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Investment Risk Evaluation and Preventive Measures in Chemical Industry

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Chemical industry is one of important cornerstone industries in China. Along with the irresistible development of China's economy, the speculative risks of China's chemical companies have been coming up as a major impediment to development of China's chemical industry to a certain extent. In this sense, it is of great significance to explore investment risks and preventive measures for chemical companies. Based on the Analytic Hierarchy Process (AHP), this paper builds a chemical investment risk analysis indicator system that involves four major ones, i.e. profitability, operation capacity, solvency, and development capacity. We take the chemical company M as a study case to analyze their investment risks herein. According to the results from analysis, M's investment risk in 2017 made a composite score of 64.32; the risk exposure was relatively high; these figures show that there are huge problems on many indicators. Hence, aiming at huge stakes in business investment, M should take specific preventive measures against risks to constantly facilitate the rationalization of the investment risk management process, examine and assess the implementation effect of investment projects in a timely manner, in conjunction with potential investment risks.

1. Introduction

As china's economy grows, inward and outbound investments that ensue in the companies have aroused wide concern of scholars (Love et al., 2005). The chemical industry as one of dominant industries in China also faces a string of risks such as political risks, economic risks, technological risks, and accident risks, etc., in the process of development (Stoessel, 2008). In recent years, the investment risks of China's chemical companies have increasingly exposed some issues, e.g., poor management practices, insufficient awareness of risks, and improper treatment at risks, which causes an impedance to the development of China's chemical industry to some extent. By far, it is imperative for us to probe into the venture capitals and preventive measures against these for chemical companies (Naito et al., 2003; Jiang and Liu, 2018).
Many scholars at home and abroad have made extensive studies on the investment risks and preventive measures for chemical companies. Their efforts have borne a wealth of fruits. Some focused on the causes of investment risks in chemical companies (Huang et al., 2008; Wickliffe et al., 2014; Krupskaya and Zvereva, 2014); some got down to the risk management for chemical companies (Larsen, 2006; Egeghy et al., 2011; Grimm and Thorbek, 2014); there are also some scholars who lay emphasis on how to prevent against the investment risks properly (Amzal et al., 2014; Wang et al., 2016). Now we take a chemical company A in Beijing as study case to investigate how to control the risk with appropriate measures proposed herein. It could be said that this study indeed has a strong directive significance for future practices.

2. AHP definition

The Analytic Hierarchy Process (AHP) is a systematic analysis method that integrates qualitative and quantitative analysis. Its principal principle is to rank various factors according to their system membership functions into several levels in descending order, whereby to associate the elements in different levels with each other, determine relative importance of each level based on objective facts, and evaluate the weight of the relative importance of any element in each level using mathematical algorithms. By sorting these results,

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we can analyze and make decisions on some issues (Saaty, 1994). The specific procedures of AHP modeling are given below:

2.1 Build a hierarchical structure model

As goals and functions to be realized differ from each other, the system is divided into three levels. In descending order, it comes in turn the target level, middle level, and program level (Ghodsypour and O'Brien, 2005). The relationship between levels in the hierarchy structure model can be illustrated in Fig. 1.

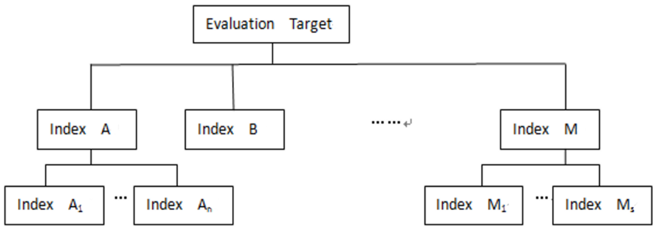

Figure 1. General hierarchy of AHP model

2.2 Construct a judgement matrix

Table 1: judgment matrix in AHP

D	X_1	X_2	...	X_n
X_1	a_{11}	a_{12}	...	a_{1n}
X_2	a_{21}	a_{22}	...	a_{2n}
:	:	:	:	:
X_n	a_{n1}	a_{n2}	...	a_{nn}

In Table 1, the judgment matrix of the indicators in level 1 is the importance comparison matrix among the indicators under the domination of the total target D.
In general, we mainly use the 1-9 scale method to quantify the relative importance of logical judgments. The specific meaning is shown in Table 2.

Table 2: The scale of Judgment matrix and its meaning

Scale	Meaning
1	The two factors are equally important
3	A factor is more important than the other factor when compared to the two factor
5	A factor is obviously more important than the other factor when compared to the two factor
7	A factor is strongly more important than the other factor when compared to the two factor
9	A factor is extremely more important than the other factor when compared to the two factor
2, 4, 6, 8	The median value of the two adjacent judgments
reciprocal	The two factor is the reciprocal of the original comparative value

When the first-level indicators compare to each other, the importance degrees are equal, that is, $a_{ij}=1$ (i=j). Due to the mutuality of the pairwise comparisons, it can be concluded that $a_{ij}\times a_{ji}=1$, so that the judgment matrix constitutes a reciprocal matrix (Dyer, 1990).

2.3 Calculate relative weights from the judgment matrix

The maximum eigenvalue and eigenvector in the judgment matrix are calculated using the geometric mean approximation method with the following steps:
(a) Calculate the product of elements in each line of the matrix

$$m_i = \prod_{i=1}^{n} a_{ij}, i = 1,2,\cdots,n \tag{1}$$

(b)Calculate the n-root

$$\overline{w_i} = \sqrt[n]{m_i} \tag{2}$$

(c) Normalize the vector $\overline{w_i} = (\overline{w_1}, \overline{w_2}, \cdots \overline{w_n})^T$

$$w_i = \frac{\overline{w_i}}{\sum_{j=1}^{n}\overline{w_j}} \quad j = 1, 2, \cdots, n \tag{3}$$

Then $w_i = (w_1, w_2, \cdots, w_n)^T$, it is an approximate value of eigenvector to be solved, i.e. the weight of each factor.

(d) Calculate the max eigenvalue λ_{max}

$$\lambda max = \sum_{i=1}^{n} \frac{(AW)_i}{nW_i} \tag{4}$$

$$A \cdot W = \begin{bmatrix} a_{11}a_{12} & \cdots & a_{1n} \\ a_{21}a_{22} & \cdots & a_{2n} \\ \vdots \quad \vdots & \cdots & \vdots \\ a_{n1}a_{n2} & \cdots & a_{nn} \end{bmatrix} \cdot \begin{bmatrix} W_1 \\ W_2 \\ \vdots \\ W_n \end{bmatrix} \tag{5}$$

$$(A \cdot W)_i = a_{i1}W_1 + a_{i2}W_2 + \cdots + a_{in}W_n \tag{6}$$

2.4 Check the consistency of single hierarchical arrangement

The factors at a level are compared based on those at the above level, to obtain the weight of this level (Vargas, 1990). When preforming single arrangement on each level, it is required to perform consistency check. We can achieve this by calculating the consistency ratio CR of the judgment matrix: $CR = \frac{CI}{RI}$.
Where, RI is the average random consistency indicator; CI is the consistency indicator: $CI = \frac{\lambda max - n}{n-1}$.
Where, λ_{max} is the maximum eigenvalue of the characteristic equation; n is the order of the judgment matrix.
The assignment values of RI are shown in Table 3.

Table 3: The average consistency index

N	1	2	3	4	5	6	7	8	9	10	11
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.51	1.67

For a judgment matrix of the order n>2, if CR<0.1, it means that the judgment matrix has satisfactory consistency. Otherwise CR≥0.1.

2.5 Rank the levels and perform the consistency check

It is necessary to calculate the ranking weight of relative importance of all elements at the indicator layer to the top level, that is, multiply the weights of the last-level elements in turn by the relative weights of the controlled elements at the previous level after their respective weights have been formed in their own subsystems, thus the absolute weight of each element relative to the total goal is formed (Ho, 2008). The consistency check on the total sort of the levels is also achieved by CR. The formula is given as follows: $CR = \frac{\sum B_i CI_i}{\sum B_i RI_i}$.
Where, $B_i$is the weight of each subsystem. Similarly, if CR<0.1, it means that the total sorting of the levels has satisfactory consistency; otherwise CR≥0.1.

2.6 Obtain the evaluation results

Based on the analytic hierarchy process, the weights of each indicator in the indicator level relative to the target level are $w_1, w_2, \cdots, w_n$, respectively. The indices obtained after nondimensionalization are $r_1, r_2, \cdots, r_n$ by the formula: $D = r^* w^T$.

3. Investment Risk Assessment for Chemical Industry

China is generally recognized as a chemical superpower in the world. In 2017, China’s chemical product output accounted for 36%. The vast majority of chemicals have a capacity that ranks first in the world. Numerous companies in this industry in China have sprung up year by year. As of 2017, the number of companies in the chemical industry in China has reached 24,897, as shown in Fig. 2.

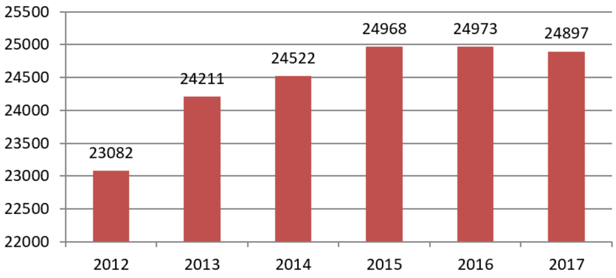

Figure 2: The number of chemical enterprises in China (2012-2017)

This paper takes chemical company M as the object to assess its investment risk. First, build a risk assessment indicator system, as shown in Fig. 3.
Target layerStandard layerScheme layer

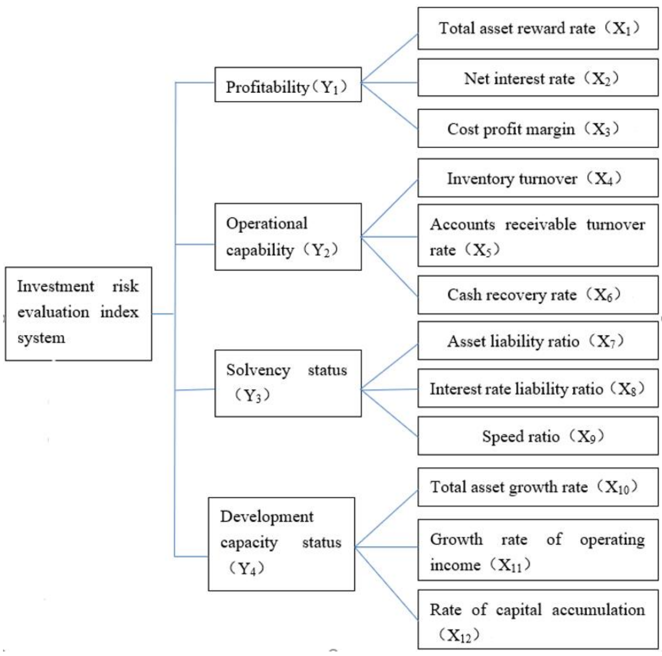

Figure 3: Model of investment risk evaluation index system

For the weight of indicators, matrix data can be available from the scores given by experts. The well-known experts in the industry are chosen to mark the score on the importance of the indicators so as to obtain the judgment matrices of the criterion levels Y_1, Y_2, Y_3, Y_4, refer to Table 4 for details.

Table 4: Expert scoring result table

	Y_1	Y_2	Y_3	Y_4
Y_1	1	2	4	3
Y_2	1/2	1	1/4	3
Y_3	1/4	4	1	2
Y_4	1/3	1/3	1/2	1

Figure out the mean value of each line based on data in Table 4, then $\overline{\beta_1} = 2.21, \overline{\beta_2} = 0.72, \overline{\beta_3} = 1.64, \overline{\beta_4} = 0.67$,and calculate the weights β_i, they are β_1=46.85%, β_2=15.25%, β_3=32.75%, β_4=10.25%.
Then reckon λmax of the judgment matrix by the formula: $\lambda\text{max} = \frac{1}{\text{n}}\sum_{i=1}^{4}\frac{(A\beta)_i}{\beta_i}$.
At last, it follows that λ_{max}=5.125. According to the foregoing formula, CI=0.0017 and RI=0.98, then CR=0.0019<0.1, so it is confirmed that the matrix is available.

The individual indicators for investment risk inM are ranked level by level. The specific results are shown in Table 5.

Table 5: M chemical enterprise investment risk evaluation index weight table

Standard layer	Weight	Scheme layer	Weight
		Total asset reward rate (X_1)	12.24%
Profitability (Y_1)	46.85%	Net interest rate (X_2)	24.38%
		Cost profit margin (X_3)	11.25%
		Inventory turnover(X_4)	7.35%
Operational capability (Y_2)	15.25%	Accounts receivable turnover rate (X_5)	5.67%
		Cash recovery rate (X_6)	2.49%
		Asset liability ratio (X_7)	11.74%
Solvency status (Y_3)	32.75%	Interest rate liability ratio (X_8)	8.23%
		Speed ratio (X_9)	11.29%
		Total asset growth rate (X_{10})	3.02%
Development capacity status (Y_4)	10.25%	Growth rate of operating income (X_{11})	5.17%
		Rate of capital accumulation (X_{12})	2.04%

Only the weight of each indicator does not intuitively reflect the investment risk of chemical companies. It is required to perform standardized computation on various indicators to determine what investment risks M faces now. The score of each indicator is calculated by the efficiency coefficient method, as shown in Table 6.

Table 6: Evaluation results of each index of M chemical industry in 2017

Index	Actual value	Weight	Standard coefficient	Base division of this file	Efficiency coefficient	Adjustment points	Basic score
X_1	11.25	12.24%	1.0	11.58	1	0	11.58
X_2	2.79	24.38%	0.2	4.82	0.46	2.17	6.99
X_3	4.24	11.25%	0.5	6.24	0.68	1.21	7.45
X_4	4.37	7.35%	0.6	2.51	0.49	0.62	3.13
X_5	8.56	5.67%	0.5	3.53	0.04	0.05	3.58
X_6	17.02	2.49%	0.6	1.41	0.62	0.24	1.65
X_7	46.43	11.74%	1.0	13.01	1	0	13.01
X_8	42.55	8.23%	0.7	6.23	0.59	0.74	6.97
X_9	0.71	11.29%	0.4	4.23	0.87	2.15	6.38
X_{10}	-13.74	3.02%	0.3	0.61	0.74	0.31	0.92
X_{11}	-32.78	5.17%	0	0	1	0	0
X_{12}	117.28	2.04%	1.0	2.45	1	0.21	2.66

Based on data in Table 6, we get the sum of the basic scores for all indicators. Eventually the composite score of M's investment risk is calculated as 64.32.

The scope of composite score and its risk exposure are shown in Table 7. We can see from this that the composite risk score of M falls within 60-70, the risk exposure level is relatively high, which shows that there are huge stakes in business investment process of M, and great issues are exposed to many indicators.

Table 7: Investment risk assessment set

Scoring interval	90-100	80-90	70-80	60-70	0-60
Risk situation	No risk	Focus on risk	Small risk	Greater risk	Major risk

In the future, aiming at the risks of chemical company Mand the like in the investment process, targeted measures against the risks should be taken to greatly facilitate the rationalization of the investment risk management process, examine and assess the implementation effect of venture projects in a timely manner. The potential investment risks should also be measured in real time.

4. Conclusions

The AHP helps build a chemical investment risk indicator system, where there are four major indicators, i.e. profitability, operation capacity, solvency, and development capacity. Each indicator covers sub-indicators, there are 12 in total. This paper takes the chemical companyM as the study case to analyze its investment risk. The resultsreveal that M's investment risk makes a composite score of 64.32 in 2017, and the risk exposure is relatively high. Many indicators have huge problems. Whence, against the huge stakes in the business investments, M should take specific preventive measures to constantly facilitate the rationalization of the investment risk management process, examine and evaluate the implementation effect of investment projects in a timely manner, in junction with potential investment risks.

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