Research on the CPA Audit Independence Risk Assessment Based on the Rough Set Theory*

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Abstract: The assessment mode of the CPA audit independence risk based on the Rough Set Theory is a risk assessment method and using the Analytical Hierarchy Process, whose aim is to solve the bid management in the process of the Financial Statement Insurance. Firstly, according to the general instance of the accountant office, the experts grade the risk elements to establish the decision-making table; secondly, construct the judgment matrix using the attribution dependence degree of Variable Precision Rough Set to obtain relative importance, and further get the general importance for all of risk elements; Finally, establish the general assessment mode of the audit independence risk.

Key words: rough set theory; audit independence risk; assessment mode

1. Introduction

Independence for CPA's audit is the theory footstone and the soul of the engaging occupation. In recent years, CPA's audit independence has been terribly havocked, which was proved by a series of the accounting & auditing fraudulent cases happened in the domestic and abroad. Independence Standards Board (ISB) issued "An Exposure Draft on Conceptual Framework for Auditor Independence" in 2000, which first gave the concept of the audit independence risk. What is called Audit Independence Risk is a risk of which threatens auditor independence to reach the level that safeguards can't keep freedom from those factors that compromise, or can reasonably be expected to compromise, an auditor's ability not to make unbiased audit decisions.[1] In 2002, American accounting Professor Joshua Ronen took lead in putting forward the Financial Statement Insurance (FSI), which will enhance the CPAs' audit independence from the system.[2] Independence risk is the core of the auditor independence problem. At present the researches concerning about the audit independence risk analysis, especially about the assessment methods, are comparatively less. In 2003, Fenghua Sue adopted traditional Fuzzy synthesis judgment method to forecast and assess the audit independence risk in her paper of Master Degree. Fuzzy Set is a method dealt with indeterminacy formation in common use. But this method needs some additive or advanced formation of data, such as fussy subjection function, which can't be easy to get sometimes. It isn't convenient to assess audit independence risk in time exactly. Standing on the base of realism problem, the penman applies the Rough Set Theory to audit field, and discuss the application of CPA audit independence risk

* This paper is supported by Humanities Social Sciences Subsidization Project of Heilongjiang Province Education Department (No.2005-10554019).
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assessment mode in the FSI, to provide the powerful technical support for carrying into execution of FSI.

2. Framework for Audit Independence Risk Factor Analysis

For investors, creditors, and other correlative benefit units who depend on the audit opinion to make the decision, the generation or aggrandizement of CPA audit independence risk can bring obvious negative influence. Scholars Zongshun Qiu and Hongling Han in our country divide the influent factors of audit independence risk into two big types: environmental preceding factors and alleviating factors, hereinto environmental preceding factors include abduction factor and the decision based on the professional judgment two parts.[3] In their opinions, the decision based on the professional judgment belongs to subjective factor of CPA, so to classify it into environmental preceding factor is not scientific and exact enough, otherwise, the generation of audit independence risk in our country also dues to special-owned causes under our country's system. Therefore, the penman thinks the framework of audit independence risk factor analysis should be constructed again, and divides it into three parts including environmental preceding factors, subjective factors and alleviating factors. Hereinto, the environmental preceding factors contain abduction factors (direct abduction factor and indirect abduction factor) and special-owned causes under our country's system; Subjective factors are the decision based on the professional judgment, mainly including the pressure of difficult accountant problems, significance judgment and audit's scope and action; Alleviating factors include fathering structure of audited company, controlling supervise, policy of the accountant office, the accountant office's culture, quality of CPA, and so on. Because each factor can't function enough by itself to eliminate or alleviate independence risk, we can adopt multi-measures to make up framework for the synthesis analysis of audit independence risk factors, and further to reach the effect of synthesizable fathering. The idiographic content can be used Figure 1 to illustrate visually.

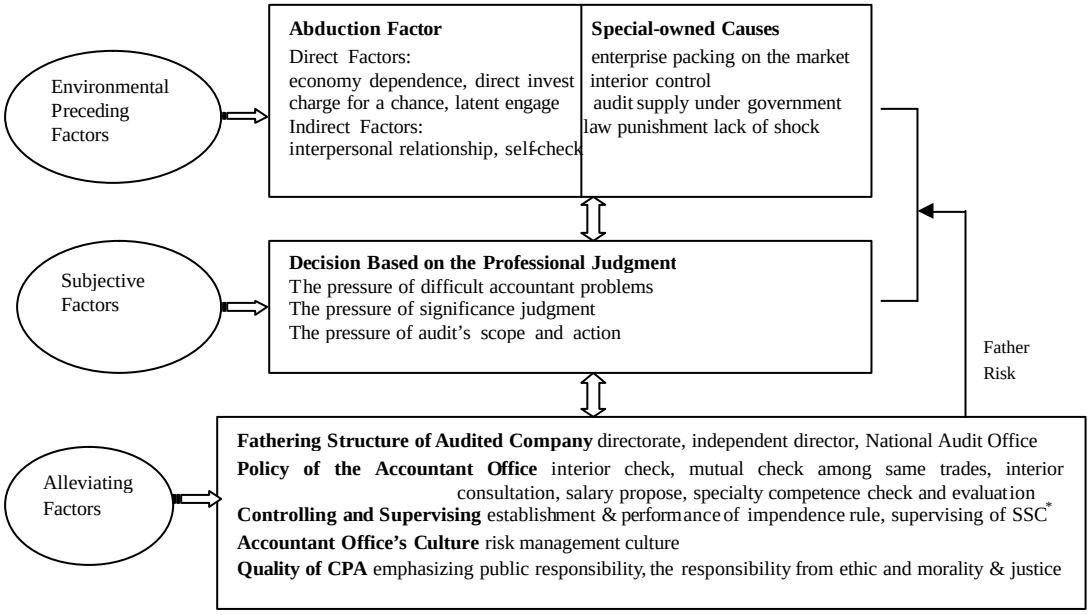

Figure 1 Framework for audit independence risk factor analysis

Notes: * SSC is the abbreviation of Securities Supervising Commission

3. Basic Concepts of Rough Set Theory

Rough Set Theory is a new mathematical tool to deal with less full and accurate problems, put forward by Poland's mathematician ZPawlak, and has gained plentiful and substantial productions in many fields, e.g. decision-making analysis, process control, mode identification, data mining, finance investment, and so on. Its specialty is having no use for presenting amount description of some characters or attributes in advance, just through indiscernibility relation to confirm approximate field of the known problem, so as to post the potential rule of the problem. [4] But Pawlak Rough Set Mode has definite localization, It must deal with the sort complete right or affirmative, and all conclusions are just the same with these objective set. Variable Precision Rough Set (VPRS) is the expansion of the Pawlak Rough Set, though setting up in advance approximate precision gene b $(0 \le b < 0.5)$ to permit the existence of error sort rate a certain degree, which is useful for solving the problem of no function or uncertainty relationship in attributes, and loosens the strict borderline definition of the Standard Rough Set Mode, in order to make the mode have the ability against data yawp. [5]

3.1 Approximate dependence degree

Suppose the information system $S = (U, A, V, f)$, hereinto, U is the nonempty finite set of the object, called as discussed field. A is the nonempty finite set of the attribute, $A = P \cup Q$, $P \cap Q = \Phi$, P is called as qualification attribute set, Q is called as decision-making attribute set, A knowledge expression system with qualification attribute set and decision-making attribute set is called as decision-making table; $V = \bigcup_{a \in A} V_a$, V_a is the value field; $f : U \times A \to V$ is an information function, which endows any object with an information value, namely $\forall a \in A$, $x \in U$, $f(x,a) \in V_a$. $ind(P)$, $ind(Q)$ denote the indiscernibility determined by P and Q. The equivalence sort of the $ind(P)$ is called as qualification sort, using U/P to express.

The b dependence degree between Q and P is defined as

$$g(P,Q,b) = |pos(P,Q,b)| / |U| \quad (1)$$

In this formula, $pos(P,Q,b) = \bigcup_{g \in U/Q} ind(\underline{P})_b g$.

3.2 Approximate reduction

Attribute reduction is one of the important concepts in the Rough Set Mode. What is called a reduction is the least qualification attribute subset. Through using the definition of approximate dependence, we bring in the concept of the approximate reduction. The b reduction or approximate reduction between Q and P is a subset $red(P,Q,b)$ for P, and meeting:

① $g(P,Q,b) = g(red(P,Q,b),Q,b)$; (2)

②to take any attribute out from $red(P,Q,b)$ will make ① not come into existence.

4. The Establishment of the Assessment Mode for CPA Independence Risk

4.1 Arithmetic design

Suppose that there are n risk factors in the index system of audit independence risk factor, hereinto, there are n_t risk factors contained in the t th risk factor sort C_t, the amount of the risk sorts is l, $\sum_{t=1}^{l} n_t = n$, R_i denotes the i th $(i = 1,2,...,n)$ risk factor, $R_{i,t}$ denotes the i th factor in C_t.

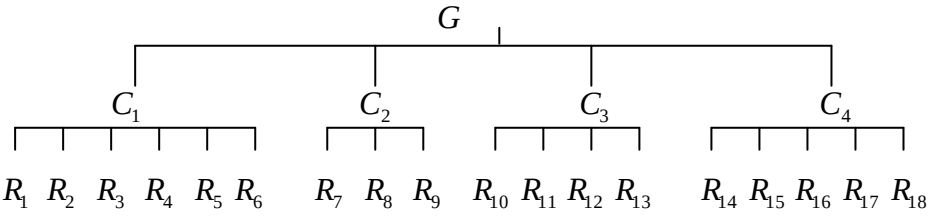

Figure 2 The index system of audit independence risk factor

Note: G Index system, C_1 Abduction factors, C_2 Decision based on the professional judgment, C_3 Special-owned causes, C_4 Alleviating factors, R_1 Economy dependence, R_2 Direct invest, R_3 Charge for a chance, R_4 Latent engage, R_5 Interpersonal relationship, R_6 Self-check, R_7 Pressure of difficult accountant problems, R_8 Pressure of significance judgment, R_9 Pressure of audit's scope and action, R_{10} Enterprise packing on the market, R_{11} Interior control, R_{12} Audit supply under government, R_{13} Law punishment lack of shock, R_{14} Fathering Structure of Audited Company, R_{15} Policy of the Accountant Office, R_{16} Controlling Supervise, R_{17} Accountant Office's Culture, R_{18} Quality of CPA.

According to the instances of the accountant's offices, the experts mark on risk factors to get the information decision-making table, and based on the formula (1), we can educe

$$g(R_{ki,t}, C_t, b) = \frac{|pos(R_{ki,t}, C_t, b)|}{|U|}, \tag{3}$$

In this formula, $R_{ki,t}$ is the mark of the k th expert on the $R_{i,t}$. Try to get the average value of the results of the experts' assessments

$$\overline{g}(R_{i,t}, C_t, b) = \frac{\sum_{k=1}^{m} |pos(R_{ki,t}, C_t, b)|}{m \times |U|}, \tag{4}$$

Apply Analytical Hierarchy Process (AHP), and take the relative importance among the bottom factors as the element to construct judgment matrix R, here, r_{ij} is the element of R in the i-row and j-line, presenting the important degree of the $R_{i,t}$ relative to $R_{j,t}$, namely $r_{ij} = \frac{\overline{g}(R_{i,t}, C_t, b)}{\overline{g}(R_{j,t}, C_t, b)}$, (5)

Due to $r_{ij} \times r_{jh} = r_{ih}$, R is a judgment matrix on all fours, the key to decision-making is that endowing their relevant weight according to the importance degree of $R_1,...,R_i,...,R_n$ relative to the whole risk G, and we can use Geometry Average Method to get it. For $R_{i,t}$, define $W_{R_{i,t}} = \left(\prod_{j=1}^{n_t} r_{ij} \right)^{\frac{1}{n_t}}$, (6)

And carry through the treat to return the same, there is $W_{C_t} = \sum_{i=1}^{n_t} W_{R_{i,t}}$, (7)

So we can get the eigenvector $\left(W_{C_t}^{R_{1,t}},...,W_{C_t}^{R_{i,t}},...,W_{C_t}^{R_{n_t,t}}\right)$ of the judgment matrix, namely weight

$$W_{C_t}^{R_{i,t}} = \frac{W_{R_{i,t}}}{W_{C_t}}. \quad (8)$$

By the same reason, according to the relative important degree c_{ij} among the $C_1,...,C_t,...,C_l$, we can construct the judgment matrix C. The weight of C_t relative to general goal G is

$$W_G^{C_t} = \left(\prod_{j=1}^{l} c_{ij}\right)^{\frac{1}{l}} \Bigg/ \sum_{t=1}^{l}\left(\prod_{j=1}^{l} c_{ij}\right)^{\frac{1}{l}} \quad (9)$$

And the general weight of apiece relative to the general goal is

$$W_G^{R_i} = W_{C_t}^{R_{i,t}} \times W_G^{C_t} \quad (10)$$

The general weight is the proportion of apiece risk factor in the general goal system, here,

$$\sum_{i=1}^{n} W_G^{R_i} = 1 \quad (11)$$

In theory, $\sum_{i=1}^{n} W_G^{R_i} = 1$, but due to the error in practical operation, the result sometimes exists the case unequal to 1.

Suppose we keep down s audit independence risk factors through reduction, noted by $R_j\left(j = 1,2,...,s\right)$, the mode of audit independence risk assessment is

$$G = \sum_{j=1}^{s} R_j W_G^{R_j} . \quad (12)$$

Hereinto, G is the general assessment value; R_j stands for the arithmetic average value of the risk grade value given by experts originally.

4.2 Carrying out steps

Step 1: set up the frame mode of the system evaluation, e.g. Figure 2.

Step 2: characterize data, establish decision-making table $S = \left(U, \left(\{e_k\} \times C\right) \cup D, V, f\right)$.

Suppose qualification attribute set $C = \{$apiece risk factor$\}$, decision-making attribute set $D = \{$audit independence risk degree$\}$. The expert team give the mark on the apiece risk factor, 0 is non-risk, $(0,1]$ is light risk, $(1,2]$ is moderate risk, $(2,3]$ is comparative heavy, $(3,4]$ is heavy risk.

Step 3: confirm b. Application of the VPRS can eliminate the negative domino effect because of the unilateralism of the experts' evaluation, but the final result and the value of b have osculating correlation. b is a

double-edged sword, whose value can be too large or small and can both effect the veracity of the assessment result. So we must choose felicitous b value according to the data case of the decision-making table. Generally speaking, when the system is mature and its data' distributing is well-proportioned, b can be chosen small value, otherwise, we can choose big one.

Step 4: according to the formula (3) and (4), calculate the relative dependence degree $g\left(R_{ki,t}, C_t, b\right)$ among attributes to get $\overline{g}\left(R_{ki,t}, C_t, b\right)$. Weed out the factor based on the formula (2) when $\overline{g}\left(R_{i,t}, C_t, b\right) = 0$. By the same reason, we can calculate $\overline{g}\left(C_t, G, b\right)$.

Step 5: calculate the relative importance degree among apiece factor based on the formula (5) to get element r_{ij} and c_{ij}, set up separately judgment matrix, and check out the coherence of the matrix.

Step 6: According to the formula (6) - (10), calculate the general importance degree. Through compositor, we can make the relevant analysis and decision.

Step 7: finally calculate the general assessment value of the audit independence risk based on the formula (12).

5. Example of the Audit Independence Risk Assessment for CPA

Suppose a nation-owned enterprise M has applied FSI, the insurance agent N organized the invite and bidding meeting openly to carry on the audit operation. The expert team (made up of 3 people) at locale give the mark of the audit independence risk factor for the 15 attended accountant offices. To be convenient for calculation, we have every expert give integral value, namely $0,1,2,3,4$. At first, give the mark on R_1, R_2, R_3, R_4, R_5, R_6 and C_1 to get the decision-making table of the risk assessment (refer to Table 1).

Table 1 The decision-making table made up of R_1, R_2, R_3, R_4, R_5, R_6 and C_1

U	E_1							E_2							E_3						
	R_1	R_2	R_3	R_4	R_5	R_6	C_1	R_1	R_2	R_3	R_4	R_5	R_6	C_1	R_1	R_2	R_3	R_4	R_5	R_6	C_1
1	1	1	1	1	1	1	1	2	1	1	1	1	1	2	1	2	1	1	1	2	2
2	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	2	2	1	2	2	1
3	1	2	1	1	1	1	1	1	2	1	1	1	1	1	1	2	1	1	2	1	1
4	1	1	2	1	1	1	1	1	2	1	2	1	1	1	2	1	1	1	2	1	2
5	1	2	2	1	2	1	2	2	2	1	1	1	2	2	2	1	1	2	2	1	1
6	2	1	2	2	1	1	2	2	2	2	3	1	1	3	2	2	1	2	1	1	2
7	2	2	1	1	1	2	2	2	3	1	1	1	1	2	1	2	1	2	2	1	2
8	2	2	1	1	2	1	2	2	3	1	2	1	1	2	1	2	2	2	2	3	2
9	2	2	2	1	3	1	3	2	2	3	1	3	2	3	2	2	2	3	3	2	2
10	2	3	1	2	2	1	3	2	3	3	1	1	2	3	2	3	2	3	3	2	3
11	3	3	2	1	3	2	3	3	3	2	2	2	3	3	2	3	2	2	3	2	3
12	3	3	3	2	3	2	3	3	3	2	2	3	3	3	3	3	2	3	3	3	3
13	3	3	3	4	3	3	4	3	4	3	4	4	3	4	3	3	2	4	3	3	3
14	4	4	4	3	3	4	4	3	4	4	3	4	4	4	4	4	4	3	4	3	4
15	4	3	4	4	4	3	4	4	3	4	4	3	4	4	4	3	3	3	4	4	4

By the reason, carry through separately assessment on R_7, R_8, R_9 and C_2; R_{10}, R_{11}, R_{12}, R_{13} and C_3; R_{14}, R_{15}, R_{16}, R_{17}, R_{18} and C_4; C_1, C_2, C_3, C_4 and G to get relevant decision-making tables. In the process of the marking, the expert all considered R_{10}, R_{11} and R_{12} were due to audit macroscopical environment problems at present, which are in common for 15 accountant offices, so all marked the value 0 to wipe them. Here, we

define b =0.2 and calculate the relative importance degree among substrate factor, super stratum factor and the same stratum factors to get the general importance degree of the audit operation (refer to Table 2).

Table 2 General importance degree of audit independence risk

	C_1	C_2	C_3	C_4	$W_G^{R_j}$
	0.2222	0.1975	0.2469	0.1605	
R_1	0.4468				0.0993
R_2	0.2340				0.0520
R_3	0.3192				0.0709
R_4	0.3608				0.0802
R_5	0.3093				0.0687
R_6	0.3299				0.0733
R_7		0.3601			0.0711
R_8		0.3367			0.0665
R_9		0.3572			0.0705
R_{13}			0.3012		0.0744
R_{14}				0.3129	0.0502
R_{15}				0.3374	0.0541
R_{16}				0.3366	0.0540
R_{17}				0.2970	0.0477
R_{18}				0.3664	0.0671*

Note: * 0.0671is the value of converse to bear based on the formula (11)

We can get the importance degree compositor of apiece risk factor in the general goal system for the invite and bidding management of the audit operation: $R_1 > R_4 > R_{13} > R_6 > R_7 > R_3 > R_9 > R_5 > R_{18} > R_8 > R_{15} > R_{16} > R_2 > R_{14} > R_{17}$.

Finally, we can get the grade value of the general audit independence risk of all attended accountant offices. Now take the first accountant office as an example to illustrate the calculation process (refer to Table 3 and the result reserved four decimal fraction).

Table 3 The marks of the first accountant office' apiece risk factor index by three experts

	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9	R_{13}	R_{14}	R_{15}	R_{16}	R_{17}	R_{18}
E_1	1	1	1	1	1	1	1	1	2	1	1	2	1	2	1
E_2	2	1	1	1	1	1	2	3	1	2	2	2	1	1	1
E_3	1	2	1	1	1	2	2	1	1	1	1	1	3	1	2

Supposing the grade of general audit independence risk for the first accountant office is G_1, so

$$\overline{R_1} = \frac{1}{3}(1+2+1) = 1.333, \quad \overline{R_2} = \frac{1}{3}(1+1+2) = 1.333, \quad \overline{R_3} = \frac{1}{3}(1+1+1) = 1,$$

$$\overline{R_4} = \frac{1}{3}(1+1+1) = 1, \quad \overline{R_5} = \frac{1}{3}(1+1+1) = 1, \quad \overline{R_6} = \frac{1}{3}(1+1+2) = 1.333,$$

$$\overline{R_7} = \frac{1}{3}(1+2+2) = 1.667, \quad \overline{R_8} = \frac{1}{3}(1+3+1) = 1.667, \quad \overline{R_9} = \frac{1}{3}(2+1+1) = 1.333,$$

$$\overline{R_{13}} = \frac{1}{3}(1+2+1) = 1.333, \quad \overline{R_{14}} = \frac{1}{3}(1+2+1) = 1.333, \quad \overline{R_{15}} = \frac{1}{3}(2+2+1) = 1.667$$

$\overline{R_{16}} = \frac{1}{3}(1+1+3) = 1.667$, $\overline{R_{17}} = \frac{1}{3}(2+1+1) = 1.333$, $\overline{R_{18}} = \frac{1}{3}(1+1+2) = 1.333$,

$G_1 = 1.333\times 0.0993 + 1.333\times 0.0520 + 1\times 0.0709 + 1\times 0.0802 + 1\times 0.0687 + 1.333\times 0.0733 +$

$1.667\times 0.0711 + 1.667\times 0.0665 + 1.333\times 0.0705 + 1.333\times 0.0744 + 1.333\times 0.0502 + 1.667\times$
$0.0541 + 1.667\times 0.0540 + 1.333\times 0.0477 + 1.333\times 0.0671 \approx 1.3248$

By the same reason, we can get

$G_2 = 1.4352$ $G_3 = 2.2136$ $G_4 = 1.5768$ $G_5 = 1.9354$ $G_6 = 2.8342$ $G_7 = 2.3468$ $G_8 = 3.0124$

$G_9 = 3.1473$ $G_{10} = 2.8405$ $G_{11} = 3.5826$ $G_{12} = 3.2457$ $G_{13} = 3.1092$ $G_{14} = 3.4431$ $G_{15} = 3.6274$

Through the contrast of the results, the insurance agent can make a decision openly and pellucid: the first accountant office wins tender thanks to the lowness of the general audit impendence risk. When the amount of information is big worked by the excessive amount of accountant offices, we can use the Rosetta decision-making system based on the Rough Set Theory to deal with the data in order to improve the work efficiency.

6. Conclusion

The risk assessment in the process of the FSI invite and bidding management is a complicated decision-making course with many uncertain factors. The assessment method of the audit independence risk based on the Rough Set Theory can be used to solve the problem of the imprecision sort existing in invite and bidding information system. Generally speaking, the general importance degree of the audit independence risk is higher, the possibility of the crisis happens in audit operation is heavier because of the appearance of the risk factor. Therefore, the result of the compositor is useful for the supervising and management organization of the CPA trade, which has the limited energy on the risk management. In order to set down the fathering countermeasure to the elimination of the audit independence risks the emphases and pertinence. Meanwhile, the assessment of the risk also provides the powerful technical support for the invite and bidding decision-making.

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(Edited by Xiaoli Chen, Xiang Dai)