STUDY ON THE PRICING OF PUBLIC-PRIVATE PARTNERSHIP FOOD WASTE TREATMENT
——AN EXAMPLE OF
TAKING NANNING'S KITCHEN WASTE TREATMENT PROJECT

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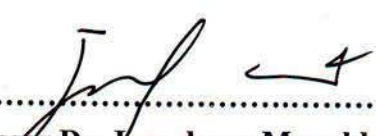
Thematic Certificate

TO

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This Independent Study has been Approved as a Partial Fulfillment of the Requirement of International Master of Business Administration in International Business Management

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ABSTRACT

Research Title: A STUDY ON THE PRICING OF PUBLIC-PRIVATE PARTNERSHIP FOOD WASTE TREATMENT – CASE STUDY OF NANNING'S KITCHEN WASTE TREATMENT PROJECT

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Public-private partnership projects (referred to as PPP projects) were used widely in many infrastructure constructions. Pricing of PPP projects is one of the critical factors to improve the efficiency of cooperation between the two parties. Reasonable pricing will make the level of public management more accurate, thereby improving social welfare. It can maximize and promote the sustainable development of the PPP project itself and help promote and apply the PPP model to similar public facilities or services. This paper summarized the related concepts of PPP projects, the pricing methods of joint PPP projects, and the factors that influence the price mechanism of PPP projects. The research also obtained the risk value β of China's kitchen waste treatment industry through data analysis. Based on the capital asset pricing model, a sample calculation found the capital rate of return of China's kitchen waste treatment industry could. Then the internal rate of return of China's kitchen waste treatment projects was calculated. The net present value method deduced the pre-pricing model of China's kitchen waste treatment PPP project. In conclusion, the actual case analysis verified the effectiveness of the pricing model. It also gave suggestions for improving the pricing mechanism of similar PPP projects, aiming to reference the preliminary pricing of similar PPP projects.

摘要

题目： 公私合营的餐厨垃圾处理项目定价研究-以南宁市餐厨垃圾处理项目为例
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公私合营项目（下面简称：PPP 项目）已被广泛应用到各类基础设施建设中，PPP 项目定价是提高双方合作效率的关键因素之一，合理的定价会使得公共管理水平更精准，从而让社会福利最大化，促使 PPP 项目本身得到可持续发展，有助于 PPP 模式在类似公共设施或服务中的推广应用。本文首先对 PPP 项目相关概念、常见 PPP 项目的定价方式以及 PPP 项目价格机制的影响因素进行了综述，其次，通过数据分析得到中国餐厨垃圾处理行业的风险值 β，基于资本资产定价模型，计算出中国餐厨垃圾处理行业的资本金收益率，进而计算出中国餐厨垃圾处理项目的内部收益率，并根据净现值法推导出中国餐厨垃圾处理类 PPP 项目前期定价模型，最后，通过实际案例分析验证了该定价模型的有效性，并对完善类似的 PPP 项目定价机制给出了建议，旨在为类似的 PPP 项目前期定价提供参考。

关键词： 公私合营 餐厨垃圾处理 资本资产定价模型 净现值

CONTENTS

CHAPTER1 INTRODUCTION

1.1 Research Background

The PPP model is that the government provides franchise rights for social capital, and social capital provides high-quality and efficient public infrastructure and services based on professional skills. The premise of PPP projects is the sharing of benefits and risks. The adoption of the PPP model can relatively reduce the government's fiscal expenditure and the investment risk of enterprises, thereby producing a utility of 1+1>2. Different from government investment and operation, public products and service projects under the PPP model must not only meet the requirements of financial affordability, but also ensure the "reasonable profits" of social capital. If the price is too high, it will damage the interests of the government and the public. If the price is too low, the social capital will not be able to recover its investment or expected profits, and will dampen the enthusiasm of the social capital to participate in the PPP project. A reasonable, fair and transparent pricing mechanism for infrastructure PPP projects can not only improve the positive externalities and economics of PPP projects, but also help improve the cooperative relationship between all parties involved. The project achieves healthy and stable development. Therefore, it is necessary to study the issue of government payment pricing in PPP projects, so that the government payment mechanism can effectively attract and motivate social capital, so as to provide better infrastructure and public services, and promote the better development of the PPP model.

1.2 Research Significance

Finding a scientific and reasonable government-paid pricing mechanism can not only reasonably relieve the government's financial pressure, but also effectively attract high-quality social capital to actively participate in government-paid PPP projects.

Provide pricing basis for government and social capital in PPP pre-investment planning, reduce the possibility of future cooperation failure, and promote the promotion of PPP model and the sustainable development of PPP projects.

1.3 Research Problems

Unreasonable PPP project pricing has caused difficulties and adverse effects on subsequent project operation and development (J. Guo, Hao, & Ren, 2017). This paper mainly studies how to price PPP projects reasonably. The specific research questions are:

1. According to the definition of capital asset pricing model theory, what is the risk factor of China's kitchen waste treatment industry? Is it higher than the market average risk?

2. How to derive the pre-pricing model of China's kitchen waste treatment PPP project based on the net present value method?

3. According to the preliminary pricing model of China's kitchen waste treatment PPP project, what is the price of Nanning's kitchen waste treatment project? Does the pricing model have up-front forecasting and guiding significance compared to actual government subsidies?

1.4 Research Objectives

The rationality of PPP project pricing can determine the profitability of future projects, thereby better motivating social capital to participate in the construction of social PPP projects. The rationality of the price needs to meet the triple goal of the government, social capital and the public, that is, to maximize social benefits, rationalize the interests of social capital, and accept the public. Based on the management knowledge learned, this paper finds and establishes a pricing model for PPP projects with theoretical basis, and proves the effectiveness of its pricing results through practical cases, providing some references for government pricing and ensuring the maximization of social welfare.

1.5 Research Hypothesis

The hypotheses of this study mainly include the following three:

H1: The earnings risk of China's food waste treatment industry is lower than the market average.

H2: Based on the net present value method, the pre-pricing model of China's kitchen waste treatment PPP project can be derived.

H3: The government subsidy price of Nanning's kitchen waste treatment project calculated according to the pre-pricing model of China's kitchen waste treatment PPP project is close to the actual subsidy price.

1.6 Research and Innovation

The main purpose of the PPP model is that the government can provide public goods and services to the society with greater efficiency through social-capital cooperation, which is a cooperative way to optimize the allocation of resources. PPP projects are divided into two types: operation, quasi-operation or non-operation, in fact, about 90% of the PPP projects in the world use the government payment model Most of the infrastructure and public service projects are quasi-operating or non-operational projects, such as affordable housing, education, pensions, medical care, environmental protection and some public transportation. In PPP projects, the main income of social capital comes from the financial expenditure of the local government. At the same time, the pricing policies for PPP projects in different countries are also different, and the research in this paper is limited to the upfront pricing of PPP projects for kitchen waste treatment that rely on government subsidies in China.

CHAPTER2   LITERATURE REVIEW

2.1 Definition of PPP model

The World Bank's definition of PPP model: PPP model is a long-term cooperative relationship between the government department and the private sector. The government department authorizes the private sector to build and operate public products. The private sector needs to take certain risks. At the same time, the profitability of the project is related to performance(Roumboutsos & Anagnostopoulos, 2008). The Canadian PPP National Committee defines: The PPP model is a long-term cooperative relationship established between the public sector and the private sector by allocating resources, sharing risks, and reasonably distributing benefits(S. Zhang, Gao, Feng, & Sun, 2015). Definition of the National Committee on PPP in the United States: The PPP model combines the characteristics of the outsourcing model and the privatization model. The government department is authorized and supervised, and the private sector is responsible for the design, construction, and operation of public products(Yanmei, 2019). The two cooperate to provide more information to the public. Good public goods. The definition of PPP model by the Ministry of Finance of China: PPP model is a long-term cooperative relationship between the public and private sectors for the construction of public goods. Social capital is responsible for the design, construction, and operation of the project. Its profit-making methods include user payments and government subsidies, and government departments are responsible for supervision(Chen, 2019).

2.2 Classification of PPP projects

According to the mode of operation, according to the Ministry of Finance's "Guidelines for Cooperation between Government and Social Capital" (Cai Jin [2014] No. 113), PPP models can be divided into entrusted operation (O&M), management contract (MC), construction-operation-transfer (BOT), Build-Own-Operate (BOO), Transfer-Operate-Transfer (TOT) and Rebuild-Operate-Transfer (ROT) modes. According to the nature of the project, PPP can be divided into three types: operating, quasi-operating and non-operating. Operating projects refer to PPP projects with strong cash flow that can recover investment and reasonable income through the normal operation of the private sector, such as expressways, urban water supply, gas supply, heating, etc.; non-operating projects refer to the cash of the project itself PPP projects with poor flow and almost or completely unable to recover most of the investors' investment, such as parks, museums, sports facilities, etc.; quasi-operational projects refer to projects that have certain operationality, but due to insufficient adjustment of price policies and fees PPP projects that require financial subsidies, such as sewage treatment, garbage treatment, nursing homes in most places in my country, are difficult to measure or charge, the large scale of investment leads to excessively high prices when the investment is recovered in the short term, and the government has special public welfare purposes. , rail transit, etc.(Zhao, 2017).

2.3 Summary of PPP project pricing research

Ho and Liu (2002) proposed a model of option pricing based on the characteristics of the scale, complexity and concession period of infrastructure PPP projects to evaluate the financial feasibility of the project. Yun, Han, Kim, and Ock (2009) used Monte Carlo simulation and multi-objective general algorithm (GA) to draw a capital structure model at the optimal equity ratio level, providing an appropriate capital structure range for privately financed infrastructure projects , while taking into account the specific risks of the project under various conditions. L. Shen, Bao, Wu, and Lu (2007) established an NPV model for the concession period under the condition of equilibrium between the income of the government and the project company, and considered the impact of the risk-adjusted discount rate on the project income. Y. Xu et al. (2012) obtained the pricing parameters and price risk factors of PPP highway projects through systematic research and established a SD-based expressway concession pricing model. L. Shen, Li, and Li (2002) established a cash flow bargaining model by using bargaining game theory to identify variables that affect project returns, so that both parties involved in a PPP contract negotiate a concession price. Carbonara, Costantino, and Pellegrino (2014) established a franchise price calculation model with Monte Carlo simulation method on the basis of reasonable risk sharing and proved it with a practical case. B. Guo and Zhang (2017) systematically analyzed the pricing mechanism of PPP quasi-operating projects, established a complete information game model with equal risks and benefits based on game theory, and used cases to verify the scientific rationality of the model.H. Wu and Zhao (2016) analyzed the difficulties and problems in the pricing of PPP projects in my country on the basis of analyzing the pricing models of foreign PPP projects, and systematically expounded suggestions for improving the pricing mechanism of public goods in my country. Lingbo and Liyao (2017) listed the existing pricing methods for PPP projects, analyzed their deficiencies, and finally put forward reasonable suggestions from two aspects of pricing and price adjustment. He (2016) explained in detail the characteristics of PP franchise projects, pricing principles and the factors that need to be paid attention to in pricing and price adjustment, and finally put forward strategies for reasonable pricing and price adjustment of PPP franchise projects in my country. X. Wu, Zhou, Peng, and Duan (2013) established a Stackelberg game model between the public and private sectors in order to meet the interests of the public and investors in analyzing the problem of government compensation for PPP projects, and finally found the optimal compensation for the government design. P. Zhang, Wang, Lan, Wu, and Li (2017) conducted an in-depth analysis of the problems existing in the current pricing mechanism of PPP projects, and proposed a PPP municipal sewage project pricing model based on the social welfare objective function, which is used for PPP projects. The pricing mechanism research provides a reference, which helps to promote the efficiency of enterprise operation, equalization of services and rational use of resources. Yi (2015) constructed the charging mechanism and model of PPP rail transit based on dynamic multi-objective planning by analyzing the pricing principles that PPP rail transit conforms to government management and market principles and the pricing objectives that conform to the interests of all parties. You and Peng (2016) based on the pricing theory of PPP intercity rail transit projects and the analysis of influencing factors, used capital asset pricing method to calculate the expected rate of return of the project and brought it into the cash flow model to solve the project pricing and optimize it. Song Jinbo,

Song, Song, and Fu (2015) analyzed the influencing factors of the income system of the waste incineration BOT project, built a project income model based on the system dynamics method, and simulated the concession period under the condition that the government and the project company meet their own income conditions with the help of cases. and franchise prices. Y. Shen and Shao (2017) analyzed the problems of the existing pricing model of PPP projects in my country, and designed the pricing problems of the three stages of pricing, respectively. Hua and Sheng (2018) believe that the construction benchmark of the current price legal system is the "importance" rather than "competitiveness" of public services, and there is a certain deviation in price behavior, which makes it difficult to achieve price equilibrium for public services under the PPP model, and it is necessary to Reconstruction of user-pays public service pricing laws. H. Sun and Li (2016) build a game model of pricing and franchise period based on incomplete information static game theory. C. Sun and Xu (2015) introduced the "fairness concern" parameter to observe its impact on social capital, government and consumers to construct a PPP project pricing model. Ren and Gao (2015) introduced the quality factor, constructed a price cap regulation model, and verified it.

2.4 Factors affecting the price mechanism of PPP projects

The PPP price mechanism is influenced by many factors, mainly including the main participant factors, project factors and external environmental factors. Participating main factors can be divided into government, social capital and public factors; project factors can be divided into competition degree, project type, cost structure, cooperation period, service quality, risk sharing factors, etc.; external environmental factors can be subdivided into political factors. Legal factors, economic factors, marketization degree, industry average profit level factors, etc. Among them, the degree of competition is the most important factor affecting the price mechanism of PPP project. The reason why PPP is more value for money than the traditional mode of supply comes from the fact that the project simulates full competition in the market by means of competitive procurement, which makes the introduction of social capital more efficient, and achieves the goal of spending less, doing more, and The purpose of doing good things, and this is also a popular commentary on the goal of the price mechanism of PPP projects.

2.4.1 Participating subject factors

One is the government factor. As the price maker and regulator of PPP projects, the government has an important influence on the price mechanism of PPP projects. On the one hand, the government can influence the price of PPP projects through government pricing, government guidance prices, investment subsidies during the construction period, loan interest discounts, and financial subsidies during the operation period. It also needs to reflect its policy proposition, which determines that the price of PPP projects should be regulated by the government, so as not to become a game for the rich. In addition, local financial affordability is also an important part of the price mechanism. According to the data of the Ministry of Finance's comprehensive information platform, as of the end of December 2016, the number

and amount of PPP projects paid by users in my country accounted for less than half, that is, a large number of PPP projects require government financial capital expenditure, and local financial capacity is strong. Weakness directly affects the level of shadow prices when social capital participates in PPP projects(Ye, 2012).

The second is the social capital factor. If the technical, financial and management advantages of social capital can be fully exerted, it will help to improve the efficiency of project operation and make public products and services more affordable. For example, under the careful operation of China Water Environment Group, the PPP project of Dali Erhai Lake Pollution Interception has saved 510 million yuan in total investment compared with the original feasibility study, and the construction period has been advanced by 6 months. The reduction of the total investment and the shortening of the construction period means that the price of the operation period is reduced, allowing ordinary people to enjoy benefits; if social capital is slow to work and asks sky-high prices, it will push up the prices of public products and services.

The third is the public factor. The public's support and opposition to the project is also one of the important factors affecting the price mechanism of PPP projects, which indirectly affects the price mechanism of PPP projects mainly through opposition to the introduction of policies, opposition to price adjustments, requests to stop construction, and opposition to project operation.

2.4.2 Project Factors

One is the degree of competition. The current policy stipulates that PPP projects can use public bidding, invitational bidding, competitive negotiation, competitive negotiation, single-source procurement, etc. to procure social capital. Among them, public bidding has the strongest degree of competition and the weakest social capital negotiation ability. Low level; there is almost no competition under single-source procurement, social capital has the strongest negotiating power and is in a monopoly position, and the pricing level is basically determined by social capital alone. From the perspective of the government, a place with a high level of economic development, a good business environment, high government credibility, strong financial strength, and broad project development prospects can attract many high-quality social capital to participate in the competition, and the government has relatively strong negotiating ability. Help provide affordable public services. The strength of competition determines the price behavior of social capital and the relationship between market supply and demand. Therefore, maintaining the competitiveness of the project is the most important key point for the effectiveness of the PPP project price mechanism.

The second is the project type factor. The PPP model has a wide range of applications, and will produce a variety of project types under certain circumstances. For example, from the operation mode, it can be divided into BOT, BOOT, BTO, TOT, ROT, O&M, etc.; from the current status of assets, it can be divided into stock, new construction and reconstruction; from the payment mechanism, it can be divided into user payment, feasibility Gap subsidy and

government payment; from the perspective of transaction structure, it can be divided into government investment plus franchise operation, government authorization plus franchise operation, government purchase of services, government resource compensation plus project revenue sharing, government authorization plus permanent operation, etc. Different project types will directly affect the expected income of social capital and the level of government payment, which in turn affects the price mechanism of PPP projects. For example, if the stock assets use the TOT model, a one-time franchise fee generally needs to be paid, which will greatly increase the capital cost of the social capital and increase the service price; and if the O&M model is used, it can be effectively Alleviate the pressure on social capital funds and reduce service prices(X. Xu, 2006).

The third factor is the cost structure. Different types of projects have different cost structures. For example, highway and railway PPP projects have large investment and low operating costs, and have a long payback period. Urban sewage treatment PPP projects have small investment and high operating costs. Analyzing the cost structure of the project can help identify PPPs. The main production factors of the project, determine the reasonable cost and profit level, prevent the corresponding risks, and then formulate a scientific price mechanism.

The fourth factor is the duration of cooperation. The PPP model is an investment model in which social capital makes a one-time investment and is recovered in installments. The length of the cooperation period determines the level of the government's average annual payment level to a certain extent. The longer the cooperation period, the lower the annual payment responsibility, and the price can be adjusted. The larger the space, the higher the payment responsibility, and the smaller the room for price adjustment. my country's policy stipulates that the minimum cooperation period of PPP projects shall not be less than 10 years and the maximum shall not exceed 30 years, which weakens the impact of the cooperation period on the price mechanism to a certain extent.

The fifth is the service quality factor. Since this round of vigorous promotion of the PPP model, the Ministry of Finance and the National Development and Reform Commission have excluded the BT model from the PPP model, indicating that operation is the focus and difficulty of this round of PPP model promotion. The quality of service in the operation process is directly concerned with the performance level of social capital. Under the user-pay model, the low performance level of social capital will lead to consumers not buying it and voting with their feet, thus resulting in a vicious circle of "low quality and low price" ; Under the feasibility gap subsidy and government payment model, if the social capital performance level does not meet the standard, points will be deducted and payment fees will be reduced according to the performance appraisal system, which may trigger the termination of the contract and compensation in serious cases.

Six is the risk sharing factor. PPP projects generally have a long time span, and the risk factors are complex and changeable in the whole life cycle. In accordance with the principles of risk allocation optimization, risk and income equivalence, and risk having an upper limit, the government's risk management capabilities, project return mechanisms and market risk

management capabilities are comprehensively considered. In principle, commercial risks such as project design, construction, finance, operation and maintenance shall be borne by social capital, risks such as laws, policies and minimum requirements shall be borne by the government, and risks such as force majeure shall be reasonably shared by the government and social capital. Social capital bears the corresponding risk, and has the right to claim a risk premium, thereby raising the level of payment.

Seven is the revenue sharing factor. Although most public services are not operational, in some areas, social capital may still make huge profits. For example, in some early expressway PPP projects, due to the lack of reasonable estimates of economic development and traffic flow, and the failure to design a revenue-sharing mechanism, a few years after the social capital began to operate, the traffic flow increased exponentially. Under the constraints of the government, the government cannot build a new expressway next to it to break down the traffic flow. The price level faced by the public is too high, and the public service field has become a place where social capital can make a lot of money and make quick money, and public interests are damaged. If the income sharing mechanism is embedded in the PPP contract, it can achieve the good effect of "shaving peaks and filling valleys". When the social capital income is too high, the government will share a part of the income, which will be used to stabilize the price level of the PPP project or supplement the new road fund. , which will reduce the price level faced by the public(Zhu, 2013).

The eighth factor is price regulation. The government's ability to supervise PPP prices also affects the price mechanism of PPP projects. Under the traditional supervision mode, it is often the case that "the railway police are in charge of each section". The phenomenon of fragmentation and multiple administrations is more serious. The supervision methods are also relatively extensive, and the discretionary power is too large; PPP emphasizes post-assessment and performance payment. If the social capital fails to meet the performance evaluation standards, the regulatory authorities have the right to deduct the corresponding expenses; the performance evaluation indicators are clear and quantified, which will help the social capital to generate stable expectations; the main body of supervision is generally formed by the overall coordination of various departments, with joint supervision and supervision The procedure is more convenient and efficient. Through such a mechanism, the PPP price mechanism can be more value for money.

2.4.3 External Environmental Factors
One is the political and legal factor. The political and legal environment faced by PPP projects also profoundly affects the pricing mechanism. For example, Chongqing raised the level of sewage treatment fees and waste treatment fees very early, which basically guaranteed the reasonable income of social capital. This was very important at the time when the sewage treatment and waste treatment industries generally suffered losses and required financial subsidies. rare. Chongqing has made almost one-step price adjustments in related fields, giving social capital a reasonable expectation of price reform, and laying a good foundation for rationalizing the price mechanism of PPP projects in the future(Yang, 2016).

The second is macroeconomic factors. Macroeconomic factors mainly include exchange rates, interest rates, price levels, taxes, etc. Changes in these factors will more or less affect the price mechanism of PPP projects. For example, PPP contracts often stipulate an anti-inflation price adjustment formula, which is mainly to deal with the sharp rise or fall in the prices of manpower, raw materials, and energy in the future. Generally speaking, the impact brought by the change within the range of 5% shall be borne by the project company itself. If the proportion exceeds 5%, the project company shall apply to the price supervision department for adjustment in the next year. For another example, a PPP project stipulates in the contract that since it is uncertain whether the project can enjoy the government tax and fee policy, if the project cannot enjoy the government tax and fee policy, the government's payment level will be adjusted according to the corresponding formula.

The third factor is the degree of marketization. The degree of marketization of a country, region and industry will have an important impact on the price mechanism of PPP projects. From a national perspective, developed countries such as the United Kingdom and France have a relatively high degree of marketization. In PPP projects, independent negotiation and pricing are often adopted, supplemented by appropriate price supervision, which can stabilize social capital income expectations and strengthen the PPP model. Sustainability is important. In recent years, the pace of price reform in my country has been greatly accelerated, the prices of a large number of commodities and services have been gradually liberalized, and the degree of marketization of prices in fields such as refined oil, natural gas, and railway transportation has been significantly improved. In the future, with the gradual improvement of the market price formation mechanism in my country, the price mechanism of the corresponding PPP projects will also become more mature. From a regional perspective, some areas and links in which pricing standards are mastered by local governments are mainly affected by the degree of regional marketization. In particular, the current PPP model is still a novelty in my country, and there are not many rules and regulations to follow in the setting of prices in different fields. For example, sponge city PPP projects, smart city PPP projects, underground pipe gallery PPP projects, etc., the central government has not issued a unified pricing standard, and the specific scale is controlled by the local government. In this case, the degree of marketization and the concept of marketization in the region will have an important impact. For example, Chongqing has been at the forefront of the country in the reform of water prices. As early as the beginning of the 21st century, it has carried out research and reform on water price policy. The research results have won high recognition from the government, the public (especially the poor), and scholars, and It has been praised by the World Bank and promoted as a typical case.

From an industry perspective, the PPP model is mainly used in infrastructure and public services, involving energy, transportation, municipal utilities, agriculture, forestry, water conservancy, environmental protection, affordable housing projects, education, science and technology, culture, sports, medical care 15 industries including health, pension and tourism. Different industries have different characteristics. Products or services that have market conditions and belong to competitive fields or links should be subject to market-adjusted prices, and the project unit should set prices independently; important public utilities, public welfare services, and network-based natural monopoly links should be subject to government pricing.

or government-guided prices. Fourth, the industry average profit level factor. The industry average profit level reflects the general necessary rate of return that a project deserves. Different projects have different project characteristics, and the specific rate of return will fluctuate around the industry average profit level. Different industries have differences in the formulation of price mechanisms due to different average profit levels. Industries with high profitability, such as real estate, take a high rate of return into consideration when setting prices; industries with low profitability, such as traditional industries, take a low rate of return into consideration when setting prices. This is important for regional benchmarking.

In summary, although there are many impression factors and problems in the pricing of PPP projects, scholars have also made a lot of explorations and designed a variety of pricing methods. The price of the products or services of a PPP project should be set according to the project's own characteristics and pricing objectives, and at the same time, risks should be reasonably shared between the public and private parties, so as to meet the requirements of project operation sustainability. At present, there are relatively few studies on the pricing of kitchen waste treatment fees, and most of the pricing analysis is based on the cash flow method based on cost and income, which lacks consideration of system risks(Lu, 2012).

2.5 Related Theories of Pricing

The theories used in this research mainly include Capital Asset Pricing Model, net present value method.

2.5.1 Capital Asset Pricing Model

Capital asset pricing model (referred to as: CAPM) is one of the prediction models based on the equilibrium of expected returns of risk assets. CAPM expounds the formation of market equilibrium under the condition that investors adopt Markowitz's theory for investment management. The theoretical relationship between the expected return of an asset and the expected risk is expressed in a simple linear relationship, that is, under the assumptions, there is a positive relationship between the expected return of an asset and the β value of a scale that measures the risk of the asset. Correlation relationship, the cost of capital is the required rate of return Ra formula is:

$$Ra=Rf+\beta(Rm-Rf)$$

where Ra is the cost of capital, β is the risk correction factor, Rm is the expected market rate of return, and Rf is the risk-free rate of return

When the capital market reaches equilibrium, the marginal price of risk is constant, and the marginal effect of any investment that changes the market portfolio is the same, that is, the compensation for increasing one unit of risk is the same.

Systematic risk refers to the risk in the market that cannot be eliminated by diversifying investment, also known as market risk. For example: interest rates, recessions, wars are all risks that cannot be eliminated through diversification.

Unsystematic risk, also known as idiosyncratic risk, is an inherent risk of individual stocks that investors can eliminate by changing their stock portfolio. From a technical point of view, the return of unsystematic risk is a component of stock returns, but the risk it entails is invariant to changes in the market. Modern portfolio theory states that idiosyncratic risks can be eliminated by diversifying investments. Even if the portfolio includes stocks in all markets, systematic risk will not be eliminated by diversification, which is the most difficult for investors to calculate when calculating the return on investment. According to the provisions of CAPM, the beta coefficient is an indicator used to measure the systematic risk of an asset, and is a risk assessment tool used to measure the volatility of a security or an investment portfolio relative to the overall market.

From the perspective of market portfolio, the systematic risk of a single asset can be regarded as the degree of reflection of changes in the market portfolio, and it can be measured by the beta coefficient. β represents the degree of simultaneous change in the rate of return of individual assets relative to the change in the market rate of return, and is a standardized indicator for measuring the contribution of a single asset to the variance of the market portfolio. That is, if a stock's price is consistent with the market's price volatility, then the stock's beta value is 1. If a stock's beta is 1.5, it means that when the market goes up 10%, the stock price goes up 15%; and when the market goes down 10%, the stock price also goes down 15%. Beta is calculated by statistically analyzing the daily returns of the market during the same period and the daily price returns of a single stock.

As a theory to explain the equilibrium price determination of risky assets, CAPM not only greatly simplifies the operation process of portfolio selection, making Markowitz's portfolio selection theory a big step towards real-world application, but also makes securities theory a great step forward. From qualitative analysis to quantitative analysis, from normative to empirical, it has a huge impact on the theoretical research and practical operation of securities investment, and even the development of the entire financial theory and practice, and has become the theoretical basis of modern finance.

2.5.2 The pricing theory of net present value method

The net present value method of pricing is to determine the franchise price of the project by discounting the project cash flow forecast during the franchise period, and finding out the case where the net present value is zero under the benchmark rate of return. The government and investors have accumulated rich experience in the development and construction of a large number of engineering projects, and can accurately measure the project's rate of return and cash flow, and at the same time, the impact on the project can be reflected in the form of cash flow. In the economic evaluation, a credible franchise price is finally solved. The disadvantage of the net present value method is that the inaccuracy of the cash flow forecast will cause the distortion of the results, and the reasonableness of the discount rate will also have a greater impact on the calculation results of the project. However, due to its advantages of strong

operability, it has been widely used and explored in the formulation of concession prices for infrastructure projects such as expressway PPP projects and sewage treatment PPP projects.

CHAPTER 3   RESEARCH METHOD DESIGN

3.1 Quantitative analysis method

Through quantitative analysis, the investment risk coefficient β of China's kitchen waste treatment industry is analyzed and determined, and the investment rate of return on capital of China's kitchen waste treatment industry is determined according to the capital asset pricing model, that is, the expected return on investment Ra.

3.1.1 Determine the investment risk coefficient β

Determine the investment risk coefficient β of China's kitchen waste treatment industry through quantitative analysis. The specific method is: first select three representative listed companies in China's kitchen waste treatment industry, namely TusEnvironment, Chengfa Environment and China Tianying, and select the past For three years, from April 2018 to April 2021, the data of individual stocks and the data of the large market where they are located will establish a linear relationship between the change rate of the large market index, namely the Shenzhen Component Index and the change rate of the stock price of the selected company. The company's risk coefficient, and then use the risk coefficient of these companies to calculate the weighted average according to the market value weight of the selected companies to determine the investment risk coefficient β of China's kitchen waste treatment industry.

Table 3.1: Historical data of TUS-EST stocks in 2018-2021

No.	Date	Opening	High	Low	Close	Quote Change
1	2018-04-02	28.46	29.22	28.41	28.84	1.37%
2	2018-04-03	28.58	29.3	28.4	28.9	0.21%
3	2018-04-04	28.99	29.21	28.67	28.97	0.24%
4	2018-04-09	29.2	29.22	28.53	29.12	0.52%
5	2018-04-10	29.11	29.3	28.8	28.93	-0.65%
6	2018-04-11	29.08	29.91	28.79	29.75	2.83%
7	2018-04-12	29.62	29.99	29.56	29.67	-0.27%
8	2018-04-13	29.88	29.9	29.23	29.32	-1.18%
9	2018-05-08	30.2	31.84	30.03	30.11	2.69%
10	2018-05-09	30.39	31.1	30.33	30.42	1.03%
...	...	...	...	...	...	...
697	2021-03-19	6.13	6.65	6.1	6.3	1.61%
698	2021-03-22	6.31	6.78	6.23	6.75	7.14%
699	2021-03-23	6.64	6.65	6.48	6.54	-3.11%
700	2021-03-24	6.51	6.93	6.49	6.79	3.82%
701	2021-03-25	6.71	6.89	6.51	6.8	0.15%
702	2021-03-26	6.87	6.9	6.64	6.77	-0.44%
703	2021-03-29	6.71	6.75	6.58	6.67	-1.48%
704	2021-03-30	6.61	6.63	6.33	6.37	-4.50%
705	2021-03-31	6.44	6.93	6.37	6.68	4.87%
706	2021-04-01	6.51	6.57	6.38	6.4	-4.19%

Table 3.2: Historical data of China Tianying Inc. stocks in 2018-2021

No.	Date	Opening	High	Low	Close	Quote Change
1	2018-07-09	6.05	6.05	6.05	6.05	-9.97%
2	2018-07-10	5.45	5.45	5.45	5.45	-9.92%
3	2018-07-11	4.91	5.15	4.91	4.91	-9.91%
4	2018-07-12	4.8	4.95	4.75	4.75	-3.26%
5	2018-07-13	4.7	4.88	4.62	4.79	0.84%
6	2018-07-16	4.72	4.79	4.38	4.48	-6.47%
7	2018-07-17	4.56	4.9	4.52	4.8	7.14%
8	2018-07-18	4.79	4.84	4.65	4.77	-0.63%
9	2018-07-19	4.75	4.78	4.58	4.63	-2.94%
10	2018-07-20	4.46	4.68	4.46	4.63	0.00%
...	…	…	…	…	…	…
649	2021-03-19	4.54	4.61	4.53	4.58	-0.43%
650	2021-03-22	4.58	5.04	4.55	4.96	8.30%
651	2021-03-23	4.9	4.94	4.81	4.86	-2.02%
652	2021-03-24	4.8	5.03	4.79	4.89	0.62%
653	2021-03-25	4.87	4.87	4.62	4.68	-4.29%
654	2021-03-26	4.66	4.76	4.63	4.68	0.00%
655	2021-03-29	4.68	4.77	4.52	4.55	-2.78%
656	2021-03-30	4.53	4.54	4.33	4.47	-1.76%
657	2021-03-31	4.48	4.68	4.43	4.6	2.91%
658	2021-04-01	4.57	4.64	4.45	4.5	-2.17%

Table 3.3: Historical data of Cevia Enviro Inc. stocks in 2018-2021

No.	Date	Opening	High	Low	Close	Quote Change
1	2018-04-02	14.93	15.17	14.82	14.87	-0.34%
2	2018-04-03	14.52	14.97	14.5	14.87	0.00%
3	2018-04-04	14.86	15.09	14.83	14.89	0.13%
4	2018-04-09	14.75	15.12	14.7	14.99	0.67%
5	2018-04-10	15.18	15.68	15.16	15.29	2.00%
6	2018-04-11	15.34	15.45	15.15	15.32	0.20%
7	2018-04-12	15.26	15.46	15.11	15.18	-0.91%
8	2018-04-13	15.2	15.33	15.04	15.16	-0.13%
9	2018-04-16	15.25	15.27	14.61	14.88	-1.85%
10	2018-04-17	14.88	15.04	14.67	14.7	-1.21%
...	…	…	…	…	…	…
705	2021-03-19	9.64	10.1	9.61	9.76	0.62%
706	2021-03-22	9.74	10.31	9.73	10.15	4.00%
707	2021-03-23	10.18	10.24	9.9	9.96	-1.87%
708	2021-03-24	9.98	10.24	9.89	10.07	1.10%
709	2021-03-25	10.04	10.07	9.92	10.01	-0.60%
710	2021-03-26	10.07	10.13	9.95	10	-0.10%
711	2021-03-29	10.04	10.06	9.88	9.9	-1.00%
712	2021-03-30	9.86	9.89	9.66	9.74	-1.62%
713	2021-03-31	9.74	10.09	9.7	9.89	1.54%

| 714 | 2021-04-01 | 9.86 | 9.86 | 9.73 | 9.74 | -1.52% |

Source: Tong Hua Shun Finance

Table 3.4: Historical data of Shenzhen Component Index in 2018-2021

No.	Date	Opening	High	Low	Close	Quote Change
1	2018-04-02	10887.47	10950.22	10835.71	10852.95	-0.14%
2	2018-04-03	10718.43	10783.93	10667.33	10754.29	-0.91%
3	2018-04-04	10778.86	10829.82	10678.94	10684.56	-0.65%
4	2018-04-09	10655.07	10725.11	10571.16	10653.38	-0.29%
5	2018-04-10	10671.69	10765.62	10628.24	10765.62	1.05%
6	2018-04-11	10796.5	10856.44	10786.84	10808.37	0.40%
7	2018-04-12	10797.35	10825.66	10720.83	10726.95	-0.75%
8	2018-04-13	10789.77	10825.67	10670.65	10687.02	-0.37%
9	2018-04-16	10660.69	10704.39	10540.69	10621.79	-0.61%
10	2018-04-17	10636.88	10669.15	10390.05	10395.16	-2.13%
...	…	…	…	…	…	…
721	2021-03-19	13738.21	13837.23	13522.94	13606	-2.56%
722	2021-03-22	13605.7	13797.3	13565.17	13760.97	1.14%
723	2021-03-23	13754.88	13794.47	13506.17	13607.27	-1.12%
724	2021-03-24	13529.93	13651.9	13378.88	13407.35	-1.47%
725	2021-03-25	13318.97	13489.29	13252.24	13421.16	0.10%
726	2021-03-26	13493.36	13810.97	13493.36	13769.68	2.60%
727	2021-03-29	13802.51	13895.61	13684.43	13771.26	0.01%
728	2021-03-30	13751.21	13933.32	13717.59	13888.44	0.85%
729	2021-03-31	13870.71	13870.71	13678.67	13778.67	-0.79%
730	2021-04-01	13812.64	13992.75	13808.32	13979.69	1.46%

Source: Tong Hua Shun Finance

Table 3.5: Company Stocks Market Value in 2021

Company Name	Stock Code	Market Value/billion RMB
China Tianying Inc.	000035	110.0
Cevia Enviro Inc.	000885	62.3
TUS-EST	000826	86.9

Source: Tong Hua Shun Finance

3.1.2 According to the capital asset pricing model

$$Ra=Rf+\beta(Rm-Rf)$$

The average annual market rate of return Rm takes the average annual increase of the Shenzhen Component Index over the past three years, the risk-free rate of return on capital Rf is the interest rate of three-year treasury bonds, and the investment risk coefficient β of China's kitchen waste treatment industry determined by quantitative analysis, we get The investment rate of return of the capital is the expected return on investment Ra of the capital.

Table 3.6: Shenzhen Component Index YoY in 2018-2021

Date	Shenzhen Component Index	Y0Y %
2018-04-02	10852.95	/
2019-04-02	10260.36	-5.46%
2020-04-02		
2021-04-02	10179.2	-0.79%
	14122.61	38.74%

Source: Tong Hua Shun Finance

3.1.3 Derivation of the pre-pricing model for China's kitchen waste treatment PPP projects based on the net present value method

According to the theory of capital asset pricing model, by adding risk considerations, under the assumptions, a model suitable for the pricing of kitchen waste treatment PPP projects is established. Specific steps are as follows:

(1) Setting assumptions

A. The full cycle of the project is T, in which the construction period is T_1, and the concession period is T_2=T-T_1; B. The depreciation is based on the average lifespan method; C. The government promises the minimum purchase amount, if it is insufficient, it will be insufficient for part of the government subsidy; D. The project investment It consists of two parts: capital and project financing; E. When the risk caused by financing interest rate and inflation exceeds a certain range, part of the government subsidy will be exceeded. F. It is assumed that the project has no other cash inflows, only government subsidies.

(2) Determine the actual cost of financing

Since the interest during the operation period is not taxable, the actual cost of financing is:

$$R_D = r(1 - s)$$

where R_D is the actual cost of project financing, r is the financing interest rate, and s is the corporate income tax rate of China's kitchen waste treatment PPP project.

(3) Determine the weighted average cost of capital

For Chinese food waste treatment PPP project companies, the capital structure includes equity capital and debt capital, and the costs and risks of these two types of capital are different. According to the principle of risk-return equivalence, the weighted average capital cost should be used as its investment rate of return (discount rate), and the weighted average capital cost R is:

$$R = R_a \left(\frac{C}{C + D}\right) + R_D \left(\frac{D}{C + D}\right)$$

(4) Calculate the nth year cash inflow of the kitchen waste treatment PPP project.

The cash inflow of the kitchen waste treatment PPP project is the project subsidy given by the government according to the franchise contract. Therefore, the total income I_n of the nth year of the kitchen waste treatment PPP project is:

$$I_n = PQ_n$$

Among them, P represents the government subsidy price for the unit treatment volume (per ton) of the kitchen waste treatment PPP project, and Q_n is the processing volume (ton) in the nth year.

(5) Calculate the nth year cash outflow of the kitchen waste treatment PPP project

The cash flow expenditure of the kitchen waste treatment PPP project mainly includes construction investment, loan interest, operating cost, sales tax and project income tax. Therefore, the total expenditure O_n in the nth year of the kitchen waste treatment PPP project is:

$$O_n = O_n^1 + O_n^2 + L_n * r + PQ_n a_1 + [PQ_n(1 - a_1) - O_n^2 - L_n * r] * s$$

Among them, O_n^1 represents the construction investment of the kitchen waste treatment and treatment PPP project in the nth year; O_n^2 represents the operating cost of the kitchen waste treatment and treatment PPP project in the nth year; L_n represents the loan balance at the beginning of the nth year of the project; a_1 represents the project sales tax rate.

(6) List the equation when the project's net cash flow is zero

The cash flow of the kitchen waste treatment PPP project in the whole cycle is discounted according to R as the discount rate. If the sum of the discounted value of the expenditure in the whole cycle is less than or equal to the sum of the sum of the discounted income of the income, it means that the project is feasible. Equal here means, When the government subsidy price is P, the project rate of return is exactly equal to R, which is expressed by the benefit-cost ratio BCR:

$$BCR = \frac{I}{O} = \frac{\sum_{n=T_1+1}^{T} I_n \ (1 + R)^{-n}}{\sum_{n=1}^{T} O_n \ (1 + R)^{-n}} = 1$$

(7) Derive the pre-pricing model of China's kitchen waste treatment PPP project.

According to the derivation of the equation, the minimum government subsidy price for the PPP project of China's kitchen waste treatment PPP project is:

$$P = \frac{\sum_{n=1}^{T_1} O_n^1 \ (1 + R)^{-n} + \sum_{n=T_1+1}^{T}(O_n^2 + L_n * r)(1 - s) \ * \ (1 + R)^{-n}}{\sum_{n=T_1+1}^{T} Q_n(1 - a_1)(1 - s) \ * \ (1 + R)^{-n}}$$

3.2 Case analysis method

I have participated in the technical and economic evaluation of the Nanning kitchen waste treatment PPP project, and I have been tracking the operation of the project. After continuous practice and adjustment, the government subsidy price has become mature, and the satisfaction of both parties is very high. The development and operation of the company is good, and the social benefits are prominent. Therefore, this paper will verify the correctness of the pre-pricing

model for the Chinese food waste treatment PPP project by extracting the actual government subsidy data of the Nanning food waste treatment PPP project.

3.2.1 Project Overview

The Nanning Food Waste Treatment PPP Project is located in Nanning City, Guangxi Autonomous Region, China. The designed daily processing capacity of food waste is 300 tons and the annual processing capacity is 109,500 tons. The investment of the project is 215.97 million yuan, the capital of the project company is 30% of the investment, that is, the capital is 64.79 million yuan, and the loan fund is 151.18 million yuan. The sewage treatment plant started construction in early 2013 and completed the main project construction at the end of 2014. The construction period is 2 years. The investment in the first year is 103.81 million yuan, and the investment in the second year is 108.74 million yuan. The project was completed in January 2015 and Fully put into operation, the project adopts the BOT model in the PPP project, the concession period is 20 years, the concession period is from January 1, 2015 to January 1, 2035, and the average annual operating cost of the project is 22 million yuan (The above data source: China Government Procurement Network).

The kitchen waste treatment PPP project is a high-tech enterprise that needs to be supported by the state, and its income tax rate is 15% (data source: the website of the State Administration of Taxation of China).

3.2.2 Project financing

The financing period of the Nanning Kitchen Waste Treatment PPP Project is 12 years, and the loan balance at the beginning of each year during the operation period is as follows:

Table 3.7: Nanning Kitchen Waste Treatment PPP Project Loan Balance Sheet

nth year of operation period	3	4	5	6	7
Loan balance at the beginning of the year (10,000 yuan)	15470.00	14316.56	13089.65	11784.58	10396.39
nth year of operation period	8	9	10	11	12
Loan balance at the beginning of the year (10,000 yuan)	8919.76	7349.07	5678.33	3901.16	2010.79

Source: Nanning Municipal People's Government

CHAPTER 4   DATA ANALYSIS

4.1 Calculation of investment risk coefficient β of China's kitchen waste treatment industry.

Use the three-year growth rates of the three listed companies, namely Enlightenment Environment, Chengfa Environment and China Tianying, to perform regression analysis on the market in which they are located, namely the Shenzhen Component Index, to obtain the respective risk coefficients of the three companies. By weighted calculation, the investment risk coefficient β of China's kitchen waste treatment industry is obtained.

4.1.1 Using the excel tool, the risk factors of the three companies are analyzed as follows

Table 4.1: China Tianying Inc. & Shenzhen Component Index Regression Analysis

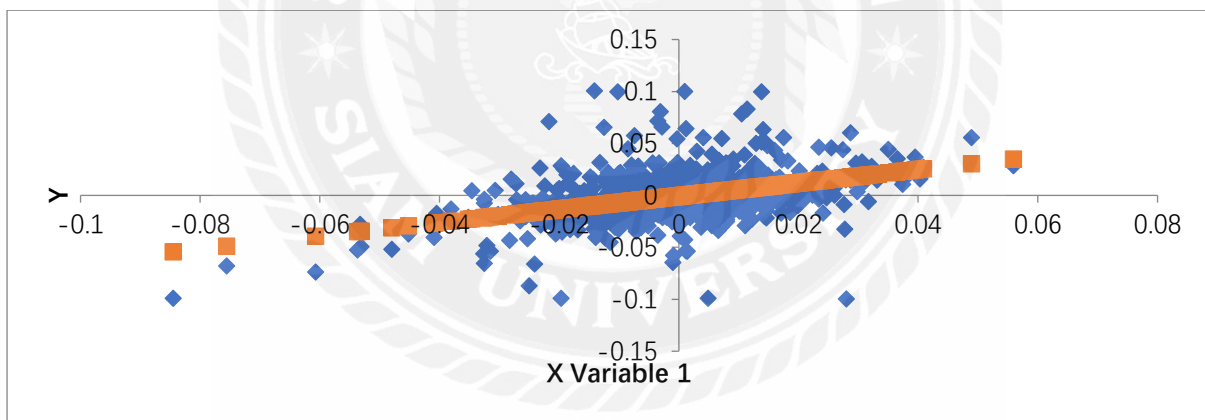|	Coefficients	standard deviation	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-0.00079415	0.000866	-0.91736	0.359292	-0.00249	0.000906
X Variable	0.636231064	0.05392	11.79959	2.83E-29	0.530355	0.742107

Source: developed by author.

Figure 4-1: China Tianying Inc. & Shenzhen Component Index Regression Analysis

Source: developed by author.
Note: X Variable is Shenzhen Component Index's Quote Change, Y Variable is China Tianying Inc. individual stocks's Quote Change; The blue dots represent the true values, and the orange dots represent the regression fitted predicted values.

Table 4.2: Cevia Enviro Inc. & Shenzhen Component Index Regression Analysis

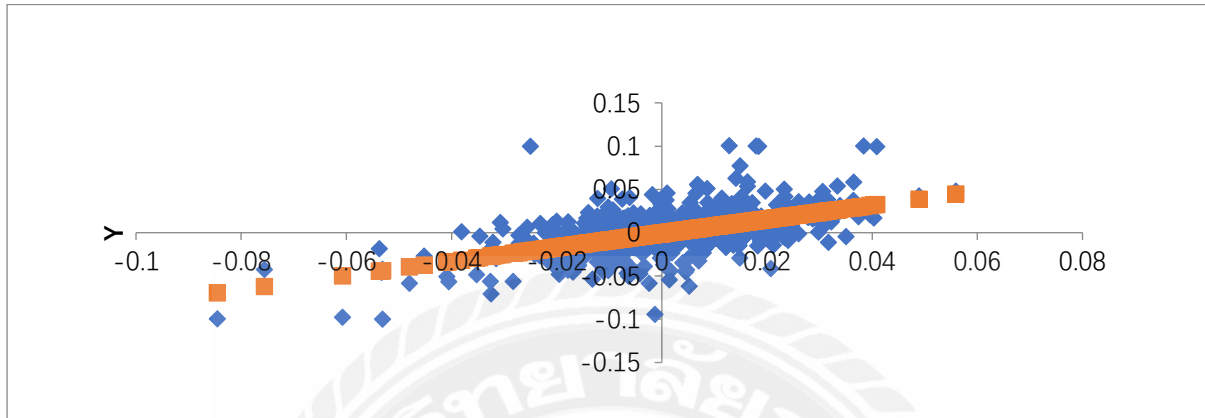|	Coefficients	standard deviation	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-0.00074281	0.000718	-1.03517	0.300943	-0.00215	0.000666
X Variable	0.812601519	0.045174	17.98843	6.36E-60	0.723912	0.901291

Source: developed by author.

Figure 4-2: Cevia Enviro Inc. & Shenzhen Component Index Regression Analysis

Source: developed by author.

Note: X Variable is Shenzhen Component Index's Quote Change, Y Variable is Cevia Enviro Inc. individual stocks's Quote Change; The blue dots represent the true values, and the orange dots represent the regression fitted predicted values.

Table 3: TUS-EST & Shenzhen Component Index Regression Analysis

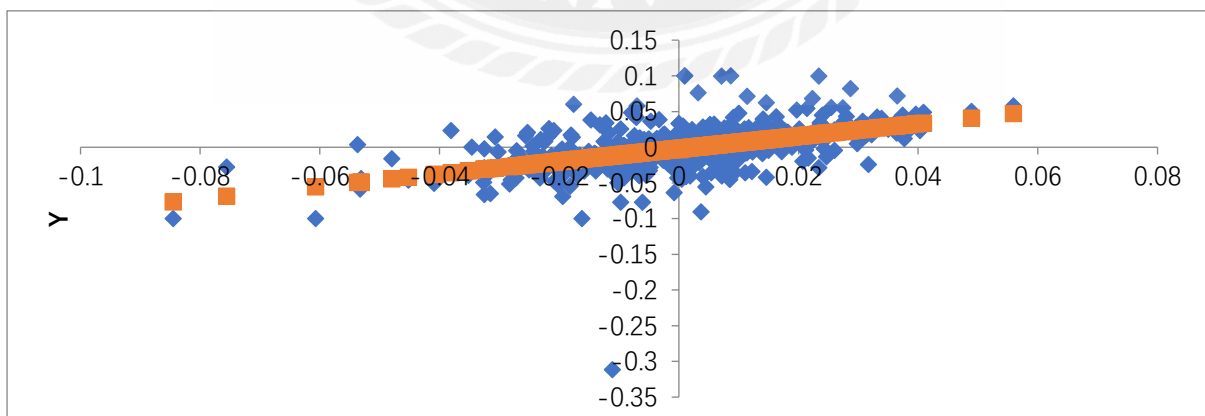|	Coefficients	standard deviation	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-0.00212437	0.00089	-2.38731	0.017235	-0.00387	-0.00038
X Variable	0.880570819	0.056011	15.72147	5.87E-48	0.770603	0.990539

Source: developed by author.

Figure 4-3: TUS-EST & Shenzhen Component Index Regression Analysis

Source: developed by author.

Note: X Variable is Shenzhen Component Index's Quote Change, Y Variable is TUS-EST individual stocks's Quote Change; The blue dots represent the true values, and the orange dots represent the regression fitted predicted values.

4.1.2 According to the market value ratio of the three companies, the investment risk coefficient β of China's kitchen waste treatment industry is obtained by weighted calculation.

$$\beta = (\beta_{TUS-EST} * TUS - EST\ Market\ value + \beta_{Cevia\ Enviro\ Inc.}$$
$$* Cevia\ Enviro\ Inc.\ Market\ value + \beta_{China\ Tianying\ Inc.}$$
$$* China\ Tianying\ Inc.\ Market\ value)$$
$$\div (TUS - EST\ Market\ value + Cevia\ Enviro\ Inc.\ Market\ value$$
$$+ China\ Tianying\ Inc.\ Market\ value)$$
$$= (0.88 * 86.9 + 0.81 * 62.3 + 0.64 * 110) \div (86.9 + 62.3 + 110)$$
$$= 0.76$$

4.2. Calculation of the average market rate of return Rm.

The average market rate of return Rm is the average annual rate of return of the broad market index, that is, the Shenzhen Component Index over the past three years.

$$Rm = (Shenzhen\ Component\ Index\ rose_{2018} + Shenzhen\ Component\ Index\ rose_{2019}$$
$$+ Shenzhen\ Component\ Index\ rose_{2021}) \div 3$$
$$= (-5.46\% - 0.79\% + 38.74\%) \div 3 = 10.83\%$$

4.3 Calculation of the expected return rate of self-owned capital investment, that is, the Ra calculation of the cost of capital

According to the capital asset pricing model and the above-mentioned calculated parameters, the expected rate of return Ra of self-owned funds invested in China's kitchen waste treatment industry is calculated by using the formula.

$$\textbf{Ra} = \textbf{Rf} + \beta(\textbf{Rm} - \textbf{Rf}) = \textbf{3.8\%} + \textbf{0.76} * (\textbf{10.83\%} - \textbf{3.8\%}) = \textbf{9.14\%}$$

4.4 Calculation of the preliminary pricing of the Nanning Kitchen Waste Treatment PPP Project

According to the deduced pre-pricing model of China's kitchen waste treatment PPP project and the relevant parameters of the Nanning kitchen waste treatment PPP project, the pre-pricing price of the Nanning kitchen waste treatment PPP project, that is, the government subsidy price, is calculated.

4.4.1 Calculation of the comprehensive capital cost of the Nanning kitchen waste treatment PPP project

The capital structure of the Nanning kitchen waste treatment PPP project includes equity capital and debt capital. The cost of these two types of capital and the risks they face are different. Therefore, according to the expected rate of return Ra of self-owned funds investing in China's kitchen waste treatment industry and the known parameters of the project, the comprehensive capital cost R of the project is:

$$R = R_a \left(\frac{C}{C+D}\right) + R_D \left(\frac{D}{C+D}\right) = 9.14\% \left(\frac{0.6479}{2.1597}\right) + 5\%(1-15\%)\left(\frac{1.5118}{2.1597}\right) = 5.72\%$$

4.4.2 Calculation of the preliminary pricing of the Nanning kitchen waste treatment PPP project

According to the known parameters of the project, the preliminary pricing calculation steps of the Nanning kitchen waste treatment PPP project are as follows:

(1) Substitute the known parameters of the Nanning kitchen waste treatment PPP project, the formula 1 is calculated as follows:

$$\sum_{n=T_1+1}^{T} Q_n(1-a_1)(1-s)*(1+R)^{-n}$$

$$= 10.95(1-5\%)(1-15\%)*\frac{(1+5.72\%)^{-3}*[1-(1+5.72\%)^{-20}]}{1-(1+5.72\%)^{-1}}$$

$$= 92.84$$

(2) Substitute the known parameters of the Nanning kitchen waste treatment PPP project, and the calculation formula 2 is as follows:

$$\sum_{n=1}^{T_1} O_n^1 \ (1+R)^{-n} = \frac{10381}{(1+5.72\%)^1} + \frac{10874}{(1+5.72\%)^2} = 19548.50$$

(3) Substitute the known parameters of the Nanning kitchen waste treatment PPP project, and the calculation formula 3 is as follows:

$$\sum_{n=T_1+1}^{T} O_n^2(1-s)*(1+R)^{-n} = 2200(1-15\%)$$

$$*\frac{(1+5.72\%)^{-3}*[1-(1+5.72\%)^{-20}]}{1-(1+5.72\%)^{-1}} = 19634.51$$

(4) According to the annual financing loan balance of the Nanning Kitchen Waste Treatment PPP Project, Formula 3 is calculated as follows:

$$\sum_{n=T_1+1}^{T} L_n * r(1-s)*(1+R)^{-n} = \left(\frac{15470}{(1+5.72\%)^3} + \cdots + \frac{2010.79}{(1+5.72\%)^{12}}\right)*5\%$$

$$*(1-15\%) = 2827.20$$

(5) According to the established pricing model, the preliminary pricing of the Nanning Kitchen Waste Treatment PPP Project is:

$$P = \frac{19548.50 + 19634.51 + 2827.20}{92.84} = 452.50$$

CHAPTER 5   RESEARCH CONCLUSIONS AND PROSPECTS

5.1 Research Conclusion

(1)   In the theory of capital asset pricing model, the premise is that the risk coefficient of the market as a whole is 1. Through the collection and analysis of historical data of Shenzhen Component Index and related industry stocks, the risk coefficient of China's kitchen waste treatment PPP project is 0.76, which is less than Overall market risk index.

(2)   The capital cost of China's kitchen waste treatment industry calculated according to the capital asset pricing model, and the pricing model of China's kitchen waste treatment PPP project based on the net present value method is:

$$P = \frac{\sum_{n=1}^{T_1} O_n^1 \ (1+R)^{-n} + \sum_{n=T_1+1}^{T}(O_n^2 + L_n * r)(1-s) \ * \ (1+R)^{-n}}{\sum_{n=T_1+1}^{T} Q_n(1-a_1)(1-s) \ * \ (1+R)^{-n}}$$

(3) Substitute the data of Nanning's kitchen waste treatment BOT project into the model, and the calculated government price is 452.50 yuan/ton. At present, Nanning's kitchen waste treatment project can process one ton of kitchen waste with an additional by-product income of 150 yuan. The government subsidy for this project is 315 yuan/ton. In summary, the actual government subsidy for the Nanning kitchen waste project that is running well is 465 yuan, and the government subsidy price calculated by the model is 452.50 yuan/ton. The difference between the two is only 465 yuan. 2.68%. This shows that the pricing model of the kitchen waste treatment PPP project based on the asset capital pricing model is relatively similar, because the input data of the model are all public and objective data in the early stage of the project, so the model has a very high degree of reference, government and social capital If the project company develops similar projects in the PPP mode, it can refer to this model to make more accurate preliminary pricing of the project.

5.2 Recommendation

The general principle of PPP project pricing is to ensure the smooth implementation of infrastructure projects, and at the same time to ensure the investment income of social capital, so as to improve and maintain the enthusiasm of social capital to enter the PPP field. It is necessary to prevent the loss of state-owned assets, safeguard the interests of ordinary people, and achieve a win-win situation for enterprises, governments and consumers. This paper focuses on building a model for the pricing of PPP projects in the early stage. However, due to the long-term characteristics of PPP projects, in order to ensure reasonable pricing in the entire life cycle of the project, there should also be a corresponding price adjustment mechanism and policy guarantee. suggestions as below:

5.2.1 Optimize and improve the top-level design of PPP project prices

Establish and improve targeted PPP price laws, regulations and policy systems, update and improve regulations and methods that are too old for the current stage, establish flexible policy mechanisms, ensure the long-term effectiveness of policy implementation, and create opportunities for PPP projects. The expected policy environment. For PPPs that have a great impact, such as laws, regulations and policies related to income level, charging period, tax-related treatment, price adjustment mechanism, etc., it is impossible to make a decision. The particularity and model characteristics of PPP projects should be fully considered. On the basis of and pilot projects, formulate policies and regulations in line with the actual situation.

5.2.2 Clarify the basic principles of the price mechanism of PPP projects

Adhere to market-oriented reforms, give full play to the decisive role of the market in resource allocation, and reduce government intervention in microscopic things. It is an inevitable requirement of the market economy to place the powers that should be delegated and the things that should be managed in place. Therefore, it is necessary to strengthen the confidence in market-oriented reforms, focus on promoting price liberalization in areas where effective competition can be formed, give full play to the role of price as a signal indicator, regulate resource flow, and optimize benefit distribution. At the same time, the supervision will focus on irregular price behavior and market order, prevent geographical discrimination and market segmentation, vigorously cultivate market competition entities, and create a favorable competitive environment.

The public interests and social capital gains should be considered in an overall manner, and the reasonable returns of social capital should be taken into account while protecting the public interests. Adhere to the price policy first, fiscal and taxation policy coordination. Adhere to the principle of "high quality and high price", and encourage social capital to enjoy higher price levels through the improvement of product quality, service level, reputation and brand.

5.2.3 Establish and improve the PPP project pricing mechanism

strengthen quota management, update and improve the local quota database in a timely manner, and at the same time strengthen the audit management of the whole process of PPP projects, and account for the various influencing factors in the pre-pricing and post-price adjustment of PPP projects. We will enrich and improve the means of price supervision, and improve the evaluation mechanism for competitive purchases. Explore the use of marginal social cost pricing.

5.2.4 Develop a reasonable post-price adjustment mechanism

Due to the long operation cycle of infrastructure PPP projects, it is necessary to formulate corresponding price adjustment mechanisms for PPP projects, such as price adjustment mechanisms for changes in operating costs and price adjustment mechanisms for technical equipment renovation, so that the benefits designed during project planning can be substantially

guaranteed, and the promotion of project development sustainable development. Establish a scientific, perfect and adjustable financial subsidy mechanism. The natural discontinuity, public welfare, and public nature of public utilities determine their production and operation activities and must be under the price control of the government. If these enterprises suffer losses under price control, in order to ensure the normal operation of the public utility enterprises and the performance of the franchise agreement, the government finance department shall subsidize the loss or grant other relevant development and operation income. This is mainly caused by the inconsistent interests and goals of all parties involved in a PPP project. The government side pursues the maximization of public interests, and hopes that the price is as low as possible and the service quality is as high as possible; the social capital side pursues the maximization of accounting profits, and the pursuit of the highest price and the lowest cost. So how to coordinate the goals of the two parties, form a community of interests, and encourage social capital to improve the efficiency of infrastructure operation are the principles and goals that should be considered when designing the government subsidy mechanism.

5.2.5 Strengthen the capacity building of PPP project price supervision and formulate a sound PPP supporting legal system

According to the characteristics of PPP projects, establishing a supporting legal system and formulating a clear contract design can effectively protect the interests of all parties, constrain the breach of contract, and ensure better performance of the contract by all parties. Strengthen information disclosure. Developed countries have emphasized the importance of openness and transparency in the process of implementing PPP. They not only disclose project procurement information to promote the extensive participation of domestic and foreign social capital in competition, but also actively disclose project information, implementation status and PPP project transaction contracts to the public. Extensive oversight by all parties. my country should make full use of the existing PPP information management platform, strengthen the functions of platform information collection, online supervision, and information sharing, and strengthen the convenience of public supervision.

5.2.6 Further improve risk sharing and benefit sharing

Supplementary consideration shall be given to the risks that did not appear in the initial design but appear in the subsequent operation, and corresponding risk compensation shall be adopted in a targeted manner to improve the enthusiasm for contract performance and lay a friendly foundation for further cooperation between the two parties.

5.2.7 Promote the construction of PPP project performance evaluation system

The performance evaluation system is a value measurement system based on the actual performance effect, and it is also an important tool for government management departments to manage. In a PPP project, the goal of establishing a PPP project performance evaluation system is to verify whether the project has achieved value for money, so as to ensure that the

PPP project is more economical and efficient than the traditional government-provided model. Performance evaluation includes verifying the effectiveness of price policies, the reasonableness of price levels, and the sustainability of government payments. In addition, the performance evaluation of PPP projects is also an important support to ensure the government's affordability. The performance evaluation of PPP projects belongs to the re-performance of the pricing process, and it is also a scientific evaluation of the price adjustment mechanism, which needs to be established and improved by the government.

From an economic point of view, the main objective of a post-PPP performance appraisal is to verify that value for money has been achieved. In the preliminary demonstration process of PPP projects, value for money is a technical means to ensure that the PPP mode is more economical, efficient and beneficial than the traditional mode of provision. However, since the project has not been actually implemented, the demonstration is based on forecast data and implementation plans. the real effectiveness has yet to be verified. After the implementation of the project, a series of financial indicators such as price level, subsidy level, and investment return have been clarified. Sustainability of financial subsidies.

From a social perspective, post-price performance appraisal of PPP is an important way to ensure the public's affordability. The price of a PPP project must not be set aside and fixed. It is necessary to track and evaluate the price level at any time according to changes in the economic, social and political environment to ensure the basic public attributes of the public products and services provided by the PPP project and ensure that the public can afford it. and user affordability (which can be expressed as the proportion of total public expenditure to GDP) and user affordability (expressed as the proportion of total user expenditure to user income) at a reasonable level; at the same time, various measures should be taken to implement special care for the poor. , based on the general principles of "user pays", "multiple use and overpayment", and "full price payment", and "poverty relief" as the special principle to achieve efficient pricing.

Therefore, on the one hand, we should start from both the economic and social perspectives, examine the implementation of the PPP project price mechanism and existing problems from the two dimensions of value for money and public affordability, and gain an in-depth understanding of the operating efficiency of social capital, changes in market supply and demand, Opinions from various aspects of the society, social capital operating costs under the fair rate of return method, etc., are organized into a post-price performance evaluation report to reflect the implementation effect of the PPP project price mechanism. In essence, this is a re-implementation of the pricing process. On the other hand, it is to evaluate the scientific nature of the price adjustment mechanism and examine whether the price adjustment factors need to be changed due to changes in the situation.

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