

# Research on the Risk Management Model of Development Finance in China<sup>\*</sup>

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**Abstract:** Risk management in development finance is an important issue, but the linear operation model of development finance in China is not conducive to risk management. The spiral operation model provides a method of preventive risk management. This model makes linear operation model into three-stage spiral cycle process which includes “the Government chose the project import”, “development finance incubator” and “to achieve the market export”. And risk assessment should be carried out before the start of each stage, according to the results to decide whether to continue to invest. The operation process and risk characteristics of this model have the characteristics of compound real options; therefore it can be used to improve decision-making flexibility, reduce investment risk by variable volatility of compound real options.

**Key words:** Development finance; Spiral operation model; Risk management; Real option

## 1 Introduction

Development finance is a financial form, which is a financial institution (usually bank) established by single or states with the national credit, to provide long-term credit for the specific needs, at the same time to accelerate economic development and achieve long-term economic growth and the other government targets by building markets and improving system<sup>[1]</sup>.

In the existing research results, Li (2005) propose a basic framework for development financial operations, which includes Credit input mechanism, the project loan management and repayment mechanism<sup>[2]</sup>. Wu (2009) believes that “government cooperation is the foundation, loans assistance institutions and platform constructing are means, risk-sharing and compensation is security”, these constitute the development finance operation mechanism which support the development of county and rural SMEs, and he evaluates the effect of the operation of the mechanism<sup>[3]</sup>. Ouyang (2009) build a development financial institution compliance risk management system which includes compliance risk identification, compliance risk assessment, compliance risk control, compliance risk monitoring and compliance risk reporting, based on the compliance risk management model, and makes recommendations on the construction of mechanisms<sup>[4]</sup>. Xie (2010) takes Beibu Gulf Economic Zone as an example, designs an operation mechanism of venture capital fund market development supported by development finance, which includes venture capital investment mechanism, the project evaluation and decision-making mechanism, risk management mechanism, venture capital exit mechanism and implementing process protection mechanism<sup>[5]</sup>.

The special historical mission and operational characteristics of development finance determine the specific risks it face, so risk management has become the focus should be considered in the course of its operation. However, there is no research result of development finance operation model in China from the perspective of risk management. The existing researches can't meet the practical needs, so this article studies development finance operation model from the perspective of risk management, and real options approach solves the development finance risk management related issues by introducing.

## 2 The Operation Model of Development Finance in China and Its Defects

The operation model of development finance in China can be summarized as “the Government chose the project import - development finance incubator - to achieve the market export”, shown in Figure 1. “The Government chose the project import” means local government in accordance with the national industrial policy and strategic planning in the region need to integrate internal resources, select and identify projects recommended applying development finance loans. Development finance institutions based on regional economic development level, financial revenue and expenditure levels, compliance and credit situation to determine the total loan. “Development finance incubator” means to promote the project and markets construction, to improve the building of governance, legal, cash flow

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and credit (four-building) under the coordination of the government and by finance. “To achieve the market export” means based on the progress of the four-building, development finance institution designs pay mechanisms according with the loan nature, purpose and use, such as general credit repayment, parent repo and issuance of shares or bonds in the capital market.

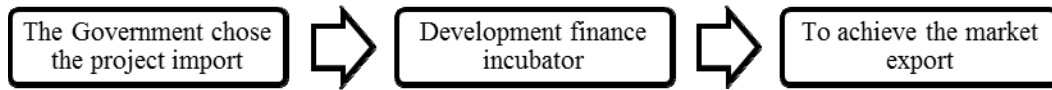


Figure 1 The Operation Model of Development Finance in China

Figure 1 can be clearly seen, the existing operation model is a straight operating mode which the capital flow from government to market, the three stages division of model also implies that only when the end of the previous stage, the next stage can begin. This model exists the following questions in risk management: (1) All stages of the model independent of each other, and didn't form a unified whole. Different stages by different main responsible for, each stage separately and did not form a good communication and coordination mechanism. This leads to high coordination costs and low coordination efficiency, while increasing the risks. (2) The existing model did not consider risk management issues. Various stages of development finance are at risk. If a stage does not handle the risk, the risk of damaging although not necessarily shown in the current period, but there may be shown in the next even next two stages. Once the risk impact the project, the impact is often devastating. The existing operation model has this defect in risk management. (3) The assumptions of development finance operation are not realistic. Current operating model is a single-period, linear model, but in the actual work is not so. For example, previous successful experiences and models may affect the evaluation of similar investments this stage, the change of participants' capabilities may affect the project success rate at different stage.

### 3 The Spiral Operation Model of Development Finance

Through the above analysis we can see, due to inherent defects in the existing operation mechanism, investment with this model results are often not satisfactory, especially in risk management. In order to solve the problems of linear order model, considering the actual operation process of development finance and its risk, the spiral operation model can be used to explain the operating model of development finance and to explore how its risk management. The spiral operation model divides the process of development finance into several stages, as shown in Figure 2.

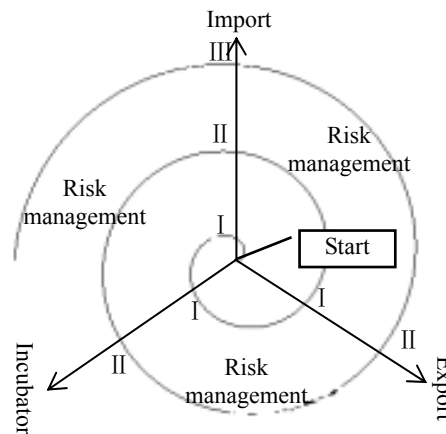


Figure 2 The Spiral Operation Model of Development Finance in China

Shown in Figure 2, the spiral operation model begins with project “start”, run counterclockwise, by “the government chose the project import I”, “development finance incubator I” and “to achieve the market export I” stage three tasks, then return to the “import”. Since then the parameters of development finance master more information markets and has accumulated experience and capital in the previous stage, therefore, each participant has a higher capacity in this stage. The spiral operation model entre into “import II”, “incubator II” and “export II”, a higher level of recycling process, and will

continue the cycle continues until the project is terminated.

It should be noted that this model is generally; in the operation process of development finance will be special case. For example, over time, development finance institutions mastered more and more rich information on investment projects, and projects risk assessment results more accurately, development finance institutions may decide to re-evaluation of investment projects or even to stop the investment because investment risk is greater than previously estimated. At this point, investment projects may return to “the government chose the project import”, and cannot enter into the “market export”. Therefore, in practical application, Stage of the model should be adjusted according to actual situation.

The spiral operation model actually provides a method of preventive risk management. It can be seen from Figure 2, there is a zone between each stage, and risk management will be conducted in this zone. This risk management method emphasizes that risk analysis should be carried out in each stage of the spiral operation model, reducing the probability of risk occurrence and the losses caused by risk rather than taking remedial measures after the risk occurred.

#### 4 The Analysis on the Spiral Operation Model Based on Real Option

Real option theory suggests that managers should wait under conditions of uncertainty, make decisions or implement projects at various stages until the situation clarified or conditions became more mature. In this way, managers can decide whether to continue or abandon the project in the follow-up stage, and avoid excessive risks which cause by a one-time investment<sup>[6]</sup>. Compared with the traditional operation model, the spiral operation model has a clearer real option means. Real option theory provides a powerful language tool to explain its meaning and essence.

The start and end time is a basic problem of the spiral operation model. In this regard, based on the operation mechanism of development finance, the basic assumptions made that if the development finance operations can promote the realization of the intended target, start the investment process; if it can't, termination of spiral process (cancel investment). For example, when great changes in international environment led to project difficulties, the project should be canceled. The spiral operation model requires testing this hypothesis at the beginning of each iteration cycle in order to decide whether to continue investment. Therefore, the spiral model of development finance is a set sequence of decision-making, the equivalent of a multi-stage compound option. From Figure 2 we can see, due to the development finance operation is usually divided into a series of different stages, each level of risk is different and variable volatility of compound options can describe the risk characteristics of development finance spiral operation process better, therefore introduced variable volatility of compound real options model of the spiral operation model analysis<sup>[7]</sup>.

Assuming a development finance project n iterations,  $t_k (k=0, 1, \dots, n)$  means the decision time of cycle k. In any decision point, when the basic assumption founded (the option value is higher than the cost of time investment) start the next iteration cycle, otherwise abandon the project. Repeat this process until the operation ended.

$I_k$  means Investment cost of each cycle,  $V_{k(k+1)}(t)(k=0, \dots, n-1)$  means the value of the underlying assets in the stage k, time  $t(t \in [t_k, t_{k+1}])$ , Suppose  $V_{k(k+1)}(t)$  subject to the following process:

$$dV_{k(k+1)} / V_{k(k+1)} = \alpha_{k(k+1)} dt + \sigma_{k(k+1)} dz_k \tag{1}$$

Where,  $\alpha_{k(k+1)}$  and  $\sigma_{k(k+1)}$  denote the instantaneous expected return and expected volatility of the instantaneous,  $dz_k$  means Standard Wiener Process and  $var(dz_k, dz_{k'})=0(k, k'=0, 1, \dots, n-1; k \neq k')$ .

Assuming that  $\alpha_{k(k+1)}$  and  $\sigma_{k(k+1)}$  may change with k, use this to describe the value of the underlying asset has different risk-return characteristics in different stage.

Any stage real option value ( $F_k$ ) is derived by contingent claims analysis (CCA) method,  $F_k(V_{k(k+1)}, t)(k=0, \dots, n-1; t \in [t_k, t_{k+1}])$  should satisfy the equation:

$$\frac{\partial F_k}{\partial t} + \frac{1}{2} \sigma_{k(k+1)}^2 V_{k(k+1)}^2 \frac{\partial^2 F_k}{\partial V_{k(k+1)}^2} + (r - \delta_{k(k+1)}) \times V_{k(k+1)} \frac{\partial F_k}{\partial V_{k(k+1)}} - rF_k = 0, (k = 0, \dots, n-1) \tag{2}$$

In volatility of compound real options, there is compound relationship between previous options and the late, the terminal conditions and boundary conditions are different from each other. First, consider the final stage,  $F_{n-1}$  can be seen as a European call option on the subject project, so the terminal condition is:

$$F_{n-1}(V_n, T_n) = \max(V_n - I_n, 0) \tag{3}$$

When the value of underlying asset is 0, the value of the option is 0 too. So its lower boundary condition is:

$$F_{n-1}(0, t) = 0 \tag{4}$$

When the underlying asset value is large enough, the options can be considered almost certain to be executed, so the difference between the value of the option and the value of underlying asset is the discounted of the final payment cost. So its upper boundary condition is:

$$\frac{F_{n-1}(V_{(n-1)n}, t)}{V_{(n-1)n} - I_n e^{-r(T_n-t)}} \rightarrow 1, V_{(n-1)n} \rightarrow \infty \tag{5}$$

Now go back to consider the terminal and boundary conditions of  $F_k$  ( $k=n-2, n-3, \dots, 1, 0$ ).  $F_k$  can be seen as a European contingent claims on  $V_{k(k+1)}$ , the latter option  $F_{k+1}$  effect of  $F_k$ , all reflected in its terminal condition:

$$F_k(V_{k+1}, T_{k+1}) = \max(F_{k+1}(V_{k+1}) - I_{k+1}, 0) \tag{6}$$

The value of compound option increases monotonically with the value of underlying assets, so the implementation threshold ( $V_k^*$ ) of the option ( $F_{k+1}$ ) need to meet the equation:

$$F_k(V_k^*, 0) = I_k, k = 0, 1, \dots, n - 1 \tag{7}$$

Similarly, we can make the upper and lower boundary conditions of  $F_{k+1}$ . Its lower boundary condition is:

$$F_k(0, t) = 0 \tag{8}$$

Its upper boundary condition is:

$$\frac{F_k(V_{k(k+1)}, t)}{F_{k+1}(V_{k(k+1)}, 0) - I_{k+1} e^{-r(T_{k+1}-t)}} \rightarrow 1, V_{k(k+1)} \rightarrow \infty \tag{9}$$

The solution area of this model is ruled half bands area( $t, V_{k(k+1)}) \in \{[t_k, t_{k+1}], [0, +\infty]\}$ , meanwhile boundary conditions and terminal conditions are the first boundary condition. Therefore, finite difference method can be used to solve the problem of simple and effective<sup>1</sup>.

### 5 An Example

A development financial institution will provide a number of \$25 million in loans for supporting the development of the Emerging Industries of Strategic Importance. According to the agreement of loan, loan term for 3 years, servicing \$30 million at the end of the third year.

#### 5.1 The traditional value analysis

According to the traditional operation model of development finance, \$25 million loans all lending at the beginning of the first year ( $t_0$ ), servicing \$30 million at the end of the third year ( $t_3$ ), set the risk-free rate  $i_0$  is 5%, using NPV computing project value:

$$NPV = \sum_{t=0}^n (CI - CO)_t (1 + i_0)^{-t} = -250000 + 300000 \times (1 + 5\%)^{-3} = 9151.3$$

#### 5.2 The spiral operation model value analysis

To simplify the calculations, the spiral operation model is divided into three cycles in this case, each cycle lasted 1 year. As projects require start-up capital, \$1 million loan to start project firstly. Before accessing to formal credit cycle, the project should be evaluated. If the projects meet the requirements, access to formal credit cycle. Risk Assessment will be done at the end of each cycle, in order to decide whether to start the next cycle. If continue, each cycle will produce \$8 million in loans.

This operation can be seen as a three-stage compound option. Therefore, the compound real option model can be used to evaluate this project. Assuming the risk volatility of each stage is 0.5, 0.4, 0.3. The model parameters are shown in Table 1.

**Table 1 Parameters**

Parameters	Value
The final value of the project	300000
The risk-free rate ( $r=i_0$ )	5%
Volatility $\sigma_k$ ( $k=1,2,3$ )	[0.5,0.4,0.3]
The loan amount of preparation period	10000
The loan amount of the first cycle	80000
The loan amount of the second cycle	80000
The loan amount of the third cycle	80000
Total cycles	3

<sup>1</sup> The specific solution process can be found in the reference 7, this paper not to repeat them.

Use these parameters and set  $I=50$ ,  $J=300$ ,  $\underline{V}_{k(k+1)} = 0.01$ ,  $\bar{V}_{k(k+1)} = 10000$  ( $k=0,1,\dots,n-1$ ), calculate by finite difference method, we can get the value of the compound option. It's \$99150. This value is far greater than the value calculated by NPV. This difference can be interpreted as the option value which contained in the spiral model.

The spiral model suggests that decide whether to continue the next cycle should consider the results of risk analysis, and the threshold is one important index of these results. If the estimated value of project exceeds the threshold, continue investing; if not, cancel. The thresholds of each stage in this case are shown in Table 2. For example, the threshold the first stage is \$222624, if the estimated value of project is greater than \$222624, the second cycle of the investment will be done; if not, this project will be cancel in order to avoid greater losses.

**Table 2 The Thresholds of Each Stage**

Stage	Threshold
The end of preparatory	142820
The end of the first cycle	222624
The end of the second cycle	156005

It is shown through the example that the spiral model gives development finance institution greater flexibility in decision-making. Risk analysis will be carried out in each stage and whether to start the next stage will be re-established. The spiral model reduces capital risk in the uncertain environment by flexible decision-making.

## 6 Conclusion

(1) The existing operation model of development finance in China is a straight operating model which the capital flow from government to market. This model exists some questions in risk management cause by all stages of the model didn't form a unified whole, the existing model did not consider risk management issues and the assumptions of development finance operation are not realistic.

(2) The spiral operation model of development finance provides a method of preventive risk management. This model makes straight operation model of development finance into three-stage spiral cycle process which includes "the Government chose the project import", "development finance incubator" and "to achieve the market export". And risk assessment should be carried out before the start of each stage, according to the results to decide whether to continue to invest. This improves the ability to resist risks of development finance.

(3) The operation process and risk characteristics of the spiral operation model have the characteristics of compound real options, therefore variable volatility of compound real options can be introduced into investment decision, value evaluation and risk management of development finance.

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