# Analysis on Fuzzy Comprehensive Evaluation Model of Overseas Investment Risk of Chinese Enterprises in “One Belt and One Road” based on Eviews Software

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Abstract: This paper explains the present situation and the types of operational risk of Chinese foreign investment in “One Belt and One Road (OBOR)”. Then, the operational risk monitoring system of Chinese enterprises' overseas investment in “One Belt and One Road” is constructed. On this basis, it uses the fuzzy comprehensive evaluation model to analyse Chinese enterprises' overseas investment risk in “One Belt and One Road”. Furthermore, Eviews software is used to calculate the result of Chinese enterprises' overseas investment risk in “One Belt and One Road”. Finally, it analyzes and summarizes the risks of Chinese enterprises' overseas investment in “One Belt and One Road”.

## 1 INTRODUCTION

Since China proposed the “one belt and one road” initiative in 2013, Chinese enterprises' overseas investment in “one belt and one road” has increased year by year. At present, the net stock of overseas investment in “one belt and one road” by Chinese enterprises has reached 110 billion US dollars, including overseas investment from 65 countries. More than 27,000 Chinese enterprises have participated in overseas investment (Fu, 2020). Overseas investment in “one belt and one road” needs a complicated process, and the risks can not be estimated. Overseas investment has become one of the three major forces driving China's economy. Only by giving full play to the role of overseas investment can China's economy achieve steady development. Therefore, we should pay more attention to how to reduce investment risks in “one belt and one road” (Callahan, 2017).

## 2 INDENTIFICATION OF OPERATIONAL RISK INFORMATION

There are many operational risks in Chinese enterprises' overseas investment in “one belt and one road” (Chen, 2018). The purpose of this paper is to classify these risks and form an appropriate combination set. In essence, overseas investment in “one belt and one road” by Chinese enterprises can be divided into five types, each of which contains corresponding sub-factors. In a word, the risk types include: political risk, operational risk, legal risk, cultural difference risk, and specific industry risk (Harjoto, 2018).



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# 3 CONSTRUCTION OF MONITORING SYSTEM FOR OPERATIONAL RISK OF CHINESE ENTERPRISE OVERSEAS INVESTMENT IN "ONE BELT AND ONE ROAD"

## 3.1 Thought for Constructing Monitoring System for Operational Risk of Chinese Enterprise Overseas Investment in "One Belt and One Road"

It is a very complicated process for enterprise to do overseas investment in "one belt and one road", the risk factors are various and uncertain, which makes evaluation of investment risk difficult to be measured by one or several indicators. The paper has adopted the analytic hierarchy process combined with fuzzy comprehensive evaluation to comprehensively appraise risks from overseas investment in "one belt and one road" of Chinese enterprise through the build-up of a set of relatively objective indicator system (Mohammed, 2016). The basic thought for appraising Chinese enterprise overseas operational risk is as follows:

1) Evaluating the fundamental factors constructed against Chinese enterprise overseas investment risks as well we the correlation among the factors;

2) The selection of appraisal indicators follows comprehensive and objective principle as well as the feature of comprehensive evaluation;

3) Result from the evaluation should not only sort the evaluation objects, but also analyse the evaluation result, through which the reason influencing the overseas investment risk should be found out for the purpose of providing Chinese enterprises with ideas to improve and enhance their ability to manage overseas investment risks in "one belt and one road".

## 3.2 Principles for Constructing Monitoring System for Operational Risk of Chinese Enterprise Overseas Investment in "One Belt and One Road"

Constructing a scientific, objective and practical risk evaluation monitoring system can effectively control and avoid the possible risks confronted by investments, so as to smoothly implement the investment projects and realize maximum profit in "one belt and one road" (Samet, 2017). The principles that require Chinese enterprise to follow in establishing investment risk monitoring system include: 1) monitoring system should follow comprehensive and scientific principles; 2) monitoring system should be logical and stratified; 3) monitoring system should be operational; 4) the difference principle of indicator system.

## 3.3 Construction of Monitoring System for Operational Risk of Chinese Enterprise Overseas Investment in "One Belt and One Road"

According to the thoughts and principles for selecting the above indicators, in combination with the categories of Chinese enterprise overseas investment risks in "one belt and one road", the monitoring system for operational risk of Chinese enterprise overseas investment in "one belt and one road" can be set up from three layers: target layer, standard layer and indicator layer (Bai, 2010).

# 4 COM PARISON AND SELECTION OF CHINESE ENTERPRISE OVERSEAS INVESTMENT RISK EVALUATION MODEL IN "ONE BELT AND ONE ROAD"

## 4.1 Determination of Chinese Enterprise Overseas Investment Risk Evaluation Indicator System

According to the monitoring system features, the analytic hierarchy process is adopted to determine the weight of indicator system. The analytic hierarchy process divides the complicated system into a few groups of factors, which form gradual hierarchy after being grouped according to dominant and subordinate relationship. By comparing each two factors, relative importance is determined and the relative importance of the target program is determined for program to choose. The whole process shows human analysis, judgement and realizes the qualitative and quantitative combination. The steps for determining the weight of analytic hierarchy process are as follows (Zhang, 2010).

## 4.2 Define the Problems to be Analysed

Before analysing problems, a clear idea of the problems should be gained, including the scope related to the problems and factors involved, correlation and subordinated relation between the factors should be determined, the final issue to be solved should be extremely defined at the beginning.

## 4.3 Set up of Hierarchical Structure for Problem Research

To set up a good hierarchical structure is the basis of calculation and analysis, for constructing a hierarchical structure to study the problems, we must first analyse various factors in the system, form different hierarchical relations by taking their possible dominant and subordinated relations into consideration. The subfactors are subject to the domination of the superior levels, hence a hierarchical structure is formed. The top of the layer is the target structure, there is only one factor, which is the whole decision objective. As a standard middle layer, that is the conditional factors for consideration. The bottom of the layer is the decision layer, where decision makers can select the appropriate program through the previous analysis.

## 4.4 Chinese Enterprise Overseas Investment Risk Evaluation Model in "One Belt and One Road"

Number from the matrix is used to obtain the accurate weight of the indicators, the steps are as follows:

First, calculation of multiplying the factors on each row of the judgement matrix

$$M_i = \prod_{j=1}^{n} a_{ij} (i, j = 1, 2, \cdots, n)$$

Second, calculate the n root of $M_i$

$$\overline{W}_i = \sqrt[n]{M_i}$$

Third, normalization calculation of vector $\overline{W} = (\overline{W}_1, \overline{W}_2, \cdots, \overline{W}_n)^T$, that is:

$$w_i = \overline{w_j} / \sum_{i=1}^{n} \overline{w_i} \quad (i = 1, 2, \cdots, n)$$

After the normalization calculation, $W = (W_1, W_2, \cdots, W_n)^T$ is the weight vector obtained.

Fourth, the formula for obtaining biggest characteristics root of the judgement matrix:

$$\lambda_{max} = \sum_{i=1}^{n} \frac{(AW)_j}{nW_j}$$

Where $(AW)_j$ refers to the j factor of $AW$ vector.

Fifth, consistency test and random test of the judgement matrix.

Judgement matrix constructed cannot be the matrix with absolute consistency, its consistency indicator can affirm the solution of practical problems in a certain range, as long as the consistency meets the requirement, some problems can be avoided, after obtain the value of $\lambda_{max}$, consistency and random tests should be conducted, here CI (measurement deviation consistency index) is introduced, RI (average consistency indicator), CR (random consistency rate).

$$CI = \frac{\lambda_{max} - n}{n - 1}$$

RI (average consistency indicator), as shown in Table 1.

When the random consistency rate $CR = \frac{CI}{RI} \leq 0.10$, judgement matrix has satisfactory consistency, then the value obtained is reasonable, otherwise more effort should be made to adjust the judgement matrix until the satisfactory consistency result is obtained.

Sixth, combination weight calculation and consistency test If the indicator system is the n-layer structure, then the combination weight of the n th (each factor of the layer) against the target layer is:

$$\omega_n = W_{(n)} \bullet W_{(n-1)} \cdots W_{(3)} \bullet \omega_2$$

Where, $\omega_n$ is the matrix formed by line vector of each factor in n th layer.

After the above calculation, in order to determine whether the whole layer is conformed with the consistency requirement, the analytic hierarchy process requires combination consistency test, the method is as follows: assume consistency of the nth layer are $CI_1^{(n)}, \cdots, CI_i^{(n)}$, random disposable indicator are $RI_1^{(n)}, \cdots, RI_i^{(n)}$ (i is the number of factors of n-1layer).

Table 1: RI Value of 1-10 Order Judgement Matrix.

| Order | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| RI | 0.0 | 0.0 | 0.6 | 0.9 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.5 |

$$CI^{(n)} = \left[ CI_1^{(n)}, \cdots, CI_i^{(n)} \right] \omega^{(n-1)}$$

$$RI^{(n)} = \left[ RI_1^{(n)}, \cdots, RI_i^{(n)} \right] \omega^{(n-1)}$$

$$CR^{(n)} = CR^{(n-1)} + \frac{CI^{(n)}}{RI^{(n)}}, n = 3, 4, \cdots$$

When the combination consistency rate $CR^{(n)} < 0.1$, the whole structure satisfies the consistency needs, and passes the consistency pressure-relief. Then corresponding appropriate program can be chosen according to the combination weight sequence, which provides basis for decision making.

# 5 FUZZY COMPREHENSIVE EVALUATION MODEL IN "ONE BELT AND ONE ROAD"

## 5.1 Fundamental of Fuzzy Comprehensive Evaluation Model in "One Belt and One Road"

In the process of evaluating overseas investment risk in "one belt and one road", there are a large number of monitoring indicators, the analytic hierarchy process is used for layering, them fuzzy comprehensive evaluation is conducted against the subfactors, systematically and comprehensively evaluate the risks in overseas investment, this is the process of multistage fuzzy comprehensive evaluation, the model established is called fuzzy comprehensive evaluation model.

## 5.2 Steps for Constructing Fuzzy Comprehensive Evaluation Model in "One Belt and One Road"

*1) Establish the Fuzzy Comprehensive Evaluation Model in "one belt and one road.*and bottom of columns.

a) *Establishment of universe of each factor theory of the evaluation object, set as U.* That is, from what angle and what factor to evaluate the risk object, this step has established the evaluation factor system.

$$U = (U_1, U_2, \cdots, U_n)$$

*b) Set up universe of review rating V*

$$V = (V_1, V_2, \cdots, V_m)$$

Determine a process of the universe, that is a fuzzy evaluation vector can be obtained after the fuzzy comprehensive evaluation, each factor evaluated can obtain the value of the degree of subordination from the review registration, can be presented by the fuzzy vector, this step reflects the fuzzy characteristic of the evaluation. Universe of review rating are set into such five orders as super low, relatively low, middle, relatively high and super high.

*c) Evaluation of the single factor on the second layer, establish fuzzy relation matrix R*

$$R = \begin{pmatrix} R_{11} & \cdots & R_{1m} \\ \vdots & \ddots & \vdots \\ R_{n1} & \cdots & R_{nm} \end{pmatrix}$$

Where $r_{ij}$ refers to the subordination between $U_i$ in factor U and $V_j$ in order V, i.e, $U_i$ is rated the subordination of $V_j$. $r_{ij}$ is the single factor evaluation of ith factor against the evaluation object, fuzzy comprehensive evaluation is based on the single factors.

*2) Set up evaluation weight vector A*

Adopt fuzzy method to endow every factor with different weights, the weight evaluation combination obtained is a fuzzy subset in factor theory universe U: $A = \{a_1, a_2, a_3, \cdots, a_n\}$, and $\sum_{i=1}^{n} a_i = 1$.

*3) Select composition operator for comprehensive evaluation calculation*

Formula of the basic model of fuzzy comprehensive evaluation:

$$B = A \circ R$$

Where "∘" means the composition operator as in $B = \{b_1, b_2, b_3, \cdots, b_n\}$, it is a fuzzy subset in review set. If the fuzzy comprehensive evaluation result $\sum_{i=1}^{n} b_i \neq 1$, appropriate ways should be used for normalization.

## 5.3 Steps for Constructing Multistage Fuzzy Comprehensive Evaluation Model in "One Belt and One Road"

*1) Factors sets U are divided into several subsets.* As in $U = (U_1, U_2, \cdots, U_p)$, the ith subset $U = (U_{i1}, U_{i2}, \cdots, U_{ik}), (i = 1, 2, \cdots, p)$, then

$$\sum_{i=1}^{p} ki = n$$

*2) For each $U_i$, respective comprehensive evaluation is conducted.* And the factor weight distribution is $A_i$, $U_i$ fuzzy evaluation matrix is $R_i$, then

$$B_i = A_i \circ R_i = (b_{i1}, b_{i2}, \cdots, b_{im}), (i = 1, 2, \cdots, p)$$

*3) Take the comprehensive evaluation B.* $B_i$ of $U_i$ in $U = (U_1, U_2, \cdots, U_p)$ as p single factor evaluation in U, the total fuzzy comprehensive evaluation matrix is obtained:

$$R = \begin{bmatrix} B_1 \\ B_2 \\ \vdots \\ B_n \end{bmatrix} = (b_{ij})_{pm}$$

After a few times of fuzzy synthetic computing, formula for grade-two fuzzy comprehensive evaluation results is:

$$B = A \circ R$$

Chinese enterprises face various risks when investing overseas in "one belt and one road". Through the above model, after analyzing the risks with Eviews software, the risk probability is between 0.3 and 0.5, and the risk level belongs to the middle and low range. We also find that operational risk, political risk, legal risk and regulatory risk have a high probability of occurrence. In addition, the probability of occurrence of risk from cultural differences and specific industries also needs the same attention. Then, we can put forward corresponding strategies for individual risk, thus providing countermeasures and basis for the decision makers. In this way, Chinese enterprises can avoid risks and achieve better development by investing in "one belt and one road".

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