

## Incentive Contract Design for Cooperation and Win-Win of Chinese Government and Enterprise in the View of Ecological Civilization

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### Abstract

In the view of ecological civilization, the incentive contract between government and enterprise to cooperate and build ecological economy is built by introducing value preference parameter into the classical principal-agent model. Model equilibrium has been analyzed and a numerical example verifies the validity of conclusion. Research results prove that value preference parameter can effectively coordinate interest relationship between government and enterprise and control incentive cost. Value preference parameter of government, marginal output and risk avoidance attitude of enterprise can influence the change of incentive contract.

**Key words:** Ecological civilization; Value preference; Cooperation between government and enterprise; Win-win; Contract design

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### INTRODUCTION

With the rapid development of Chinese economic and social construction, resources are willfully exploited in

some areas; soliciting of natural ecology has far exceeded what it can bear. For a long period, since GDP is the main assessment index for governmental performance, the values of ecological environmental protection and sustainable development give way to the performance concept only focusing on GDP and ecological civilization makes place for industrial civilization under the values of polluting before governing. Some local governments achieved short-term rapid economic development at the cost of natural environment. However, since they apply extensive economic development pattern and there are many enterprises of “high-energy-consuming, high-pollution and resource-dependent-product”, some local resources are consumed a lot with heavily polluted environment and river or soil, and there is more and more hazy weather in the city (in 2013, “haze” and “PM<sub>2.5</sub>” are two topics drawn the most attention of Chinese citizens). The natural ecosystem is severely imbalanced, which has hindered sustainable economic development to a large degree. Faced with increasing resource constraints, severe environmental pollution and a deteriorating ecosystem, it is urgent to re-review and coordinate the relation between industrial civilization and ecological civilization in economic development.

The report on 18<sup>th</sup> CPC National Congress puts forward that we must give high priority to ecological civilization construction and incorporate it into all aspects and the whole process of advancing economic, political, cultural and social progress. We must raise our ecological awareness of the need to respect, accommodate to and protect nature, which reflects the value orientation and ecological ethic of ecological economic construction. Building ecological civilization is to surpass and abandon extensive development mode can unreasonable consumption pattern and make human activities acceptable to the natural environment. We should strengthen resource guarantee for economic and social development and promote the transformation of

development mode through increasing income and reducing expenditure, saving and intensive mode. We should combine saving and environmental protection and adjusting industrial structure, ecological protection and optimizing productivity space layout to from a spatial framework, industrial structure, production mode and life style characterizing by resource saving and environmental protection. We should a new sustainable way for environmental protection with a little cost, good returns and low emission. Faced with big change in the economic development pattern, the government should ensure economic construction to quickly develop under expected target as well as make enterprises obtain many economic benefits. It is a significant historical proposition that the government and enterprise cannot avoid: Enterprise achieves economic benefits without sacrificing ecological environment while promoting recovery and protection of the ecological environment system.

The paper proposes exploring long-term mechanism for government and enterprise in building ecological civilization and win-win cooperation under the theory of mechanism design. On the one hand, for the enterprise, building ecological civilization is mainly to develop green and circular economy, govern environmental pollution and achieve large economic benefits from economic construction of ecological civilization. On the other hand, for the government, building ecological civilization is to mainly develop green-GDP-focused industry, protect ecological environment system and ensure stable and safe operation of economic and sustainable development.

Structure of the paper is as follows: Part 2 provides related literatures about government and enterprise in ecological civilization and economic construction and makes discussion on research result; Part 3 establishes a model of incentive contract between government and enterprise in win-win cooperation and building ecological civilization based on value preference; Part 4 analyzes the model equilibrium and draws conclusion with practical significance; Part 5 verifies model conclusion with value example; Part 6 summarizes related conclusions and gives outlook for future research.

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## 1. LITERATURE REVIEW

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For research on ecological civilization construction and industrial civilization construction, many foreign scholars carry out study on the relation between the ecological environment and economic development. For example, Vandergeest et al. (2012) hold that transnational ecological authentication can strengthen global ecological protection. Gorobets (2014) puts forward an education policy focused on sustainable ecology, which is to avoid systematic global environmental problem through forming human mind and behavior in social ecology rather than the predominant model of economic growth at present. Zhang et al. (2011) hold that it is necessary to build a

platform for cooperation between the government and enterprise, provide green technological support system and financial service, support ecological civilization construction, include ecological civilization index into governmental performance evaluation and strengthen legalization of ecological civilization. DeCanio et al. (2013) make a study on climate diplomacy with game theory, discuss prisoner's dilemma and chicken game, and put forward that negotiation between governments depends on severity degree of climatic change risk. Chen et al. (2013) review the risk assessment model for the ecological environment and establish comprehensive risk assessment facing ecological system which helps environmental management. Korhonen (2004) carries out a study on strategic decision of sustainable development from the perspective of industrial ecology, which promotes industrial ecology integration through ecological economics and environmental management. Boland et al. (2012) carry out study on public participation in environmental activity based on community, and make discussion on incentive structure of project organizers and participants through green community activity in China.

However, Chinese scholars research strategic game among government, enterprise and environmental protection department from the perspective of game theory. Wang Dongmei makes a study on application of game theory in environmental protection. She points out that we should change gains of the government, enterprise and citizen with combination of market mechanism and government policy (Wang & Li, 2004). Wu et al. (2001) taking rational enterprise and individual, etc. as decision-making subject, analyze equalization of game and provide some political suggestions on pollution prevention from the perspective of environmental pollution and treatment. Lu (2007) analyzes the game strategy between enterprises with environmental pollution, environmental protection department and enterprise with environmental pollution with evolutionary game theory method. He holds that we can ensure the environment not to be polluted only by punishing enterprises with pollution, reducing expected gains without treating pollution and investing more in environmental protection. Wang and Deng (2012), from the perspective of ecological civilization, discusses the mode of cross-gradient, ecological chain and network supporting industries to implement industrial transfer to promote sustainable development of economic society and ecological environment in implementing area. Cai et al. (2009) establish a mixed strategy repeated game model between governmental administrative department and production and discharging enterprise with system dynamics theory. Zhu et al. (2007) study the game relation between government and enterprise. He holds that the government should establish environmental regulations and strengthen reward and punishment; core enterprises should initiatively carry out environmental

management at first; which are essential for both parties to achieve long win-win. Cui et al. (2009) make a study which shows that social welfare target of local government has direct influence on its treatment strategy for environmental pollution. An et al. (2013) make a study on the game relation between government and enterprise, local government and central government and enterprise and customer, and hold that encouraging customers to buy environment-friendly products is an important method to promote enterprise to prevent pollution and protect environment. Yuan et al. (2012) make a game study on government, discharging enterprise and environment-friendly enterprise, and hold that environmental policy by the government is the most important factor influencing development environmental protection industry. Su Ming et al. hold that we should promote environmental protection through transferring development outlook in practice, increasing environmental protection investment by many ways, especially financial investment, to promote environmental protection (Yuan & Geng, 2010).

Based on the above analysis, through there are many studies on ecological environment issues, there still exists some problems: Foreign scholars study ecological environment protection, industrial ecology and global ecology mainly from a macro level while scarcely viewing the relation between ecological environment and economic development from the perspective of ecological civilization; though domestic scholars explore the ecological system from the perspective of ecological civilization, they mainly start from a micro level, and study the game relation among government, enterprise and environmental protection department mainly with the game theory, and they suggest to protect ecological environment mainly through environmental policy, environment legislation and punitive measures.

As for the above mentioned problems, the essay explores availability of ecological economic building between government and enterprises under ecological civilization in new perspective and thinking pattern. Different from previous research, the essay introduces value preference parameter through classic delegate-agency model to construct stimulating contract design for government and enterprises to jointly construct ecological civilization, to discuss impacts of stimulating contract resulted from value preference parameter of the government, marginal output of enterprise unit effort and risk aversion attitude of the enterprise. The government and enterprises will change the traditional game "cat chases for mice" through cooperation and creation. The relation between the two is no longer conflicting. The government encourages and supports the enterprise in technical transformation and industrial upgrading; the enterprise obtains an economic benefit through developing green economy, recycling economy and other ecological economic methods; the government achieves good political performance through green GDP.

## 2. MODEL ASSUMPTION AND ESTABLISHMENT

During the game process where government protects ecological system and enterprise production damages environment, both sides take their own benefits into account in the long run. Government will collect higher taxes from enterprise income and enterprise will gain more support from government. When enterprises transform from traditional production to new industry production of ecological civilization construction, they will experience technical reform & industrial structure upgrading and input manpower and financial & material resources of large quantity, which increases production and management costs with reduced operational profit. Enterprises will not undertake this proactively. Therefore, government will provide political and fund supports for enterprises, stimulating them to input on environmental protection and ecological civilization construction; encourage enterprises to make for ecological civilization construction which improves production and beautifies ecological environment, so as to protect ecological system from being damaged and ensure normal operation as well as sustainable development of economic society. To explain game behavior between government (G) and enterprise (E), assumptions are hereby made as follows:

**Assumption 1** To make convenience for the problem discussion without loss of generality, it is assumed that enterprise should transform from traditional production to ecological economic construction, creating earnings through ecological economic construction as  $w = re + \varepsilon$ . Where,  $e$  refers to effort level made by enterprises to meet requirement of ecological economic construction transformation (including technical reform and structure upgrading, etc.),  $e \in [0, +\infty)$ ;  $r$  refers to marginal output made by enterprises working on ecological economy, subject to enterprise effort level; refers to exogenous and independent random variable. It is assumed that random variable should comply with  $N(0, \sigma^2)$  distribution.

**Assumption 2** It is assumed that in order to stimulate enterprise to carry out ecological economic construction, government should provide enterprise with linear mixed incentive contract  $s = \alpha + \beta w$ . Where:  $\alpha$  refers to fixed compensation provided by enterprise to compensate enterprise for ecological economic construction investment;  $\beta \in [0, 1]$  refers to distribution coefficient provided by government for enterprises working on ecological economic construction and creating value (it is assumed hereof that government should distribute earnings with enterprises through fiscal taxation); larger  $\beta$  indicates less tax collected by government from enterprises and more support of government for enterprise, vice versa. When  $\alpha$  is 0, it indicates that government provides performance contract; when  $\beta$  is 0, it is fixed contract. Meanwhile, effort cost function of enterprise is assumed as  $C = be^2/2$ , where  $b$  refers to

effort cost coefficient of enterprise. Effort cost of the enterprise is related to effort level  $e$ , with  $C'(e) > 0, C''(e) > 0$ . Namely,  $C$  is the strictly convex function of  $e$ . To effort level  $e$  increasing, effort cost  $C$  increases more rapidly.

**Assumption 3** Assuming government risk neutral; enterprise risk aversion; absolute risk aversion measurement of  $\rho > 0$ , risk cost should be  $\rho\beta^2\sigma^2/2$ .

According to the above assumption, certain equivalence income of enterprise is

$$CE_E = \alpha + \beta re - be^2/2 - \rho\beta^2\sigma^2/2$$

**Assumption 4** As the regulator, government shall consider both long-term interest of ecological environmental protection & sustainable development and value creation of enterprise interest during the process of decision making, ensuring economic and social sustainable development. Further more, without loss of generality, reservation utility of enterprise is assumed as  $u_0 = 0$ .

On account of the above assumption, decision-making behavior of government can be expressed as:

$$\max_{\alpha, \beta, e} EU_G = (1 - \lambda)[(1 - \beta)re - \alpha] + \lambda re, \quad (1)$$

$$s.t. (IR)\alpha + \beta re - be^2/2 - \rho\beta^2\sigma^2/2 > \tilde{u}, \quad (2)$$

$$(IC)e \in \arg \max \alpha + \beta re - be^2/2 - \rho\beta^2\sigma^2/2. \quad (3)$$

Where,  $\lambda \in [0, 1]$  is the value preference parameter of government; when  $\lambda \rightarrow 1$ , government pays more attention to value creation of enterprise economic interest; when  $\lambda \rightarrow 0$ , it pays more attentions to ecological system protection and sustainable development of economic construction.

### 3. MODEL BALANCE AND ANALYSIS

#### 3.1 Model Equilibrium

Backward induction is applied to solve game equilibrium between government and enterprise underneath. Under the condition of complete information, incentive and restrictive mechanism gives no play to restriction and government can compel enterprise to execute contract. For optimum problem (1), restriction in Formula (1) is constrictive under equilibrium state. Namely, the following formula comes into existence:

$$\alpha + \beta re = be^2/2 + \rho\beta^2\sigma^2/2 + \tilde{u}$$

Substitute the above formula to objective function (1):

$$\max_{\alpha, \beta} re - (1 - \lambda)(be^2/2 + \rho\beta^2\sigma^2/2 + \tilde{u}) \quad (4)$$

Further more, calculate Formula (3) on first-order optimum condition of effort level  $e$ :

$$e = \beta r / b \quad (5)$$

Substitute Formula (5) to Formula (4), calculate  $\beta$  first derivation, and obtain the optimum profit distribution coefficient provided by government for enterprise:

$$\beta^* = r^2 / (1 - \lambda)(r^2 + b\rho\sigma^2). \quad (6)$$

Substitute Formula (6) to Formula (5) and obtain the optimum effort level of enterprise:

$$e^* = r^3 / (1 - \lambda)b(r^2 + b\rho\sigma^2). \quad (7)$$

According to  $\beta^*, e^*$  and the condition of Formula (2), the optimum compensation made by government for enterprise can be calculated as:

$$\alpha^* = \left[ r^4(b\rho\sigma^2 - r^2) / 2(1 - \lambda)^2 b(r^2 + b\rho\sigma^2)^2 \right] + \tilde{u} \quad (8)$$

Where,  $\alpha^* < 0$  at  $b\rho\sigma^2 \leq r^2$  indicates that enterprise will pay environmental protection fee for government;  $\alpha^* \geq 0$  at  $b\rho\sigma^2 \geq r^2$  indicates that government shall compensate certain amount for enterprise to support technical reform, transformation, upgrading and other investment.

#### 3.2 Comparative Static Analysis

To discuss the win-win cooperative mechanism between government and enterprise, other exogenous parameters involved in fixed standard model remain the same. Now, comparative static analysis is conducted on the value preference parameter of government, marginal output of enterprise effort and risk aversion attitude, discussing influence of these variables on contract parameter, performance, optimum effort level and cost.

##### 3.2.1 Analysis of Contract Parameter, Effort Level and Risk Aversion Attitude

**Proposition 1** Set presumptive model and other parameters invariable:

(a) With  $\lambda$  increasing, government will provide higher distribution coefficient and compensation for enterprise. Under the influence of contract modification, optimum effort level of enterprise will improve and total revenue of enterprise will increase.

(b) With  $r$  increasing, for  $0 < r^2 \leq 0.5616b\rho\sigma^2$ , government will enlarge distribution coefficient and enterprise compensation to ensure that enterprises carry out ecological economy construction. When enterprise marginal output meets  $0.5616b\rho\sigma^2 < r^2 \leq b\rho\sigma^2$ , government will further increase distribution coefficient of enterprise and reduce fixed compensation  $\alpha$  to regulate enterprise income. Under the influence of contract modification, optimum effort level of enterprise will rise up with marginal output  $r$  increasing.

(c) With  $\rho$  increasing, distribution coefficient of enterprise will decrease. Under the influence of contract modification, enterprise effort level will decrease too. When  $\rho \in (0, 3r^2/b\sigma^2)$  condition is satisfied, government will only decrease enterprise distribution coefficient and will not reduce fixed compensation for enterprise. When  $\rho \in (3r^2/b\sigma^2, +\infty)$  condition is satisfied, government will decrease both enterprise distribution coefficient and fixed compensation.

**Prove:** Let's prove the conclusion (1) in proposition 1. Fix other parameters invariable and calculate first-order derivative of  $\lambda$  in Formula (6) - Formula (8):

$$\partial\beta^*/\partial\lambda = r^2/(1-\lambda)^2(r^2 + b\rho\sigma^2) > 0,$$

$$\partial e^*/\partial\lambda = r^3/(1-\lambda)^2b(r^2 + b\rho\sigma^2) > 0,$$

$$\partial\alpha^*/\partial\lambda = r^4/(1-\lambda)^3b(r^2 + b\rho\sigma^2)^2 > 0.$$

It can be inferred from the derivation result that  $\beta^*$ ,  $e^*$  and  $\alpha^*$  increase with  $\lambda$  increasing. It is obviously knowable in combination with formula  $w=re+\varepsilon$  that total revenue  $w$  will increase with effort level  $e$  increasing.

Let's prove conclusion (2) in proposition 1. Similarly, calculate first-order derivative  $r$  in Formula (6) - Formula (7):

$$\frac{\partial\beta^*}{\partial r} = \frac{2rb\rho\sigma^2}{(1-\lambda)(r^2 + b\rho\sigma^2)^2} > 0,$$

$$\frac{\partial e^*}{\partial r} = \frac{r^2(r^2 + 3b\rho\sigma^2)}{(1-\lambda)b(r^2 + b\rho\sigma^2)^2} > 0.$$

The result of derivation indicates that  $\beta^*$  and  $e^*$  increase with marginal output  $r$  increasing.

Formula (8) calculates first-order derivative for  $r$

$$\frac{\partial\alpha^*}{\partial r} = -\frac{\lambda^2 r^3 [r^4 + 3b\rho\sigma^2 r^2 - 2b^2 \rho^2 \sigma^4]}{(1-\lambda)^4 b (r^2 + b\rho\sigma^2)^3}.$$

Obviously, symbol of  $\partial\alpha^*/\partial r$  is subject to  $\varphi(r) = r^4 + 3b\rho\sigma^2 r^2 - 2b^2 \rho^2 \sigma^4$ . Solve  $\varphi(r)$  and reach the following conclusion:

$\partial\alpha^*/\partial r > 0$  at  $r^2 \in (0, 0.5616b\rho\sigma^2]$ , it can be known through combining  $\partial\beta^*/\partial r > 0$  that government will increase enterprise distribution coefficient and fixed compensation to ensure that enterprises carry out ecological and economical production of new industry;  $\partial\alpha^*/\partial r > 0$  at  $r^2 \in (0.5616b\rho\sigma^2, b\rho\sigma^2]$ , it can be known through combining  $\partial\beta^*/\partial r > 0$  that government will further increase enterprise distribution coefficient, and will reduce fixed compensation  $\alpha$  to regulate enterprise income; conclusion (2) in proposition 1 comes into existence according to  $\partial e^*/\partial r > 0$ .

For conclusion (3) in proposition 1, calculate  $\rho$  first-order derivation for Formula (6) - Formula (7):

$$\frac{\partial\beta^*}{\partial\rho} = -\frac{r^2}{(1-\lambda)} \cdot \frac{b\rho^2}{(r^2 + b\rho\sigma^2)^2} < 0,$$

$$\frac{\partial e^*}{\partial\rho} = -\frac{r^3}{(1-\lambda)b} \cdot \frac{b\rho^2}{(r^2 + b\rho\sigma^2)^2} < 0,$$

$$\frac{\partial\alpha^*}{\partial\rho} = \frac{\sigma^2 r^4}{2(1-\lambda)^2} \cdot \frac{(3r^2 - b\rho\sigma^2)}{(r^2 + b\rho\sigma^2)^3},$$

$\partial\alpha^*/\partial\rho > 0$  at  $3r^2 - b\rho\sigma^2 > 0$ , namely:  $0 < \rho < 3r^2/b\sigma^2$ ;  $\partial\alpha^*/\partial\rho < 0$  at  $3r^2 - b\rho\sigma^2 < 0$ . Conclusion (3) indicates that the risk aversion measurement of enterprise has certain interval. Within the interval, government will only reduce distribution coefficient and will not decrease fixed compensation level; out of the interval, government will reduce both enterprise distribution coefficient and fixed compensation.

Proposition 1 illustrates that the optimum effort level of enterprise ecological economy construction, distribution coefficient and fixed compensation of government for enterprise are functions of government value preference parameter, enterprise marginal output and risk aversion parameters. When government pays more attention to enterprise ecological economy construction ( $\lambda \rightarrow 1$ ), it will give higher distribution coefficient and fixed compensation for enterprises. Under the influence of government incentives, enterprises will improve the effort level and the total revenue will increase at the same time. When marginal output of unit effort increases, government will stimulate enterprise by transforming incentive method of increasing distribution coefficient and fixed compensation to the method of enterprise performance level. Enterprise will improve and maintain higher effort level at the same time. When enterprise risk aversion attitude increases, namely to reduce input to ecological economy construction, government will cut down enterprise performance revenue and collect more tax from enterprise. When enterprise risk aversion level is within the expectation of government, it will only decrease distribution coefficient, and will not reduce fixed compensation for enterprise; if it exceeds expectation of government, it will reduce both distribution coefficient and fixed compensation of enterprise.

### 3.2.2 Economic Benefit Analysis

**Proposition 2:** Given that model and other parameters are invariant, the following conclusions may be drawn:

(a) As the value preference parameter  $\lambda$  increases, economic output of enterprise will increase while income of government (mainly tax revenues) will decrease. When  $\lambda \in (0, 1/2)$ , income of government is positive with per

unit increasing income of enterprise greater than that of government. When  $\lambda \in (1/2, 1)$ , income of government is negative with per unit increasing income of enterprise less than that of government.

(b) As the marginal output  $r$  increases, economic output of enterprise will increase. When  $0 < \lambda < 1/2$ , certain income of government will increase as  $r$  increases; when  $1/2 \leq \lambda < 1$ , certain income of government will decrease as  $r$  increases.

(c) As risk measurement  $\rho$  increases, economic output of government will decrease. When  $\lambda \in (0, 1/2)$ , certain income of government will decrease as  $\rho$  increases; when  $\lambda \in [1/2, 1)$ , certain income of government will increase as  $\rho$  increases.

**Prove:** First prove conclusion (1). Based on Formula (6) -Formula (8), respectively calculate the economic output of enterprise and certain income of government is as follows:

$$Ew = re^* = r^4 / (1 - \lambda)b(r^2 + b\rho\sigma^2) \quad (9)$$

$$\begin{aligned} CE_G &= (1 - \beta^*)re^* - \alpha^* \\ &= \left[ r^4(1 - 2\lambda) / 2(1 - \lambda)^2 b(r^2 + b\rho\sigma^2) \right] - \tilde{u} \end{aligned} \quad (10)$$

Conduct first derivation for Formula (9) and Formula (10) concerning  $\lambda$ :

$$\partial Ew / \partial \lambda = r^4 / (1 - \lambda)^2 b(r^2 + b\rho\sigma^2) > 0,$$

$$\frac{\partial CE_G}{\partial \lambda} = - \frac{2\lambda(1 - \lambda)r^4}{2b(1 - \lambda)^4(r^2 + b\rho\sigma^2)} < 0.$$

The results show that  $Ew$  will increase as  $\lambda$  increases while  $CE_G$  will decrease as  $\lambda$  increases. That is to say: economic output of enterprise will increase while certain income of government will decrease. If set  $u\% = 0$  and  $CE_G = 0$ , then  $\lambda = 1/2$ . Since  $\left| \frac{\partial Ew / \partial \lambda}{\partial CE_G / \partial \lambda} \right| = \frac{1 - \lambda}{\lambda}$ , for any  $0 < \lambda < 1/2$ ,  $CE_G > 0$ ,  $1 - \lambda / \lambda < 1$  indicates that income of government is positive but per unit increasing income of enterprise is greater than that of government. For any  $1/2 < \lambda < 1$ ,  $CE_G < 0$ ,  $1 - \lambda / \lambda < 1$  indicates that income of government is negative and per unit increasing income of enterprise is less than that of government. At this moment, government not only obtains no tax revenues from enterprise but gives funding to ecological economic construction of enterprise.

Then prove conclusion (2), conduct first derivation for Formula (9) and Formula (10) concerning  $r$ :

$$\frac{\partial Ew}{\partial r} = \frac{2r^3(r^2 + 2b\rho\sigma^2)}{(1 - \lambda)b(r^2 + b\rho\sigma^2)^2} > 0,$$

$$\frac{\partial CE_G}{\partial r} = \frac{(1 - 2\lambda)r^3(r^2 + 2b\rho\sigma^2)}{(1 - \lambda)^2 b(r^2 + 2b\rho\sigma^2)^2}.$$

Since  $\partial Ew / \partial r > 0$ , as  $r$  increases, economic outcome of enterprise will increase.

Based on the sign of  $\partial CE_G / \partial r$ , conclusion can be drawn: when  $\lambda \in (0, 1/2)$ ,  $\partial CE_G / \partial r \geq 0$  which shows that income of government will increase as  $r$  increases. When  $1/2 \leq \lambda < 1$ ,  $\partial CE_G / \partial r < 0$  which shows that income of government will decrease as  $r$  increases.

For conclusion (3) of proposition, conduct first derivation for Formula (9) and Formula (10) concerning  $\rho$ :

$$\frac{\partial Ew}{\partial \rho} = - \frac{r^4}{(1 - \lambda)b} \cdot \frac{b\sigma^2}{(r^2 + b\rho\sigma^2)^2} < 0$$

$$\frac{\partial CE_G}{\partial \rho} = - \frac{r^4(1 - 2\lambda)}{2(1 - \lambda)^2 b} \cdot \frac{b\sigma^2}{(r^2 + b\rho\sigma^2)^2}$$

Since  $\partial Ew / \partial \rho < 0$ , when risk control of enterprise is enhanced, economic income will decrease. When  $\lambda \in (0, 1/2)$ ,  $\partial CE_G / \partial \rho < 0$  which shows that as  $\rho$  increases income of government will decrease. When  $\lambda \in [1/2, 1)$ ,  $\partial CE_G / \partial \rho > 0$  which shows that as  $\rho$  increases income of government will increase.

Proposition 2 shows that during the process of motivation for enterprise, if government provides enterprise ( $\lambda \rightarrow 1$ ) with concern and support, economic income of both government and enterprise will increase. When  $\lambda \in (0, 1/2)$ , income of government is positive while income of government itself will decrease and increasing income of enterprise will be greater than decreasing income of government. When  $\lambda \in (1/2, 1)$ , income of government is negative while increasing income of enterprise will be less than decreasing income of government. During the process of actual distribution, government will adjust distribution coefficient  $\beta$  and fixed compensation  $\alpha$  to adjust income of enterprise and income of government more reasonable. Therefore, when value preference of government focuses on mutual benefits, income of both government and enterprise will increase and achieve win-win. When risk control of enterprise is enhanced, overall benefits will decrease as well as income of government.

### 3.2.2 Cost Analysis

**Proposition 3:** given that model and other parameters are invariant, the following conclusions may be drawn:

(a) As  $\lambda$  increases, both incentive cost and general agency cost of enterprise caused by information asymmetry will decrease. When  $\lambda \in [0, b\rho\sigma^2 / 2(r^2 + b\rho\sigma^2))$ , both incentive cost and general agency cost of enterprise are positive. When  $\lambda \in (b\rho\sigma^2 / 2(r^2 + b\rho\sigma^2), 1/2)$ , incentive cost is negative while general agency cost of enterprise is

positive. When  $\lambda \in (1/2, 1]$ , both incentive cost and general agency cost of enterprise are negative.

(b) When  $\lambda \in (0, 1/2)$ , general agency cost of enterprise caused by information asymmetry will increase as  $r$  increases. When  $\lambda \in (1/2, 1)$ , general agency cost of enterprise caused by information asymmetry will decrease as  $r$  increases. When  $r$  increases, government will choose a general agency cost of enterprise of value preference parameter control close to  $1/2$ .

**Prove:** For conclusion (1), when information is symmetrical, government may observe the effort level of enterprise. At this moment, the constraint of incentive compatibility  $IC$  lose efficacy and objective function of government is:

$$\max_{\beta, e} u' = re - \frac{1}{2}(1-\lambda)be^2 - \frac{1}{2}(1-\lambda)\rho\beta^2\sigma^2 \quad (11)$$

Conduct first derivation for Formula (11) respectively concerning  $\beta$  and  $e$ , distribution coefficient and optimal effort level of enterprise are as following:

$$\beta^{**} = 0,$$

$$e^{**} = r/(1-\lambda)b.$$

$\beta^{**}=0$  shows that under information symmetry, government only provide enterprise with fixed compensation. When information changes from symmetry to asymmetry, effort level of enterprise will decrease. Net loss of economic income caused by decreasing of effort level of enterprise is:

$$\Delta Ew = re^{**} - re^* = \rho r^2 \sigma^2 / (1-\lambda)(r^2 + b\rho\sigma^2). \quad (12)$$

While corresponding cost savings of effort is:

$$\Delta C = \frac{be^{**2} - be^{*2}}{2} = \frac{(2r^2 + b\rho\sigma^2)\rho\sigma^2 r^2}{2(1-\lambda)^2(r^2 + b\rho\sigma^2)^2}. \quad (13)$$

Resultant incentive cost is:

$$\begin{aligned} \Delta IC &= \Delta Ew - \Delta C \\ &= \frac{-2\lambda\rho\sigma^2 r^4 + (1-2\lambda)br^2\rho^2\sigma^4}{2(1-\lambda)^2(r^2 + b\rho\sigma^2)^2}. \end{aligned} \quad (14)$$

Meantime, risk cost caused by information asymmetry is:

$$\Delta RC = \frac{\rho\sigma^2 r^4}{2(1-\lambda)^2(r^2 + b\rho\sigma^2)^2} \quad (15)$$

Add incentive cost to risk cost to get the general agency cost:

$$TC = \frac{(1-2\lambda)\rho r^2 \sigma^2}{2(1-\lambda)^2(r^2 + b\rho\sigma^2)} \quad (16)$$

Conduct first derivation for  $\Delta IC$  and  $TC$  concerning  $\lambda$ :

$$\frac{\partial \Delta IC}{\partial \lambda} = -\frac{(1+\lambda)\rho\sigma^2 r^4 + \lambda br^2 \rho^2 \sigma^4}{(1-\lambda)^3(r^2 + b\rho\sigma^2)} < 0,$$

$$\frac{\partial TC}{\partial \lambda} = -\frac{\lambda\rho r^2 \sigma^2}{(1-\lambda)^3(r^2 + b\rho\sigma^2)} < 0.$$

Since  $\partial \Delta IC / \partial \lambda < 0$  and  $\partial TC / \partial \lambda < 0$ , incentive cost of enterprise and general agency cost caused by information asymmetry will decrease as increases.

If  $\lambda \in \left[0, \frac{b\rho\sigma^2}{2(r^2 + b\rho\sigma^2)}\right)$ ,  $\Delta IC > 0$  and  $TC > 0$ , which means that both incentive cost and general agency cost caused from information symmetry to information asymmetry are positive. If  $\lambda \in \left(\frac{b\rho\sigma^2}{2(r^2 + b\rho\sigma^2)}, \frac{1}{2}\right)$ ,  $\Delta IC < 0$  and  $TC > 0$ , which means that incentive cost is negative and general agency cost caused from information symmetry to information asymmetry is positive. If  $\lambda \in (1/2, 1]$ ,  $\Delta IC < 0$ ,  $TC < 0$  which means that both incentive cost and general agency cost caused from information symmetry to information asymmetry are negative.

For conclusion (2), when  $0 < \lambda < 1/2$ ,  $\frac{\partial TC}{\partial r} = \frac{(1-2\lambda)r b \rho^2 \sigma^4}{(1-\lambda)^2(r^2 + b\rho\sigma^2)^2} > 0$  which shows that when value preference parameter  $\lambda \in (0, 1/2)$ ,  $TC$  will increase as  $r$  increases.

When  $\lambda \in (1/2, 1)$ ,  $\frac{\partial TC}{\partial r} = \frac{(1-2\lambda)r b \rho^2 \sigma^4}{(1-\lambda)^2(r^2 + b\rho\sigma^2)^2} < 0$  which shows that when value preference parameter  $\lambda > 1/2$ , will decrease as  $r$  increases. Since  $(1-2\lambda)/(1-\lambda)^2$  monotonic decreases when  $\lambda \in (0, 1)$ , concerning  $TC$  when  $r$  increases, government will choose a general agency cost of enterprise of value preference parameter control that is close to  $1/2$ .

Proposition 3 shows that under state of uncertain information, government will focus on win-win cooperation between government and enterprise, which enables fine operation of both ecological system and economic income of enterprise. In order to sustain this economic operation mode for a long term, government may decrease the pressure of information asymmetry, incentive cost, agency cost and increase economic output efficiency of enterprise. When marginal output of enterprise increases, government shall choose greater value preference parameter to control cost and achieve win-win cooperation.

#### 4. VALUE EXAMPLE AND ANALYSIS

Assume that a certain local government G supports and assists a certain enterprise E in transition from conventional manufacturing in ecological economy. Assume the marginal output of enterprise efforts is R and the government value preference parameter is  $\lambda$ . Assume the risk avoidance measurement of absolute risk is  $\rho$ , effort cost coefficient is  $b$ , and standard deviation is  $\sigma$ .

Assume  $\alpha, \beta, e$  are respectively fixed compensation, partition coefficient, and effort level. Assume  $w$  is benefit in that enterprise gets from ecological economic construction,  $CE_A$  is government income,  $\Delta IC, TC$  are respectively incentive cost, total agency cost. Assume the enterprise reservation utility is 0. Assumed value of each parameter and other change in specific value is shown in Table 1.

From Table 1, the influence of change in value

**Table 1**  
**Comparison of Government and Enterprise Parameter Variation**

$r$	$\lambda$	$\rho$	$b$	$\sigma$	$\alpha$	$\beta$	$e$	$w$	$CE_A$	$\Delta IC$	$TC$
3.00*	0.33	0.75	1.00	30.00	0.13	0.02	0.06	0.18	0.04	3.20	3.33
5.00*	0.33	0.75	1.00	30.00	0.93	0.05	0.27	1.34	0.33	8.07	9.04
7.00*	0.33	0.75	1.00	30.00	3.23	0.10	0.71	4.97	1.24	13.65	17.13
8.00*	0.33	0.75	1.00	30.00	5.16	0.13	1.04	8.31	2.08	16.23	21.92
9.00*	0.33	0.75	1.00	30.00	7.67	0.16	1.45	13.02	3.25	18.40	27.12
10.00	0.20*	0.75	1.00	40.00	5.09	0.10	0.96	9.62	3.61	37.72	43.27
10.00	0.25*	0.75	1.00	40.00	5.79	0.10	1.03	10.26	3.42	34.71	41.03
10.00	0.50*	0.75	1.00	40.00	13.02	0.15	1.54	15.38	0.00	-14.20	0.00
10.00	0.75*	0.75	1.00	40.00	52.07	0.31	3.08	30.77	-30.77	-426.04	-369.23
10.00	0.80*	0.75	1.00	40.00	81.36	0.38	3.85	38.46	-57.69	-781.07	-692.31
5.00	0.25	0.50*	1.00	10.00	2.47	0.44	2.22	11.11	3.70	2.47	7.41
5.00	0.25	0.75*	1.00	10.00	2.78	0.33	1.67	8.33	2.78	4.17	8.33
5.00	0.25	1.00*	1.00	10.00	2.67	0.27	1.33	6.67	2.22	5.33	8.89
5.00	0.25	1.25*	1.00	10.00	2.47	0.22	1.11	5.56	1.85	6.17	9.26
5.00	0.25	1.50*	1.00	10.00	2.27	0.19	0.95	4.76	1.59	6.80	9.52

Note. \* means that this parameter has changed while other parameters are fixed.

preference parameter  $\lambda$ , marginal output  $r$  and risk avoidance measurement  $\rho$  on the incentive structure can be seen. As  $\lambda$  increases,  $\alpha, \beta, e, w$  will increase. When  $1/2 \leq \lambda < 1$ ,  $\Delta IC < 0$ ,  $TC < 0$ ; When  $0 < \lambda \leq 1/2$ ,  $CE_G > 0$ ; when  $1/2 < \lambda < 1$ ,  $CE_G < 0$ . As  $r$  increases,  $\alpha, \beta, CE_G, w$ , etc., each value will increase. With the increase of enterprise risk avoidance measurement, enterprise partition coefficient will decrease and its profit will transform from performance distribution to fix compensation.

#### CONCLUSION

This paper is based on the view of ecological civilization and introduces value preference parameter into the classical principal-agent model, discussed the issue of incentive mechanism design for mutual benefit of government and enterprise and the equilibrium solution of the model has been worked out. After the equilibrium analysis of the model, the main conclusion reached is as follows: (a) value preference parameter can effectively coordinate the interest relationship between government and enterprise. Government with value preference can, at the cost of sacrificing part of their own benefit and via contract design, stimulate enterprises to exert their best effort level in ecological economic construction and effectively control agency cost from information asymmetry via value preference to raise efficiency. (b)

With the increase of marginal output, the government will change the incentive structure. Via modification of fixed compensation benefit and partition coefficient, government can stimulate enterprise to transform more fixed compensation benefit to incentive structure of distribution association with enterprise performance, and then raise the effort level of enterprise. To release the pressure of incentive cost increase, government will choose a mutual method to protect ecosystem from damage and promote the economic efficiency of enterprise. (c) With difference in risk avoidance extent of enterprise, change in risk preference may lead to change in the incentive structure.

This paper focuses on the design of a mutual-benefit incentive mechanism between a local government and an enterprise, but not the design of incentive mechanism for multilateral contract. Multilateral incentive problem will be further conducted in the subsequent study.

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