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## Game analysis on full coverage and sustainability of social protection system in China

Xingpeng Luo, Xiangqian Zhang\*

Business Administration College HuaQiao University, No. 269, Chenghua North Road, Quanzhou 362021, (P.R.CHINA)

E-mail : Xqzhang1998@163.com

### ABSTRACT

Full coverage and sustainability of China's social protection system is a basic system of social justice and social progress. Through construction and analysis of two game models, think that the sustainability of urban social endowment insurance system is influenced by local government's subsidy, social benefit distribution proportion and residents' payment. The sustainability of the new rural endowment insurance is affected by central government's supervision efficiency and local government's punishment of "illegal execution". Then propose policy recommendations to achieve full coverage and sustainability of China's social protection system, including reasonable benefit share mechanism, long-term mechanism of financial support, multi supervision mechanism, comprehensive supplement mechanism and learning from foreign experience.

### KEYWORDS

Social protection system; Full coverage; Sustainability; Game.



INTRODUCTION

Social protection system, as a safety net or a shock absorber, plays a vital role in the modern society. It is directly related to the interest of each citizen and it has important significance to ensure social stability, social harmony and sustainable development. Social protection coverage, in most countries of the world, have experienced from the government, public sector and gradually extended to the private sector workers, and finally to the remaining residents<sup>[1,2]</sup>. China has attached great importance to the work of social security. The report of the eighteenth National Congress of the Communist Party of Chinese make it clearly that "we should institute a complete, multi-tiered and sustainable system for providing basic social security for both the urban and rural population, with emphasis on making the system more equitable and sustainable and ensuring the smooth transfer of social security accounts between localities." By the end of 2011, the basic medical insurance for urban and rural residents has covered 1.3 billion people, basically achieving full coverage. In 2012, our country has further expanded the pilot scope of the new rural endowment insurance and the urban social endowment insurance. The social protection system in China is rapidly push on, while it also faces serious challenges, such as incomplete coverage, low security level, fairness and normative, lack of overall level, and poor transfer and continuity. Full coverage of social protection is the basis and prerequisite for fairness and accessibility<sup>[3]</sup>. Coverage of target group is a measure of the social protection. Sustainability mainly relates to the sustainability of the social protection system both in finance and management. It is a fact that "providing basic social security ", both basic old-age insurance and basic medical insurance, is the key to full coverage and sustainability of China's social protection system. Social protection system, a quasi-public product close to the pure public goods in nature, involves different interest groups in society. Whether the system is reasonably designed is a key factor to guarantee full coverage of social security. Game theory, an effective analysis tool of system design, is a study of equilibrium problems of decision-making and the decision<sup>[4]</sup>, which is popularized in the study of social protection. Chinese scholars have used the game theory methods to research social protection, mainly focusing on the game of stakeholders in the social security policy implementation<sup>[5]</sup>, management of social security funds<sup>[6]</sup>, endowment insurance<sup>[7]</sup>, medical insurance<sup>[8]</sup> and minimum subsistence guarantee<sup>[9]</sup>. Other scholars have introduced the game theory into the study of social security for special groups<sup>[10,11]</sup>. This paper, based on game theory, is to analyze the game between local government and residents in the implementation of the urban social endowment insurance, the game between local government and central government in the implementation of the new rural endowment insurance. It will have vast importance to the full coverage and sustainability of social protection system in China.

THE GAME BETWEEN LOCAL GOVERNMENT AND RESIDENTS IN THE IMPLEMENTATION OF URBAN SOCIAL ENDOWMENT INSURANCE

The distribution of different uses of local government's financial capacity and resources determines the coverage of social security and the subsidy level in different regions<sup>[12]</sup>. Based on the utility maximization of each other, local government and residents start the game in the implementation of urban social endowment insurance.

Hypothesis 1: There are two players, local government and residents, in complete information dynamic game. The local government can choose whether to give financial subsidies to urban social endowment insurance, whose strategies are "subsidy" or "no subsidy". Residents can choose whether or not to participate in the urban social endowment insurance and pay insurance premium, whose strategies are "payment" or "no payment". Given that residents is the ultimate beneficiaries of urban social endowment insurance, no matter whether local government subsidize or not, "Payment" is residents' optimal strategy.

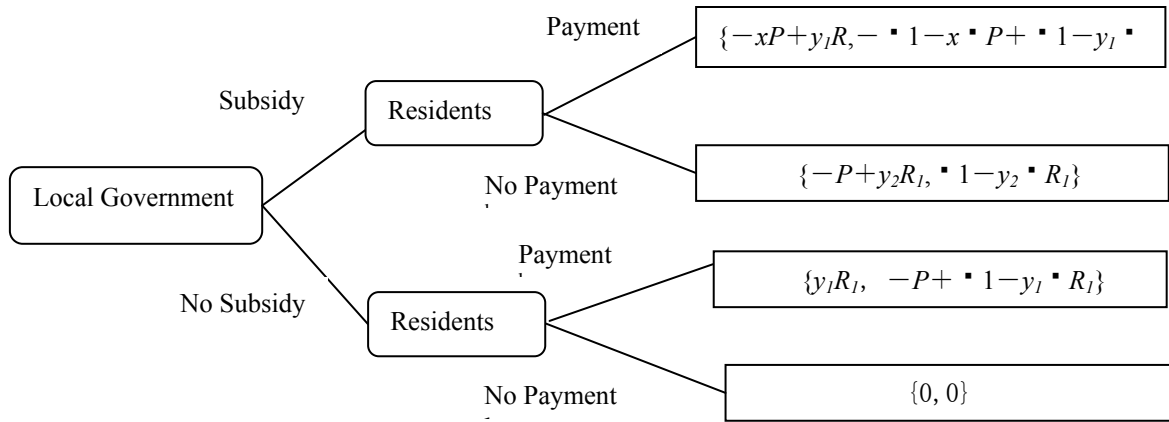
Hypothesis 2: The total cost of urban social endowment insurance is  $P$ . Local government's financial subsidies for the proportion of  $P$  is  $x$  ( $x=0 \sim 1$ ) and  $1-x$  means the proportion of  $P$  that residents should pay for.

Hypothesis 3: The total social benefit when the two sides involve in insurance (namely local government chooses "subsidies" and residents choose "payment") is  $R$ , which overweighs  $R_l$ .  $R_l$  is the total social benefit when either party involves in insurance,  $R > R_l$ . When residents choose "payment", the local government's distribution proportion of total social benefit is  $y_l$ . When residents choose "no payment", the local government's distribution proportion of total social benefit is  $y_2$ , and  $y_1 < y_2$ .

Game payoff matrix and game process are respectively shown in TABLE 1 and Figure 1.

TABLE 1 : Game payoff matrix of local government and residents

		Residents	
		Payment	No Payment
Local Government	Subsidy	$-xP + y_l R, - \cdot 1-x \cdot P + \cdot 1-y_l \cdot R$	$-P + y_2 R_l, \cdot 1-y_2 \cdot R_l$
	No Subsidy	$y_l R_l, -P + \cdot 1-y_l \cdot R_l$	0,0



**Figure 1 : The game process of local government and residents**

By hypothesis1, there is

$$\begin{cases} -(1-x)P + (1-y_1)R > (1-y_2)R_1 \\ -P + (1-y_1)R_1 > 0 \end{cases} \tag{1}$$

$$\rightarrow \begin{cases} (1-y_1)R - (1-y_2)R_1 > (1-x)P \\ (1-y_1)R_1 > P \end{cases} \tag{2}$$

According to  $R > R_1$  in hypothesis 3 and equation (2), it can be derived

$$(1-y_1)R > P \tag{3}$$

Since residents' optimal strategy is “payment”, in order to achieve Nash equilibrium, there is

$$-xP + y_1R > y_1R_1 \rightarrow y_1(R - R_1) > xP \tag{4}$$

Equation (1) shows, on the premise that local government choose “subsidy”, the total benefit difference between residents' “payment” and “no payment” is much bigger than the total cost of urban social endowment insurance that residents assume. Therefore, residents' optimal strategy is “payment”.

Equation (2) and (3) show, even in the absence of local government subsidies conditions, the total benefit of residents' “payment” is more than that of residents' “no payment”. So “payment” is residents' optimal strategy. Noticing that equation (2) and (3) are set up on the condition that local government's distribution proportion of total social benefit is  $y_1$ , smaller than  $y$ .

Equation (4) shows, on the assumption that residents choose “payment”, the total benefit difference between local government's “subsidies” and “no subsidies” is larger than the total cost of urban social endowment insurance that local government bear. Therefore, the local government's optimal strategy is “subsidy”.

Above all, three conclusions can be drawn: firstly, local government's subsidy will facilitate residents to participate in urban social endowment insurance and pay a certain amount of pension cost. Secondly, local government can encourage participation of residents in urban social endowment insurance by reasonably designing distribution proportion of total social benefit. Thirdly, both local government and residents assume a certain amount of urban social endowment insurance cost, which is conducive to ensure the sustainable urban social endowment insurance system.

**THE GAME BETWEEN LOCAL GOVERNMENT AND CENTRAL GOVERNMENT IN THE IMPLEMENTATION OF NEW RURAL ENDOWMENT INSURANCE**

With the expansion of assurance coverage, the welfare competition between local governments makes them fiscal burden in the practice of new rural endowment insurance<sup>[13]</sup>. Local government, as a rational economic person, may be adverse selection on the consideration of maximization of its own interests. The central government should regulate local government's possible violation. The basic assumptions are as follows.

There are two players, local government and central government, pursuing their own utility maximization. Local government may exist opportunistic behavior and seek more local interests, whose strategies are “active execution” or

“illegal execution”, denoted by “SA<sub>1</sub>” or “SA<sub>2</sub>”. Central government can choose whether to regulate local government's opportunism behavior, whose strategies are “supervision” or “no supervision”, denoted by “SB<sub>1</sub>” or “SB<sub>2</sub>”. Two players, with complete information, can take action at the same time. The game is divided into three stages.

In stage I, local government's active execution should cost local government more, which will bring central government more social benefit. Meanwhile it may gain more fiscal transfer payments from central government as rewards. Local government's illegal execution will bring loss to central government and itself. Assuming that the local government's probability of “SA<sub>1</sub>” is  $x$  ( $x = 0 \sim 1$ ), and the local government's probability of “SA<sub>2</sub>” is  $1-x$ . In stage II, assuming that the central government's probability of “SB<sub>1</sub>” is  $y$  ( $y = 0 \sim 1$ ), and the central government's probability of “SB<sub>2</sub>” is  $1-y$ . If central government chooses “supervision”, it must pay the corresponding cost. In stage III, assuming that central government has chosen “supervision” in stages II, when faced with local government's illegal execution, there are two kinds of results for central government: “seized” or “not seized”. Assuming the “seized” probability is  $\theta$  ( $\theta = 0 \sim 1$ ), and the “not seized” probability is  $1-\theta$ . Once local government's illegal execution is seized, it should assume administrative or economic punishment.

Game payoff matrix and game process are respectively shown in TABLE 2 and Figure 2.

Parameters are explained as follows.  $R_1$  means local government's normal income in the new rural endowment insurance, namely, the existing central government's financial transfer payments.  $C_1$  means local government's normal cost in the implementation of new rural endowment insurance.  $\Delta R$  means the extra income that local government obtains when it actively executes the policy of new rural endowment insurance, which refers to more central government's financial transfer payments as rewards owing to its active execution.  $\Delta C$  is the local government's extra cost when it chooses “active execution”.  $R_2$  is the positive external benefit obtained by central government when local government chooses “active execution”, e.g. insurance coverage expansion, farmer satisfaction increase, social harmony and stability.  $L$  means local government's credit losses caused by its illegal execution.  $W$  means government's potential losses when local government chooses “illegal execution”, e.g. the image and credibility damage of central government.  $C_2$  is supervision cost.  $F$  is local government's punishment when its “illegal execution” is seized.

When  $\theta \cdot F - C_2 - W < 0 \rightarrow C_2 < F - W$ , central government's dominant strategy is “SB<sub>1</sub>”, “no supervision”. When  $C_1 + \Delta C > C_1 + L$ , local government's dominant strategy is “SA<sub>2</sub>”, “illegal execution”. There is a unique Nash equilibrium (SA<sub>2</sub>, SB<sub>2</sub>), (illegal execution, no supervision).

TABLE 2 : Game payoff matrix of local government and central government

		Local Government	
		SA <sub>1</sub> : Active Execution (x)	SA <sub>2</sub> : Illegal Execution (1-x)
Central Government	SB <sub>1</sub> : Supervision (y)	$R_1 + \Delta R - C_1 - \Delta C, R_2 - C_2$	$\theta \cdot R_1 - C_1 - L - F + 1 - \theta \cdot R_1 - C_1 - L, \theta \cdot F - C_2 - W + 1 - \theta \cdot -C_2 - W$
	SB <sub>2</sub> : No Supervision (1-y)	$R_1 + \Delta R - C_1 - \Delta C, R_2$	$R_1 - C_1 - L, -W$

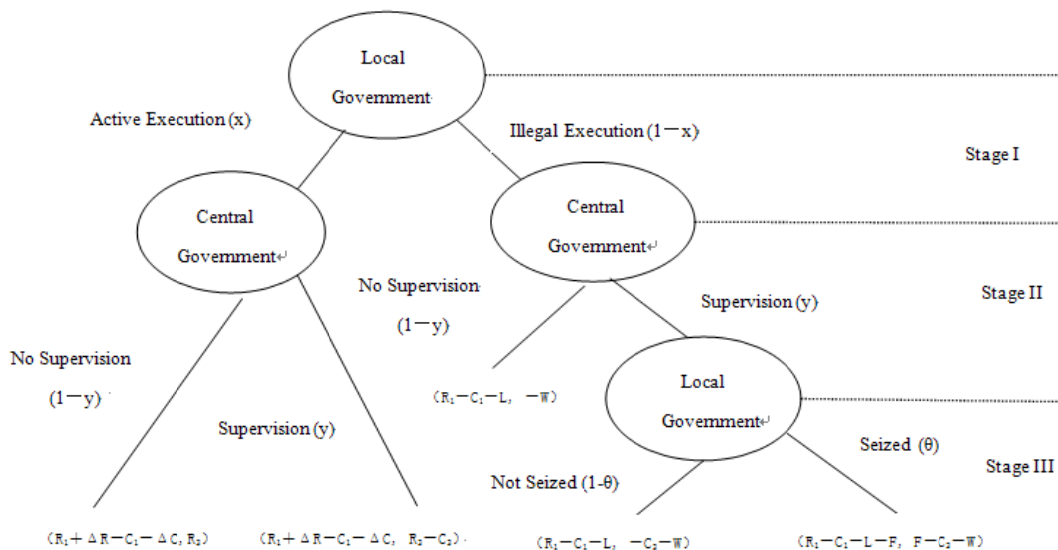


Figure 2 : The dynamic game process of local government and central government

When  $\theta \cdot F - C_2 - W > 0$ , there is no Nash equilibrium. Assume that the local government's probability of "active execution" is  $x$ , the central government's probability of "supervision" is  $y$ , the local government's expected revenue is  $Ea(x, 1-x)$  and the central government's expected revenue is " $Eb(y, 1-y)$ ". The solving process of the mixed strategy equilibrium is as follows.

$$Ea(x, 1-x) = x[y(R_1 + \Delta R - C_1 - \Delta C) + (1-y)(R_1 + \Delta R - C_1 - \Delta C)] + (1-x)\{y[\theta(R_1 - C_1 - L - F) + (1-\theta)(R_1 - C_1 - L)] + (1-y)(R_1 - C_1 - L)\} \quad (1)$$

$$Eb(y, 1-y) = x[y(R_2 - C_2) + (1-y)R_2] + (1-x)\{y[\theta F - C_2 - W) + (1-\theta)(-C_2 - W)] + (1-y)(-W)\} \quad (2)$$

Respectively compute the partial derivatives of equation (1) and (2), the optimal first-order condition can be get:

$$\frac{\partial Ea(x, 1-x)}{\partial y} = R_1 + \Delta R - C_1 - \Delta C - \{y[\theta(R_1 - C_1 - L - F) + (1-\theta)(R_1 - C_1 - L)] + (1-y)(R_1 - C_1 - L)\} \quad (3)$$

$$\frac{\partial Eb(y, 1-y)}{\partial x} = -xC_2 + (1-x)(\theta F - C_2) \quad (4)$$

Make equation (3) and (4) equal to 0, and get the solution:

$$\begin{cases} X = 1 - \frac{C_2}{\theta F} \\ Y = \frac{\Delta C - \Delta R - L}{\theta F} \end{cases} \quad (5)$$

Equation (5) is the Nash equilibrium, which shows that when  $0 \leq x \leq X$ , the strategy set of local government and the central government is  $\{SA_2, SB_1\}$ , {illegal execution, supervision}; When  $X \leq x \leq 1$ , the strategy set of local government and the central government is  $\{SA_1, SB_2\}$ , {active execution, no supervision}; When  $0 \leq y \leq Y$ , the strategy set of local government and the central government is  $\{SA_2, SB_2\}$ , {illegal execution, no supervision}; When  $Y \leq y \leq 1$ , the strategy set of local government and the central government is  $\{SA_1, SB_1\}$ , {active execution, supervision}.

Nash equilibrium of the game indicates that the local government's probability of "active execution" is directly proportional to the central government's probability of "seized" and local government's punishment when its "illegal execution" is seized. But the local government's probability of "active execution" is inversely proportional to central government's supervision cost. These above mean the central government's supervision efficiency and punishment affect whether local government chooses "active execution".

Therefore, in order to promote local government's active execution and guarantee full coverage and sustainability of the new rural endowment insurance, central government should improve the supervision efficiency by reducing supervision cost, increasing the "seized" probability and increasing the local government's punishment when its "illegal execution" is seized.

## COUNTERMEASURES AND SUGGESTIONS

### Establishing reasonable benefit share mechanism

On the one hand, expand residents' distribution proportion of total benefit by increasing government's subsidies. Suggest that local governments at all levels formulate reasonable residents' payment standard of endowment insurance according to the local indexes (e.g. the number of population, the level of economic development, per capita income). The minimum payment standard and minimum government subsidy standard should be gradually improved with economic development. Set up reasonable payment grades of social endowment insurance based on crowds with different income. Follow the principle "more payment, more subsidies" to perfect incentive mechanism of social insurance payment. On the other hand, increase the total revenue through the hedge and increment of the social old-age insurance fund. Recommend that governments, considering the risk prevention and reservation for full payment of the reserve funds, do the following two types of treatment for the remaining social insurance fund. One part of fund is used to conduct a robust investment (e.g. put into the bank or purchase treasury bonds). Another part is used for market operation to get the portfolio returns by entrusting some big investment institutions with strength and good reputation.

### Building long-term mechanism of financial support

First of all, suggest that rationally divide the government's subsidy ratio of social security to ensure the interface supporting policy and the scheduling of funds use. Central government should appropriately adjust the transfer payment

amount in different regions. Implement the policy of local government's subsidy in the developed regions, and appropriately increase the transfer payment aiming at reducing local government financial burden, which comes from social security subsidy in the developing regions. Besides, the social insurance fund budget mechanism should be improved. Central government and local governments at all levels should appropriately raise the proportion of social security funds in budget, gradually include social security expenditure into the main project of government financial expenditure, and put social security funds coming from other channels (e.g. collective benefits, social donation, lottery, etc.) into the social security budget. Effective supervision of the budget funds are necessary.

### **Setting up multi supervision mechanism**

To begin with, establish a sound internal control mechanism. Given the legal lack of current pension protection law and pension fund supervision law, central government should improve the punishment power by legislation, including the relevant regulations and specific laws. Strengthen the censorship of the various links: the fund raising, allocation, distribution and other aspects to prevent local government misusing or misappropriating the social security funds. Accelerate the reform and adjustment of the social security sectors at all levels. Conscientiously fulfill the audit and inspection, make clear division of functions and powers and standardize business processes. In addition, establish democratic and scientific supervision mechanism. Take the collective (Social Organizations), the insured persons (urban residents, farmers) and experts into the supervision system together with governments. Set up specialized agencies, composed of representatives of the executive branch of government and the community, to carry out the guidance and supervision work of social security fund. Progressively construct the audit and supervision network, multi-party participation and mutual checks and balances. Promote and encourage media, public sectors to involve in the supervision of social security funds, and build the third line—public supervision to realize national social security fund supervision, which can both reduce central government's supervision cost and increase the “seized” probability.

### **Constructing comprehensive supplement mechanism**

At first, encourage state-owned enterprises as “third sector” to participate in the full coverage of social security, aiming at alleviating the government's pressure of fiscal transfer payment. Our government might consider using tax method to extract parts of state-owned enterprises' profits as a special social security pension. Meanwhile give state-owned enterprises some preferential policies as a compensation. Besides, select parts of provinces as pilots, in a planned way, to implement a unified urban and rural social security management system. Promote rural surplus labor force to the second and third industry step by step, and reform urban registered permanent residence system, employment system and social security system. Lastly, delay retirement age by progressive reform. Suggest that government design humanization elastic retirement system to extend the retirement age to 65 years, achieving synchronization with most western countries.

### **Learning from foreign experience.**

Firstly, given that social security crisis of legitimacy caused due to its narrow coverage in Argentina, China should decide to expand social security coverage, and gradually realize the full coverage. It is worth learning that “the progressive unification” road for America to achieve a unified social security system and the integration of social security fragmentation in Europe. Secondly, referring to Australian future fund model, increase the social security fund financial budget as soon as possible to maintain the government's future pension payment capability and gradually realize sustainability of social security. Moreover, in aspect of social security fund management, try pension self-management and investment pattern of western countries so as to strengthen personal sense of responsibility in the social security. Open a personal account and allow individuals to flexibly choose the pension fund investment institutions and portfolio strategies. In aspect of social security fund supervision, Australian diversified supervision mode with a single target principle is for reference. Finally, in order to avoid local governments' adverse selection behaviors, China could learn from western countries' social security management mechanisms established by integrating mutual division of social security, gradually building a unified social security management system. For example, Australia puts distributed social security institutions together into a nationwide networking services alliance. Germany changes decentralized management mode into consolidated management mode for its 253 industry social security institutions.

## **CONCLUSION**

The implementation of urban social endowment insurance and new rural endowment insurance directly affects the full coverage and sustainability of China's social security system. Based on game analysis, draw a conclusion that the sustainability of urban social endowment insurance system is influenced by local government's subsidy, social benefit distribution proportion and residents' payment. The sustainability of the new rural endowment insurance is affected by central government's supervision efficiency and local government's punishment of “illegal execution”. Finally, propose policy recommendations in this paper, including reasonable benefit share mechanism, long-term mechanism of financial support, multi supervision mechanism, comprehensive supplement mechanism and learning from foreign experience. It is a long way to achieve full coverage and sustainability of social protection system in China.

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