Early Warning Model of Financial Risk Based on Enterprise Life Cycle

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Abstract Enterprise life cycle determines the survival and development of enterprises. This article combines the theory of enterprise life cycle and financial risk organically, then analyzes the financial characteristics during different stages of enterprises' life cycle, and builds up an early warning index system of financial risk on the basis of cash flow. Then concerns factors infecting enterprises life cycle, and builds a financial risk early warning model with grey system theory, and amends the model concerning the influence factors of enterprises' life cycle.
Key words Life cycle; Financial risk; Grey system; Early warning

1 Introduction

Each enterprise will experience four stages of life cycle: start-up stage, expansion stage, profitable stage and decline stage. Different characteristics of life cycle stages will have certain different characteristics of financial risk. So the grasp of financial characteristics in different stages exactly is useful for the financial control and its design. Start with cash flow and risk of different stages of enterprises life cycle, this article tries to explain enterprises' financial characteristics such as investment, financing and income distribution, and so on.
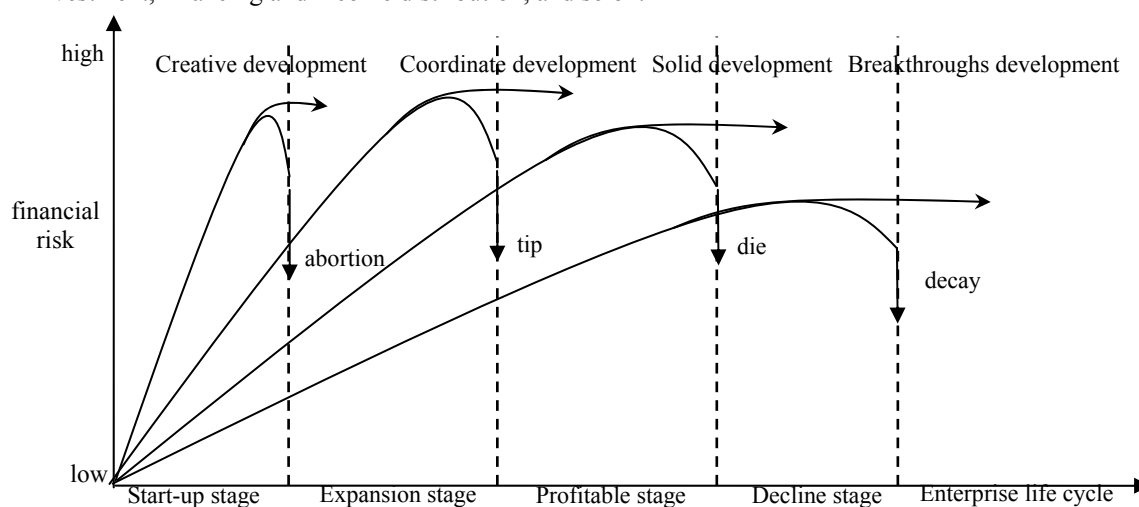

Figure 1   Enterprise Life Cycle and Its Financial Characteristics

1.1 Start-up stage

During this stage, enterprises need to invest many funds on market researching and products developing. When working capital is lack, enterprises will face the threat of abortion. During this stage, there are many unknown problems such as whether the product would be produced successfully, and be accepted by customers or not. Similarly, only would the market expand to certain scale so as to give enough developing room for the product and compensate the cost.

1.2 Expansion stage

During expansion stage, an enterprise should build up its product awareness. When its sales volume grows up, its operating risk will reduce. Besides, during high expanding stage, high volume of sales based on the reasonable profit will bring more rich cash flow. Meanwhile, enterprises must invest many funds to develop and expand its market shares. The result is that the cash produced in operating must be reinvested in production. These will make enterprises lacks of money. So its operating risk reduced, but the absolute risk remains high.

1.3 Profitable stage

This stage has the characteristics of perfect manage system, high and stable sale, reasonable profit room and plus cash flow. With the operating risk reduces further, enterprises will have relatively enough cash flow and higher volume of profit to be distributed. At the same time, due to the lack of new growth points, the efficiency of capital and asset-liability ratio is lower. Although financing channels are rich, enterprises are unwilling to owe more money. During this stage, enterprises have sound financial situation while lacks of long-term profitability ability.

1.4 Decline stage

In this stage, enterprises have enough cash flow and lower operating risk. Meanwhile, its market begins to shrink, and the increase rate of sale has negative number. Besides, its profiting ability declines and enterprises can't keep its debt paying ability. Enterprises in this stage face two results: find new business opportunity or go bankrupt. If enterprises expand in time, they will enter in another start-up stage and develop continually. If failed, enterprises will exhaust all of their assets and move towards decay. Usually the operating cash flow of these enterprises is negative.

2 Building Stages of Early Warning Model of Financial

2.1 Determination of index system

This article chooses the early warning index system of financial risk on the basis of cash flow as sample variable.

2.2 Deciding threshold

During the method of grey disaster forecast, the threshold is the standard of building disaster sequence and it can be decided according to the character of cash flow.

2.3 Determination of cash flow disaster class

This step is to collect the raw data sequence of the cash flow and then determine the cash flow disaster class according to the threshold.

2.4 Accomplishment of early warning of cash flow in the future

This step is to get the time class according to the cash flow disaster class, then forecast the disaster time class, so as to accomplish early warning of cash flow in the future.

2.5 Construction of early warning model based on enterprises life cycle

This process is to choose the value of dy_i according to the stage of life cycle of enterprises and build up the early warning model of enterprises life cycle.

2.6 Check on the precision of model

Usually we choose the relative error test rating. If the model is unqualified, we can amend it by building up verified model and check out it with posterior errors.

Table 1   Early Warning Index System of Financial Risk Based on Cash Flow

Category	Index	Purpose analysis
Operating activities risk Early warning index	The current rate of sales	Quality of earnings
	Net operating cash ratio	
	Net operating cash per share	Acquire cash ability
	Ratio of cash flow structure	Cash flow structure analysis
	Cash inflow and outflow rates	
	Net operating cash flow growth rate	Developing ability
	Cash cycle	Turnover ability
Investing activities risk Early warning index	Cash flow rate of total assets	Acquire cash ability
	Deviate from the standard ratio of cash flow	Quality of earnings
	Ratio of cash flow structure	Cash flow structure analysis
	Appropriate ratio of investment	Cash Sufficiency
	Reinvestment cash ratio	
	Investing activities net cash flow growth rate	Developing ability
Financing activities risk Early warning index	Cash flow ratio	Debt paying ability
	Total debts Cash flow ratio	
	Current asset cash ratio	Fluidity
	Cash interest cover	Financial flexibility
	Purchase cash ratio	
	External financing ratio	

3 Early Warning Index System of Financial Risk Based on Cash Flow

This article constructs the early warning index system of financial risk mainly by the introduction of cash flow and the concrete explanation is in Table 1:

4 Early Warning Model of Financial Risk Based on Enterprises Life Cycle

This article will build up an early warning model financial risk with the theory of grey system and the detailed process is as follows.

4.1 Design of the early warning model of financial risk

The main design of grey system model has such stages as follows:

(1)Suppose the primitive array $X = \left[X_{(1)}, X_{(2)}, \cdots, X_{(n)} \right]$ is an unsmooth array.

(2)Suppose σ is a threshold decided, the th net cash flow is $X_i, i = 1, 2, \cdots, n.$

(3)When $X_i < \sigma$, X_i is an informal number. All of the informal numbers form a disaster collection, then:

$$X_{\xi} = \left[X_{(T1)} \big| 1 \in L, L = (1, 2, 3, \cdots, s) \right]$$

(4) Assume $X^{(0)} = (t_1, t_2, t_3, \cdots, t_s), t_1 \Leftrightarrow i, t_2 \Leftrightarrow j, t_3 \Leftrightarrow k, \cdots, t_s \Leftrightarrow q$ is a disaster time distribution, and then we call $X^{(0)} = \left[t \big| t \in H, H = (i, j, k, \cdots, q) \right]$ is a disaster time collection of net cash flow.

(5) Suppose $X^{(1)}$ is the aggregate array of $X^{(0)}$: $X^{(1)} = \left[X^{(1)}(1), X^{(1)}(2), \cdots X^{(1)}(n) \right]$

(6) Assume $Z^{(1)}(K) = 1/2 \left[X^{(1)}(K-1) + X^{(1)}(K) \right]$ $(K = 2, 3, \cdots n)$,

Then we construct a data matrix B as follows:

$$B = \begin{vmatrix} -Z^{(1)}(2) & 1 \\ -Z^{(1)}(3) & 1 \\ \vdots & \vdots \\ -Z^{(1)}(n) & 1 \end{vmatrix},$$ we call $X^{(0)}(K) + aZ^{(1)}(K) = b$ is disaster amount GM(1,1).

In which, a is development coefficient and b is grey action.

(7)Suppose, $\hat{a} = \begin{bmatrix} a \\ b \end{bmatrix}$, then evaluate parameter $\hat{a}$ with method of least square, $\hat{a} = (BTB)^{-1} B^T Y$

$$Y = \left[X^{(0)}(2), X^{(1)}(3), \cdots X^{(0)}(n) \right]^T$$

(8)The reactive array of disaster time array GM（1，1）:

$$\begin{cases} \hat{X}^{(1)}(S+1) = \left[X^{(0)}(1) - \dfrac{b}{a} \right] e^{-as} + \dfrac{b}{a} \\ \hat{X}(S+1) = \hat{X}(S+1) - \hat{X}^{(1)}(S), S \geq 1 \end{cases}$$

It's $(S+1) = \left(1 - e^{-as} \right) \left[X^{(0)}(1) - \dfrac{b}{a} \right] e^{-as}$

(9) If $\hat{X}^{(0)} = \left[\hat{X}^{(0)}(1), \hat{X}^{(0)}(2), \cdots, \hat{X}^{(0)}(n), \hat{X}^{(0)}(n+1) \right]$, the last n numbers are fitted value of $X^{(0)}$, and $\hat{X}^{(0)}(n+1)$ is Early warning value.

(10) Test the accuracy of the model

The residual value $\varepsilon(S) = \hat{X}^{(0)}(S) - X^{(0)}(S), S = 1, 2, \cdots, n$

The relative mistake $\Delta_S = \dfrac{|\varepsilon(S)|}{X^{(0)}(S)}$

The average relative deviation $\overline{\Delta} = \dfrac{1}{n} \sum\limits_{S=1}^{n} \Delta_S$

The rank of accuracy is as shown in the table 2:

Table 2   The Rank of Accuracy table

the Rank of Accuracy	First grade	Second grade	Third grade	Fourth grade
the average relative deviation	0.02	0.05	0.1	0.2

4.2 Amendment of the model

The model ahead doesn't concern the impact of life cycle to forecast results. So we put in compensation factor $dy_i = (i = 1, 2, 3, 4)$ in the last number responsive GM（1，1）to amend the mode.

Then we get the main factors infecting the dividing of life cycle such as enterprises age、sales volume、scale and organization structure with questionnaire survey and Delphi method, and then give the experts assess according to impact of each factor to the life cycle character， then get the evaluation of dy_i. dy_i can be calculated as follows：$dy_i = \sum X_i y_i / 4,$ $i = 1, 2, 3, 4$

In which, X_1 is age of enterprises, X_2 is cash flow, X_3 is sales volume, X_4 is the scale of enterprises；y_1 is start-up stage，y_2 is expansion stage，y_3 is profitable stage，y_4 is decline stage.

The model amended of enterprises life cycle is：

$$\hat{X}(S+1) = \left(1 - e^{-as}\right)\left[X^{(0)}(1) - \frac{b}{a}\right]e^{-as}dy_i, \qquad i = 1, 2, 3, 4$$

5 Conclusions

From the perspective of life cycle of enterprises and choosing the cash flow index, this article builds an early warning model of financial risk with grey system theory. The model has advantages of representative index, quantitative analysis and comprehensive evaluation, which can help enterprises to identify and efficiently avoid the financial risk in time.

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