it is still a arduous task to determine the specific values of the subjective indicators, which will not be demonstrated here.

## 4 Premium level assessment of data services

The market environment is complex. In most cases, the actual transaction still needs to go through a process of bargaining. On the basis of the above-mentioned multi-dimensional pricing, a bargaining space is determined for each data service, and the scientific nature of the bargaining process and transaction efficiency are an important aspect. Important mechanism design.

The fuzzy comprehensive evaluation method is used to judge the premium of data service. Based on the above data service price index system, a fuzzy evaluation factor set is constructed. The factor set has 21 evaluation factors. The set domain of the premium evaluation index is expressed as:

$$U = \{u_1, u_2, u_3, \ldots, u_{21}\} \tag{9}$$

The definition of data service premium is related to the accuracy of expert scoring. In this study, the division of data service premium level is based on a full score of 100 points. According to the value of data service, the premium level of data service is divided into high premium and high additional. There are five grades: price, medium surcharge, expected return price, and breakeven price, as shown in Table 3.

According to the data service premium level, the fuzzy comment set of the data service premium level can be obtained as follows:

$$V = \{V_1(A^+),\ V_2(A),\ V_3(B^+),\ V_4(B),\ V_5(C)\} \tag{10}$$

**Table 3.** Classification of premium levels

| Premium level | Symbolic representation | Score range | Premium factor $\gamma$ | Meaning description |
|---|---|---|---|---|
| High premium | $A^+$ | (80,100] | (300% unlimited) | The application value far exceeds the cost, and the premium capacity is high, and the price can be increased within the acceptable range of customers to obtain excess returns. |
| High premium | $A$ | (60,80] | (100%, 300%] | The application value is very high, the premium ability is strong, and excess returns can be obtained. |
| Medium premium | $B^+$ | (40,60] | (40% ,100%] | The application value is relatively high, the premium capacity is acceptable, and the income is relatively considerable. |
| Expected return price | $B$ | (20,40] | (20% ,40%] | The application value is general, and it can maintain a lower expected income. |
| Breakeven price | $C$ | [0,20] | [0, 20%] | There is almost no application value, the premium capacity is low, and the price can only be slightly increased on the basis of cost. |

Premium coefficient $\gamma$ means that the premium is a multiple of the basic cost price.

Employ $m$authoritative experts in the field of data, and ask them to collect information about the business status and credit-related information of the rated enterprise from all walks of life based on their own experience and understanding of the data service and the market environment of the data service provider. Based on the experience and knowledge of the data domain, the price index of the target data service is scored, and the fuzzy comprehensive evaluation method is used to evaluate its premi-

um. According to the scores given by experts to determine the corresponding level of the indicator, and then count the number of experts who rated each indicator as a certain level $P_{ij}$. $P_{ij}$Indicates $B_i$the number of experts whose evaluation index is the first $j$ level ( $j = 1,2,3,4,5$represents $A^+$, $A$, $B^+$, $B$,$C$).

Single factor evaluation was made for 21 price influencing factors respectively, and the method of fuzzy statistics was applied and normalized, and the evaluation results were represented by a matrix.

According to the score, the single-factor fuzzy evaluation vector can be obtained:

$R_1 = (r_{11}, r_{12}, r_{13}, r_{14}, r_{15})$

$R_2 = (r_{21}, r_{22}, r_{23}, r_{24}, r_{25})$

…

$R_{21} = (r_{21,1}, r_{21,2}, r_{21,3}, r_{21,4}, r_{21,5})$

$r_{ij} = \frac{P_{ij}}{m}$, $i = 1,2,\dots,21$; $j = 1,2,\dots,5$, $r_{ij}$ represents the percentage of experts who score the level of the $B_i$ index to the total number of experts.

$R_1, R_2, \dots, R_{21}$are combined into a judgment matrix $\underset{\sim}{R}$,

$$\underset{\sim}{R} = (R_1, R_2, \dots, R_{21})^T = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{15} \\ r_{21} & r_{22} & \cdots & r_{25} \\ \vdots & \vdots & \cdots & \vdots \\ r_{21.1} & r_{21.2} & \cdots & r_{21.5} \end{bmatrix} \tag{11}$$

The weight distribution vector of the known sub-standard layer indicators is $\underset{\sim}{D} = (d_1, d_2, \dots, d_{21})$, make fuzzy transformation, the fuzzy comprehensive evaluation vector can be obtained:

$$\underset{\sim}{H} = \underset{\sim}{D} \circ \underset{\sim}{R} \tag{12}$$

The results are further normalized to get:

$$\underset{\sim}{H} = (h_1, h_2, h_3, h_4, h_5) \tag{13}$$

$$h_j = max\{h_1, h_2, h_3, h_4, h_5\} \tag{14}$$

The premium level grade represented by the decision is obtained, and the range $V_j$ corresponding to the grade is the $\boldsymbol{\gamma}$ range of the data service premium coefficient according to the $\boldsymbol{\gamma}$ premium level grade division table.

## 5 Comprehensive price calculation

Initial price $P$of the data service is:

$$P = TC + TC * \gamma = TC \times (1 + \gamma) \tag{15}$$

The specific steps of the data service price calculation method based on OWA operator and fuzzy comprehensive evaluation method, as shown in Fig.2:

(1) Construct the data service price index system, use the OWA operator to weight each index, and obtain the weight of each index affecting the data service price.

(2) Construct the data service premium level grade, use the fuzzy comprehensive evaluation method to standardize the results, use the subordination principle to determine the premium level of the data service, and obtain the premium coefficient range.

(3) The data service provider shall, according to its own situation and in combination with the pricing strategy, specify the premium coefficient within the range of the premium degree $\gamma$, and then calculate the initial price of the data service by synthesizing the basic cost price.

(4) The data service provider forms the final transaction price after several "negotiations" through agreements with the platform or games with the buyer.

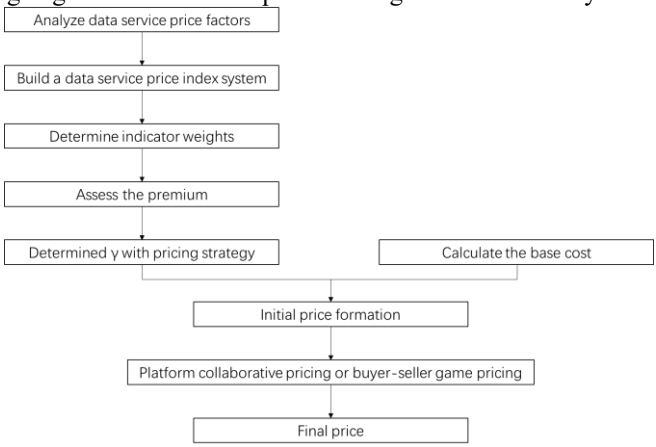


**Fig. 2.** Data service pricing mechanism based on basic cost and premium

## 6 Conclusion

This paper studies the influencing factors of data service price, premium assessment and pricing strategy, summarizes the influencing factors of data service price, and divides them into basic cost system and price influence system based on the improved cost method and value perception method. Affects the base cost and premium portion of the data service, respectively. The basic cost can be accurately measured by the data service provider; however, in order to satisfy the "bargaining" price evaluation mechanism in the actual transaction process, the fuzzy comprehensive evaluation method and the price influencing factors of the data service are used to propose a hierarchical premium data service pricing mechanism.

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