Fuzzy Comprehensive Evaluation Model of Enterprise M&A Risk Based on AHP*

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Abstract. Enterprise Merges and Acquisitions (M&A) achieves the target of rapidly expand and increase asset scale, promote industrial upgrading and optimize resources allocation within the community as well as improve scale economic value of enterprises by transfer and reconstruct existing resources in the economic structure. However, the identification, evaluation and control on risk of enterprises M&A are of severe shortage. The paper firstly analyzed and evaluated on six kinds of general evaluation model about enterprise M&A risk. The disadvantages of these models were also given. On this basis, fuzzy comprehensive evaluation model based on AHP was presented. The specific application of comprehensive evaluation model was also provided.

Introduction

M&A is a very complicated system. There are many uncertain factors in the M&A process that M&A process is complex, participants in a wide range, technical operation, professional and strong, operating cycle is longer and organizational decision-making coordination and cooperation required to implement high, so the risks faced by acquisition company are particularly large [1-4]. Enterprise M&A risk refers to possibility that can not achieved intended goals in M&A process as well as impact of it on normal management and business. At present, in the enterprise M&A practices, the evaluation on M&A risk only based on experiences, knowledge, ability and intuition of individual entrepreneurs. The understanding of its risk is only in the initial stage. In the theoretical world, there have been four ideas about risk evaluation on investment projects. The first is probability laws that mark the probability when investment income less than a standard income as risk evaluation index. The second is variance method that regards mean-variance or standard deviation of investment income ratio of project as risk evaluation index. The third is mean-standard deviation method that is use the ratio of standard deviation to mean as risk evaluation index. The forth is mean square error-loss law to regard the product of variance expected loss as index. Currently, most evaluation methods on M&A risk are evolved from the basis of these ideas. Aiming at problems of empirical M&A risk evaluation, the paper presents a fuzzy comprehensive evaluation model based on AHP. The paper is organized as follows: section 2 introduces 6 kinds of general evaluation models; section 3 gives fuzzy comprehensive evaluation model based on AHP; section 4 provides specific application example and section 5 concludes our work.

M&A Fuzzy Comprehensive Evaluation Model Based on AHP

The main steps of fuzzy comprehensive evaluation are as following:

- (1) Establish index set $U = \{u_1, u_2, \dots, u_n\}$, namely evaluation index system.
- (2) Establish evaluation set $V = \{v_1, v_2, \dots, v_n\}$, namely schema set for evaluation.

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(3) Establish weight set $A=\{a_1, a_2, \dots, a_n\}$, namely relative importance of different index, where, $\sum_{i=1}^n a_i = 1$ and $a_i > 0$.

(4) Establish fuzzy membership matrix, namely combination of membership vector to evaluate elements

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix}$$

Where, r_{ij} ($i=1,2,\dots,m; j=1,2,\dots,n$) is membership of index U_{ki} in sub-element layer to the j -th level evaluation V_j . The value of r_{ij} can be determined with the method as follows: statistically collect expert score and obtain that there is V_{i1} review at V_1 level for index U_{ki} , V_{i2} reviews at V_2 level, ..., V_{im} reviews at V_m level. For $i=1,2,\dots,m$, there is:

$$r_{ij} = \frac{V_{ij}}{\sum_{j=1}^n V_{ij}} \quad (j=1,2,\dots,n).$$

(5) Fuzzy comprehensive evaluation. Perform fuzzy synthesis operation $B=A \cdot R$, and then B is the comprehensive evaluation result. So we can determine the level of object belongs to based on maximum membership principle.

Case Study

Here is the case of A company to acquisition B company to illustrate the specific application of the above model.

(1) According to AHP theory, establish index system of M&A risk evaluation [8. 9] as shown in Fig. 1.

(2) Establish evaluation set.

Divide M&A risk into 5 levels as high, higher, medium, lower and low to achieve the goal of early warning, namely $V = \{v_1, v_2, v_3, v_4, v_5\} = \{ \text{high, higher, medium, lower, low} \}$.

(3) Determine weight of indexes

Using Delphi method, we can obtain determination matrix at the appropriate level of each index. So we can arrive at relative weights as shown in Table. 1, Table. 2, Table. 3 and Table. 4.

From the above we can know that C.I.=0.0327 and C.R.=0.0565 in Table 1; C.I.=0.0347 and C.R.=0.0310 in Table 2; C.I.=0.0606 and C.R.=0.0673 in Table 3; C.I.=0.0079 and C.R.=0.01362 in Table 4. It means the consistency test is passed and acceptable.

(4) Establish fuzzy membership matrix R as shown in Table 5. with rating result from statistical experts

(5) M&A risk evaluation

Firstly perform fuzzy matrix computation on evaluation matrix R_i of each second level index U_{ik} to obtain membership vector B_i as shown in Table 6 of first-level index U_i on review set V , $B_i = A_i \cdot R_i = \{v_{i1}, v_{i2}, v_{i3}, v_{i4}, v_{i5}\}$.

Then conduct fuzzy operation on R , we can obtain membership vector B of evaluation object on review set V , $B = A \cdot R = (a_1, a_2, a_3) \cdot (B_1, B_2, B_3)^T$. Its comprehensive evaluation result is $B = (0.1453 \ 0.3842 \ 0.2971 \ 0.1422 \ 0.0038)$. According to maximum membership principle, we can arrive at the following conclusion that the M&A risk of the enterprise on target company is higher, which should be handled with care.

Conclusion

At present, the evaluation on M&A risk only based on experiences, knowledge, ability and intuition of individual entrepreneurs in the enterprise M&A practices. The understanding of its risk is

only in the initial stage. To address the problem, the paper analyzed and evaluated on six kinds of general evaluation model about enterprise M&A risk. The disadvantages of these models were given and fuzzy comprehensive evaluation model based on AHP was presented. The model application process and method were illustrated with specific case.

Figure 1. M&A risk comprehensive index system.

TABLE 1. M&A RISK DETERMINATION MATRIX IN STAGES

U	U_1	U_2	U_3	a_i
U_1	1	1/7	1/5	0.0738
U_2	7	1	3	0.6434
U_3	5	1/3	1	0.2828
Σ	13	1.4762	4.2	1.0000

TABLE 2. RISK DETERMINATION MATRIX IN PREPARATION AND DESIGN STAGE

U_1	U_{11}	U_{12}	U_{13}	U_{14}	U_{15}	a_{1k}
U_{11}	1	1/3	1/5	2	1/2	0.0848
U_{12}	3	1	1/3	5	3	0.2454
U_{13}	5	3	1	7	5	0.4963
U_{14}	1/2	1/5	1/7	1	1/3	0.0500
U_{15}	2	1/3	1/5	3	1	0.1235
Σ	11.5	4.8667	1.8762	18	9.8333	1.0000

TABLE 3. RISK DETERMINATION MATRIX IN NEGOTIATION AND IMPLEMENT STAGE

U_2	U_{21}	U_{22}	U_{23}	U_{24}	a_{2k}
U_{21}	1	5	7	9	0.6545
U_{22}	1/5	1	3	3	0.1849
U_{23}	1/7	1/3	1	3	0.1060
U_{24}	1/9	1/3	1/3	1	0.0546
Σ	1.454	6.667	11.333	16	1.0000

TABLE 4. RISK DETERMINATION MATRIX IN M&A INTEGRATION STAGE

U_3	U_{31}	U_{32}	U_{33}	a_{3k}
U_{31}	1	1	5	0.4663
U_{32}	1	1	4	0.3830

U_{33}	1/5	1/4	1	0.1007
Σ	2.2	2.25	10	1.0000

TABLE 5. M&A RISK EVALUATION MATRIX

u_i (weight a_i)	u_{ik} (weight a_{ik})	Risk assessment value r_{ij}				
		<i>High</i>	<i>Higher</i>	<i>Medium</i>	<i>Lower</i>	<i>Low</i>
u_1 ($a_1=0.0738$)	u_{11} ($a_{11}=0.0848$)	0.2	0.3	0.4	0.1	0.0
	u_{12} ($a_{12}=0.2454$)	0.5	0.3	0.1	0.1	0.0
	u_{13} ($a_{13}=0.4963$)	0.4	0.3	0.2	0.1	0.0
	u_{14} ($a_{14}=0.0500$)	0.1	0.4	0.2	0.2	0.1
	u_{15} ($a_{15}=0.1235$)	0.1	0.3	0.4	0.2	0.0
u_2 ($a_2=0.6434$)	u_{21} ($a_{21}=0.6545$)	0.1	0.5	0.3	0.1	0.0
	u_{22} ($a_{22}=0.1849$)	0.1	0.3	0.4	0.2	0.0
	u_{23} ($a_{23}=0.1060$)	0.0	0.1	0.4	0.5	0.0
	u_{24} ($a_{24}=0.0546$)	0.0	0.1	0.3	0.5	0.1
u_3 ($a_3=0.2828$)	u_{31} ($a_{31}=0.4663$)	0.1	0.3	0.4	0.1	0.0
	u_{32} ($a_{32}=0.3830$)	0.4	0.5	0.1	0.0	0.0
	u_{33} ($a_{33}=0.1007$)	0.3	0.4	0.2	0.1	0.0

TABLE 6. RISK DETERMINATION MATRIX IN EACH STAGE OF M&A

u_i	Risk assessment value r_{ij}				
	<i>High</i>	<i>Higher</i>	<i>Medium</i>	<i>Lower</i>	<i>Low</i>
u_1	0.3555	0.3050	0.2171	0.1174	0.0050
u_2	0.0839	0.3988	0.3291	0.1827	0.0055
u_3	0.2300	0.3717	0.2450	0.0567	0.0000

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