

Study on Assess of Enterprise Risk Management in China Based on Entropy Weight/TOPSIS Method

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Abstract

Enterprise risk management (ERM) has raised increasing concern in the field of risk management, and brought practical revenues to enterprises in today's complex interrelated global business environment. It is a valuable question for China enterprises how to improve the ERM performance. Based upon ERM implemental goals published by COSO, we user elevant data from non-financial listed corporations in SSE, from the perspectives of strategic effectiveness, operational efficiency, reporting reliability and corporate compliance. The data of 509 Chinese enterprises is validly interpreted by entropy weight/TOPSIS method to assess the ERM performance, and to analyze the status of ERM in China. Such models provide means quantitatively improve decision making with respect to the ERM performance.

Keywords: *Enterprise risk management, ERM performance, Assess, Public corporations*

1. Introduction

With the continuous increase in the uncertainty of global economic environment, enterprise risk management has received worldwide recognition universally. Enterprise risk management defines a process, which is executed by the broad of directors with one principal entity, the management layer and others. This process is applied in strategy formulation and throughout the enterprise, aimed at identifying potential events which may affect the entity, managing risks to control it within the entity's risk capacity and providing reasonable assurance for the realization of the entity's goals [1]. Enterprises in China started late in this area. Theoretically or practically speaking, there is a huge gap between Chinese enterprises'ERM performance and the advanced international level. Moreover, the discrepancy exists between different domestic corporations' capacities. Therefore, scientific analyses of the ability to implement enterprise risk management among the domestic enterprises would contribute not only to interpretation of the contemporary implementing condition of domestic corporate enterprise risk management but also the discovery of effective method to strengthen the ERM performance, enhancing overall international competitiveness of Chinese enterprises.

Since enterprise risk management has been engaged greatly high universality among foreign enterprises, the related researches are also carried widely and profoundly, most of which are based on case studies [2-4]. A lot of research findings concerning the effectiveness of enterprise risk management have been provided [5-7]. These achievements contribute to form a solid foundation to improve enterprise risk management performance. Comparatively speaking, related researches in China are inadequate. Most researching works are limited to simply illustrating theories, which lack the foundation of empirical data. Meanwhile, most

of them concern mainly on measuring the risk itself, instead rarely focus on the quality and implemental capacity of enterprise risk management [8-11].

2. The Construction of Index

2.1. The Logic of the Research

According to the definition of enterprise risk management by COSO, enterprise risk management consists of eight interrelated components. They derive from the management layer's operating strategy, and integrated into management process. [1] Practically speaking, it is difficult to find financial data related to objective operational conditions of relevant implementation. Moreover, since the relationship between the components is complex and hard to measure, the difficulty to compare ERM performance among the enterprises has furthered. On the Other hand, according to the research from Gordon and his colleagues, [7]the degree to which the enterprise achieves his ERM goal corresponds to its ERM performance. Thus, Re-examining ERM performance from the perspective of target bears adequate feasibility and necessity.

2.2. Goal Selection

The goal of enterprise risk management could be attributed to 4 aspects: Strategy---High level goal, which is associated and supports its mission; Operations---validly and effectively utilizing its resources; Reporting---the reliability of the report; Compliance---corresponding to suitable laws and rules. Based on enterprises' ability to fulfill the mentioned four goals, a standard comprehensive metric system, namely ERM index, is formed, ensuring the horizontal comparison between different enterprises. The details are displayed in Table 1.

Table 1. The Illustration of ERMI

| ERMI | | Illustration |
|------------------------------------|---|---|
| Strategic Effectiveness (S) | S1: Industrial Competitive advantage | Comparing to average industrial sales, one enterprise's higher sales stands for a better performance and more effective strategic implementation among the competitors. Therefore, one method to measure a company's industrial competitive advantages concerns using its sales' standard deviation within the industrial sales. |
| | S2: Control of systematic risks | Compared to other enterprises, strategically effective enterprises possess lower systematic risk. This is mainly because the main advantage of enterprise risk management is reducing corporate risk through managing diversified risk portfolio. β coefficient could precisely measure the relationship of systematic risk between enterprises and market. Thus, analyzing one's β coefficient compared to other enterprises in the same industry would help to measure one's strategic effectiveness. |
| Operational Efficiency (O) | O1: The input-output ratio of assets | The input-output ratio contributes to measure the operational efficiency of the enterprise. Therefore, a measure of operational efficiency could be defined as the quotient of corporate sales divided by assets circulation defined by the total assets. |

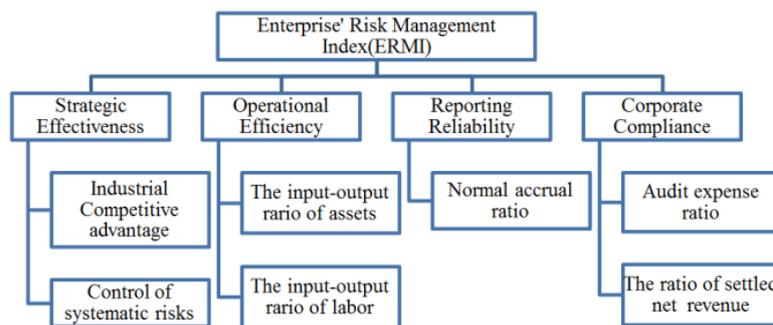
| | | |
|----------------------------------|--|--|
| | O2: The input-output ratio of labor | As mentioned, another measure of operational efficiency is the quotient of sales divided the amount of employees, which defines the input-output ratio of labor. |
| Reporting Reliability (R) | R1: Normal accrual ratio | The value of normal accrued value divided by the sum of absolute values of normal and abnormal accrued values. |
| Corporate Compliance (C) | C1: Audit expense ratio | Audit expense is the expense paid for auditors who offer auditing services, in order to compensate the auditing cost during the process of audit. ¹ |
| | C2: Non-operating revenue ratio | If the corporation concerns more in laws and rules, they are supposed to reduce their settlement losses and improve settlement gains. |

2.3. Construction of Index System

Based on the analysis above, the integrity of index system and the principle of data accessibility, the index constructed in this paper, namely ERMI, could be expressed with Formula (1) as mentioned below. The index system is illustrated in Figure 1.

Enterprise' Risk Management Index(ERMI)

$$\begin{aligned}
 &= \sum_{k=1}^2 \alpha_k \cdot \text{Strategic Effectiveness}_k \\
 &+ \sum_{k=1}^2 \alpha_k \cdot \text{Operational efficiency}_k \\
 &+ \sum_{k=1}^2 \alpha_k \cdot \text{Reporting Reliability}_k \\
 &+ \sum_{k=1}^2 \alpha_k \cdot \text{Corporate Compliance}_k
 \end{aligned}$$



(1)
eight.

Figure 1. ERM Performance Index System

¹According to O'keefe's research,[12] Corporate compliance would increase with the improvement of auditexpens. Therefore, it is reasonable to utilize the percentage of audit expense within the sales to measure corporate compliance.

3. Assess of ERM Performance

3.1. Evaluated Objects Selection and Data Origin

The evaluated objects in this paper are restricted in the range of listed corporations in Shanghai Stock Exchange based on two main reasons. Initially, the ability to implement enterprise risk management is closely related to corporate scale and strength. The Shanghai Stock Exchange focuses on large -sized and medium-sized state - owned enterprise while the Shenzhen Stock Exchange focuses on venture capital and small and medium-sized enterprises. Additionally, evaluating indexes selected by institutions might involve some data related to stock market fluctuation, therefore need to consider their comparability. Moreover, since financial industry bears obvious difference with others in both internal and external environment, this paper would only focus on the evaluation of non-financial enterprises. Also, because the data of some companies is not complete, after detailed sifting, this paper would select 509 comparatively stable and data-detailed listed corporations in SSE as the samples and would analyze their ERM performance in 2012.

The data mainly relies on RESSET Financial Research Database, Wind Information Financial Database and financial statement, annual report and other relevant market information filed by every company.

3.2. Evaluating Methods Selection

In order to eliminate the influence of subjective factors, this research would select entropy weight/TOPSIS method to evaluate the enterprise risk management of the mentioned 509 enterprises.

(1) Entropy weight method

Entropy weight method is to define the weight objectively with the decisive data exclusively. According to the basic principle of Information Theory, entropy is the measure of the degree of systematic disorder. If the informational entropy of one specific index is small, the index provides more information, which in turn possesses greater impact when evaluating, thus should be placed with higher weight. Using E_j as the entropies, the formula could be expressed with Formula (2) as below.

$$E_j = -K \sum_{i=1}^m p_{ij} \ln p_{ij} \quad j = 1, 2, \dots, n \quad (2)$$

Within the formula, K is a constant and p_{ij} indicates corporation ranked No. i 's contribution of disorder to index ranked no. j within the decisive matrix. Based on Formula (2), the unity of index j could be illustrated by $(1 - E_j)$, and the weight of each index could be determined after normalization.

(2)TOPSIS

TOPSIS is an effective method based on the sequence of proximity between target objects and ideal goals. Its principle is to compare the ideal solution and negative ideal solution of each object. The object which is closer to ideal solution and meanwhile further from negative ideal solution would perform better comprehensively considering all the indexes. In this paper, we use C_i to express the comparative distance between ERMI levels of different enterprises.

$$C_i = \frac{S_i^-}{(S_i^- + S_i^*)} \quad i = 1, \dots, m \quad 0 \leq C_i \leq 1 \quad (3)$$

Within the formula above, S_i^- represents the distance between corporation i 's ERMI level and the negative ideal solution, while S_i^* represents the distance between corporation i 's ERMI level and the ideal solution. The bigger is the value of C_i , the bigger comparative distance with negative ideal solution and the higher ERMI level.

3.3. Evaluation of ERM Performance

(1) Weight of each index

Based on the decisive matrix after data-collecting and through positive treatment and normalization, a new matrix could be formed. On the basis of this new matrix, the weight of each index could be calculated with entropy weight method. The value of constant K is 0.160($K = 1 / \ln m$ $m=509$). Detailed computation would be illustrated in Table 2. (Relevant results are rounded to 6 effective Figures.)

Table 2. Computational Data Related to Entropy Weight Method

| | | | | | | | |
|---------------------------------|-----------------|-----------|-----------|-----------|-----------|-----------|-----------|
| K | 0.160451 | | | | | | |
| Attribute | S1 | S2 | O1 | O2 | C1 | C2 | R1 |
| Entropy | 0.967597 | 0.972482 | 0.959708 | 0.874443 | 0.909501 | 0.960849 | 0.99435 |
| Differential Coefficient | 0.032403 | 0.027518 | 0.040292 | 0.125557 | 0.090499 | 0.039151 | 0.00565 |

Further calculation leads to the weight of each attribute, which is shown in Table 3.

Table 3. The Weight of Each Attribute

| Index | Weight |
|---------------------------------------|---------------|
| S1 : Industrial Competitive Advantage | 0.08974 |
| S2 : Control of systematic risks | 0.07621 |
| O1 : The input-output ratio of assets | 0.11159 |
| O2 : The input-output ratio of labor | 0.34774 |
| R1 : Normal accrual ratio | 0.01565 |
| C1 : Audit expense ratio | 0.25064 |
| C2 : The ratio of settled net revenue | 0.10843 |

(2) Evaluation process and results

Initially, based on the value of weight calculated and data collected, the ideal solution and negative ideal solution could be determined, as shown in Table 4.

Table 4. Ideal Solution and Negative Ideal Solution

| Attributes | S1 | S2 | O1 | O2 | C1 | C2 | R1 |
|---------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Ideal solution v_j^* | 0.62609 | 0.621055 | 0.217366 | 0.770848 | 0.449159 | 0.87379 | 0.166948 |
| Negative ideal solution v_j^- | -0.04923 | -0.0545 | -0.05804 | -0.0198 | -0.03056 | -0.02835 | -0.17199 |

Additionally, enterprise risk management performance of the 509 samples in 2012, could be calculated with TOPSIS method. Within the formula

$$S_i^* = \sqrt{\left(\sum_{j=1}^n (v_{ij} - v_j^*) \right)^2}$$

(4)

$$S_i^- = \sqrt{\left(\sum_{j=1}^n (v_{ij} - v_j^-)\right)^2}$$

(5)

Thirdly, the scores in the form of percentage would be ordered.

4. The Analysis of the Results

According to CMM model (Capability Maturity Model for software) offered by SEI (Software research institution of Carnegie Mellon University, the U.S), this paper would categorize enterprise-wide ERM performance into 5 levels [13] (zero, decentralized, integrated, improved and optimized) to further observe the overall condition of China's enterprise-wide enterprise risk management's development.

4.1. The Distribution of China's Enterprises' ERM Performance

4.1.1. Huge Discrepancy Exists Among China's Enterprises' ERM performance

Observed from previews evaluation data, the discrepancy of China's enterprises' ERM performance is rather obvious. Shanghai Automobile Industry Corporation, which ranks No.1, bears huge difference with others in score. Although the comparison is only limited to domestic corporations in China and deficient of objective contrast with advanced foreign enterprises due to the limitation of data origin, it would also be beneficial for the development of domestic corporations. Classifying SAIC as ERM5 level, the optimized level, would also help to establish the standard of ERM for other companies.

4.1.2 The Overall Level of China's Enterprises' ERM Performance is Comparatively Low.

According to clustering analysis of the evaluation results, at present, China's overall enterprise-wide risk management ability is not high. Only 10 enterprises reach the level of optimized and improved, which is less than 2% of all. However, enterprises staying in the level of zero (basically having no sense of risk and lacking risk management methods and rules) surpass 48.5% of all the samples. Such a phenomenon corresponds to the contemporary condition of China's enterprises, which is starting comparatively late in enterprise risk management and lacking the basis of related theories and practice.

4.1.3. Enterprise Risk Management Abilities Vary in Different Industries

Through the analysis of evaluation results from the industry perspective, within top 20 enterprises, manufacture corporations consist of 50%, wholesalers and retailers followed and mining corporations and constructing company account for 3 and 1 corporations individually. As for corporations ranked after 20th, corporations related to transportation and warehousing consist of a bigger proportion with the amounts of 8 companies. Besides, enterprises related to construction, manufacture, social service, mining, real estate industry and ect are sparsely separated in each industry. The cause of this discrepancy could be attributed to different marketing environments of different industries. For example, manufacturing environment is comparatively more centralized and thus easier for relevant companies to achieve their goals. Meanwhile, logistics and transport industries are more decentralized. Therefore, it is extremely hard for these corporations to excel in their industries and achieve the 4-level goal of ERM.

4. 2. Analysis of Strategies to Improve ERM Performance

In order to further analyze enterprise risk management performance of China enterprises, we define ΔC_{ij} as the comparative distance between corporation i 's index j and the optimized solution S_{ij}^* . The formula is shown in Formula (6). According to the values of ΔC_{ij} , it would be available to observe each company's ERM performance and set up relevant strategies to improve it. Table 5 shows the ΔC_{ij} values of the enterprises ranked last 10.

$$\Delta C_{ij} = (S_{ij}^* - S_{ij}) / S_{ij}^* \quad (6)$$

Take corporation C600674 as an example. Within the 7 indexes, the distance between the input-output ratio of labor and the optimized solution defines the biggest one. This would mean that the operational efficiency of this company, especially the aspect of input and output of labors, bears great potential to improve, which should be concerned in the strategies to improve ERM performance. Moreover, on the behalf of corporate compliance, the deficiency of audit expense ratio might be one of the bottlenecks of enterprise risk management implementation. Therefore, higher concern on audit work would be necessary in next-step ERM improving strategies. Furthermore, we could see the distance between reporting reliability and the optimized solution is comparatively the smallest, which means the corporation work in reporting reliability would be comparatively the best.

Table 5. ΔC_{ij} Ranked the Last 10

| Rank | Stock code | S1 | S2 | O1 | O2 | C1 | C2 | R1 |
|------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 500 | C600157 | 0.09168 | 0.077882 | 0.13449 | 0.353851 | 0.265837 | 0.109064 | 0.015221 |
| 501 | C600269 | 0.092427 | 0.078518 | 0.136264 | 0.35262 | 0.265383 | 0.108443 | 0.014602 |
| 502 | C600550 | 0.091037 | 0.077312 | 0.1343 | 0.354232 | 0.264236 | 0.108981 | 0.018239 |
| 503 | C600896 | 0.09308 | 0.079078 | 0.134621 | 0.351804 | 0.263085 | 0.109473 | 0.017574 |
| 504 | C601188 | 0.093235 | 0.07921 | 0.137436 | 0.35409 | 0.261566 | 0.109055 | 0.014473 |
| 505 | C600106 | 0.093259 | 0.079231 | 0.139549 | 0.349919 | 0.26279 | 0.109063 | 0.015445 |
| 506 | C600239 | 0.092152 | 0.078239 | 0.141385 | 0.353061 | 0.264142 | 0.108558 | 0.012313 |
| 507 | C600790 | 0.093788 | 0.079918 | 0.139287 | 0.353888 | 0.260833 | 0.10907 | 0.013133 |
| 508 | C600190 | 0.093041 | 0.079044 | 0.137298 | 0.353401 | 0.263203 | 0.108883 | 0.015604 |
| 509 | C600674 | 0.092463 | 0.078559 | 0.139031 | 0.351034 | 0.265597 | 0.109031 | 0.015315 |

Through the analysis of the difference of the 509 enterprises' ERM performance in different indexes mentioned above, from the mean and median values of the comparative discrepancy in different indexes, we could conclude that the comparatively big discrepancy in corporate compliance, especially input-output ratio of labor and audit expense ratio, would be the reason why Chinese enterprises' enterprise risk management abilities vary greatly. The fact which need to be concerned is that the discrepancy in reporting reliability among all the enterprises is relatively low. This is corresponded to the actual condition known by us, however is caused by various reasons and therefore might not reflect the real condition of reporting reliability of China's enterprises.

Table 6. Discrepancy of ERM Performance of China's Enterprises

| | S1 | S2 | O1 | O2 | C1 | C2 | R1 |
|------|----------|----------|----------|----------|----------|----------|----------|
| Mean | 0.089748 | 0.076216 | 0.111438 | 0.347724 | 0.250743 | 0.108427 | 0.015628 |

| | | | | | | | |
|--------|----------|----------|----------|----------|----------|----------|----------|
| Median | 0.091216 | 0.077469 | 0.117157 | 0.352138 | 0.257807 | 0.108928 | 0.015874 |
|--------|----------|----------|----------|----------|----------|----------|----------|

5. Conclusion and Prospective

Based on data from annual reports and financial market, this paper assesses and analyzes ERM performance of 509 enterprises listed in SSE. Through further observation of status of China enterprises ERM implementation, we discover that the overall level of ERM performance among China enterprises is relatively low and huge discrepancy exists between different corporations. Also, we provide basic solutions to set up strategies to enhance ERM performance.

In the future, we would focus on broadening the amount of the samples and enlarging the cross section data to panel data. Additionally, we would observe the dynamic developing condition of ERM in China closely and execute horizontal comparison with foreign company's ERM implementation, in order to further discover effective methods to improve ERM performance of China enterprises.

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