

## RESEARCH ARTICLE



# Tax Burden and Influencing Factors During Waste Incineration Power PPP Project Operation

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**Abstract:** Waste incineration power generation is an effective way to treat domestic waste as a resource, an effective way to reduce carbon emissions, and an important model for developing the circular economy, practicing the spirit of emission reduction promoted by COP26. The tax burden during the operation of public-private partnerships (PPPs) projects in this field directly affects the selection and development of the supply model. This paper selected the data of enterprises participating in the waste incineration power generation PPP project from the Ministry of Finance's PPP project management database and the financial data of the company from the CSMAR database for the corresponding year and used tax burden evaluation indicators to empirically analyze the tax burden of the operation period of a waste incineration power generation PPP project from the perspectives of value-added tax and enterprise income tax. It was found that the asset-liability ratio, the income capacity from electricity sales, the profitability, and whether the preferential tax policy of "three exemptions and three halves" could significantly affect the corporate income tax burden of the project had to be considered. Combined with current preferential tax policies, this paper provided targeted optimization suggestions such as emphasizing the role of a "debt tax shield," optimizing the output structure, and extending the duration of the "three exemptions and three halves" tax incentives. The research in this paper is helpful to find an effective way to reduce the tax burden of enterprises, improve the economic benefits of waste incineration power generation projects, and also provide a reference for the government to formulate more reasonable tax policies and promote a better tax system.

**Keywords:** influence factors, PPP, tax burden, tax incentives, waste incineration

## 1. Introduction

The 26th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP26) urged Parties to transition to low-emission energy systems. By accelerating the green transition, the economy can help mitigate the greenhouse effect [1]. Compared with the traditional sanitary landfill waste treatment method, waste incineration power generation can not only reduce methane and carbon dioxide emissions in the slow degradation process in a landfill but can also play a role in replacing fossil fuels through energy utilization in the incineration treatment process, which has a dual emission reduction effect [2].

The Fifth Plenary Session of the 19th Central Committee of the Communist Party of China proposed that garbage classification, reduction, and recycling must be promoted and that construction of a recycling system for waste materials must be accelerated. High population growth and industrialization place stress on fundamental infrastructure and municipal services, and poor management of municipal solid waste can be detrimental to residents [3]. It contributes significantly to reducing the quantity of solid waste that requires treatment, as well as generating electricity [4]. Driven by

the dual carbon goals of "carbon peak and carbon neutrality," waste incineration power generation has ushered in new development opportunities due to its significant energy savings and emission reduction effects. Since many waste incineration power generation operators lack construction capabilities and have qualification deficiencies, the majority of these projects are bid on as consortiums, and the winning private party is responsible for construction and operation. Public-private partnership (PPP) refers to a PPP model that aims to improve the efficiency of public infrastructure construction and supply by sharing benefits and risks. As a cooperative model based on public assets or public utilities and with the participation of non-governmental departments and governments in operation and management, PPP has been widely used in the construction of waste incineration power generation projects.

Vigorously developing PPP projects for waste incineration power generation is not only an important measure to recycle domestic waste, improve the status quo of "garbage siege," and adhere to sustainable development principles but also an effective way to improve the environmental governance capabilities of governments at all levels, achieve carbon emission reduction goals in the post-COP26 era, and achieve the goals of the Fifth Plenary Session of the 19th Central Committee of the Communist Party of China. However, at this stage, whether from the perspective of the number of projects or the amount of investment, the development of waste incineration power generation PPP projects is lagging,

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which is incompatible with the framework of rapid and standardized development of China's PPP model and the incremental demand for urban domestic waste as a resource. "Garbage siege" has gradually become a livelihood issue that the government and the people are concerned about, and the promotion of waste incineration power generation PPP projects is imperative. The PPP model has obvious advantages in solving the financial pressure of government departments in public services, and the operational capabilities of private parties help to reduce project operating costs and construction costs, optimize the quality of infrastructure construction, and guarantee service levels. To promote the development of waste incineration power generation PPP projects, China has introduced policies such as value-added tax (VAT) rebates and corporate income tax reductions and exemptions. No matter what kind of preferential tax policies is used, implementing tax reductions and exemptions for specific targets and reducing taxable income can reduce the tax payable by enterprises, which is reflected in the corporate tax burden to a certain extent. To compare the tax burden of waste incineration PPP projects with that of other industries, based on the financial data of listed companies in the CSMAR database for 2020–2021, this study calculated the corporate tax burden of various industries such as manufacturing, real estate, mining, finance, and transportation. At the same time, to ensure data comparability, the tax burden calculation involved only the VAT, the urban construction tax, and additional and corporate income tax. Because the financial statements of listed companies do not directly give the amount of VAT payable, the VAT calculation was reversed as "VAT = (education surcharge + local education surcharge)/5% - consumption tax" [5]. The industries involved and the calculation results are shown in Table 1.

It was found that due to the preferential treatment of the VAT levied and refunded, the VAT burden of waste incineration power generation PPP projects was significantly lower than those of the five industries listed in Table 1, but the corporate income tax burden was higher than for these five industries, and the tax incentives for corporate income tax were not large. Generally speaking, the overall average tax burden of these five industries was 9.63%, whereas the overall tax burden of waste incineration power generation PPP projects was roughly 9.58%. The overall tax burden of such PPP projects was comparable to the overall average tax burden of other industries and did not reflect tax incentives.

At present, China no longer blindly promotes the construction of PPP projects, gradually recognizes the importance of the research on key success factors of PPP projects, and gradually deepens the exploration of key success factors, but the majority are concentrated in smart cities, high-speed railways, municipal engineering, etc., and the construction of domestic waste incineration power generation PPP projects needs more comprehensive and in-depth research on

key success factors to ensure success. Compared with other PPP projects, domestic waste incineration power generation PPP projects have distinguishable characteristics, significant negative externalities, uniqueness, etc. The investigation in this paper can provide more content on the key factors of PPP project success, which has high theoretical significance. What factors will affect the tax burden of waste incineration power generation PPP project companies? From an empirical point of view, this paper will explore the influencing factors of the tax burden during operation of PPP projects and combine the existing preferential tax policies to study the impact of the tax burden on the development of waste incineration power generation PPP projects. By examining the influencing factors of the tax burden of domestic waste incineration power generation PPP projects, this paper avoids problems or even stagnation caused by incomplete identification of key success factors, and the research in this paper has certain reference and reference value for the construction of future waste incineration power generation PPP projects, as well as substantial practical significance.

The innovations of this paper are as follows: first, converting unquantifiable tax incentives into specific corporate tax burdens for research, from the theoretical to the empirical level, is conducive to obtaining the actual tax burden of the waste incineration power generation industry, which will reflect the actual effect of the preferential tax policies on the waste incineration power generation industry to a certain extent. Second, based on empirical results, this paper makes targeted suggestions to promote the development of waste incineration power generation PPP projects and to speed up the mitigation of shortcomings in the operation of PPP projects in China in public health, municipal engineering, energy, new infrastructure, and other fields.

## 2. Literature Review

Research on tax-related issues in the PPP model has mainly focused on the importance of tax policy to developing the PPP model and of current preferential tax policies for the PPP model. Tax policy support for PPP projects generally refers to preferential tax policies. During operation of a PPP project, the preferential tax policies that can provide benefits include VAT exemption, immediate refund of VAT, the "three exemptions and three halves" of enterprise income tax, and the comprehensive use of resources to reduce income. Wang et al. [6] argue that PPPs involve multiple uncertainties that private investors often need to mitigate through government support, one of the most common forms of government support being minimum income guarantees. Yang et al. [7] analyzed the relevant tax policies of PPP projects for vehicle charging infrastructure in China and pointed out that top-level design of tax laws is key to promoting PPP projects. Zhang et al. [8] explored how to foster a favorable institutional

**Table 1**  
**Tax burdens for various industries**

|                             | Manufacturing | Real estate | Mining | Finance | Transportation | Waste incineration power generation PPP project |
|-----------------------------|---------------|-------------|--------|---------|----------------|---|
| Value-added tax burden      | 7.86%         | 4.12%       | 4.52%  | 4.06%   | 2.61%          | 1.43%   |
| Additional tax burden       | 0.84%         | 0.41%       | 0.55%  | 0.48%   | 0.30%          | 1.12%   |
| Corporate income tax burden | 3.02%         | 5.34%       | 3.64%  | 4.33%   | 6.05%          | 7.03%   |
| Overall tax burden          | 11.72%        | 9.87%       | 8.71%  | 8.87%   | 8.96%          | 9.58%   |

**Note:** The data come from the CSMAR database and have been calculated and collated.

environment for the success of PPP projects, showing that changes in institutional arrangements must go hand in hand with the introduction of PPPs and that the performance of PPPs is closely related to their institutional environment. Because PPP projects generally provide public goods and are characterized by their complexity and high risk, appropriate policies are essential for PPPs to flourish [9]. Wang et al. [6] present the reciprocal preference theory to analyze the risk-sharing ratio most suitable for the government and argue that incentives can be used to encourage investors to avoid moral hazard in cooperation. Garrido et al. [10] analyzed the EU's support for Spain's transport PPP projects and its impact on the country's economic performance and concluded that the fiscally expended projects had good economic performance. Other research has mainly focused on preferential tax policies and their functions, as well as certain existing problems. These studies generally state that the government, as one of the participants in the PPP model, can take effective measures to promote the development of the PPP model [11]. Ali [12] noted that Pakistan's application of PPP to build schools and the implementation of tax exemptions have greatly accelerated the country's development in education. Based on the theory of system dynamics, Liu et al. [13] constructed a dynamic model of the risks of PPP projects, studied the risks of using PPP models in China's construction waste recycling industry, and discovered that PPP projects in the construction waste recycling industry were profitable. Zhang and Durango-Cohen [14] presented a simple, two-stage, game-theoretic model of a partnership agreement between a government and a concessionaire and believed that the government's level of enthusiasm affects the development of PPP projects and that making tax commitments as early as possible can improve the project implementation rate. Nonetheless, there are obstacles to PPP project development. The lack of preferential tax policies in certain industries, or the lack of incentives, or their limited scope have affected the development of PPPs in related industries [12].

Su et al. [15] constructed a multi-stage dynamic planning model and designed the payment structure model of the public sector at each stage of performance appraisal and found that the greater the deduction limit in the performance appraisal of the private sector, the lower the profit of the private sector. Liu et al. [16] simulated the impact of different taxes, including China's VAT, education surcharge, urban construction tax, and enterprise income tax on the economic benefits of construction waste recycling enterprises. They found that the available authority to increase VAT and enterprise income tax can improve the profitability of construction waste recycling enterprises in China. China's preferential tax policies for PPP projects also have shortcomings. From the perspective of the whole PPP life cycle, PPP projects have a long operation period [17], and changes in the tax system structure and the resulting changes in tax burden during this period will have a huge impact on the operation of PPP projects. In addition, PPP projects have long lifecycles, and the probability of losses in the initial stage of operation is high. Once the company obtains the first operating income, the "three exemptions and three halves" policy will take effect in the same year, but the company has not paid corporate income tax due to losses. Under such circumstances, preferential treatment cannot substantially reduce the corporate tax burden and has little effect.

Many researchers have also carried out studies on the risks of PPP projects during the operation period. Whether PPPs can be a tool to prevent "white elephants" depends heavily on the effective transfer of operational risks to private partners [18]. Wu et al. [19] proposed a risk assessment framework for PPP waste-to-energy

incineration power generation projects and constructed a risk assessment index system for such projects in China using 14 measures such as construction, operation, and macroeconomic risks. Luo et al. [20] subsequently validated the robustness, effectiveness, and superiority of the method by conducting a risk assessment of a PPP waste-to-energy incineration power generation project in China and selecting a promising project through a method based on a weighted multi-grain fuzzy rough set based on two domains. Wang et al. [21] stated that to prevent investors from speculating, the government should establish incentive mechanisms, and that adoption of flexible incentive mechanisms at different project stages can effectively reduce PPP project risk.

Regarding the influencing factors of the corporate tax burden, existing studies have mainly analyzed this question from macro or micro aspects. At the macro level, economic policies also affect corporate tax burden. Uncertainty in economic policies is positively correlated with corporate tax burdens. Maintaining the transparency and stability of economic policies can help effectively reduce tax burdens [22]. At the same time, Jiang et al. [23] studied the impact of China's *ad valorem* tax reform on the iron ore industry and found that corporate tax burdens can be effectively reduced through a combination of tax types and tax rates. Blindly increasing the amount of a reward or a penalty is not an effective way to guide an investor's behavior [21]. Kulczycka et al. [24] analyzed the reasons for the increase in the overall tax burden of Polish mining companies and found that higher tax levels would have a positive impact on local finances but may reduce the investment incentives of mining companies. At the micro level, most researchers believe that enterprise scale, asset-liability ratio, profitability, and other similar factors may affect the enterprise tax burden. In terms of enterprise scale, some researchers believe that the larger the enterprise, the more capital there will be for tax planning, which reduces the corporate tax burden to a certain extent, or in other words, the size of the enterprise is significantly negatively correlated with the corporate tax burden [25]. Some researchers have also pointed out that the tax burden of large-scale enterprises is relatively high. From the perspective of political cost theory, the higher the tax burden and the larger the sample of listed companies, the more strongly empirical analysis proves this point of view. Fang et al. [26] studied the asymmetric effects of VAT promotion in China in 2012 on enterprises of different sizes and found that VAT reduced the total tax burden of small-scale taxpayers, but that the effect was negligible for general taxpayers. In addition, some studies have pointed out that there was no obvious relationship between enterprise size and enterprise tax burden.

Scholars have carried out a lot of research related to waste incineration power generation PPP projects; however, the tax incidence of waste incineration power generation PPP projects during their operation has received insufficient attention. Although the PPP model has many benefits for enhancing the efficiency of public asset utilization, its tax burden is also an important factor to consider. Reasonable and effective risk management is the key to the success of PPP projects, and the tax burden during the operation period of PPP projects has a direct impact on the risks of PPP projects, which merits our attention. Considering that most previous research on tax-related issues of PPP projects has been conducted from the theoretical aspect, and there have been few empirical studies. Based on previous research, this paper will study the tax burden of the operation period of waste incineration power generation PPP projects from a microscopic perspective based on public data.

**Table 2**  
**Calculation formula of the tax burden of a waste incineration power generation PPP project**

| Tax                                   | Tax burden formula  | Rate   |
|---------------------------------------|---|--|
| Value-added tax                       | $\Sigma$ The actual value-added tax paid each year during the operation period/ $\Sigma$ The annual operating income during the operation period                                  | 16%, 17% (considering that the value-added tax rate had not been adjusted at the time of signing the project contract) |
| Urban construction tax and additional | $\Sigma$ The urban construction tax and education surcharge actually paid each year during the operation period/ $\Sigma$ The annual operating income during the operation period | Urban construction tax: 7% (city), 5% (county, town), 1% (other); additional: central 5%, local 2%                     |
| Corporate income tax                  | $\Sigma$ Actual corporate income tax paid each year during the operation period/ $\Sigma$ Annual operating income during the operation period                                     | 25%  |

**Note:** The data came from the PPP project management database of the Government and Social Capital Cooperation Center of the Ministry of Finance – the “Implementation Plan” and “Feasibility Study Report” of the project and were obtained after sorting.

### 3. Theoretical Analysis and Study Design

#### 3.1. Tax burden structure of PPP projects

“Waste minimization, waste recycling, and safe disposal”<sup>1</sup> are the basic principles of environmental pollution prevention and control for solid waste in China. In accordance with this principle, waste incineration power generation PPP projects use incineration technology to effectively control secondary pollution of domestic waste in the environment, with good environmental benefits. The cooperation period of the PPP model of waste incineration power generation is usually 30 years (including the 2-year construction period), and its costs mainly consist of variable costs, fixed costs, and various taxes. Among these, variable costs include the cost of purchased materials, garbage collection and transportation, and cleaning costs; fixed costs include depreciation expenses, interest expenses, and employee salaries; and the various taxes include VAT, corporate income tax, and additional taxes. The return mechanism of such projects is mostly product sales revenue and feasibility gap subsidy. Specifically, product sales revenue includes electricity sales revenue and other income, and feasibility gap subsidies are garbage disposal fee subsidies. Under normal circumstances, after the operation period has expired, the project company needs to hand over the PPP project to the government, so that the operation mode of such projects is BOT (build-operate-transfer).

As a significant component of the production cost of enterprises, the tax burden has an important impact on the fixed asset investment behavior of enterprises [27], and the level of corporate cash flow is closely related to the investment behavior of enterprises [28]. The increased tax burden reduces the cash flow level of enterprises, resulting in insufficient investment funds, which is not conducive to stimulating the enthusiasm of enterprises to participate in waste incineration power generation PPP projects. In the sustainable development of PPP projects in China, the level of corporate tax burden should be fully considered to ensure the implementation status of engineering projects and gradually reduce risks. This paper uses “the overall tax burden of the enterprise = all taxes paid by the enterprise/the operating income of the enterprise” to measure the tax burden of the operating period of such projects and further subdivides the enterprise tax burden, as shown in Table 2. Due to the long operating period of such projects and the gradual

improvement of garbage disposal capacity, the overall tax burden throughout the operation period will be used for analysis. Taxes such as real estate tax and urban land use tax are relatively low, and these taxes are not considered when calculating the tax burden in this paper.

Tax incentive policies affect the actual enterprise tax burden and cannot be ignored when evaluating the tax burden [29]. The production and sale of electricity using waste as raw material meet the conditions of preferential tax policies such as the immediate refund of VAT and the “three exemptions and three halves” of corporate income tax. The specific preferential tax policies enjoyed by this type of PPP project during the operation period are shown in Table 3. Although industry benefits from these policies, a tax burden comparison of different industries (see Table 1) shows that the corporate income tax burden of waste incineration power generation PPP projects is still too high. Therefore, this paper focuses on the corporate income tax burden of such PPP projects and further analyzes the influencing factors behind it.

#### 3.2. Data and variables measurement

##### 3.2.1. Variable setting

This paper examined several main economic policy factors that affect the corporate income tax burden of waste incineration power generation PPP projects from a micro perspective. According to previous literature, this paper examined the following factors: capital scale, asset-liability ratio, capital intensity, profitability, and electricity sales income capacity, as well as the “three exemptions and three halves” tax incentives. The relevant variables were constructed as follows: *ETR* (effective tax rate) is the explained variable, which represents the corporate income tax burden of the waste incineration power generation PPP project, and which is measured by the corporate income tax paid in the current year compared with the operating income of the current year. The explanatory variables in the model are as follows: *Size* represents the size of capital, measured by the natural logarithm of total assets; *Lev* (leverage) represents the asset-liability ratio, measured by the ratio of total liabilities to total assets<sup>2</sup>; *Capital* represents capital intensity, measured by the ratio of net fixed assets to total assets; *ROA* (return on assets) represents profitability, which is measured by the ratio of net profit after tax

<sup>1</sup>“Waste minimization, waste recycling, and safe disposal” (referred to as “Three Modernizations”) refers to waste management methods that can conserve natural resources, protect human health and the ecological environment, and are not affected by or even have negative impacts, which are the fundamental principles followed in China for the prevention and control of environmental pollution by solid waste.

<sup>2</sup>Due to the particularity of PPP projects, some waste incineration power generation PPP projects incorporate fixed assets into intangible assets for amortization as operating concessions. For these PPP projects, this paper uses the average of the proportion of “fixed assets/(fixed assets + intangible assets)” of the remaining PPP projects as the accounting basis.



**Table 3**  
**Preferential tax policies enjoyed during the operation period of a waste incineration power generation PPP project**

| Tax                  | Tax incentive forms                                       | Specific content of tax incentives   |
|----------------------|---|--|
| Value-added tax      | Immediate withdrawal                                      | 70% of the value-added tax for garbage disposal services will be refunded immediately after collection; 100% of the value-added tax will be refunded immediately after sales of electricity produced with waste as fuel that meets relevant standards  |
| Corporate income tax | Three exemptions and three halves                         | Income from engaging in qualified environmental protection, energy-saving, and water-saving projects; starting from the year in which the first production and operation income is obtained, enterprise income tax shall be exempted for the first 3 years, and the enterprise income tax shall be halved in the fourth to sixth years |
|                      | Investment credits against taxable amount                 | 10% of the investment in the purchase and actual use of the stipulated environmental protection, energy-saving and water-saving, and safe production equipment is credited against the payable corporate income tax  |
|                      | Special financial subsidies are not subject to income tax | Fiscal funds for specified special purposes obtained by enterprises can be regarded as non-taxable income and are not included in taxable income   |

**Note:** The data came from the State Administration of Taxation (<http://www.chinatax.gov.cn/>) and were obtained after sorting.

to total assets; *Electricity sales* represents the ability to generate electricity sales revenue, which is an explanatory variable analogous to profitability and is measured by the ratio of electricity sales revenue to total assets; and *Incentives* is the “three exemptions and three halves” tax policy. The tax preference dummy variable is one when the project benefits from the preferential policy in the current year and zero otherwise.

### 3.2.2. Data sources and descriptive statistics

Taking the year in which the enterprise income tax payment of waste incineration power generation PPP projects is greater than zero as the starting year, the data of the next 5 years are selected for data collection and collation, the data are from the PPP project management database of the Government and Social Capital Cooperation Center of the Ministry of Finance; the PPP projects with unpublished data or incomplete data are removed; and finally, the panel data of 23 waste incineration power generation PPP projects for five consecutive years are obtained, with a total of 115 valid sample observations. The microdata of the relevant enterprises involved in the waste incineration power generation PPP project are derived from the CSMAR database. The descriptive statistics for each variable are shown in Table 4.

**Table 4**  
**Descriptive statistical analysis of the main variables**

| Variable name            | N   | Average value | Standard deviation | Minimum value | Maximum value |
|--------------------------|-----|---------------|--------------------|---------------|---------------|
| <i>ETR</i>               | 115 | 0.0321        | 0.0196             | 0.00602       | 0.0865        |
| <i>Size</i>              | 115 | 10.47         | 0.452              | 9.546         | 11.42         |
| <i>Lev</i>               | 115 | 0.535         | 0.141              | 0.145         | 0.838         |
| <i>Capital</i>           | 115 | 0.833         | 0.105              | 0.518         | 0.973         |
| <i>ROA</i>               | 115 | 0.0293        | 0.0135             | 0.00613       | 0.0664        |
| <i>Electricity sales</i> | 115 | 0.162         | 0.0406             | 0.0779        | 0.281         |
| <i>Incentives</i>        | 115 | 0.470         | 0.501              | 0             | 1             |

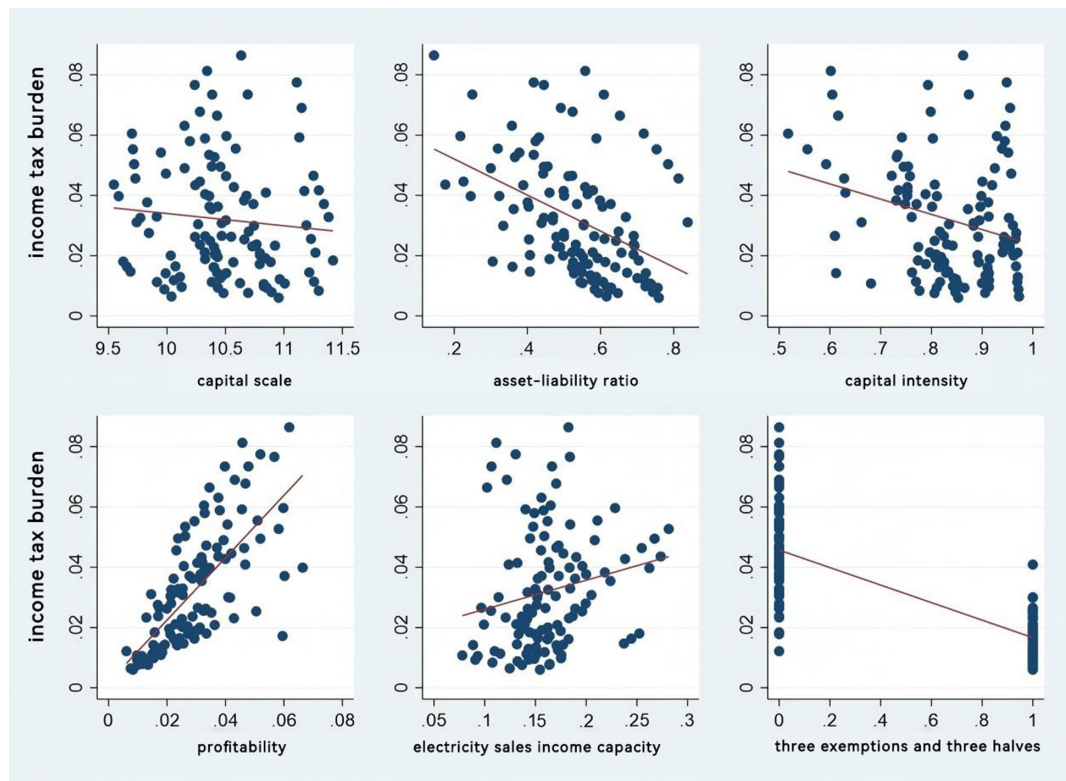
From the descriptive statistical results, the mean value of *ETR* was 0.0321, and the maximum and minimum were 0.0865 and 0.00602, respectively, indicating that the corporate income tax burden of different waste incineration power generation PPP projects varied widely; the average value of capital scale was 10.47. The maximum value of the debt ratio was almost six times the minimum, indicating that different waste incineration power generation PPP projects had large differences in capital structure. The average value of capital intensity was 0.833, and the minimum value was 0.518, indicating that the capital intensity of waste incineration power generation PPP projects was generally high. There were certain differences between the maximum and minimum in terms of electricity sales revenue capacity and profitability, especially profitability, which showed huge differences in different projects. As for the “three exemptions and three halves” benefit, fewer than half the companies enjoyed the benefits of this preferential policy.

### 3.3. Related research hypotheses

Figure 1 shows a scatter plot of each influencing factor and income tax burden. A linear relationship can be drawn between the two, which gives a preliminarily indication of their relationship. For example, a lower asset-liability ratio and higher profitability may be the reasons for a high burden of income, and other variables such as capital scale, capital intensity, electricity sales revenue capacity, and “three exemptions and three halves” tax incentives may also affect the income tax burden to a greater or lesser extent.

Zimmerman [30] analyzed data for American companies and found that the 50 largest American companies have the highest tax burden. Based on this, he proposed the hypothesis of political costs, arguing that the larger the company, the higher will be its political costs. Negative information will attract more attention and exert greater pressure on public opinion, and therefore to reduce political sensitivity, larger companies tend to engage in less tax avoidance behavior. In addition, the government and the

**Figure 1**  
Scatter plot of various influencing factors and income tax burden



public are more inclined to supervise large-scale enterprises, which makes it difficult for them to evade tax, and their corporate income tax burden is also higher. Therefore, according to the political cost hypothesis, the large capital scale of PPP projects will lead to an increase in their tax burden. Hypothesis 1 is therefore stated as follows:

**Hypothesis 1:** The larger the capital scale, the higher will be the corporate income tax burden.

Figure 1 does not clearly show a positive relationship between the scale of capital and the corporate income tax burden. On the contrary, its regression line shows a weak negative correlation. However, it should be noted that the correlation in Figure 1 was a simple correlation, and the influence of other variables was not controlled. Therefore, the specific capital scale remains to be tested more formally in the next step.

According to the data in the PPP project management library, most loans for waste incineration power generation PPP projects were bank loans, and China's tax law stipulates that the interest on such loans can be deducted before tax. Moreover, the debt tax shield theory and the MM (Modigliani and Miller) theory point out that liabilities play the role of a tax deduction to a certain extent in that the higher the debt level, the more obvious will be the tax deduction effect, and the lower will be the corporate income tax burden. Therefore, this paper proposes Hypothesis 2:

**Hypothesis 2:** The higher the asset-liability ratio, the lower will be the corporate income tax burden.

The second figure in Figure 1 shows that there was indeed a clear negative correlation between the asset-liability ratio and the corporate income tax burden.

If as many expenses as possible can be deducted before tax, the reduction in taxable income will lead to a reduction in corporate

income tax. Most waste incineration power generation PPP projects are capital-intensive enterprises with numerous pieces of machinery and equipment, and the annual depreciation amount is relatively large. The depreciation amount of fixed assets is a pre-tax deduction item that can effectively reduce the corporate income tax burden. Therefore, this paper proposes Hypothesis 3:

**Hypothesis 3:** The higher the capital intensity, the lower will be the corporate income tax burden.

The third graph in Figure 1 shows that there was indeed a negative correlation between capital intensity and the corporate income tax burden.

According to the principle of tax fairness, taxpayers with different economic and tax payment capacity should bear different tax burdens. Profitability can comprehensively examine the economic and tax payment ability of an enterprise. Therefore, profitability can affect the tax burden to a certain extent, and improvements in enterprise profitability may increase the corporate income tax burden. Therefore, this paper proposes Hypothesis 4:

**Hypothesis 4:** The higher the profitability, the higher will be the corporate income tax burden.

In the fourth graph in Figure 1, the positive correlation between profitability and income tax burden was very clear.

Waste incineration power generation can convert waste resources into electricity resources. As a developing country, China should pay attention to the development of electricity [31] because electricity can improve public productivity and contribute to China's economic growth. The electricity produced by the waste incineration power generation PPP project belongs to the category of additional subsidies for renewable energy electricity price. The financial subsidy amount is dedicated to project

**Table 5**  
**Benchmark regression**

|                       | (1)                   | (2)                   | (3)                 | (4)                  | (5)                  | (6)                   | (7)                   |
|-----------------------|-----------------------|-----------------------|---------------------|----------------------|----------------------|-----------------------|-----------------------|
| Size                  | −0.156***<br>(−11.34) |                       |                     |                      |                      |                       | 0.016<br>(0.90)       |
| Lev                   |                       | −0.179***<br>(−15.97) |                     |                      |                      |                       | −0.153***<br>(−7.86)  |
| Capital               |                       |                       | −0.110**<br>(−2.09) |                      |                      |                       | 0.020<br>(1.18)       |
| ROA                   |                       |                       |                     | 1.551***<br>(12.39)  |                      |                       | 0.689***<br>(5.79)    |
| Electricity sales     |                       |                       |                     |                      | 0.821***<br>(11.96)  |                       | −0.631***<br>(−5.50)  |
| Incentives            |                       |                       |                     |                      |                      | −0.031***<br>(−17.88) | −0.022***<br>(−14.72) |
| Constant              | 1.661***<br>(11.56)   | 0.128***<br>(21.12)   | 0.124***<br>(2.81)  | −0.013***<br>(−3.52) | −0.101***<br>(−9.04) | 0.046***<br>(41.94)   | 0.024<br>(0.12)       |
| <i>N</i>              | 115                   | 115                   | 115                 | 115                  | 115                  | 115                   | 115                   |
| <i>R</i> <sup>2</sup> | 0.586                 | 0.737                 | 0.046               | 0.628                | 0.611                | 0.778                 | 0.933                 |

**Note:** The parentheses below the coefficient are *t*-values. \*\*\*, \*\*, and \* represent significance at the 1%, 5%, and 10% levels, respectively.

investment and operation and to the maintenance costs incurred when the renewable energy power generation project is connected to the power grid system. It is a special subsidy and is not subject to income tax, and the financial subsidy is based on the amount of on-grid electricity. The electricity price of waste incineration power generation is uniformly regulated by the state, meaning that there is an approximately proportional relationship between electricity sales revenue and on-grid electricity and that an increase in on-grid electricity sales will bring about an increase in special financial subsidies. In other words, the greater the income capacity from electricity sales, the higher will be the special subsidy received by the project enterprise before tax. At the same time, the tax incentives of “three exemptions and three halves” directly reduce the tax payable by project companies and reduce the corporate income tax burden. Therefore, this paper proposes Hypotheses 5 and 6:

**Hypothesis 5:** The greater the project’s ability to sell electricity, the lower will be the corporate income tax burden;

**Hypothesis 6:** If a company benefits from the “three exemptions and three halves” exemption, its corporate income tax burden will be lower.

The fifth graph in Figure 1 clearly shows that the higher the income from electricity sales, the higher will be the corporate income tax burden. This may indicate that the special subsidy for non-taxation did not significantly reduce the income tax burden for enterprises, but that the improvement of electricity sales income capacity has increased the level of corporate profitability, which in turn has pushed up the corporate income tax burden (Hypothesis 4). This possibility is left for further empirical testing. The sixth graph in Figure 1, the corporate income tax burden in years when the project benefitted from the “three exemptions and three halves” policy, was significantly lower than in years without the policy, and therefore preliminary analysis suggests that the policy has played a role.

## 4. Empirical Analysis

### 4.1. Benchmark regression analysis

To test Hypotheses 1–6, this study first constructed a univariate panel data regression model and then included the above variables in

the equation. Table 5 shows the results. The first to sixth columns showed that all variables passed the significance test, except for the capital intensity variable that was significant at the 5% level; the rest of the variables were significant at the 1% level. However, in terms of symbols, the symbols of the two variables of capital scale and electricity sales revenue capacity were not in line with expectations, whereas the symbols of the two variables of asset-liability ratio and the “three exemptions and three halves” incentive were in line with expectations. The regressions in the first to sixth columns were similar to the scatter plot regression in Figure 1, which incorporated other variables into the perturbation term, ignoring the influence of these variables and their mutual influence. To control the influence of each of these variables, all variables were included in the equation at the same time, and the results are listed in the last column of Table 5.

In the regression results for all variables, the regression coefficient of capital size was 0.016, indicating that for every unit increase in capital size, the income tax burden of waste incineration power generation PPP projects will increase by 0.016 units. Compared with the results in the first column, the value was significantly smaller, the sign changes from negative to positive, and the significance level changes from 1% to insignificant, indicating that there was no significant correlation between capital scale and the income tax burden of waste incineration power generation PPP projects, meaning that Hypothesis 1 was not verified.

The regression coefficient of the asset-liability ratio was −0.153, indicating that for every unit increase in the asset-liability ratio, the corporate income tax burden is reduced by 0.153 units; the value did not change much compared to the second column, the symbol is consistent with the second column, and the *t*-value was −7.86, which was also significant at the 1% level. This indicated that the asset-liability ratio significantly affected the corporate income tax burden of waste incineration power generation PPP projects and that an increase in the asset-liability ratio reduced the income tax burden, which is consistent with Hypothesis 2.

The regression coefficient of capital intensity was 0.020, indicating that for every unit increase in capital intensity, the income tax burden of waste incineration power generation PPP projects increases by 0.02 units, which was significantly smaller than the figure in the second column, failed the significance test,

and was in the opposite direction to the results in the second column. Therefore, although the scatter plot initially showed an inverse correlation between capital intensity and income tax burden, no further evidence was found to support Hypothesis 3. This may be the case because the higher the capital intensity, the higher becomes the degree of automation, which is conducive to improving production efficiency and increasing revenue capacity, which leads to an increase in the tax burden.

The regression coefficient of profitability was 0.689, which was about one-half the previous one, the sign had not changed, indicating that for every unit increase in profitability, the income tax burden of waste incineration power generation PPP projects increases by 0.689 units, and the *t*-value dropped to 5.79, but was still significant at the 1% level. This confirmed that profitability had a significant positive correlation with the corporate income tax burden of waste incineration power generation PPP projects, which is consistent with Hypothesis 4.

The regression coefficient of electricity sales revenue capacity was  $-0.631$ , indicating that for each unit increase in electricity sales capacity, the income tax burden of waste incineration power generation PPP projects is reduced by 0.631 units, which was not much different from the simple regression result in numerical value, but the sign was opposite. Therefore, after controlling for the influence of other variables, the electricity sales revenue capacity began to meet expectations. The *t*-value was  $-5.50$ , which was still significant at the 1% level, indicating that improving the income capacity of electricity sales from waste incineration power generation PPP projects significantly reduced the corporate income tax burden. The conclusion is in line with Hypothesis 5.

The regression coefficient of the dummy variable Incentives was  $-0.022$ , indicating that for each additional unit of the “three exemptions and three halves” tax preferential policy enjoyed, the income tax burden of the waste incineration power generation PPP project is reduced by 0.022 units, and the *t*-value was  $-14.72$ , which was significant at the 1% level. This result was similar to the simple regression result in the sixth column, indicating that when the waste incineration power generation PPP project benefited from the “three exemptions and three halves” tax incentive policy, the corporate income tax burden was significantly reduced. This conclusion is in line with Hypothesis 6.

## 4.2. Robustness testing

Three methods were used for robustness testing:

### 4.2.1. Control endogeneity

There may be a bidirectional causal relationship between the independent and dependent variables in this paper. To control the endogeneity problems caused by this, all explanatory variables in this paper were lagged by one period. The regression situation is shown in the first column of Table 6, except for the significance of some variables. Except for the change in the significance level of some variables, the sign direction has not changed, and neither have the conclusions.

### 4.2.2. Heteroscedasticity problems

The benchmark model was tested for heteroscedasticity and intra-group autocorrelation, and their presence was confirmed, but no inter-group autocorrelation was found, meaning that the regression results could be corrected using the cluster robust standard error, as shown in the second column of Table 6. Compared with the benchmark regression results, only the significance level of profitability decreased, but it still passed the

**Table 6**  
**Robustness checks**

| Variable name            | Lag the explanatory variable by one period | Control heteroscedasticity    | Replace explanatory variables  |
|--------------------------|--|-------------------------------|--------------------------------|
| <i>Size</i>              | 0.085**<br>(2.20)                          | 0.016<br>(0.68)               | 0.017<br>(0.74)                |
| <i>Lev</i>               | $-0.258^{***}$<br>( $-5.60$ )              | $-0.153^{***}$<br>( $-4.18$ ) | $-0.162^{***}$<br>( $-5.24$ )  |
| <i>Capital</i>           | $0.145^{***}$<br>(3.58)                    | 0.020<br>(0.90)               | $0.055^{**}$<br>(2.12)         |
| <i>ROA</i>               | $0.688^{***}$<br>(3.95)                    | $0.689^*$<br>(1.81)           |                                |
| <i>Electricity sales</i> | $-0.199$<br>( $-0.75$ )                    | $-0.631^{***}$<br>( $-4.33$ ) | $-0.639^{***}$<br>( $-4.75$ )  |
| <i>Incentives</i>        | $-0.006^*$<br>( $-1.97$ )                  | $-0.022^{***}$<br>( $-9.73$ ) | $-0.022^{***}$<br>( $-11.01$ ) |
| <i>Roe</i>               |  |                               | $0.527^{**}$<br>(2.33)         |
| Constant                 | $-0.822^*$<br>( $-1.90$ )                  | 0.024<br>(0.10)               | $-0.009$<br>( $-0.04$ )        |
| <i>N</i>                 | 92   | 115                           | 115                            |
| <i>R</i> <sup>2</sup>    | 0.803                                      | 0.933                         | 0.939                          |

**Note:** The brackets below the coefficient are the *t*-values after the cluster robustness standard error correction. \*\*\*, \*\*, and \* represent significance at the 1%, 5%, and 10% levels, respectively.

significance test at the 10% level, and the significance levels and signs of the remaining variables did not change.

### 4.2.3. Replacing the explanatory variables

This paper uses return on equity, which is *ROE* (net profit/total net assets) instead of *ROA* to measure profitability, with other variables remaining unchanged. After the variables were replaced, the VIF values of each explanatory variable were all less than 10, indicating that there was no multicollinearity. Similarly, through the test, it was found that the model exhibited heteroscedasticity and intra-group autocorrelation, but there was no inter-group autocorrelation. The regression results could have been corrected by using the cluster robustness standard, and the regression results are shown in the third column of Table 6. Except for the increase in the significance level of capital intensity, the regression results of other variables did not change much, indicating that the regression results presented in this paper are stable.

## 5. Conclusions and Recommendations

China is vigorously promoting garbage classification and resource recycling, and increasing tax incentives during the operation of waste incineration power generation PPP projects to reduce the burden on enterprises and promote sustainable development. This paper reasonably evaluates the tax burden level and influencing factors of waste incineration power generation PPP projects, which can provide a reference for the government to formulate reasonable tax preferential policies for waste incineration power generation enterprises according to the requirements of tax policies, so as to effectively protect the legitimate rights and interests and policy protection of waste incineration power generation enterprises. This study has examined 23 waste incineration power generation PPP projects and has found that the average tax burden of these projects is 9.63%, which is comparable



to the average tax burden of the other five industries, at 9.58%. The VAT incentives have greatly reduced the tax burden of waste incineration power generation PPP projects, but some corporate income tax incentives such as “three exemptions and three halves” still have room for improvement in reducing their tax burden.

Among China’s environmental protection enterprises, the main tax is income tax, the tax rate is 25%, and the preferential policy is mainly “three exemptions and three halves,” which means that eligible enterprises can be exempted from paying enterprise income tax from the first to the third year of obtaining business income, and the taxes in the fourth to sixth years are halved. However, the preferential income tax policy requires enterprises to enjoy this preferential policy when they are profitable, and it is not an obvious choice for some projects with large initial investment, longer duration, less profit, or losses. PPP projects generally have a long construction period, generally no profit or small profit in the early stage of operation, relatively low return on investment, long return period, and other problems. Enterprises participating in PPP project construction, when they obtain their first operating income, often in the loss stage, the “three exemptions and three halves” policy has only 6 years of timeliness. With enterprise profits and taxes, the enterprise can enjoy this preferential policy for only a little time, making it difficult to enjoy the exemption or even to halve the levy incentive. As a result, this preferential policy has difficulty in playing its full role, and the implementation effect of the policy is weakened for environmental protection enterprises. Therefore, this type of PPP project has greater room for tax reduction in terms of corporate income tax.

Further study of the enterprise income tax on waste incineration power generation PPP projects has found that the asset-liability ratio, the income capacity of electricity sales, and whether to benefit from the “three exemptions and three halves” policy in the current year are significantly negatively correlated with the corporate income tax burden of such projects. Profitability has a positive impact on the corporate income tax burden, whereas the relationship of capital scale and capital intensity with the enterprise income tax burden is not obvious. In other words, the asset-liability ratio, the improvement in electricity sales income capacity, and the benefit of the “three exemptions and three halves” policy can significantly reduce the income tax burden, whereas improvements in profitability will bring about an increase in the income tax burden. Under the circumstance that the amount of urban domestic waste in China is increasing year by year, improving relevant tax policies and further reducing the tax burden on waste incineration power generation PPP projects can provide stronger support for developing such projects. Therefore, this paper makes the following targeted recommendations.

### 5.1. Focus on the role of the “debt tax shield”

On the government side, credit assessments must be made for various social capitalists. On the one hand, there is a need to provide different levels of loans to social capitalists in a targeted manner, and on the other hand, to give the greatest loan support within the scope permitted by the assessment level to ensure that the risks are controllable. In terms of enterprises, social participants in PPP projects need to strengthen their own credit structures and improve their corporate reputation and image to increase the possibility of obtaining external loans. At the same time, the project should moderately increase its own asset-liability ratio, and under the condition that the debt level is kept within a reasonable range and the risks are controllable, the role of the “debt tax shield” can be maximized to reduce the tax burden of enterprises and increase their after-tax profits.

### 5.2. Optimizing output structure to increase electricity sales revenue

The higher the revenue capacity of the waste incineration power generation PPP project, the more tax dividends the enterprise enjoys, and correspondingly the tax burden level will decrease. Improving the ability of enterprises to sell electricity can be viewed from the perspectives of both government and the enterprise. The government should increase innovation input and incentives, improve the effective capacity of the waste incineration power generation industry, improve infrastructure, and reduce power loss during transportation. As for the enterprise itself, through adjustment of its own business processes, more resources will be transferred to waste incineration power generation to improve the project’s ability to generate profits from electricity sales.

### 5.3. Improve the “three exemptions and three halves” tax policy

According to the empirical results, the preferential “three exemptions and three halves” policy can significantly reduce the corporate income tax burden of waste incineration power generation PPP projects. The problem that needs to be solved is how to implement this preferential policy. In the early stage of operation of a waste incineration power generation PPP project, there will generally be a period of losses. If the preferential policy is calculated from the year in which the first operating income is obtained, it is difficult for the enterprise to fully benefit from the preferential policy. If the “profit year” is calculated differently or the preferential period extended, the preferential policy can play a greater incentive role. Among the 23 projects in this paper, only 12 projects fully benefited from the preferential tax “three exemptions and three halves” policy; the remaining 11 projects experienced a long or short period of losses in the early stage of operation, during which only operating income was generated and no current income tax expense was incurred. Although the “three exemptions and three halves” policy has been implemented, these project companies have not actually received the tax reduction dividends flowing from the preferential treatment. Therefore, in practice, many waste incineration power generation PPP projects cannot fully obtain the economic benefits offered by this preferential treatment. Improving the preferential “three exemptions and three halves” tax policy should include two aspects: on the one hand, expand the scope of application of the “three exemptions and three 50% reduction” tax incentives to match the applicable fields of PPP projects and improve the universality of the incentives. On the other hand, the starting year of the “three exemptions and three halves” tax incentives should be changed to the year of “starting to make a profit”, or the applicable period of the incentives should be extended from 6 years to 10 years.

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## Ethical Statement

This study does not contain any studies with human or animal subjects performed by any of the authors.

## Conflicts of Interest

The authors declare that they have no conflicts of interest to this work.

## Data Availability Statement

Data available on request from the corresponding author upon reasonable request.

## Author Contribution Statement

**Tong Yang:** Conceptualization, Writing – review & editing, Visualization, Supervision, Project administration, Funding acquisition. **Ziwei Yuan:** Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – original draft. **Chengran Xing:** Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – original draft.

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