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.

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>
<thead>
<tr>
<th>Category</th>
<th>Index</th>
<th>Purpose analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating activities risk</td>
<td>The current rate of sales</td>
<td>Quality of earnings</td>
</tr>
<tr>
<td>Early warning index</td>
<td>Net operating cash ratio</td>
<td></td>
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<td></td>
<td>Net operating cash per share</td>
<td>Acquire cash ability</td>
</tr>
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<td></td>
<td>Ratio of cash flow structure</td>
<td>Cash flow structure analysis</td>
</tr>
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<td></td>
<td>Cash inflow and outflow rates</td>
<td></td>
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<td></td>
<td>Net operating cash flow growth rate</td>
<td>Developing ability</td>
</tr>
<tr>
<td></td>
<td>Cash cycle</td>
<td>Turnover ability</td>
</tr>
<tr>
<td>Investing activities risk</td>
<td>Cash flow rate of total assets</td>
<td>Acquire cash ability</td>
</tr>
<tr>
<td>Early warning index</td>
<td>Deviate from the standard ratio of cash flow</td>
<td>Quality of earnings</td>
</tr>
<tr>
<td></td>
<td>Ratio of cash flow structure</td>
<td>Cash flow structure analysis</td>
</tr>
<tr>
<td></td>
<td>Appropriate ratio of investment</td>
<td>Cash Sufficiency</td>
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<td></td>
<td>Reinvestment cash ratio</td>
<td></td>
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<td></td>
<td>Investing activities net cash flow growth rate</td>
<td>Developing ability</td>
</tr>
<tr>
<td>Financing activities risk</td>
<td>Cash flow ratio</td>
<td>Debt paying ability</td>
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<td>Early warning index</td>
<td>Total debts Cash flow ratio</td>
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</tr>
<tr>
<td></td>
<td>Current asset cash ratio</td>
<td>Fluidity</td>
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<td>Cash interest cover</td>
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<td></td>
<td>Purchase cash ratio</td>
<td>Financial flexibility</td>
</tr>
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<td></td>
<td>External financing ratio</td>
<td></td>
</tr>
</tbody>
</table>
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 \( X = [X_{(1)}, X_{(2)}, \cdots, X_{(s)}] \) is an unsmooth array.

2) Suppose \( \sigma \) is a threshold decided, the \( i \) 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:

\[
X_{(i)} = [X_{i(1)}, L, L = (1, 2, 3, \cdots, s)]
\]

4) Assume \( X^{(0)} = (t_1, t_2, t_3, \cdots, t_s), t_i \Leftrightarrow i, t_2 \Leftrightarrow j, t_s \Leftrightarrow q \) is a disaster time distribution and then we call \( X^{(0)} \) 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 \( Z^{(1)}(K) = \frac{1}{2} \left[ X^{(1)}(K-1) + X^{(1)}(K) \right] \) \( (K = 2, 3, \cdots n) \)

Then we construct a data matrix \( B \) as follows:

\[
B = \begin{bmatrix}
-Z^{(1)}(2) & 1 \\
-Z^{(1)}(3) & 1 \\
\vdots & \vdots \\
-Z^{(1)}(n) & 1 \\
\end{bmatrix}
\]

we call \( X^{(0)}(K) + aZ^{(1)}(K) = b \) is disaster amount GM(1,1).

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

(8) The reactive array of disaster time array GM(1, 1):\( \hat{X}(S+1) = \left[ X^{(0)(1)} - \frac{b}{a} \right] e^{-\alpha} + \frac{b}{a} \)

\( \hat{X}(S+1) = \hat{X}(S+1) - \hat{X}^{(0)}(S), S \geq 1 \)

It’s \( (S+1) = (1 - e^{-\alpha}) X^{(0)}(1) - \frac{b}{a} e^{-\alpha} \)

(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 \( \hat{X}^{(n+1)} \) is Early warning value.

(10) Test the accuracy of the model

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

The relative mistake \( \Delta_S = \frac{\|e(S)\|}{X^{(0)}(S)} \)

The average relative deviation \( \bar{\Delta} = \frac{1}{n} \sum_{S=1}^{n} \Delta_S \)

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

<table>
<thead>
<tr>
<th>the Rank of Accuracy</th>
<th>First grade</th>
<th>Second grade</th>
<th>Third grade</th>
<th>Fourth grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>the average relative deviation</td>
<td>0.02</td>
<td>0.05</td>
<td>0.1</td>
<td>0.2</td>
</tr>
</tbody>
</table>

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 \( dy_i \) can be calculated as follows: 

\[
\hat{X}(S + 1) = \left[ \begin{array}{c}
1 - e^{-\omega} \\
X^{(0)}(t) - \frac{b}{a} \\
e^{-\omega} dy_i
\end{array} \right], \quad i = 1, 2, 3, 4
\]

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.

References

