Public Service Outsourcing Incentive Contract Design with Public Satisfaction Considered

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Keywords: Public participation, Mobile application security, Governance.

Abstract. Contract outsourcing is regarded as an important means to improve public service level and save service cost. Aiming at the moral risk of service providers caused by information asymmetry in the process of outsourcing, this paper established a two-principal agency framework of public service outsourcing composed of the public, the government, and service providers, and designed the incentive contract of outsourcing to the public satisfaction under two conditions of complete information and incomplete information. Model analysis and simulation show that the introduction of public satisfaction into contracts can effectively improve service providers' efforts, reduce government agency costs, improve contract elasticity, and reduce moral risks. The research results provide decision reference and theoretical basis for government investment in high-quality and efficient public services.

Introduction

The rise of the new public management movement in the world provides a good opportunity for the country to promote the marketization of public services, and marketization mechanism is conducive to improving the efficiency of resource allocation and public service supply of government departments when contract outsourcing is an effective way for it. On the one hand, the implementation of government outsourcing of public services can alleviate the financial pressure of the government and speed up the transformation of government functions. On the other hand, it can improve the quality and supply efficiency of public services and meet the public's ever-growing and increasingly diversified demand for public services. In the process of outsourcing, due to the inconsistency between the interests of the government and the service provider, there is a natural deviation in the pursuit of value and goal. Service providers are likely to use their information advantages to engage in unethical behaviors for self-interests, thus leading to moral risk problems. The academic community has conducted research on the related issues of public service outsourcing. Ming Yanfei and Sheng Qiongyao (2010) pointed out that contract outsourcing could easily lead to problems such as corruption, cutting corners and transaction of property rights. Contract outsourcing has opened a convenient door for public power to rent and market forces to erode public interests, which is easy to induce rent-seeking. Xu Shu (2011) believed that there is an inconsistency of interests between the government and the service provider in the public service outsourcing. Zhou Wei (2014) believed that it is possible to prevent the contractual collusion between tenants and rent-seekers in public service outsourcing by introducing third-party supervisors without relevant interests. With the further advancement of the service-oriented government construction centering on the public demand, the public, as the direct consumers of public services, is also included in the research system. Previous studies have shown that there is a significant positive correlation between public satisfaction and public service level and performance, thus public satisfaction can be used as an important criterion and basis to evaluate government's public service level. All the above literatures have conducted in-depth research on public service outsourcing from various aspects, which has provided theoretical basis for the research in this paper.
Problem Description and Research Hypothesis

Problem Description

In the public service outsourcing, the government, as the decision-maker and the employer, stipulates the quantity and quality standards of public services, entrusts service providers to produce public services and provide them for public consumption. As the producer of public service, the service provider knows that the public demand, production cost, product quality and other information best. As the ultimate consumers of public services, the public directly perceives the value brought by public services and feedback to the government departments. Public evaluation tends to reflect the level of public service more truthfully. If the subjective evaluation of the public is ignored, the incentive effect of contract on service providers is not good, and the moral risk of service providers cannot be effectively reduced. According to service provider of the moral hazard problem, this paper adopts the method of principal-agent, the public opinion of the public service or public satisfaction to government incentive contracts for services, public satisfaction by analyzing model and simulation validation of contract design, the influence of solution by the method of quantitative analysis in the process of public service outsourcing service provider of the moral hazard problem.

Research Hypothesis

To facilitate problem analysis, the following hypothesis is proposed:

1 Assuming that the output of public service outsourcing project is $\pi$, which is reflected in the service level provided by service providers for the public, and its functional form is:

$$\pi(x, \theta) = kx + \theta$$ (1)

In the formula, $k > 0$ represents the output coefficient of service providers, $x$ represents the effort level of service providers, $\theta$ represents the exogenous factor obeying the normal distribution.

2 Assuming that the public is the ultimate consumers of public services, the level of effort invested by service providers in public service outsourcing projects can be reflected by public satisfaction, the higher the public satisfaction reflects the higher the effort level of service providers and the higher the public service level. Therefore, it is feasible to take public satisfaction as an external monitor variable in order to reflect service providers' efforts more truly. In order to simplify the analysis and ignore the cost for the government to obtain public satisfaction, the contract form between the government and service providers is as follows: $s(\pi, m) = \alpha + \beta(\pi + pm)$.

$s$ is total payment of service provider received under the contract; $\alpha$ is fixed payments, $\beta(0 \leq \beta \leq 1)$ is the revenue sharing coefficient, $m$ is the public satisfaction; it obeys the normal distribution with the mean value of 0 and the variance of $\delta^2$; $p$ is the coefficient value of public satisfaction converted into contract income. When the output $\pi$ of the public service outsourcing project is higher, the public satisfaction $m$ is greater. Therefore, the $m$ is related to $\pi$ and the correlation coefficient is set as $u$. The public satisfaction $m$ is written in incentive contract of public service outsourcing, making service providers not only rely on their own performance, but also on the subjective perception of public service consumers.

3 As a public management department, the government has strong ability to resist risks and is risk-neutral. The expected return is $U_g$; service providers are less risk-resistant than the government, and have the characteristics of risk aversion and expected benefits $U_s = -e^{-\rho w}$, among which the actual income of service providers is $W$, the risk aversion degree of service providers is $\rho > 0$.

4 It is assumed that service providers must input the cost of implementing public service outsourcing projects, including: ①the effort cost $c$, Positive correlation with service provider's effort level and marginal effort cost, denoted as $C(x) = cx^2/2$; ② risk cost $\Delta RC$, expressed as: $\Delta RC = \rho \beta^2 [\sigma^2 + p^2 \delta^2 + 2p \text{cov}(\pi, m)]/2$. 

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Model Building

In summary, as the client, the government is the risk neutral, whose expected return is shown in the formula (4), and the real monetary income obtained by the service provider from the contract is shown in the formula (5):

\[ U_g = \pi - \alpha - \beta(kx + pm) \]  

\[ U_s = s(\pi, m) - c(x) = \alpha + \beta(kx + pm) - cx^2/2 \]  

Due to the risk aversion of service providers, its deterministic equivalent income needs to take the risk cost into account:

\[ s' = \alpha + \beta kx - cx^2/2 - \rho \beta^2 \sigma^2 + p \text{cov}(\pi, m)/2 \]  

Based on the above formula, the principal-agent model P1 between government and service providers is established as follows:

P1: Max \( U_g \)  
\[ (\alpha, \beta, p) \]  

st. IR: \( U_s \geq w \)  

IC: \( x = \arg\max_x U_s' \)  

In P1, (5) is the expected revenue of the government, (6) is the participation constraint, and (7) the incentive compatible constraint.

Solution Method for Model

The government cannot observe the effort level of service providers. At this point, service providers choose the effort level to maximize their own benefits according to the incentive compatibility constraint. The first order condition of \( x \) in formula (4) can obtain: \( x = k\beta/c \). Obtain \( \alpha \) from the equation of (IR), and substitute \( \alpha \) into \( U_g \) to obtain:

\[ \max_p \beta \frac{k^2}{c} - \frac{\rho \beta^2}{2} \left( \sigma^2 + p^2 \delta^2 + 2p \text{cov}(\pi, m) \right) = \frac{k\beta}{c} = 0 \]  

Formula (13) is first order condition about \( p, \beta \), and substitute it into \( \text{cov}(\pi, m) = \mu \sigma \delta \):

\[ p = -\frac{\text{cov}(\pi, m)}{\delta^2} = -\mu \sigma / \delta < 0 \]  

\[ \beta = \frac{k^2}{k^2 + \rho c(1-\mu^2) \sigma^2} \]  

When \( \beta \) is substituted into the expression \( x \), the effort level is:

\[ x = \frac{k^3}{ck^2 + \rho c(1-\mu^2) \sigma^2} \]  

Agency cost includes risk cost and incentive cost. The expression is:

\[ Ac = \frac{\rho(1-\mu^2) \sigma^2 k^2}{2[k^2 + \rho c(1-\mu^2) \sigma^2]} \]  

To analyze the impact of public satisfaction on contract design, take \( p = 0 \) and \( p \neq 0 \) to obtain the contractual comparison not introduced (scenario 1) and (scenario 2) public satisfaction, as shown in table 1:
Table 1. The optimal contract comparison table in both scenarios.

| Scenario | Effort level of service provider | Revenue sharing coefficient | Agency cost |
|----------|----------------------------------|----------------------------|-------------|
| Scenario 1 | $\frac{k^3}{ck^2 + p\sigma^2}$ | $\frac{k^2}{k^2 + p\sigma^2}$ | $\frac{\rho\sigma^2k^2}{2(k^2 + p\sigma^2)}$ |
| Scenario 2 | $\frac{k^4}{ck^2 + p\sigma^2(1-\mu^2)\sigma^2}$ | $\frac{k^2}{k^2 + p\sigma(1-\mu^2)\sigma^2}$ | $\frac{\rho(1-\mu^2)\sigma^2k^2}{2(k^2 + p\sigma(1-\mu^2)\sigma^2)}$ |

**Contract Analysis**

**Effort Level Analysis**

**Conclusion 1:** the optimal effort level $x$ of service providers is negatively correlated with its marginal effort cost $c$ and positively correlated with the output coefficient $k$.

It is proved that the first partial derivative of $x$ with respect to $k$, $c$ can be obtained from formula (16),\[ \frac{\partial x}{\partial c} < 0 \text{ and } \frac{\partial x}{\partial k} > 0. \]

In the public service outsourcing project, the effort level of service providers is restricted by their marginal effort cost and marginal output level.

For the government, prior to the public service outsourcing contract is signed, and a series of factors that can reflect the output coefficient and effort cost of service providers should be considered comprehensively, including the service technical ability, management level, human capital, and past experience of outsourcing projects, etc. And the qualification and access conditions of service providers are assessed to reduce the negative impact caused by information asymmetry.

**Conclusion 2:** introducing $m$ into the public service outsourcing incentive contract is beneficial to promote service providers to invest higher effort level, and effort level is positively correlated with the correlation coefficient.

It is proved that: according to table 1, the difference between service providers' effort level in both scenarios is $\Delta x > 0$ and

\[ \frac{\partial x}{\partial c} = \frac{2\mu k^6 p c^2 \sigma^2}{(ck^2 + p\sigma(1-\mu^2)\sigma^2)^2} > 0 \] (13)

Scenario 2 introduces public satisfaction, $m$ as a variable of external supervision, the information asymmetry between the government and service providers is reduced. Therefore, the government can obtain more information about service providers' effort level, thus restricting their opportunistic behavior.

But it's worth noting, (1) When $\mu = 0$, public satisfaction has nothing to do with the output of public service outsourcing project. Scenario 1 and scenario 2 has no difference, so it is not valid to introduce public satisfaction into the contract. (2)When $\mu \neq 0$, public satisfaction is related to the output of public service outsourcing projects, and the greater the correlation between the two, the higher the level of service providers’ efforts.

Next, the effect of correlation coefficient and output coefficient on service provider’s effort level is tested by numerical simulation. The parameter is assigned as; $p = 0.5$, $c = 1$, $\sigma^2 = 4$, $k \in (0,1)$, $\mu \in (0,1)$. The simulation results are shown in Fig. 1, where the $x$ axis is the output coefficient, the $y$ axis is the correlation coefficient, and the $z$ axis is the level of effort.
According to the figure, the service provider’s effort level $x$ increases with the increase of the output coefficient $k$ and the correlation coefficient $\mu$. After the introduction of public satisfaction, the magnitude of the correlation coefficient changed the marginal effect of the output coefficient on the level of effort. The greater the correlation coefficient, the bigger the slope of the curve between the effort level of the service provider and the output coefficient. That is, the increase of correlation coefficient will strengthen the marginal effect of output coefficient on the level of effort. By comparing the curve of service provider’s effort level and output coefficient, the new comparison of correlation coefficient curve shows that the service provider’s effort level is more sensitive to the correlation coefficient.

**Revenue Sharing Coefficient $\beta$ Analysis**

**Conclusion 3:** The revenue sharing coefficient $\beta$ is the decreasing function of the risk evading coefficient $\rho$ and the marginal effort cost $c$ of the service provider, and the increasing function of the output coefficient $k$.

It is proved that the first order partial derivatives of $\beta$ with respect to $\rho, c$ and $k$ can be obtained from the Formula (15), $\frac{\partial \beta}{\partial \rho} < 0$, $\frac{\partial \beta}{\partial c} < 0$, $\frac{\partial \beta}{\partial k} > 0$.

According to the conclusion 3, $i$ $\frac{\partial \beta}{\partial c} < 0$ shows that the increase of cost will have a negative effect on the service provider’s effort input, and the incentive intensity of the service provider shall be increased at this time, and the effort level shall be improved. $ii$ $\frac{\partial \beta}{\partial k} > 0$ shows that the higher the output coefficient $k$, the stronger the ability to resist risks, and the higher the output under the same level of effort. At this time, the government can increase the incentive intensity of service provider and increase the risk to service provider. $iii$ $\frac{\partial \beta}{\partial \rho} < 0$ shows that different incentive strategies shall be adopted for the service providers with different risk attitudes.

**Conclusion 4:** The revenue sharing coefficient $\beta$ is positively correlated with the correlation coefficient $\mu$, that is, the introduction of public satisfaction will strengthen the government’s incentive to service providers.

It is proved that $\frac{\partial \beta}{\partial \mu} = \frac{2\mu k^2 \rho c \sigma^2}{(k^2 + \rho c (1 - \mu^2) \sigma^2)^2} > 0$ the revenue sharing coefficient is an increasing function of the correlation coefficient.

The greater the correlation coefficient $\mu$, the stronger the public supervision power, the weaker the interference of exogenous uncertainties, and the greater the probability of opportunistic behavior of service providers being discovered. At this time, the government can increase the incentive intensity to service providers and to invest it to a higher level of effort.

Next, the effect of correlation coefficient and marginal effort cost on revenue sharing coefficient is tested by numerical simulation. The parameter is assigned as: $\rho = 0.5, k = 1, \sigma^2 = 4, c \in (0,1), \mu \in (0,1)$. The simulation results are shown in Fig. 2, where the x axis is the marginal effort cost, the y axis is the correlation coefficient, and the z axis is the revenue-sharing coefficient.
Figure 2. The influence of marginal effort cost and correlation coefficient on revenue sharing coefficient.

From the figure, it can be seen that the revenue sharing coefficient $\beta$ decreases with the increase of marginal effort cost $c$, and increases with the increase of correlation coefficient $\mu$. When the marginal effort cost is small, the correlation coefficient has little effect on the revenue sharing coefficient. The higher the marginal effort cost, the greater the sensitivity of the correlation coefficient to the revenue sharing coefficient. Consider an extreme case where when $\pi$ and $m$ are completely related, that is, $\mu = 1$, public satisfaction fully reflects the true level of effort of the service provider. It can be seen from the diagram that the revenue sharing coefficient is always equal to 1, and the service provider’s level of effort is equal to the Pareto optimal level $x = k/c$, and $\Delta R_c = 0$ that is, the service provider does not bear any risk, thus realizing the Pareto optimal result.

**Agency Cost $Ac$ Analysis**

**Conclusion 5:** Agency cost is positively correlated with risk aversion coefficient $\rho$ and output coefficient $k$ of service provider, and negatively correlated with marginal effort cost $c$.

It is proved that from Formula (14), the following can be obtained:

$$\frac{\partial Ac}{\partial \rho} > 0, \frac{\partial Ac}{\partial k} > 0, \frac{\partial Ac}{\partial c} < 0$$  \hspace{1cm} (14)

The greater the risk aversion coefficient $\rho$, the lower the profit from the high effort level of the service provider, and the lower the enthusiasm of the service provider to work hard, the lower the risk aversion coefficient is, the lower the profit may be when the service provider does not accept the entrustment. At this time, the optimal contract requires the government to give the service provider more incentives to pay to improve the service provider’s level of effort, which increases the total agency cost. The bigger the output coefficient $k$ is, the higher the output of service provider is under the level of unit effort, then the more incentive payment the government gives, the higher the total agency cost will be. The smaller the marginal effort cost $c$, the lower the incentive intensity of the government to the service provider. The service provider will look for other ways to maximize its own interests, and the government will pay more agency cost to encourage the agent to choose the contract, and the total agency cost will increase.

**Conclusion 6:** It is beneficial to reduce the agency cost of the government by writing the public satisfaction $m$ into the public service outsourcing incentive contract, and the agency cost decreases with the increase of the correlation coefficient $\mu$.

It is proved that according to the table 1, the difference of agency cost under two contracts is $\Delta Ac > 0$, the first order partial derivative of agency cost with respect to correlation coefficient $\mu$ is:

$$\frac{\partial Ac}{\partial \mu} = \frac{-4\mu \rho \sigma^2 k^4}{[2(k^2 + \rho c(1-\mu^2)\sigma^2)^2] < 0}$$  \hspace{1cm} (15)

After introducing public satisfaction, both incentive cost and risk cost are reduced, and then the total agency cost is reduced. Only when $\mu = 0$, is the agency cost the same. From the Formula (15), it is clear that the higher the correlation coefficient is, the lower the Agency cost is, until $\mu = 1$, the Agency cost is zero, and the Pareto optimal result is realized.
Then the effect of output coefficient and correlation coefficient on agency cost is tested by numerical simulation. The parameter is assigned as: $\rho = 0.5, c = 1, \sigma^2 = 4$, and the simulation results are shown in the Fig. 3. The x axis is the output coefficient, the y axis is the correlation coefficient, and the z axis is the agency cost.

![Figure 3. The influence of output coefficient and correlation coefficient on agency cost.](image)

According to the figure, the agency cost $AC$ decreases with the increase of the correlation coefficient $\mu$, and increases with the increase of the output coefficient $k$, and the increase of the correlation coefficient will weaken the marginal effect of the output coefficient of the service provider on the agency cost.

**Conclusions**

On the basis of combing the existing research results, this paper creatively writes public satisfaction into incentive contracts. The research shows that the government can establish incentive and constraint mechanism of public service outsourcing projects according to public satisfaction, which can not only effectively reduce the cost of contract agency, but also improve the level of effort of service providers, and reduce the possible moral hazard in the implementation of the contract. The countermeasures are as follows: first, promote the incentive contract design of public service outsourcing. The government should identify the information of the service provider in advance. For the service provider with low marginal effort cost, high marginal output and low risk aversion, the revenue sharing coefficient should be improved and the incentive intensity should be increased in order to urge the service provider to put in a higher level of effort. Second, create conditions to guide the public to participate actively. This study has verified the effectiveness of introducing public satisfaction to incentive contract design, so the government should take various measures to guide the public to participate in the evaluation of public service level. First, reduce the cost of public participation, and to actively participate in the evaluation of individuals to provide a certain incentive, public satisfaction as a public service outsourcing project output of the subjective performance criteria. Second, build a scientific public service performance evaluation system. The incalculable nature and fuzziness of public service performance increase the difficulty of restricting the opportunistic behavior of service provider through contract. Through the scientific evaluation of service provider’s performance output, the service provider’s effort input level can be identified more truthfully. It was accompanied by a contract to put more effort into it.

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