

Influence of green supply chain risk management on performance of Chinese manufacturing enterprises

Zhang Dongying¹, Duan Yuting¹ And Shen Junyi¹

¹ Harbin University Of Science And Technology, Heilongjiang, China.

E-mail: 1203749061@qq.com

Abstract. This paper briefly introduces the background of the research on the impact of green supply chain risk management on corporate performance, reviews the relevant research literature at home and abroad, and uses the gray relational analysis to analyze the impact of the green supply chain risk management on enterprise performance based on 26 industry-related statistical data, from purchasing risk management performance, manufacturing risk management performance and marketing risk management performance.

1. Introduction

Accelerating the construction of green manufacturing system, promoting green products, green factories, green parks and green supply chain comprehensive development, strengthening the green industry, enhancing the international competitive new advantages, to achieve efficient manufacturing clean and low carbon cycle and sustainable development, promote industrial civilization and ecology civilized and harmonious communion[1]. However, in recent years, with the risk of various events intensified, the supply chain risk is more and more prominent, in order to gain high competitive advantage among the competition, more attention should be paid to the supply chain risk management. Based on the green supply chain risk management, this article takes the manufacturing enterprises in China as the research object, combs the related literatures and carries on the hypothesis to the relationship of the two, analyzes the correlation between the green supply chain risk management and the manufacturing enterprise performance by using the gray correlation analysis. Finally, through the empirical analysis, we find that there is a direct and positive relationship between the two, so that realize the green, low-carbon and sustainable development of the enterprise.

2. Theoretical Hypothesis and Model Establishment

Through the combing of relevant literature, we can see that there is no unified definition of the basic concept about supply chain risk management. Paulsson (2004) argues that supply chain risk management is in collaboration with the parties in the supply chain or on its own, dealing with some risks and failures by using risk management tools in supply chains that are either affected by or affected by logistics or related activities certainty [2]. On the basis of combing the relevant papers, this paper mainly considers the risk of supply chain, such as purchasing risk, manufacturing risk and marketing risk caused by uncertain factors. Which can divide the risk management performance of supply chain into three dimensions: green purchasing risk management performance (GPRMP), green manufacturing risk management performance (GManRMP) and green marketing risk management performance (GMarMP). Xu Dehui, Li Gang, and Sun Linyan (2013) measure firm performance from two aspects: operational performance and financial performance, and argue that operational



performance improvement will improve corporate financial performance and thus increase performance across the firm [3].Liu Yuhui(2014) think that good environmental management policy is a reliable guarantee to enhance financial performance [4].Hu Tun (2012) argues that active and effective environmental prevention management can lead to a win-win between environmental performance (EP) and financial performance (FP) , and environmental performance (EP) has a significant positive correlation with financial performance [5].Combined with the research of related scholars, this paper will measure the performance of enterprises from environmental performance(EP) and financial performance (FP) as standard. The following assumptions are presented in this article:

H1: GPRMP has a direct and positive correlation on EP and FP;

H2: GMarRMP has a direct and positive correlation on EP and FP;

H3: GManRMP has a direct and positive correlation on EP and FP.

Based on the above research assumptions, the conceptual model of this study is presented, as shown in Figure 1:

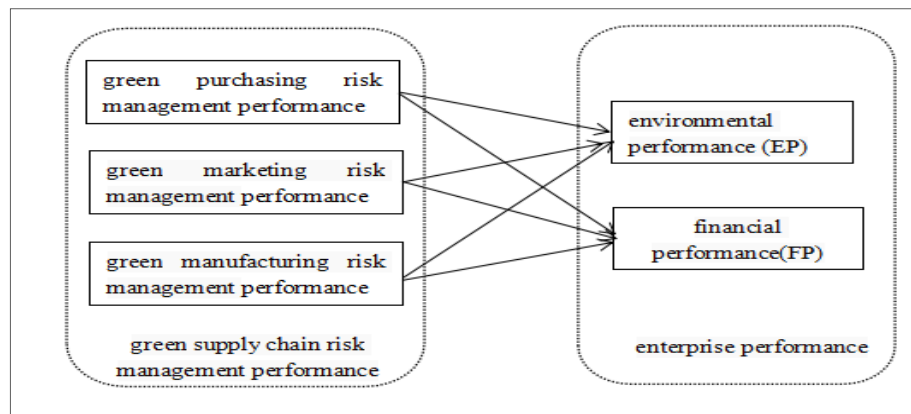


Figure 1. Conceptual model.

3. Empirical analysis

3.1. Gray Relational Model Construction

Gray relational analysis is a common method for studying the degree of correlation among factors in the system. The advantage is that the amount of sample size and the normal distribution of the sample data is not strictly required, and easy to calculate. Therefore, this article analyzes the green supply chain risk management performance and enterprise performance by using gray relational analysis. Gray relational analysis mainly through the consistency of sequence data changes to explore the relationship between the various factors within the system closely. If the two factors in the system development process has a high consistency change, the degree of correlation between the two variables on the high, on the contrary, low correlation.

Determine the reference sequence and the comparison sequence. Set the reference data sequence $Y = (y_{i1}, y_{i2}, \dots, y_{in})$ ($i=1,2$) represents the reference sequence of environmental performance(EP) and financial performance(FP); The comparative data sequence $X_j = (x_{j1}, x_{j2}, \dots, x_{jn})$ ($j=1,2,3$) represent comparative list of green purchasing risk management performance, green manufacturing risk management performance and green marketing risk management performance.

Dimensionless processing. This article takes the mean method to carry out dimensionless processing. Calculate the correlation coefficient.

$$\xi_{ij}(t) = \frac{(\Delta_{\min} + \rho \Delta_{\max})}{(\Delta_{ij}(t) + \rho \Delta_{\max})} \quad (1)$$

$\Delta_{ij}(t) = y_i(t) - x_j(t)$ represents the absolute value of the difference between the t-time reference

sequence and the comparison sequence; $\Delta_{\min}, \Delta_{\max}$ for the maximum and minimum values in all absolute differences; ρ is the resolution factor, the general situation to take 0.5. Calculate the degree of correlation. Ranges from $[0, 1]$, the closer the R is, the greater the effect of this factor.

$$R = \frac{1}{m} \bullet \sum_{t=1}^m \xi_{ij}(t) \quad (2)$$

3.2. Indicator selection and data description

We select the growth rate of the general solid waste comprehensive utilization rate to measure the green purchasing risk management performance; and select the growth of waste water treatment and management costs accounted for the proportion of the total cost, the growth rate of the emission control, operating costs accounted for the proportion of the total cost and the slip rate of the general solid waste production to comprehensively measure the green manufacturing risk management performance; and select the growth rate of the new product sales revenue accounted for the proportion of total revenue to measure the green marketing risk management performance; and select the reduction rate of the unit output value of energy consumption to measure the environmental performance of enterprises; and select the growth rate of sales rate to measure the financial performance of enterprises. The data is derived from the "China Statistical Yearbook", "China Environmental Statistical Yearbook", "China Energy Statistical Yearbook", "China Industrial Economics Statistical Yearbook". The sample data selected in this article is panel data for 2010-2014. At the same time, the sample industry is 26 manufacturing industries due to the lack of large deficiencies in the tobacco products industry, waste resources and waste materials recycling and handicrafts and other manufacturing data.

3.3. Empirical test results

Entropy based on entropy method. As the GManRMP using a multi-indicator comprehensive measurement, therefore, the need to merge multiple indicators into a single indicator. This is the use of entropy method to merge its indicators.

Empirical Test Results Based on Gray Relational Analysis. According to the gray-related calculation steps, this article calculates the gray correlation of the GPRMP, GManRMP and GMarRMP three aspects with the EP and FP of the enterprise. The results are shown in table 1.

Table 1. Green supply chain risk management performance enterprise EP and FP of the gray correlation

	EP			FP		
	GPRM P	GManR MP	GMarR MP	GPRM P	GManR MP	GMar RMP
Processing of Food from Agricultural Products	0.5954	0.8629	0.7004	0.5785	0.8945	0.7566
Manufacture of Foods	0.9318	0.9265	0.5274	0.9383	0.9342	0.5279
Manufacture of Drinks	0.8653	0.8246	0.9787	0.8679	0.8268	0.9786
Manufacture of Textile	0.7510	0.7888	0.8205	0.7616	0.8056	0.8178
Manufacture of Textile Wearing and Apparel	0.8856	0.8714	0.6666	0.9064	0.8917	0.6638
Manufacture of Leather, Fur, Feather and Related Products	0.9068	0.8382	0.7189	0.8852	0.8738	0.7739
Processing of Timber, Manufacture of Wood, Bamboo, Rattan, Palm, and Straw Products	0.7863	0.7927	0.6843	0.8194	0.8455	0.7216
Manufacture of Furniture	0.7436	0.7436	0.7436	0.8104	0.8167	0.8423
Manufacture of Paper and Paper Products	0.9999	0.9993	0.7238	0.9999	0.9993	0.7238
Printing, Reproduction of Recording Media	0.8374	0.7487	0.7207	0.8987	0.7821	0.7262

Manufacture of Articles for Culture,Education and Sport Activity	0.9012	0.7777	0.8244	0.9186	0.7676	0.8716
Processing of Petroleum,Coking,Processing of Nuclear Fuel	0.7887	0.8588	0.8366	0.6088	0.8630	0.7841
Manufacture of Raw Chemical Materials and Chemical Products	0.8765	0.8805	0.6775	0.8803	0.8770	0.6764
Manufacture of Medicines	0.8085	0.7805	0.7649	0.8666	0.8732	0.8157
Manufacture of Chemical Fibers	0.8592	0.8398	0.8554	0.9470	0.8496	0.9256
Manufacture of Rubber and Plastic	0.8714	0.8335	0.8488	0.8738	0.8338	0.8423
Manufacture of Non-metallic Mineral Products	0.7933	0.7627	0.5092	0.8310	0.8000	0.5260
Smelting and Pressing of Ferrous Metals	0.9780	0.9294	0.8337	0.9764	0.9277	0.8545
Smelting and Pressing of Non-ferrous Metals	0.8429	0.7993	0.6645	0.8674	0.8249	0.5852
Manufacture of Metal Products	0.7734	0.7657	0.6715	0.8186	0.7811	0.6677
Manufacture of General Purpose Machinery	0.7579	0.7466	0.6355	0.8300	0.8019	0.6888
Manufacture of Special Purpose Machinery	0.9257	0.9267	0.6353	0.9292	0.9385	0.6382
Manufacture of Transportation Equipment	0.6544	0.6544	0.6544	0.8064	0.7544	0.6738
Manufacture of Electrical Machinery and Equipment	0.8924	0.8356	0.8968	0.9129	0.8799	0.9747
Manufacture of Computers,Communication,and Other Electronic Equipment	0.7436	0.7436	0.7436	0.6650	0.7804	0.8265
Manufacture of Measuring Instrument	0.6621	0.7325	0.6797	0.6981	0.7397	0.7058
Mean	0.8243	0.8179	0.7314	0.8422	0.8447	0.7534

4. Results

For ease of comparison, this paper divides the degree of correlation into five dimensions(as shown in table 2),So as to measure the relevance of environmental performance and financial performance of green supply chain risk management.

Table 2 Correlation coefficient division

correlation coefficient	$0 < R \leq 0.2$	$0.2 < R \leq 0.4$	$0.4 < R \leq 0.6$	$0.6 < R \leq 0.8$	$0.8 < R \leq 1$
influence level	smaller	small	smaller general	Greater	Great

4.1. Green supply chain risk and environmental performance relevance

*4.1.1. the overall relevance of the manufacturing industry analysis.*As shown in table 1, from the mean of correlation degree,we can see that the degree of association of GPRMP,GManRMP,GMarRMP and corporate EP respectively is 0.8243, 0.8179 and 0.7314.According to table 2,it can be seen that the impact of GPRMP and GManRMP on enterprise EP is very large, and the impact of GMarRMP on enterprise EP is larger than that of GPRMP and GManRMP,indicating that green purchasing risk management and green manufacturing risk management will greatly affect the EP;The impact of GPRMP on corporate EP is slightly higher than the impact of GManRMP ,which means that the green purchasing risk management is the most important part .

*4.1.2. Analysis of the degree of correlation in different industries.*On the aspect of GPRMP impacting on corporate EP,most industries and enterprises associated with EP are very high,including

manufacture of foods, manufacture of leather, fur, feather and related products manufacture of paper and paper products, manufacture of articles for culture, education and sport activity, smelting and pressing of ferrous metals, manufacture of special purpose machinery, and their the degree of association respectively is 0.9318, 0.9068, 0.9999, 0.9012, 0.9780 and 0.9257, indicating that their association degree of GPRMP and corporate EP are closely related; And the impact of green purchasing risk management in 19 industries such as manufacture of drinks is also more obvious; The green purchasing risk management of processing of food from agricultural products has a weak influence on the EP, and its correlation coefficient is 0.5954.

On the aspect of the impact of ManRMP on corporate EP. The correlation coefficient of manufacture of foods, manufacture of paper and paper products, smelting and pressing of ferrous metals, manufacture of special purpose machinery is still the highest, respectively is 0.9265, 0.9993, 0.9294 and 0.9267, it shows that the green manufacturing risk management of these four industries has the greatest impact on the EP. While the manufacture of drinks and other 21 industries' green manufacturing risk management impact is also more obvious; The impact of green manufacturing risk management of manufacture of transportation equipment is relatively weak, and its correlation coefficient is 0.6544.

On the aspect of MarRMP on the impact of corporate EP, the correlation coefficient of manufacture of foods, manufacture of chemical fibers and manufacture of electrical machinery and equipment with environmental performance are highest, and their correlation coefficient respectively is 0.9787, 0.8968 and 0.8554; While processing of food from agricultural products and other 21 industries' green marketing risk management impacting on corporate EP are also more obvious; Manufacture of non-metallic mineral products and manufacture of foods' green marketing risk management impact is relatively weak, the correlation coefficient is 0.5092 and 0.5274.

4.2. Green supply chain risk and financial performance of the degree of correlation

4.2.1. Relevancy analysis of manufacturing industry as a whole. As shown in Table 1, from the mean of correlation degree, we can see that the degree of association of GPRMP, GManRMP, GMarRMP and corporate FP respectively is 0.8422, 0.8447 and 0.7534. According to table 2, GPRMP and GManRMP, have the greatest impact on the FP. The impact of GMarRMP is high, but a little lower than the other two. Indicating that green purchasing risk management and green manufacturing risk management in the the green supply chain risk will greatly affect the FP; and the impact of GManRMP is slightly higher than the impact of GPRMP, means that the enterprise's green manufacturing risk management is the most important part on the impact on corporate FP.

4.2.2. Analysis of the Correlation Degree of Different Industry. On the aspect of the GPRMP impacting on corporate FP, most industries and corporate FP are highly correlated, including manufacture of foods, manufacture of textile wearing and apparel, manufacture of paper and paper products, manufacture of articles for culture, education and sport activity, manufacture of chemical fibers, smelting and pressing of ferrous metals, manufacture of special purpose machinery and manufacture of electrical machinery and equipment, the highest degree of correlation between the eight industries, and their correlation coefficient respectively is 0.9383, 0.9064, 0.9999, 0.9186, 0.9470, 0.9764, 0.9292 and 0.9129, among which the highest degree of correlation is manufacture of paper and paper products; manufacture of drinks and other 17 industries associated with a larger degree; and processing of food from agricultural products is relatively weak, and its degree of coefficient is 0.5785, which indicates that the green purchasing risk management of the processing of food from agricultural products has no obvious effect on the EP of the enterprise.

On the aspect of GManRMP, manufacture of foods, manufacture of paper and paper products, smelting and pressing of ferrous metals and manufacture of special purpose machinery have the highest correlation coefficient, and respectively is 0.9342, 0.9993, 0.9277 and 0.9385. Indicating that the four industries' green manufacturing risk management have the greatest impact on the FP; And the

impact of green manufacturing risk management on the FP in 21 industries such as processing of food from agricultural products is also obvious. The impact of green manufacturing risk management on manufacture of measuring instrument is relatively weak, the correlation coefficient is 0.7397, but its impact is also a greater impact.

On the aspect of the impact of GMarRMP manufacture of drinks, materials and chemical products and manufacture of electrical machinery and equipment have the greatest impact on corporate FP, with correlation coefficients of 0.9786, 0.9256 and 0.9747 respectively. Processing of food from agricultural products and other 20 industries' impact of green marketing risk management on corporate FP are also greater than normal, and manufacture of foods, manufacture of non-metallic mineral products and smelting and pressing of ferrous metals three correlation coefficients respectively is 0.5279, 0.5260 and 0.5852, indicating that the three industries' impact of green marketing risk management on FP of enterprises are in general.

5. conclusion

The results show that the green purchasing risk management, green manufacturing risk management and green marketing process risk management have a direct and positive impact on the environmental performance and financial performance of Chinese manufacturing enterprises. Among them, the green purchasing risk management is the most important part of the enterprise environmental performance, green manufacturing risk management is the most important part of the financial performance of enterprises.

References

- [1] Green Manufacturing Engineering Implementation Guide (2016 - 2020).
- [2] Paulsson U. 2004, Supply chain risk management[A]. In: Brindley C. Supply Chain Risk[C]. Ashgate Publishing Limited, 79-96.
- [3] Dehui X, Gang L, Linyan S 2013 Empirical Study on the Impact of Supply Chain Operational Risk on Enterprise Competitive Ability and Performance [J]. *Journal of Scientific Research Management*, 34 (6): 129-137.
- [4] Yuhui L, Shanbo Y, Yangyang Z 2014 Effects of Environmental Performance on Financial Performance and Cooperative Countermeasures [J]. *China Business*, (19): 120-121.
- [5] Quying H 2012 A Study on the Correlation between Environmental Performance and Financial Performance of Listed Companies[J]. *Chinese Journal of Population Resources and Environment*, 22 (6) :23-32.