The study on concession pricing mechanism of traditional village conservation projects based on PPP mode

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Abstract: Even though the introduction of PPP mode to the traditional village protection programs can make the private capital living and ease the government’s fiscal pressure, the direct contradiction between the interests of traditional village is an important factor influencing the successful implementation of the projects. The research on concession pricing mechanism of traditional village projects based on PPP mode aims to deal with the design of reasonable incentive mechanism and the establishment of the government compensation system, and coordinate the relationship among multiple stakeholders in PPP mode to ensure the smooth development of traditional village protection programs. Based on the above analysis, a model of traditional village protection PPP mode by the Multi-objective Planning could be built and according to the interests of participating subjects, the constraint conditions and priority ranking could be set. In the end of this paper, the solution of the franchising price interval was calculated by empirical analysis.

1. Introduction

Traditional villages have unique geographical environment and ethnic composition, which form the diversified human resources and natural heritage resources. However, with the acceleration of new urbanization, the contradiction between the protection of the characteristic culture of traditional villages and the goal of rural economic development has gradually deepened, and many traditional villages are suffering from continuous destruction in entities such as characteristic buildings or ecological landscapes, and they are on the verge of extinction. According to the statistics of the Ministry of Civil Affairs, from 2002 to 2012, the total number of natural villages in China has decreased by 900,000, including a large number of traditional villages. The amazing speed of disappearance of traditional villages has aroused great concern. From 2014 to 2016, the central government provides 11.4 billion yuan in subsidies for the traditional villages and infrastructure construction, which based on an average of 3 million yuan per village, and invests 700 million yuan for the protection of cultural relics and cultural heritage in these villages. However, the routine calculation of traditional villages shows that the central financial subsidy funds are insufficient to cope with the needs of large-scale traditional village protection projects. The funding gap seriously restricts the advancement of traditional village protection. In view of the fact that the PPP mode can revitalize private capital and alleviate the government's financial pressure, the introduction of the PPP mode in the construction of traditional village protection projects has become one of the effective ways to solve the funding gap. However, the traditional village protection PPP project faces problems such as lack of
relevant research and successful practical experience, low enthusiasm for private capital, and difficulty in coordinating contradictions among stakeholders. Therefore, it’s necessary to deal with the design of reasonable incentive mechanism and the establishment of government compensation system, and coordinate the relationship between stakeholders to ensure the smooth development of traditional village protection PPP projects.

There are differences in the definition and type of traditional villages at home and abroad. There are no traditional villages abroad, but they are defined as historical towns, mostly linked to historical and cultural heritage. Foreign research on PPP financing mode is early, and the results are rich. The PPP mode is also widely used in the protection of historical towns. Dr. Hanneke Ronnes studied the reasons why the PPP mode was applied to the restoration of urban heritage, and analyzed different financing modes in Amsterdam, Paramaribo, Vancouver, Seattle and Pittsburgh, and believed that the PPP mode require legal framework and incentive support. Biserka Dumbović Bilišić pointed out that the repair of historical buildings need to be improved through tax incentives, subsidies and financing interest rate support. Susan Macdonald pointed out that the cultural genetic protection faces insufficient supply of funds, personnel, technology and other resources, so the government and third-party units should explore the potential of PPP to better protect heritage. Nur Farhana Azmia surveyed 9 stakeholder organizations to conclude that the protection of historical towns not only depends on sound laws, but also requires active cooperation between community activities and stakeholder groups. Domestic scholars have little research on the application of PPP mode in traditional village protection projects, and only related research on similar projects, such as rural infrastructure, cultural heritage, tourism development. Quanzhi Liu pointed out that there are problems such as the lag of water conservancy facilities and the low efficiency of investment and financing in Liaoning Province, and put forward the PPP mode is an effective way to improve the efficiency of investment and financing in Liaoning Province and make up for the lack of funds. Kang Jia, Jie Sun pointed out that the adoption of PPP mode in rural infrastructure can revitalize private capital and avoid heavy construction and light operation and maintenance, which is conducive to improving the operational management efficiency of rural infrastructure. Jianqiang Li proposed to solve the problem of fund raising by setting up the “Shaanxi Grand Site Tourism Industry Development Fund”, which was led by the provincial party committee and the provincial government. The Shaanxi Tourism Group Corporation and a securities company jointly established a fund company to raise funds from the public. Songhua Wang explored the urban heritage protection of the intermediate organization as a hub under the PPP mode, focusing on the Hong Kong heritage and building protection system under the PPP mode. Yanhua Wang summarized that the current business mode of traditional village protection projects mainly includes government-led investment management, enterprise leasing original project management, individual contracting existing project management and local village collective management. Li Guan concludes that the PPP mode can achieve the balance of the three major interests of the government, enterprises and villagers, and ultimately achieve multi-win.

Combined with the above analysis, the key to the introduction of the PPP mode is to grasp the supporting mechanism of the traditional village protection PPP project under the premise of sound contract system and government supervision. Therefore, this paper combines the protection content and industrial characteristics of traditional villages, constructs the concession pricing model of traditional village PPP projects, and optimizes the investment return mechanism of PPP mode. Thereby coordinating the interests of the government, private capital, tourists and local residents, and ensuring the smooth development of the traditional village based on PPP mode.

2. Thoughts on the Construction of Concession Pricing Model for Traditional Village Protection PPP Project
The traditional village protection PPP project mainly involves 4 stakeholders, which are government, private capital, tourists, and villagers. The primary purpose of the government is to ensure that traditional villages are protected. Private capital is responsible for the infrastructure construction, operation and maintenance of traditional villages, and invests a large amount of capital, manpower,
technology and equipment. Therefore, it is necessary to ensure that private capital can recover the investment during the concession period and get a return on the level of effort. Tourists are consumers in traditional village protection projects and should have a good experience of play, watch and study, and the price paid should be no higher than their maximum affordability. The villagers are the masters of traditional villages and the main body of cultural inheritance. The protection of traditional villages must improve their living standards, enlighten their awareness of protection, and enable them to participate in daily business activities. Therefore, the concession pricing of traditional village protection PPP projects needs to balance the interests of government, private capital, tourists and villagers, and construct a concession pricing model scientifically and rationally.

The SPV of traditional village protection PPP project is responsible for the construction and operation of the project. The proportion of income distribution in the final contract can be negotiated according to the proportion of the capital contribution and the risk. The total cost of the traditional village protection PPP project includes the total investment during the construction period, the operating cost during the operation period, and the annual repair and protection costs. Multiplying the total cost of the project by a reasonable rate of return is the benefit that the traditional village protection PPP project should receive. The project income mainly includes income from main business, other operating income and government feasibility gap subsidy. Therefore, the key of pricing the traditional village PPP project is to balance the interests of the interested parties, determine the government subsidy method and the amount, so that the project company should obtain the main business and other operating income, and finally calculate the price.

3. Basic hypotheses of the model
Hypothesis 1: For the simplicity of model calculation, it is assumed that the traditional village protection PPP project equity funds are only composed of private capital and government, in which the proportion of private capital is k, and the income of the project is allocated according to the proportion of capital contribution.

Hypothesis 2: Under normal circumstances, investors can recover all the investment and obtain a reasonable ROI. After the end of the operation period, the entire project will be handed over to the government without compensation, and the proceeds will be equal to the risk.

Hypothesis 3: The potential shareholders of the traditional village protection PPP project are clearly divided into functions, the government is responsible for subsidizing the private capital policy losses, and the private capital is responsible for the financing, construction and operation of the project, so as to clarify the participants’ cost and benefit.

Hypothesis 4: In order to facilitate the calculation, we assumes that the annual loan interest rate and expected ROI remain unchanged, the annual operating cost remains unchanged, and the loan only occurs during the construction period, which is repaid in the same way as principal and interest.

4. Construction of concession pricing model for traditional village protection PPP project based on multi-objective programming

4.1 Determination of main parameters of influencing factors in the model

4.1.1 Expected ROI \( (f1) \). The fund structure of SPV of the traditional village protection PPP project includes equity funds and debt funds. Their financing costs and risks are different. Therefore, the ROI is expressed by the weighted average cost of capital. The formula is as follows:

\[
R = R_e \left[ \frac{C}{C + D} \right] + R_d \left[ \frac{D}{C + D} \right]
\] (1)

In formula (1), \( R_e \) represents the cost of equity funds, \( R_d \) represents the cost of debt funds, \( D \) represents the market value of debt funds, and \( C \) represents the market value of equity funds.

The cost of capital can be calculated by CAPM, and the formula is as follows:
In formula (2), \( R_f \) represents the risk-free investment rate of return; \( R_m \) represents the industry benchmark rate of return; \( \beta \) represents the capital investment risk coefficient for specific investment options including risk. \( \beta \) is also affected by the debt ratio. Different project companies have different debt ratios. The relationship between them can be described by the following formula:

\[
\beta_i = \beta_n + \beta_a \left[ \frac{\beta(1 - t)}{C} \right]
\]

In formula (3): \( \beta_n \) represents the coefficient of the same company without debt, and \( t \) represents the comprehensive tax rate of the project company.

**4.1.2 Determined total investment in project construction \( (f_2) \).** The protection contents of the traditional village protection PPP project during the construction period are mainly the restoration of ancient buildings, the safety of disaster prevention, the restoration of historical environmental, the repair of infrastructure and supporting services, and the protection of heritage. The construction cost of these protection contents, the purchase cost of equipment and tools, other construction expenses, basic reserve fees, construction period interest and working capital constitute the total investment in project construction. We assume that total investment in project construction is \( C_t \).

**4.1.3 Project annual operating cost \( (f_3) \).** The operating costs of the traditional village protection PPP project mainly include: 1) personnel salary and welfare expenses; 2) equipment repair costs; 3) energy consumption costs; 4) daily management expenses; 5) cultural relics and environmental protection costs; 6) Historical cost of repair; 7) financial expenses; 8) operating taxes and fees. Assume that the operating cost of the \( i \)th year is \( C_i \).

**4.1.4 Annual main business income \( (f_4) \).** The income from the main business of the traditional village protection PPP project is mainly the ticket income. Annual main business income during the operation period \( Y_t = \text{Ticket price} \times \text{Amount of tourists} \). \( Q_i \) is the number of visitors in the \( i \)th year.

**4.1.5 Annual other business income \( (f_5) \).** The incomes from other business of traditional village protection PPP projects refer to the income outside the tourist tickets, mainly including the income from the development of ancient buildings and the income from the tourism industry, which have a great correlation with the income of the main business. We suppose that \( Y_i = \chi Y_t \).

**4.1.6 Government subsidies \( (f_6) \).** When operating income cannot make private capital recover the total investment and obtain a reasonable rate of return, the government needs to subsidize the gap. The higher the government subsidies are, the lower the price of traditional village cultural tourism and the higher the consumer surplus. At the same time, the increase in the number of tourists is conducive to increasing the income of the villagers. The government’s subsidy for the \( i \)th year is expressed in \( T_i \).

**4.1.7 Determined project concession period \( (f_7) \).** The franchise period of the traditional village protection PPP project includes the construction period and operation period. We suppose that the construction period is \( t_1 \), the operation period is \( t_2 \).

**4.2 Solving the benefits of traditional village protection PPP project based on cost reverse method**

According to the process of financial calculation of PPP projects, the main cash outflow during the construction period is the construction investment and construction period interest. The main cash inflows during the operation period of the project include annual main business income, annual business income and government subsidies. The main cash outflows include annual operation and
maintenance costs, value added tax and surcharges, income tax, and repay capital with interest. The government should ensure a reasonable ROI for private capital, mainly including the purchase of availability cost to the project company (project completion and completion acceptance), as well as operation and performance service fees linked to performance and based on operation and maintenance costs. The annual fee for payment is based on the total investment of the construction, and the reasonable ROI is used as the discount rate, which is paid by Level Payment Method. The operation and maintenance performance service fee is based on the operation and maintenance cost, and is paid according to the results of the annual performance appraisal.

The formula for the availability of paid $L_i$ is as follows:

$$L_i = C_i(A / P, R_i, c_i) = C_i \frac{R_i(1 + R_2)^{y_i}}{(1 + R_2)^{y_i} - 1}$$

(4)

In formula (4): $R_1$ represents the project availability return rate and $R_2$ represents the profit margin for the operation and maintenance cost.

The annual operating performance service fee $K$ is calculated as follows:

$$K = \delta C_i(1 + R_2)$$

(5)

In formula (5): $\delta_i$ represents the coefficient of government performance appraisal for the $i$th year. In order to achieve a reasonable ROI for private capital investment income, therefore:

$$(1 + \chi)Y_i + T_i = L_i + K_i$$

(6)

The pricing of traditional village protection PPP projects may not consider performance appraisal factors. The performance appraisal can be used as an important influencing factor of price adjustment, when the investment income of private capital just reaches a reasonable ROI:

$$P = \left[ C_i \frac{R_i(1 + R_2)^{y_i}}{(1 + R_2)^{y_i} - 1} + C_i(1 + R_2) - T_i \right] / (1 + \chi)Q_i$$

(7)

According to formula (7), the ticket price $P$ of the traditional village protection PPP project is mainly affected by the government's annual subsidy and demand, and the price $P$ is inversely proportional to the government subsidy. When the government increases subsidies, the traditional village ticket price $P$ decreases, and consumers receive more benefits. However, government subsidies need to consider their own affordability and overall social welfare. In addition, the number of tourists is a key factor affecting the operating income of the project company. The unknown variable $Q_i$ can be predicted to weight the relationship between the price $P$ and the government's annual subsidy.

According to the annual cash flow analysis of the traditional village protection PPP project, the income before income tax of the PPP project company for each year is:

$$W_i = (1 + \chi)PQ_i + T_i - C_i - D_i r - C_d - M_i - Z_i$$

(8)

The income after income tax of the PPP project company for each year is:

$$W_i = [(1 + \chi)PQ_i + T_i - C_i - D_i r - C_d - M_i - Z_i](1 - T_i)$$

(9)

In formula (8) and (9): $W_i$ represents the pre-tax net profit for the $i$th year of the operation period. $W_i$ represents the after-tax net profit for the $i$th year of the operation period. $PQ_i$ represents the main business income for the $i$th year of the operation period, which is ticket income. $T_i$ represents the $i$th year of the operation period Government subsidy quota. $D_i r$ represents the financial cost of the $i$th year of the operation period, which is the loan interest expense. $C_d$ represents the annual depreciation and amortization expenses, using the average years method, the annual amortization expense is the same. $M_i$ represents the management fee for the $i$th year of the operation period. $Z_i$ represents the value-added
tax and surcharge for the \(i\)-th year of the operation period. \(T_i\) represents the income tax rate. When \(W_i > 0\), the stakeholders can be allocated according to the proportion of income distribution.

The annual net cash flow during the project operation period can be calculated by analyzing the total investment cash flow of traditional village protection PPP projects. The formula is as follows:

\[
N_i = (1 + \chi)PQ_i + T_i - C_i - M_i - Z_i
\]  \hspace{1cm} (10)

We let the project discount rate be \(R_c\), and the cumulative net cash flow of the project is:

\[
N = \sum_{t=1}^{N} \frac{N_t}{(1 + R_c)^t} C_t
\]  \hspace{1cm} (11)

When \(N=0\), the internal rate of return of the project is obtained.

To sum up, the price determination of the traditional village protection PPP project mainly needs to balance the government subsidy method, the quota and the annual operating income of the project.

### 4.3 Solving the benefits of traditional village protection PPP projects based on cost inverse method

Recreational value is not only the main way to rationally use traditional village tourism resources, but also an important factor in determining the concession price of traditional village protection projects. The Contingent Valuation Method (CVM) is widely used at home and abroad to measure the public’s willingness to pay (WTP) for environmental resources or willingness to accept (WTA). For the traditional village protection PPP project, WTP indicates the monetary income that tourists give up in order to obtain the utility of the traditional village tourism experience. WTA indicates the minimum payment that tourists hope to obtain for the deterioration of the traditional village environment. This paper uses WTP to measure the consumer surplus of traditional village protection PPP projects and further evaluate the value of its tourism resources. The main steps are as follows:

#### 4.3.1 Questionnaire design and investigation of CVM

The survey questionnaire on the value of traditional village tourism resources mainly includes 3 parts: 1) Detailed background information and protection planning of traditional villages. 2) The basic social information of the respondents and the importance attached to the protection of traditional villages. These conditions will be used to analyze and verify the results of WTP. The main contents include the gender, age, occupation, education level, income level, number of annual trips, the importance of traditional villages, and the awareness of the protection content of traditional villages. 3) The respondent’s willingness to pay for the traditional village tourism resources.

#### 4.3.2 Conduct surveys and statistical survey data

The estimation of the sample size of the value assessment of traditional village tourism resources uses the following formula:

\[
m = M/\left(1 + M \times e^2 \right)
\]  \hspace{1cm} (12)

In formula (12): \(m\) represents the number of samples, \(M\) represents the total population of the survey area, and \(e\) represents the expected error.

#### 4.3.3 Survey results statistics and analysis

Firstly, SPSS can be used to calculate the basic socio-economic characteristics of the respondents and the various levels of awareness of traditional village protection. Finally, the recreational value of traditional villages and the willingness of tourists to pay can be obtained by constructing a conditional logit model.

We suppose that the respondent’s utility function is represented by \(U\), then:

\[
U(X_{ni}) = V(X_{ni}) + \varepsilon_{ni}
\]  \hspace{1cm} (13)
In formula (13): $U(X)$ represents the direct utility function, $V(X)$ represents the indirect utility function, $\varepsilon$ represents the random variable, and $X_{mi}$ represents the characteristic attribute of the $m^{th}$ person selecting the $i$ scheme. The conditional logit model can be expressed as:

$$P_{mi} = \frac{e^{\alpha X_{mi}}}{\sum_{j=1}^{u} e^{\alpha X_{mj}}}. \quad (14)$$

In formula (14): $\lambda$ represents a scalar parameter, usually takes 1, $P_{mi}$ represents the probability that the $m^{th}$ respondent chooses the $i$ scheme in the selection set $C$ instead of the other $j$ scheme, $V_{mi}$ represents the utility of the $m^{th}$ respondent to select the $i$ scheme, $V(X)$ is a linear function, $V(X_{mi})=\beta X_{mi}$. Its log likelihood function is:

$$1 \log L = \sum_{i=1}^{u} \sum_{j=1}^{u'} y_{ij} \log\left(\frac{e^{\alpha X_{ij}}}{\sum_{j=1}^{u'} e^{\alpha X_{ij}}}\right). \quad (15)$$

In formula (15): $y_{ij}$ is an indicator variable, which is 1 when the $i^{th}$ person selects the scheme $j$, and 0 otherwise.

Through the conditional logit model to simulate the survey results, the STATA software can be used to obtain the fitting results, and the model variable coefficients can be tested for significance and fitness to judge the accuracy of the simulation results. The value of traditional village recreation is calculated by the Compensating Surplus (CS) method. The calculation formula is as follows:

$$CS = \frac{V_{i0} - V_{ij}}{-\beta}. \quad (16)$$

In formula (16): $\beta$ represents the coefficient of willingness to pay, and $V_{i0}$ and $V_{ij}$ represent the utility change caused by the change of the attribute of the scheme $i$.

The expected willingness to pay can be calculated according to formula (17):

$$E(WTP) = -\alpha \sum \beta_j X_{nj}. \quad (17)$$

In summary, the conditional logit model can be used to simulate the relationship between the variable and the target. After the fitting result is tested, the consumer’s remaining increase and the expected willingness to pay with improved traditional village conditions can be obtained according to the fitted function relation expression. The value of traditional villages can be determined by the number of traditional village tourists, which can provide reference for the pricing of traditional village PPP projects to meet the interests of consumers.

4.4 Estimation of government subsidy intensity of traditional village protection PPP project

The traditional village protection PPP project has certain public welfare. The ticket price is subject to the consumer’s maximum willingness to pay, and its income may be difficult to cover its total cost. So the government's reasonable subsidy is necessary to ensure the smooth development of traditional village protection PPP projects. According to Article 25 of the Ministry of Finance's "Guidelines for the Financial Capability of Government and Private capital Cooperation Projects", "Each year, all PPP projects need to be arranged from the budget, and the proportion of general public budget expenditure should not exceed 10%" (Applicable to PPP projects for feasibility gap subsidies), therefore:

$$T_i / K_i \leq 10\% \times k_i. \quad (18)$$

In formula (18): $T_i$ represents the expenditure responsibility for the $i^{th}$ year of the project that needs to be arranged from the budget, $K_i$ is the general public budget expenditure for the $i^{th}$ year, $k_i$ represents the proportion of all PPP projects in the year in the $i^{th}$ year of the project.

4.5 Construction of multi-objective programming model

Multi-objective programming is to sort different targets in the system according to their importance,
and to determine the priority level of achievement according to the importance of the goals. All levels of objectives hope to reduce the deviation between the expected goals and the actual goals. In the traditional village and village protection PPP project, the most important goal is to maximize the social welfare. The second is to meet the reasonable ROI of private capital. Then, the villagers should receive the annual profit distribution of PPP project companies. Finally, in order to protect social welfare, the traditional village protection PPP project concession pricing should not exceed the consumer's willingness to pay. When the actual charges can’t make up for the cost of private capital and the reasonable ROI, the government should subsidize the gap, but the amount of subsidies should not exceed the maximum subsidy intensity of the government, as shown in Figure 1.

Figure 1. Multi-objective programming ideas for franchise pricing of traditional village protection PPP projects

The variables of the multi-objective programming of the traditional village protection PPP project include the traditional village concession pricing $P$, and the government annual financial subsidy $T_i$. The following one absolute constraint and four target constraints are mainly met:

1. The absolute restraint means that in order to ensure the success of the traditional village PPP project, the reasonable ROI of private capital should be met, and the return on private capital should not be less than the benchmark rate of return, which is formula (6).

   $$\sum_{i=1}^{N} X_i = \alpha + \sum \beta_j X_{w, j} \geq P$$

2. The first-level priority $p_1$ satisfies the tourists' maximum willingness to pay. The ticket price $P$ should be no more than the maximum willingness of the tourists to pay, which is formula (17).

3. The second-level priority $p_2$ satisfies the private capital return rate not lower than the benchmark rate of return. According to formula (10) and (11), the cumulative net present value of the after-tax benchmark rate of return is greater than zero.

4. The third-level priority $p_3$ satisfies the government subsidy, and the government's subsidy amount should not be greater than the subsidy intensity of the government, which is formula (19).

5. The four-level priority $p_4$ satisfies the income distribution of the villagers. Each year, the PPP project company should give the villagers collective dividends for the traditional village tourism income, and set the proportion of consultation $k$. The total degree $L$ should ensure that the villagers reach the middle income level. The annual after-tax income of the PPP project company can be calculated according to formula (10).
In summary, the specific multi-objective programming model is as follows:

\[
\min Z = p_1d_1 + p_2d_2 + p_3d_3 + p_4d_4
\]

\[
(1 + \chi)PQ_i + T_i - C_i \left( \frac{R(1 + R)^i}{(1 + R)^i - 1} - \delta_i(1 + R_i) \right) = 0
\]

\[
P + d_2^* - d_1^* = E(\text{WTP})
\]

\[
\sum_{i=1}^{i} N_i(1 + R_i)^{\gamma} - C_i \geq 0
\]

\[
T_i / K_i + d_1^* - d_1^* = 10% \times k_i
\]

\[
(1 + \chi)PQ_i + T_i - C_i - d_1^* - d_2^* - M_i - Z_i \geq (1 - T_i)k_i + d_i^* - d_i^* = L
\]

According to the multi-objective programming model of traditional village protection PPP project pricing, the decision variables included in the model are only \( P \) and \( T \), so the model can be solved by graphic method. In order to facilitate the solution of the model, it is assumed that the annual tourist capacity can reach the maximum carrying capacity of the traditional village \( Q_{\text{max}} \), that is, the annual amount of tourists is the same, the annual operating costs, management fees, VAT paid and surcharges are also the same, therefore, the annual government subsidies constant.

As shown in Fig 2, let \( d_{14}^* \), \( d_{44} = 0 \) get the \( P_{14} \) curve, first consider the realization of the target of priority factor \( P_1 \), which is \( \text{mind}_1^* \). It can be seen from the figure that if the condition is satisfied, the value can only be taken below the \( p_1 \) line, that is, \( d_1^* = 0 \). Secondly, consider the target realization of the priority factor \( P_2 \), that is, \( \text{mind}_2^* \). It can be seen from the figure that if the condition is satisfied, the value can only be taken at the upper right of the \( p_2 \) line, that is, \( d_2^* = 0 \). Once again, the target realization of the priority factor \( P_3 \) is satisfied. It can be seen from the figure that if the condition is satisfied, the value can only be taken to the left of the \( P_3 \) line, that is, \( d_3^* \), and the targets of the three priority factors constitute the shadow part \( ABGH \) in the figure, this area is a feasible solution to meet the first three constraints. The \( L \) line is the absolute constraint of the variable price \( P \) and the government subsidy \( T \). It should be in the \( ABGH \) region. Therefore, the set of \( CF \) segment solutions can satisfy the tourists’ willingness to pay, the maximum intensity of government subsidies, the private capital to reach the benchmark rate of return, and the ability to obtain a reasonable ROI. Finally, consider the target realization of the priority factor \( P_4 \), namely \( \text{mind}_4 \), where the \( p_4 \) line is above the \( L \) line. Since the slopes of \( L \) and \( p_4 \) are the same, in order to minimize the negative deviation, the set of solutions of the \( CE \) segment can satisfy the condition. The concession pricing range for traditional village protection PPP projects is:

\[
P = \left[ c_i(1 + R)^i - 1 + \frac{R_i^i(1 + R_i)^i}{(1 + R)^i - 1} - \delta_i(1 + R_i) \right] / (1 + \chi)Q_i E(\text{WTP})
\]
The concession pricing $P$ of the interval is a satisfactory solution to the model, which can meet the constraints that can satisfy the tourists' willingness to pay, the maximum intensity of government subsidies, the private capital to reach the benchmark rate of return, and achieve a reasonable ROI. However, when the villagers collectively demand a higher proportion of income distribution and higher living standards of the villagers, although the satisfactory solution interval of the concession price can minimize the negative deviation, it cannot satisfy the constraint of the $p_z$ target.

The inability to reach the $p_z$ target constraint reflects a major contradiction in the current traditional village protection PPP project, that is, the villagers' interests are difficult to reach, resulting in disputes between the villages and the private capital. Therefore, in order to make the traditional village protection PPP project healthy and sustainable development, the enthusiasm of the villagers should be mobilized, the villagers should be trained in the job, the income should be increased through employment and individual villagers, and the proportion of dividends of the villagers’ projects should be reduced, so that the $p_z$ target constraint can be moved to below the $L$ line, as shown in the figure $p_z^*$, in this case, the satisfaction range of the concession pricing of the traditional village protection PPP project can simultaneously satisfy the interests of all parties.

5. Empirical analysis

The construction period of a traditional village protection PPP project is 2 years, and the operation period is 28 years. The construction content includes infrastructure, tourism supporting service facilities, environmental remediation, cultural relics protection and restoration of historical environmental elements. The SPV is jointly funded by the government-designated funded representative and private capital. The registered capital is 100 million yuan, the project capital is 810 million yuan, the government and private capital investment ratio is 2:8, and the total construction investment is estimated to be about 4.055 billion yuan. According to the calculation, the annual operation and maintenance cost is 679.172 million yuan. According to CAPM calculation, the project asset availability return rate measured by this project is 6.9%, and the operation and maintenance investment return rate is 6%. The project adopts the BOT method, and after the end of the operation period, the private capital transfers the project to the government without compensation.

The SPV evaluated the recreational value of the project and used CVM to conduct the investigation and analysis. Finally, the maximum willingness to pay for the tourists was 110 yuan. Taking the maximum carrying capacity of the traditional village as the basis for the calculation of the tourist volume, the designed maximum carrying capacity is 3 million/year, and the other operating income of the project company accounts for 10% of the ticket income. Then the revenue of the SPV is:

$$
R = \frac{C_i (1 + R)^{t_i} + C_{2i} (1 + R)^{t_{2i}} - C_{3i} (1 + R)^{t_{3i}} - 1}{(1 + R)^{t_{1}}},
$$

The maximum annual subsidy intensity of the government is 120.86 billion yuan.

According to the multi-objective programming model solving formula of the above traditional village protection PPP project, the concession pricing range of the project is:

$$
P = \left[ C_e \frac{R (1 + R)^{t_e}}{(1 + R)^{t_e} - 1} + C_{2e} (1 + R)^{t_{2e}} - 10\% R_e \right] / (1 + \chi Q_e, E(WTP) = [85, 110]
$$

The annual management fee of the project company is 1 million yuan, and the value-added tax and the additional value is 63.23 million yuan.

$$
K = \frac{\sum_{m} (1 + \chi)Q_m + L - C_{2e}}{(1 + R)^{t_e}} - C_{e} = \frac{4.09287 - 0.679172 - 0.01 - 0.6323}{(1 + R)^{t_e}} - 40.55 = 0
$$

Substituting data to get the project internal rate of return $R_e=4.95\%$. From this, it can be judged that the income of the project is enough to attract the private capital party. The concession price of the traditional village protection PPP project based on the satisfaction of all parties is 85–110 yuan.
6. Research Conclusions
This paper constructs a traditional village protection PPP project concession pricing model based on multi-objective programming, and obtains the absolute constraint of government subsidies and the project company’s operating income through the cost reversal method. The first-level priority constraint of the multi-objective programming model of the traditional village protection PPP project is the maximum willingness of the tourists to pay. It is obtained through the evaluation of the value of CVM-based traditional village tourism resources. The second-level priority constraint is to satisfy the private capital return rate not lower than the benchmark rate of return, which is calculated through the financial calculation of the project company. The three-level priority constraint is that the government's subsidy amount should not be greater than the subsidy intensity of the project. The fourth-level priority constraint is that the villagers should obtain a reasonable income distribution, first calculate the project company's post-tax distributable profit, and then divide it according to the agreed proportion. Through the graphical method of multi-objective programming, the price satisfaction solution of the interests of all parties is finally obtained. Because it is difficult to meet the four-level priority constraint, and a reasonable solution is proposed. Finally, the reliability of the model is verified by empirical analysis, which is conducive to the successful implementation and development of the traditional village protection PPP projects.

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