

# The Construction of the Theoretical Model of the Synergistic Effect of Government Guidance Fund, Venture Capital and Start-ups

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## Abstract:

Government intervention and market operation are two means of market development. In order to effectively drive innovation, China has adopted the practice of setting up a government guidance fund to drive venture capital and encourage innovation of start-ups. Theoretically, can the government guidance fund actively play a guiding role in promoting synergy in the process of investment, venture capital investment, venture capital financing and innovation? With this problem, by constructing a tripartite game model, this paper demonstrates the process and conditions of the formation of synergy among government guidance fund, venture capital and venture enterprises. The results show that there is an investment and financing balance between government guidance fund, venture capital and venture enterprises. Finally, based on this, the paper puts forward some suggestions to solve the conflict of interest among them through incentive and constraints.

**Keywords:** Government guidance fund, Venture capital, Venture enterprise, Synergy.

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## I. INTRODUCTION

In order to implement national innovation driven policy of China, the government of China has adopted the way of establishing entrepreneurship guidance fund. The purpose is to give full play to the leverage of financial funds, drive venture capital to invest in start-ups with high growth potential, alleviate the financing constraints of start-ups <sup>[1]</sup> and make up for the gap of innovation funds, so as to promote the innovation and development of enterprises <sup>[2]</sup>.

As a means of government intervention, can the establishment of guidance fund form the expected synergy with venture capital and start-ups? Theoretically, government guidance funds, venture capital and start-ups are all market participants with different utility objectives. From the perspective of economics, the contract is incomplete. Therefore, the information among government guidance funds, venture capital and venture enterprises is asymmetric, that is, there is a possibility that they cannot cooperate. The “virtuous circle” hypothesis holds that in the early stage of entrepreneurship, the establishment of government guidance fund can create a virtuous circle and pave the way for social funds to enter the venture capital market in the later stage; Opponents believe that government funds are only a substitute for social funds, that is, the establishment of government guidance funds cannot guide social funds into the

field of venture capital, but will squeeze out social funds.

In the existing empirical research in China, there are still different conclusions about whether the government guidance fund plays a guiding role. Some studies have proved that the government guidance fund has played a positive guiding role and significantly promoted innovation [3-6]. Some studies have found that the guidance fund has only played a partial guiding role [7-9], but there is also evidence that the guidance fund has not played an effective guiding role, and even inhibits the of enterprise innovation [10]. Under different market environments, the role of the guidance fund is different. How to make the guidance fund promote the virtuous cycle of the market is related to the implementation of China's innovation driven policies. Therefore, it is necessary to explore whether the guidance fund can form a synergistic mechanism with venture capital and venture enterprises from a theoretical perspective, so as to provide theoretical support for practical development and empirical research.

This paper intends to include the government guidance fund, venture capital and start-up enterprises in the same system, draw lessons from the emergency disaster relief model, deduce the relationship among the three subjects in the system, and study whether and how the three subjects are connected through a certain relationship to produce synergy. This model can not only provide theoretical support for the virtuous circle hypothesis from a new perspective, but also provide theoretical support for the government to meet the financing needs of start-ups with the participation of venture capital, and further provide theoretical guidance for the relevant policy-making of government departments.

## **II.CONSTRUCTION OF THE TRIPARTITE GAME MODEL OF GOVERNMENT GUIDANCE FUND, VENTURE CAPITAL AND START-UPS**

### **2.1 Definition of the Constituent Elements**

In order to facilitate the research, the model assumes that there are only three participants, namely government departments, venture capital and entrepreneurial enterprises. Considering the current situation of China's market, it is assumed that there is information asymmetry and interest conflict among the three subjects. On this premise, this paper puts forward the relevant definitions of the constituent elements of the model:

Financing of start-ups: in our model, the gap of venture capital demand in a certain region is so large that venture capital alone cannot fully meet it.

Participant: There are three capital channels involved in the model: government departments, venture capitalists and start-ups. When the financing demand of start-ups arises, the capital supply of government departments is the most convenient, followed by venture capital institutions. There are several explanations for this hypothesis. Firstly, compared with venture capital, government guided funds can meet the financing needs of enterprises faster and more directly, but government guided funds should not be not invested too much funds in start-ups to prevent intervention in the market economy, resulting in limited capital scale. Secondly, venture capitalists are not a "crazy investment" that prefers risk. For start-ups that are in the initial stage and have huge financing risk under the current background, venture capitalists are not willing to actively invest. Even if it invests, it has little motivation to encourage enterprises to invest in innovation. After all, the innovation has high risk and spillover. Thirdly, venture capitalists will usually determine their investment strategy and direction according to the government's policies when the start-ups are facing huge financing risks. Finally, it should be emphasized that the profitability and financing ability of start-ups are also very important, but they often depend on the investment strength of

government departments and venture capital. This shows that the financing capacity of start-ups is limited, and venture capital and government funds are important ways to meet their financing needs.

### 2.2 Event Description

Firstly, the model assumes that the entrepreneurial financing needs arise in certain market (shown in Fig 1). Government departments send experts or commissioners to investigate after learning the news. After demonstrating the importance of demand for economic development, government departments decide to invest in 'I<sub>g</sub>', including direct financial support and indirect policy subsidies. Of course, considering the objective existence of risk, the variable 'P' is introduced to represent the impact of the government's failure to give support to venture capital institutions (such as reputation, rating, etc.).

Secondly, the start-ups are capital demanders in the model. Based on the observed I<sub>g</sub> and P, the start-ups decides to use its own funds to strive for financing level 'e'. In other words, the model assumes that 'e' represents the degree of financing self satisfaction and the degree of effort to invest in innovation (hereinafter referred to as the degree of effort), but this can only be observed by entrepreneurial enterprises (there is information asymmetry in the market). C (e) represents the cost of financing and innovation of start-ups, which is referred to as innovation financing cost for short. It is assumed that the innovation financing cost of start-ups will increase with the increase of the effort of start-ups, C '(e) > 0 and meet the nature of increasing marginal cost (the cost function is concave function), C'' (e) > 0.

'I<sub>v</sub>' represents the amount of capital invested by venture capitalists in the financing of start-ups.

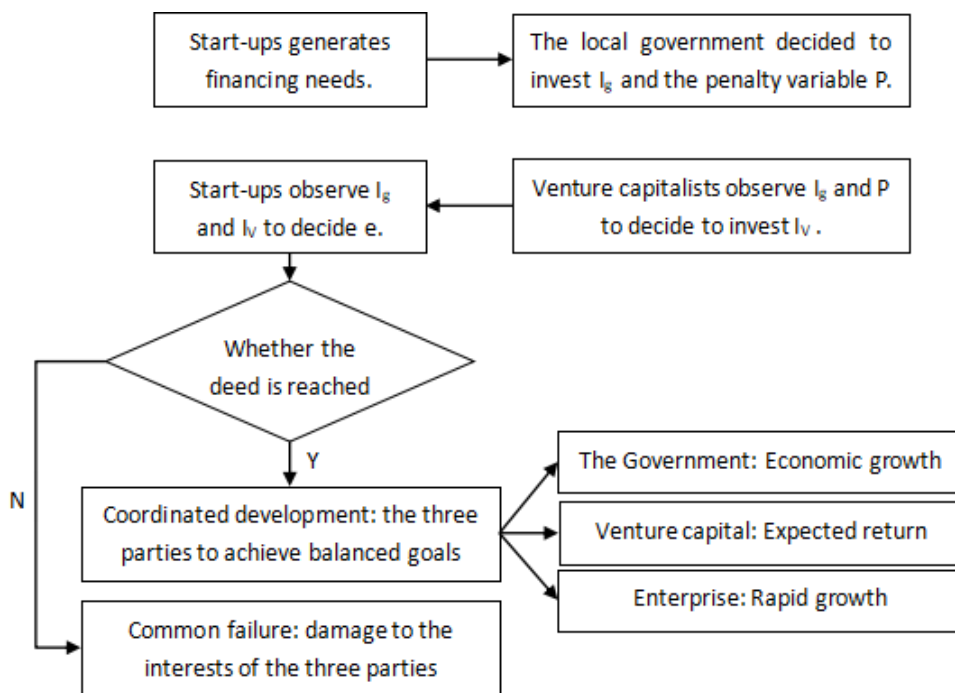


Fig 1: Three-party game process

It assumes that there is only one stage in the game process. The result of the tripartite negotiations is nothing more than an agreement, namely success, or if no agreement can be reached, namely failure. The

probability of success depends on  $I_g$ ,  $I_v$ , and  $e$ , and they are independent to one another. We express the probabilities of their occurrence as  $\alpha(I_g)$ ,  $\beta(I_v)$ , and  $\gamma(e)$ , respectively. If the probability of independent satisfaction among the three parties is the same, the assumption of  $\alpha(I_g)$  satisfies:  $0 \leq \alpha(I_g) \leq 1$ ,  $\alpha'(I_g) > 0$ ,  $\alpha''(I_g) < 0$ .

It means that the success rate of the above assumed state is  $\alpha(I_g)$  and it satisfies:

- (1) Between 0 and 1.
- (2) It increases as investment increases.
- (3) Declining marginal returns reflects the growth in investment.

We make the same assumption for  $\beta(I_v)$  and  $\gamma(e)$ .

Once the financing needs are effectively met, that is, the agreement is successful, we assume that all three participants receive their own income, and  $R$  (the total income is  $R$ )  $> 0$ . Otherwise, they will all be equal to zero.

It supposes that all participants know the rules of interest and its sequence and they all know the role of  $\alpha(I_g)$ ,  $\beta(I_v)$ , and  $\gamma(e)$ , the cost of the investment, and the possibility of success.  $\alpha(I_g)$ ,  $\beta(I_v)$ , and  $\gamma(e)$  are affected by  $I_g$ ,  $I_v$ , and  $e$ . Once the local government decides to invest  $I_g$ , both  $I_v$  and  $e$  will be made clear decisions. Instead, only the demanders know the specific value of  $e$ .

According to the observed  $I_g$  and  $P$  of government departments, Start-ups determine their own “degree of effort”, namely active efforts to meet the financing needs though increasing their own funds such as reducing dividends and costs in the process of financing. It assumes that the initiative is not assessed for other participants (government departments and venture capitalists) of the game, and it is represented by the variable  $e$ . At the same time, it defines the function that measures the cost of start-ups due to effort, namely the cost function ( $C_e$ ). The model assumes that the cost function is only related to  $e$ , and the cost increases as  $e$  increases, namely  $C'(e) > 0$ , and the cost function meets the nature of increasing marginal cost (the cost function is concave function), that is,  $C''(e) > 0$ . Similarly, according to the observed  $I_g$  and  $P$  of government departments, venture capitalists decide to invest  $I_v$ .  $I_v$  includes monetary capital and value-added services of venture capital investment.

The model assumes that there is only one stage in the game process, and the final disaster relief results can only be in “success” or “failure” state. Besides, it assumes that the financing success probability is  $\alpha(I_g)$ ,  $\beta(I_v)$ , and  $\gamma(e)$ , and  $\alpha(I_g)$ ,  $\beta(I_v)$ , and  $\gamma(e)$  are the probability functions which are respectively by  $I_g$ ,  $I_v$  and  $e$  to determine.

It can be seen from the model that the three elements of government investment, venture capitalists investment and the efforts of start-ups are indispensable. Otherwise, as long as there is an investment that is zero, the financing will certainly fail.

Once the financing is successful, the model assumes that government departments, venture capitalists and start-ups all receive their respective profits, which are recorded as  $R_g$ ,  $R_v$  and  $R_e$ . Otherwise, the returns of all three are zero.

### 2.3 Decision-Making of the Participants

The expected returns of government departments, venture capitalists and start-ups are expressed by the variables  $U_g$ ,  $U_v$  and  $U_e$ . The calculation process is as follows:

$$U_g = \alpha (I_g) \beta (I_v) \gamma (e) (R_g - P) - I_g + P$$

$$U_v = \alpha (I_g) \beta (I_v) \gamma (e) (R_v + P) - I_v - P$$

$$U_e = \alpha (I_g) \beta (I_v) \gamma (e) (R_e) - C (e)$$

This model assumes that  $U_g \geq 0$ ,  $U_v \geq 0$  and  $U_e \geq 0$ , that is, the expected return is not negative, otherwise the financing fails. And it assumes that the parties involved in the game meet the assumption of “rational economic man”.

### III. EQUILIBRIUM ANALYSIS OF THE GAME MODEL OF GOVERNMENT GUIDANCE FUND, VENTURE CAPITAL AND START-UPS

It supposes that the government sector is a “Stackelberg leader”, which is the dominant player who grasps the response function of other players in the game and maximizes their utility based on the consideration of the impact which their own behavior will affect other participants. In this game process, the government departments choose the value  $(I_g, P)$  based on the self-interested motives of venture capitalists and start-ups, and it assumes that the government departments use the “reverse induction method” to make decisions. The “backward induction”, also known as the “inverse push method”, is a more classical method to solve the dynamic game equilibrium. The so-called “dynamic game” is that there is an order of the actions of the game participants, and the participants in the latter action can observe the previous action, while the “backward induction” is pushed back from the last step of the dynamic game to solve the equilibrium result of the dynamic game.

In order to study how this game reaches the equilibrium state, the expected return function of a venture capitalists seeks the first partial derivative for its input variable  $I_v$  and the start-ups revenue function finds a first derivative for the effort level variable  $e$ . Then, we make them equal to zero, that is:

The expected return function of a venture capitalists seeks the first partial derivative for its input variable  $I_v$ :

$$\frac{\partial U_v}{\partial I_v} = \alpha(I_g)\beta(I_v)\gamma(e)(R_v + P) - 1$$

Make it equal to zero:

$$\alpha(I_g)\beta(I_v)\gamma(e)(R_v + P) - 1 = 0 \tag{1}$$

The start-ups revenue function finds a first derivative for the effort level variable  $e$ :

$$\frac{\partial U_e}{\partial e} = \alpha(I_g)\beta(I_v)\gamma'(e)(R_e) - C'(e)$$

Make it equal to zero:

$$\alpha(I_g)\beta(I_v)\gamma'(e)(R_e) - C'(e) = 0 \tag{2}$$

The Formula (5.1) and Formula (5.2) can determine the investment level and the effort level of venture

capital institutions under the equilibrium state,  $I_v^* = I_v^*(I_g, P)$ ,  $e^* = e^*(I_g, P)$ .

Because it assumes that the government department adopts the “backward induction” to make the decision, it plugs the sum  $e$  obtained by Equation (1) and Equation (2) into the expected utility function of government departments, and seek the first partial derivative of the input variables  $I_v$  and the penalty variable  $P$  respectively, namely:

The government department expects the utility function to find the first-order partial derivative for its input variable  $I_g$ .

Make it equal to zero:

$$\alpha(I_g)\beta(I_v^*)\gamma(e^*)(R_v + P) - 1 = 0 \quad (3)$$

The government department expects the utility function to find the first partial derivative of the variable  $P$ :

$$\frac{\partial U_g}{\partial P} = \alpha(I_g)\beta(I_v^*)\gamma(e^*)P + 1$$

Make it equal to zero:

$$\alpha(I_g)\beta(I_v^*)\gamma(e^*)P + 1 = 0 \quad (4)$$

According to Equation (3) and Equation (4), the values of  $I_g$  and  $P$  can be solved, and then we plug them into  $I_v^* = I_v^*(I_g, P)$  and  $e^* = e^*(I_g, P)$  respectively to obtain  $I_v^*$  and  $e^*$  in equilibrium.

According to the solution of the game equilibrium state, it can be concluded that as long as the sub-game equilibrium between venture capitalists and start-ups exists, there is an equilibrium solution in the whole game process. The expected return function of venture capitalists and start-ups are concave shapes. According to the “theory of Nash equilibrium point existence”, there is an equilibrium state in this sub-game, so there is an equilibrium solution in the whole three-way game process.

Let’s consider how venture capital determines  $I_v$  and how start-ups determine  $e$ . Firstly, we find the second-order partial derivative of the expected return function  $U_v$  of venture capital with respect to the variable  $I_v$ :

$$\frac{\partial^2 U_v}{\partial I_v^2} = \alpha(I_g)\beta''(I_v)\gamma(e)(R_v + P) \quad (5)$$

$\beta''(I_v) < 0$ , and  $\alpha(I_g)$ ,  $\gamma(e)$ ,  $R_v$ ,  $P$  are greater than 0, so we can obtain  $\frac{\partial^2 U_v}{\partial I_v^2} < 0$ .

Similarly, the second-order partial derivative is obtained for the expected return function  $U_e$  and effort level  $e$  of the start-ups:

$$\frac{\partial^2 U_e}{\partial I_e^2} = \alpha(I_g)\beta(I_v)\gamma''(e)R_e - C''(e) \quad (6)$$

For  $\gamma''(e) < 0$  and  $C''(e) > 0$ , so  $\frac{\partial^2 U_e}{\partial I_e^2} < 0$ .

From the solution process of the game equilibrium, it can be seen that as long as the sub game equilibrium between venture capital and start-ups exists, there is an equilibrium solution in the whole game process. It can be seen from equations (5) and (6) that the expected return functions of venture capital and start-ups have concave characteristics. According to the ‘Nash equilibrium point existence theory’, this sub game has an equilibrium state, and there is an equilibrium solution in the whole tripartite game process.

#### **IV. THE PRACTICAL SIGNIFICANCE AND ENLIGHTENMENT OF THE GAME MODEL OF GOVERNMENT GUIDANCE FUND, VENTURE CAPITAL AND START-UPS**

According to the game model of government guidance fund, venture capital and start-ups established in this paper, it can be concluded that because of the consistent interest pursuit, there is the possibility of a balance between government guidance fund, venture capital and start-ups, when there is a game balance between venture capitalists and start-ups. This conclusion is in line with the law of social development and provides a theoretical basis for the establishment of Chinese government guidance fund. Besides, the reality has provided some evidence: in current economic society of western developed countries and China, the rapid development of venture capital and start-ups has proved the existence of market balance; and Chinese government guidance fund also has played an important guiding role at the present stage.

This paper also provides the necessary theoretical support for the design of a framework for synergies among government guidance fund, venture capital and start-ups through the tripartite game model analysis. Although China’s government guidance fund has played a positive role, it is undeniable that there are still some problems such as non-standard management and insignificant effect in promoting venture capital to encourage the innovation of start-ups. This also shows that the information asymmetry among government guidance fund, venture capital and start-ups exists objectively, and the interest conflicts of the three parties are also unavoidable. Usually, there are two ways to resolve conflicts of interest, namely incentives and constraints. According to the analysis of the three-party game model of government guidance fund, venture capital and start-ups, it is clear that punishment cost is also a necessary condition for the formation of synergistic effect. At present, the government guidance fund focus on guidance and incentive, but the lack of corresponding punishment mechanism is that some guidance funds are set up and operated like “herd effect”, but they have not achieved the due performance. Therefore, to strengthen supervision and evaluation, and form a strong accountability mechanism and appropriately increase punishment, are necessary conditions for forming a benign and healthy cycle of government guidance fund, venture capital and start-ups, and also an urgent need for the efficient use of government funds. At the same time, the policy design should fully consider the characteristics and interrelationships of guidance funds, venture capital and start-ups, and properly use positive incentives and punishment means, in order to better achieve the synergistic effect.

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