

# Research on Estimates of Xi'an City Life Garbage Pay-As-You-Throw Based on Two-part Tariff method

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**Abstract:** Domestic waste whose pricing can't be separated from the pricing of public economics category is quasi public goods. Based on Two-part Tariff method on urban public utilities, this paper designs the pricing model in order to match the charging method and estimates the standard of pay-as-you-throw using data of the past five years in Xi'an. Finally, this paper summarizes the main results and proposes corresponding policy recommendations.

## 1. Introduction

With the rapid improvement of the level of urbanization in China, the problem of municipal solid waste becomes more and more serious, and the funds needed for the effective treatment of municipal solid waste are increasing, resulting in heavy financial burden. How to control the emissions from the source to achieve the dual objectives of environmental governance and alleviating burdens on finance, which is a major issue in front of public policy makers. Referring to the international experience, the garbage charge system, which is widely used in the world, is an important economic means to control and reduce the pollution from the source. At the beginning of 2002, the Ministry of Construction issued "notice on the implementation of city life garbage fee system to promote garbage disposal industrialization" and "city garbage management measures", requiring that according to the actual situation of the region and local conditions, waste collection system should be implemented scientifically and municipal solid waste charging standards should be formulated. In September 2002, the state promulgated the "opinions on promoting urban sewage and the development of garbage treatment industrialization", and further put forward that the garbage disposal fee should be levied according to the local actual conditions. But now many city garbage fees levied are in different degree, most cities charged fees at a fixed price, and even at present, there is still some cities don't start urban living garbage disposal fee [1]. Therefore, calculating the reasonable price of garbage is the premise to carry out pay-as-you-throw schemes.

At present, most countries in the world mainly adopts fixed charges and pay-as-you-throw city life garbage charge method [2]. The fixed charges is suitable for the initial stage, but when the garbage fee develops to a certain level, its effect is very limited. Therefore, it is necessary to implement the pay-as-you-throw system, which can achieve higher returns with low cost. At present a fixed charge model of Xi'an city although to some extent relieved the situation that the funds to run the garbage disposal facilities are inadequate. But in the long run, it can't change the concept of garbage emissions and achieve environmental goals. Many foreign countries and regions achieved good results by pay-as-you-throw policy, reducing the waste output and making garbage collectors reduce the waste emissions [3]. Therefore, in the long run, pay-as-you-throw policy should be measured in cities. The research on the pricing of domestic waste charge has been relatively rich, but the domestic research on the pricing of garbage collection is almost blank. Therefore, this paper uses the two pricing method to



calculate the price of urban garbage, to determine the reasonable price and to provide a reference for the promotion of urban garbage management capacity.

## 2. The choose of two-part pricing method

Choosing a pricing model to match the pay-as-you-throw is the key to set charging standards. The following two points about pricing models need to be paid attention: first of all, the pricing model need to connect the municipal solid waste charging with the actual life garbage emissions; secondly, the pricing model needs to make up for the treatment cost of municipal solid waste disposal site. The cost of living garbage disposal facilities are divided into fixed investment cost and variable operating costs by two part pricing method. It's basic fee is based on the fixed investment in the early stage of garbage disposal facilities, or we can say that it is based on initial input costs and capital gains, which has nothing to do with the actual discharge of domestic waste. Fees according to quality are variable operating expenses, which are based on the actual amount of domestic waste emissions. The application of the two-part pricing method in natural monopoly industry can be traced back to the earliest 1892 when Hopkinson in British designed the electricity price system. After that, it was be perfected formally by Lewis and Willing [4].The advantage of the two-part pricing method is that it is based on the balance of payments to realize economic welfare maximization, which has strong maneuverability. At the same time, it is based on marginal cost pricing, and actually it is a kind of optimal pricing. But it is also limited to the assumption that the market information is complete and there is no other transaction cost. Although there are still some shortcomings in the implementation of the two part pricing method, the introduction of the two pricing method has its unique advantages:

Firstly, that separating the basic fee from the unit price can more effectively compensate for the cost and ease the problem of domestic waste emissions.

Secondly, two-part pricing method can be developed for different regions of different charges, achieve the specific analysis of specific issues, and help to achieve a reasonable allocation of resources.

## 3. The price calculating of living garbage for pay-as-you-throw

### 3.1. Model construction

Rubbish disposing costs include the cost of distribution, such as waste transportation, transfer, handling costs, and the cost of public sector management, such as the cost of collection, monitoring costs and education costs. Municipal domestic refuse treatment fee can be divided into fixed cost and variable cost in this two pricing model.

After the above analysis, combined with the principle of Two-part tariff models, we can create model for the unit garbage fee, such as the model shown in equation1:

$$T = X + Y \quad (1)$$

Wherein X is the fixed cost in solid waste disposal fees, the garbage fee is zero as well as no amount of garbage generated, then the fixed cost is calculated as follows:

$$Q < Q_1, T = X; \quad X = \frac{C_1}{Q_1} \quad (2)$$

The  $C_1$  is fixed cost of landfill and the  $Q_1$  is average daily production of municipal solid waste planned in Equation2.And Y is the flow of solid waste disposal fees also the cost of incremental costs. It is calculated as:

$$Y = \frac{(1+R)C_2}{Q - Q_1} \quad (3)$$

The  $C_2$  is the total operating costs in Equation 3, which including staff salaries and benefits , other labor costs, various office expenses, operating expenses, depreciation of fixed assets, equipment maintenance fees, etc in garbage disposal plant. The household garbage of more than optimal life rubbish emissions will collect unit cost:

$$T = \frac{C_1}{Q_1} + \frac{(1+R)C_2}{Q - Q_1} \quad (4)$$

After the pricing model of unit garbage has designed, we can based on the actual emissions from specific residents to charge amount-based by the residents within a certain time. So we need to understand the amount of waste per emissions. Let Z be the garbage fees for people's actual payable, to give the formula:

$$Z = \begin{cases} \frac{C_1}{Q_1}, & Q_2 < Q_3; \\ \frac{C_1}{Q_1} + \frac{(1+R)C_2}{Q - Q_1}, & Q_2 > Q_3 \end{cases} \quad (5)$$

The model 5 reflects if the residents want to reduce the solid waste disposal fees payable, you will need to reduce emissions of garbage. So not only can pay less solid waste disposal fees, but also to reach the target of the effect of garbage reductions.

### 3.2. Parameter Settings and Setting-up of Fees Standard

According to bulletin of statistics for the bureau of Xi'an landscaping in 2015, listing 1:

**Table 1.** 2010--2015 Statistical Data

years	2010	2011	2012	2013	2014	2015
Production of Refuse(10000 tons /year)	233	237	265	287.32	290.76	359.37
Production of Refuse(10000 tons /day)	6316.14	6493.15	7260.27	7871.78	7966.03	9845.75
Cleaning area (10000 square meters)	5900	6290	6411	6952	8725	10110
Sanitation vehicles (cars)	1042	1042	1200	1279	1639	1990
Domestic garbage clean-up rate (%)	93.8	93.9	93.7	94.93	93.95	93.48

Data sources: Statistical bulletin of Xi'an Landscaping Bureau in 2015

First, according to the Xi'an Bureau of Landscape Survey data show that currently more than 90% of the Xi'an city garbage removal and transportation to be harmless landfill and buried in River Village Ditch garbage treatment plant, so this article assumes that all of life garbage with innocuous processing in there, this landfill has planned to invest 150 million in the entire project [5]. The plant can be designed to use 2,000 tons at the average daily treatment capacity for 50 years by River Village Ditch landfill, which has been used for 20 years. As the table shows, the Production of Refuse is rapid growth per day with the increase of urban population and urbanization rapid growth in 2010 to 2014, and from the cleaning area of 62.9 million square meters in 2010 to grow to 10,110 square meters in 2014. If it is assumed using a variable rate of charging system when the waste quantities are shown a downward trend, and this may wish to use the average of the past five years to make a clear prediction

$$Q^* = \sum_{i=1}^{n=5} X_i / 5 = 7887.40$$

of the daily average volume of garbage in the future , so ton. While the Average daily processing capacity of only 2,000 tons at landfill in the early stages construction, meaning that it has reduced the time for the estimated time of 1/4, as 7.5 years. There fore, The fixed costs with used for 20 years: = 15,000 / 50 \* 20 = 600 million yuan, The fixed costs of remaining 7.5 years: = 15000-60000 = 900 million yuan.

Second, the parameter setting. R is the appropriate annual profit margins of garbage disposal Enterprises, herein R is determined with reference to the relevant waste listed companies net profit margin of main business, which was about 7%; The net profit of Xi'an High-tech park and the economic development zone relates to garbage treated about 14 companies net profit margin (including landfill gas power plant in Xi'an, a comprehensive treatment plants and hazardous waste disposal plant), with an average of 6%; Therefore, this article takes on margin  $R = 6\%$  [6].

Third, We have to organize the data provides by Environmental Sanitation in our city, by the end of 2015, the survey area have households 2.506 million who are permanent and non-permanent residents. Among them, the collector of waste by the streets office is 1.6 million and by the property company is 906000.

The following is three link cost and relevant taxes of accounting domestic waste collection, transportation, processing.

**Table 2.** 2015 life garbage disposal cost accounting in Xi'an tables

Units: ten thousand yuan

Link / department	Sanitation office	street office	Jiangcun landfill ditch	total	unit cost
Collecting costs	6,500.00	10,240.00		16,740.00	46.58
transportation cost	16,500.00			16,500.00	45.91
Landfill, incineration costs			9,020.00	9,020.00	25.10
Subtotal	23,000.00	10,240.00	9,020.00	42,260.00	117.59
Taxes and surcharges				2,600.00	7.23
total	23,000.00	10,240.00	9,020.00	44,860.00	
Unit cost (yuan)	64.00	28.49	25.10		124.82
Annual waste (ten thousand tons)				359.37	

As can be seen from the above table, the total cost of garbage disposal in Xi'an urban area is 448.6 million yuan, the cost per unit ton is 124.82 yuan. Which collects the cost of 46.58 yuan per ton, the cost of transport 45.91 yuan per ton, incineration costs 25.10 yuan per ton, taxes and additional charges on behalf of the charge fee of 7.23 yuan per ton.

### 3.3. Based on the two-part pricing method of measurement fees

The total cost of garbage disposal with the amount of garbage emissions, cleaning area increased in Xi'an, to the 2015 data as the base, assuming that the operating costs and garbage volume was a linear relationship, then when the garbage collection capacity of 3.5937 million, the total operating expenses of 448.6 million yuan, the average operating cost per ton of 124.82 yuan.

Came to the conclusion that the total operating expenses in the last seven years. If the reduction in the amount of waste can also reduce the total operating costs, then we take the average of nearly seven years of total operating costs as a calculated reference value.

$$\text{which is: } \bar{C}^* = \frac{x_1 + x_2 + \dots + x_n}{n} = 33685 \quad \text{ten thousand yuan}$$

If you use the general linear type, calculate the total operating costs of the year, the list is as follows:

**Table 3.** Total Operating Cost Calculation

years	2009	2010	2011	2012	2013	2014	2015
x(10000 tons or 10000 square meter)	179	233	237	265	287.3	290.7	359.37
c = bx (ten thousand yuan)	22342. 78	29,083 .06	29,582 .34	33,077 .30	35,860 .79	36,285 .17	44,856 .56

Therefore, the total operating expenses of the treated garbage are set at 336.85 million yuan. It can get a fixed cost of living garbage treatment fee in Xi'an:  
Incremental charges are, take 2015 as an example:

$$X = \frac{C_1}{Q_1} = \frac{90000 / 7.5 / 12 / 30}{0.33} = 101 \text{ yuan / ton}$$

$$Y = \frac{(1+R)C_2}{Q - Q_1} = \frac{1.06 \times 33685}{359.37 - 118.8} = 148.42 \text{ yuan / ton}$$

Pricing standard for unit life garbage collection is:  $T = X + Y = 249.42 \text{ yuan/ton} \approx 0.25 \text{ yuan/kg}$ .

Known in 2015 the number of inhabitants was 2 million 502 thousand and 600, the optimal waste emissions per household was 472 kg ( $118/250.26 \times 1000$ ), that is, when the household emissions are within the 472 kg, they only need to pay the fixed cost of 47 yuan ( $101 \times 472/1000$ ), equivalent to 0.1 yuan per kilogram. When the household emissions are more than 472kg, the users need to pay the cost of 0.25 yuan / kg. In summary, through the pay-as-you-throw model, government can give the residents certain subsidies in the different stages to achieve the purpose of appropriate relief and benefits according to the specific development of charging system.

#### 4. Conclusion and recommendations

In this paper, the two-part pricing method is used to calculate the price of Xi'an city household garbage, we can draw the following conclusions from this paper:

Pay-as-you-throw schemes of household garbage mainly consider the fixed costs and variable costs, further reflecting the fairness of cost allocation and maximizing the interests of users. At the same time, according to the pay-as-you-throw principle, users who produce more garbage need to pay more, and this interest orientation helps to form city residents' consumption concept and ultimately develop the green consumer preferences, encourage enterprises to cleaner production and ultimately reduce waste emissions to achieve a resource-saving and environment-friendly society.

In order to use the two-part pricing method to calculate the price of Xi'an municipal solid waste, this paper puts forward the following policy recommendations:

First, determine a reasonable fee standards. The establishment of garbage charge standard faces many difficulties: on the one hand, it is difficult to accurately calculate the cost of waste disposal; on the other hand, other factors determining the cost of fees (such as sanitation management costs, the price of labor) lack of unified standard basis. Therefore, Xi'an should be based on it's actual economic and social development, calculates and determines a reasonable fee, in order to ensure the city life garbage fees can be really carried out, and the two-part pricing method can play a better role.

Second, take effective measures to ensure the full collection of garbage disposal fees. Appropriate garbage collection mechanism should be established to improve the efficiency of garbage collection and charging rate. The current charging method of garbage collection are: automatic payment, commissioned collection and site payment, and most people choose site payment, which increases the cost of charges. Therefore, the Xi'an municipal government should consider open more channels to collect the fees or entrust some corresponding charging institution to collect garbage disposal fees.

Coexistence of a variety of charge modes can improve the efficiency of the charges as well as the convenience of urban residents.

## **5. References**

- [1] Chen Minxia. Research on the pricing of municipal solid waste charging [J]. Jiangsu Environmental Science and Technology, 2008, (S1):24-28.
- [2] Zhang Xuecai, Li Dayong. Comparison of municipal solid waste charging [J]. Ecological economy, 2005, (10):98-100.
- [3] Chen Minxia. Comparison of domestic and international urban domestic garbage charging experience [J]. Economist, 2008, (06):92-93.
- [4] Wang Qiuyue. Research on the pricing mechanism of natural monopoly industry [M]. Nanjing: Nanjing University Press, 2011:36.
- [5] Wang Yingying. Study on the influence of Xi'an Jiang cunqou landfill leachate on the surrounding ecological environment in Xi'an City [D]. Xi'an, Chang'an University, 2008.
- [6] Cao Na. Study on the price of domestic refuse disposal in China [D]. Beijing: China University of Geosciences, 2010.