

## An Application of Fuzzy Analytic Hierarchy Process Evaluation

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### Abstract

*Unlike previous studies on political risk and Outward Foreign Direct Investment (ODI) that used macro-level ODI data to make analysis, this paper uses of firm-level data to study the relationship between political risk and ODI from institutional distance perspective. This paper builds a relative political risk evaluation system between home country (China and US) and host country (Russia) by Fuzzy Analytic Hierarchy Process (FAHP). We find that relative political risk strengthens China's ability of investing in Russia, and weakens US's. This paper argues that firms that desire investing in high political risk countries should cultivate their relative political risk advantages for their overseas investments.*

**Keywords:** fuzzy analytic hierarchy process, relative political risk, institutional distance

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### 1. Introduction

Recently in the field of international business, developing countries tend to demonstrate their enthusiastic tendencies in outward foreign direct investment (ODI). Taking China for example, by the end of 2011, China's ODI flows had reached 74.65 billion dollars, and ODI stock had reached 424.78 billion dollars, which had covered 177 countries and/or regions. Nowadays China's ODI flows rank sixth among the global ODI countries and rank first among the developing countries. However in recent years, the worsened political situation in North Africa, West Asia and East Asia has caused tremendous losses to countries all over the world. In the Libyan war, for example, China's investment in this country had suffered huge economic losses. In 2009, a survey of Multilateral Investment Guarantee Agency (MIGA) on the global 300 multinational enterprises showed that political risk had become the largest constraint to the internationalization of multinational corporations, and in the next three years, its importance would continue to rise. Thus, the firms in host countries, which are under the internationalization process, should pay more attention to political risk due to its great influence on outward foreign direct investment.

We find that nowadays there are some interesting phenomena in the field of outward foreign direct investment. When investing in a host country, the host-country political risk exerts different effect on home-country firms. High as in the Russian political risk, the Western countries have presented lukewarm enthusiasm in investment, shrinking investment in recent years, but the Chinese enterprises have made ever rising investment with great enthusiasm. What cause this phenomenon? Why countries with low technology, low level of managerial skills and small amount of money seem to give more importance to high political risk countries than developed countries do? Does host-country political risk exert even influence on firms from different home country? If not, what cause that? This study aims to figure them out.

Considerable researches have been done to study the relationship between political risk and ODI. Busse and Hefeker [1] and Cheung and Qian [2] state that high political risk indicates bad institutional quality in host country. High political risk means that the host country political situation is not stable, and high political risk makes negative effect on the development of host country. The threat of incidence of civil wars, political violence, trade sanctions or an all-out war increases the risk premium of investment projects, thus reducing overall managerial efficiency and increasing costs of investment. The consequences caused by political risk also

include sluggish domestic consumption, worsened investment environment and foreign exchange fluctuation. All of these make investments full of uncertainty and people halt to invest in this sort of country. Different from the studies above, Vadlamannati [3] uses of data on U.S. firms' investment activities in 101 developing countries during the period 1997-2007 to make an analysis. He finds that high political risk in host country is associated with a higher proportion of fixed assets, an increase in the return on investments, a reduce in management efficiency, and a decline in sales. Considering political risk in host country, the ODI firms tend to invest in stable countries and are reluctant to invest in country with high political risk [4]. However, previous studies regarding political risk take the absolute indices to make analyses and it's hard to explain developing countries', like China, ODI activities that Chinese firms are eager to invest abroad without absolute advantages. So we should take relative political risk into account in future research [5].

The influence mechanism between political risk and ODI also attract considerable researches interests. Institutional difference is the one of the most important factors affecting ODI. Entering informally-distant countries, firms are challenged to bridge differences between the home- and host-country market, which makes the chance of success slim [6]. The effects caused by host-country political risk are different as institutional distance changes. That's because distance makes firms face additional hazards, restrictions, and costs resulting from political, economic, and legal institutions. Hence the higher institutional distance is associated with more difficult adaptability to investment profile, and the rise in business cost and risk [7]. Schwens et al. [8] uses a data sample of 227 German SMEs to study the relationship between institutional distance and ODI. They find that firms attach great importance to institutional distance, and they find that small distance leads to competitive advantage in host country. Lots of studies have also been done to study the negative relationship between institutional distance and ODI firms. The greater the institutional distance between home and target country, the more difficult it is to transfer the former management model and adapt to local practices and preferences, the more uncertainty that firms have to take [9].

Existing literatures regarding political risk result from researches on country risk of ODI, which are written by western scholars for industrialized countries. Meanwhile, few researches for developing countries have been done. What's more, existing researches use macro-level data to study host-country political risk, ignoring that different home-country firms are differently affected by host-country political risk. Apart from previous studies, this paper uses firm-level data and starts from institutional distance perspective to study political risk in host country. We obtain several findings. Due to the heterogeneity of the firm's capability and external environment, firms from different countries are affected differently by different level of political risks. This paper also shows the political risk management capability can be cultivated by firms to adapt to political situation in host-country in order to obtain better performances on investment.

## 2. Theory Analysis Framework and Index Establishment

According to the institutional distance perspective, the institutional distance is behaved as two aspects: the external and internal factors. The external institutional distance factors include legal distance, cultural distance, political relation, economic relation, and policy quality. Previous studies find that investors from industrialized country that invest in countries with better institutions choose countries with the best democratic and legal institutions. On the contrary, those from developing country choose to invest in countries with worse institutions than at home, since institutional distance deters them. Cultural difference can lead to strangeness and the lack of identity between two countries, which makes foreign investors cost too much on getting familiar with the local market, searching for information of local market, communicating, negotiating, guaranteeing contract performing and other relative activities. The cost will lower the possibility and frequency of trading, at the same time, raise the cost of trade and increase the difficulty of business operation. The political relation has the great impact on commercial cooperation of firms between two countries. Vadlamannati [3] states the Bilateral Investment Treaty (BIT) signed by two countries as well as whether the countries are included in the same international organization makes obvious positive impact on investment. The economic relation also affects ODI profoundly, including two parts: the host-country economic dependence on home country and the friendly relationship caused by investment, aid and

trade, both of which affect the performance of investment in local market. Close and good economic relationship can improve firms' enthusiasm for ODI, meanwhile, not only cut down the cost of getting familiar with local market, culture, and environment, but also reduce the business uncertainty [10]. Quality Policy contains three characters: sustainability, security and comprehensiveness. Among them, sustainability is the most important feature to determine whether a policy is good or bad. The frequent changes of policy are the most anxious burdens for foreign investors. Fickle policy shall badly affect the firms' operation [11]. For example, fluctuations in policy uncertainty around the timing of national elections generate cycles in cross-border flows around the world and FDI flows from home-country firms to host country drop significantly when there is a national election in the host country [12].

The institutional distance factors inside the firms mainly behave as their own ability to adapt to the host-country business environment, including investment information, business profile, and bureaucracy efficiency. Investment information means the information regarding ODI that is hold by home-country firms in host countries, which helps firms to get to know host-country market better, and reduces the risks. Information accumulation is crucial for ODI firms [13]. The process of ODI actually is the development of being aware of host-country market and upgrading foreign trade. Through export, setting up offices, making foreign cooperation, acquiring company, taking Greenfield investment and so on. Firms accumulate information on market to reduce the uncertainty in business and to make ODI obtain better performance. Sound business environment contributes to favor the investment and operation in host countries, obtain the satisfactory return on investment, and stimulate investor's enthusiasm. International firms are deeply affected by host-country government in the means of administration management. The bureaucracy efficiency indicates their administrative efficiency. Low bureaucracy efficiency of governments deters investment form international firms, because it will increase the cost [14]. Figure 1 shows ODI relative political risk evaluation framework.

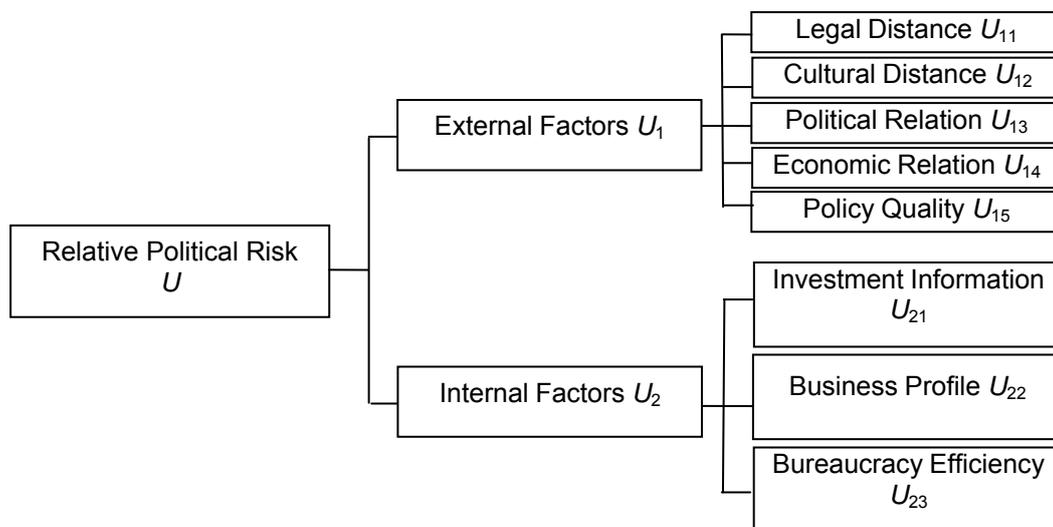


Figure 1. ODI Relative Political Risk Evaluation Framework

### 3. Building Relative Political Risk Fuzzy Analytic Hierarchy Process Evaluation System

Based on the principle of universality, we select the United States and China as home countries, and Russia as host country to make the relative political risk evaluation. The United States is the largest developed country investor, and on the other hand, China is the largest developing country investor. Selecting the two countries as the research objects can reflect the development of status of the current investment more clearly. The reason why select Russia as the host country is that Russia owns high political risk level and charming attraction of investments, which can reflect the phenomena of this study. To the investment in Russia, the United States shows a decreasing trend in the investment scale. In contrast with this, the scale

of Chinese investment in Russia is constantly rising. This paper aims to use the relative political risk system to study this phenomenon.

The data of this paper comes from questionnaires. We sent a total of 400 questionnaires, and the researchers of the study are limited to the senior managers of firms engaged in foreign trade, and international business or related field researchers so as to ensure the information providers obtain high familiarity and understanding on the questionnaire. Finally we get a total of 237 samples for the research, and the effective rate of the questionnaires is up to 59.3%.

The indicators of evaluation include both the external and internal factors. The external factors include legal distance, cultural distance, political relation, economic relation and policy quality. The internal factors include investment information, business profile and bureaucracy efficiency. Considering that the eight indicators are qualitative, they are fuzzy and difficult to quantify. If we use classical mathematical method to extract information, we would loss some information, so we study the eight indices by virtue of Fuzzy Analytic Hierarchy Process (FAHP).

### 3.1. Building Fuzzy Analytic Hierarchy Process

Fuzzy Analytic Hierarchy Process that combines Analytic Hierarchy Process (AHP) with Fuzzy Comprehensive Evaluation is a combination of qualitative and quantitative analysis method based on fuzzy reasoning. The detail of FAHP Evaluation System is as follows:

(a) **AHP:** AHP is to compare the two elements, and then establishes the judgment matrix based on the results of the comparison. The judgment scale is as shown in Table 1 ( $A_i$  denotes element)

judgment scale	Meaning
1	$A_i$ is as important as $A_j$
3	$A_i$ is a little more important than $A_j$
5	$A_i$ is more important than $A_j$
7	$A_i$ is much more important than $A_j$
9	$A_i$ is a lot more important than $A_j$
2,4,6,8	Between $A_i$ and $A_j$

The evaluation team of this study is composed of 10 experts, according to the views of experts analysis, we establish the following judgment matrix  $A$ ,  $A_1$  and  $A_2$ ,

$$A = \begin{bmatrix} 1 & 1/2 \\ 2 & 1 \end{bmatrix}$$

$$A_1 = \begin{bmatrix} 1 & 2 & 1 & 1/2 & 1 \\ 1/2 & 1 & 1/2 & 1/3 & 1/2 \\ 1 & 2 & 1 & 1/2 & 1 \\ 2 & 3 & 2 & 1 & 2 \\ 1 & 2 & 1 & 1/2 & 1 \end{bmatrix}$$

$$A_2 = \begin{bmatrix} 1 & 2 & 4 \\ 1/2 & 1 & 2 \\ 1/4 & 1/2 & 1 \end{bmatrix}$$

Calculate eigenvector matrices  $W$ ,  $W_1$ ,  $W_2$ , where:

$$\sum_{i=1}^m W_i = 1 \quad (1)$$

According to  $A$ ,  $A_1$ ,  $A_2$  and (1), that is:

$$W = \begin{bmatrix} 0.3333 \\ 0.6667 \end{bmatrix}$$

$$W_1 = \begin{bmatrix} 0.1843 \\ 0.0980 \\ 0.1843 \\ 0.3491 \\ 0.1843 \end{bmatrix}$$

$$W_2 = \begin{bmatrix} 0.5714 \\ 0.2857 \\ 0.1429 \end{bmatrix}$$

According to the consistency index formula:

$$CI = \frac{\lambda_{\max} - n}{n - 1} \quad (2)$$

Here,  $CI_1=0.0025$ ,  $CR_1=0.0022$ ,  $CI_2=0.0028$ ,  $CR_2=0.0053$ . It shows the acceptability of consistency of judgment matrix.

**(b) Determine the evaluation factor set and evaluation level set** The evaluation factor set is a collection of evaluation factors, which is denoted by  $U=(U_1, U_2, \dots, U_m)$ , and it is composed of all indicators. The evaluation level set consists of all evaluation results on evaluation object, which is expressed with  $V=(V_1, V_2, \dots, V_m)$ . The evaluation class is divided into five, that is  $V=($  excellent, good, medium, poor, very poor), which is replaced by  $V=(4,3,2,1,0)$ .

**(c) Determine multistage fuzzy comprehensive evaluation, and establish a single factor evaluation set:**  $R=R(R_{ij})$ . The single factor evaluation set is  $R_i=(R_{i1}, R_{i2}, \dots, R_{in})$ , it represents the degree of membership between  $U_i$  and  $V_j$ . Fuzzy evaluation matrix  $R(R_{ij})$  is expressed as follows:

$$R = \begin{bmatrix} R_{11} & R_{12} & \dots & R_{1n} \\ R_{21} & R_{22} & \dots & R_{2n} \\ \dots & \dots & \dots & \dots \\ R_{m1} & R_{m2} & \dots & R_{mn} \end{bmatrix} \quad (3)$$

According to the questionnaire materials and the expert analysis, we can determine the membership and weight of evaluation index for the evaluation set  $V$ , and establish FAHP evaluation level table for home countries ( the United States and China), as shown in Table 2 and Table 3.

Table 2. FAHP Evaluation Level Table for the United States

1-stage		2-stage		Evaluation matrix				
Index	weight	Index	weight	$V_1$	$V_2$	$V_3$	$V_4$	$V_5$
$U_1$	0.3333	$U_{11}$	0.1843	0.0338	0.6245	0.1730	0.1224	0.0464
$U_1$	0.3333	$U_{12}$	0.0980	0.0211	0.5738	0.2405	0.1097	0.0549
$U_1$	0.3333	$U_{13}$	0.1843	0.0169	0.1181	0.3966	0.4219	0.0464
$U_1$	0.3333	$U_{14}$	0.3491	0.0000	0.2110	0.4515	0.2785	0.0591
$U_1$	0.3333	$U_{15}$	0.1843	0.0127	0.2363	0.4093	0.2911	0.0506
$U_2$	0.6667	$U_{21}$	0.5714	0.0464	0.0886	0.3080	0.4388	0.1181
$U_2$	0.6667	$U_{22}$	0.2857	0.0127	0.1181	0.3291	0.4093	0.1308
$U_2$	0.6667	$U_{23}$	0.1429	0.0000	0.1055	0.2869	0.4346	0.1730

Table 3. FAHP Evaluation Level Table for China

1-stage		2-stage		Evaluation matrix				
Index	Weight	Index	Weight	$V_1$	$V_2$	$V_3$	$V_4$	$V_5$
$U_1$	0.3333	$U_{11}$	0.1843	0.0127	0.4430	0.4304	0.0759	0.0380
$U_1$	0.3333	$U_{12}$	0.0980	0.0042	0.5865	0.2658	0.1139	0.0295
$U_1$	0.3333	$U_{13}$	0.1843	0.2700	0.5612	0.1435	0.0253	0.0000
$U_1$	0.3333	$U_{14}$	0.3491	0.3249	0.5063	0.1266	0.0380	0.0042
$U_1$	0.3333	$U_{15}$	0.1843	0.1013	0.6793	0.1603	0.0422	0.0169
$U_2$	0.6667	$U_{21}$	0.5714	0.4768	0.2532	0.1435	0.1055	0.0211
$U_2$	0.6667	$U_{22}$	0.2857	0.1983	0.5781	0.1814	0.0422	0.0000
$U_2$	0.6667	$U_{23}$	0.1429	0.2574	0.5401	0.1477	0.0464	0.0084

According to the tables above that is:

$$R_1 = \begin{bmatrix} 0.0338 & 0.6245 & 0.1730 & 0.1224 & 0.0464 \\ 0.0211 & 0.5738 & 0.2405 & 0.1097 & 0.0549 \\ 0.0169 & 0.1181 & 0.3966 & 0.4219 & 0.0464 \\ 0.0000 & 0.2110 & 0.4515 & 0.2785 & 0.0591 \\ 0.0127 & 0.2363 & 0.4093 & 0.2911 & 0.0506 \end{bmatrix}$$

$$R_2 = \begin{bmatrix} 0.0464 & 0.0886 & 0.3080 & 0.4388 & 0.1181 \\ 0.0127 & 0.1181 & 0.3291 & 0.4093 & 0.1308 \\ 0.0000 & 0.1055 & 0.2869 & 0.4346 & 0.1730 \end{bmatrix}$$

#### (d) Fuzzy Comprehensive Evaluation:

$$B = W \bullet R = (W_1, W_2, \dots, W_m) \bullet \begin{bmatrix} R_{11} & R_{12} & \dots & R_{1n} \\ R_{21} & R_{22} & \dots & R_{2n} \\ \dots & \dots & \dots & \dots \\ R_{m1} & R_{m2} & \dots & R_{mn} \end{bmatrix} = (b_1, b_2, \dots, b_n) \quad (4)$$

Where  $b_j$  is computed by multiplication between  $W$  and the  $j$ -th row of  $R$ , that is:

$$b_j = \bigvee_{k=1}^m (w_k \wedge R_{kj}) \quad (5)$$

Here by virtue of (4) and (5),  $B_{1A} = R_1 \bullet W_1 = (0.0338, 0.2110, 0.3491, 0.2785, 0.0591)$ ,  
 $B_{2A} = R_2 \bullet W_2 = (0.0464, 0.1181, 0.3080, 0.4388, 0.1429)$ ,  
and normalized to:  $B_{1A} = (0.0363, 0.2265, 0.3748, 0.2990, 0.0634)$ ,  
 $B_{2A} = (0.0440, 0.1120, 0.2922, 0.4162, 0.1356)$ ,

$$R = (B_{1A}, B_{2A}) = \begin{bmatrix} 0.0363 & 0.2265 & 0.3748 & 0.2990 & 0.0634 \\ 0.0440 & 0.1120 & 0.2922 & 0.4162 & 0.1356 \end{bmatrix}$$

$$B_A = [0.0381, 0.1960, 0.2884, 0.3602, 0.1173]$$

And the result is replaced to  $V = (4, 3, 2, 1, 0)$ , So the FAHP evaluation result of the U.S. firms is  $BV_A = 1.6774$

Similarly, we can calculate the FAHP evaluation result of the Chinese firms as follows:

$$B_{1C} = (0.1428, 0.2674, 0.2674, 0.3530, 0.0395), B_{2C} = (0.1440, 0.1121, 0.2922, 0.4162, 0.0355),$$

$B_C = (0.1440, 0.2674, 0.2922, 0.4162, 0.0355)$ , So the FAHP evaluation result of the Chinese firms is  $BV_C = 2.3788$

### 3.2. Result

After FAHP of relative political risk, this paper obtains several findings. Firstly, because China's relative political risk (2.3788) is greater than US's relative political risk (1.6774), that is, Chinese firms own more advantages in investing in Russia over U.S. firms, and the Russian political risks have less negative impact on Chinese firms than on U.S. firms. Compared with U.S. firms, due to the strong ability to adapt to the Russian business environment, Chinese firms are better able to deal with Russian high political risk. This paper with Empirical study shows something. To the firms from different home countries, the effects of political risks of host country are in heterogeneity. It stems from the ability differences of the home-country firms itself.

Secondly, it's easy to know that the relative political risk actually changes the political risk level of firms in the host countries, when the relative political risk is less than 2. The relative political risk actually reduces the level of political risk for the firm in host countries, when the relative political risk is greater than 2. The relative political risk effect can be neglected, when the relative political risk equals 2.

Lastly, Chinese firms make excellent performances in relevant information (3.0593), business profile (2.9325) and government efficiency (2.9917). It shows that Chinese firms own higher degree of adaptation to the Russian business environment. However, U.S. firms make worse performance in these three indicators with the score of (1.5062,1.4726,1.3249). Because of their greatly weighted influence, the final result of America in the relative political risk falls behind China. It should be noted that in the field of the legal distance, the score of U.S. firms is 2.4771 while Chinese firms' score is 2.3165, which means that US get the greater similarity in the legal environment with Russia than China does, therefore the U.S. firms are better able to adapt to the Russian legal environment than Chinese firms does.

### 4. Conclusion

This paper explores the effect on home-country firms caused by host-country political risk with firm-level data, and studies the difference of host-country political risk by building relative political risk FAHP evaluation between home country (China and US) and host country (Russia).

This paper obtains several findings. First, comparing with U.S. firms, Chinese firms own political risk management advantage due to small institutional distance between China and Russia. That is, it is more adaptive for Chinese firms to invest in Russia due to their capabilities and adaptations. Second, the capability of firms plays very important part in resisting political risk when firms invest abroad. Three indices of firms' internal factors are the most weighted part in our evaluation system. Unlike previous studies that used absolute indices, this paper uses relative indices to make study and finds that ODI firms from different countries are influenced by host-country political risk. That is, the method with relative index provides stronger explanation for ODI.

The findings from this paper are helpful in completing political risk management policy in China. First, this paper finds that China's ODI firms tend to invest in countries with small institution distance. These target countries are with high political risk due to poor institution quality in China. So government should improve the institution construction (such as legal construction) to reduce the distance between China and developed countries, which will provide Chinese ODI investors for a sound business environment. Second, information, business profile and bureaucracy efficiency are the most weighted parts in relative political risk evaluation. However, this capability can be obtained by learning. That is, firms who aim to invest in country with high political risk should cultivate their relative political risk advantages for their overseas investments.

There are several limitations in this paper. First, no industry-level factors have been taken into account. As we know, different industries face different levels of political risk. Second, more indices of political risk need to be completed. This paper chooses the indices that have been studied by other papers, as time goes by we surely believe that more indices will be completed.

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