Construction of Mathematical Model of Green Innovation Risk Measurement in Manufacturing Industry under Global Value Chain

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Abstract: In order to cope with increasingly serious environmental problems, such as smog, the government carries out environmental regulation to solve the external problems caused by pollution, in order to achieve the goal of protecting the environment and achieving economic development. This paper mainly studies the mathematical model of green risk measurement in manufacturing industry under the global value chain. It uses literature review method and expert survey method to summarize the influencing factors of manufacturing green innovation risk measurement. On this basis, it constructs the green risk of manufacturing industry under the global value chain. The mathematical model is measured, the research hypothesis is put forward, the data is collected by issuing questionnaires, and the reliability and validity of the collected data are analyzed by SPSS, and the reliability of the data is tested. Verify the correctness and reliability of the mathematical model of green risk measurement in manufacturing industry under the global value chain.

1. Introduction

The total scale of manufacturing industry in China ranks first in the world and China has become a genuine global manufacturing power. However, China's manufacturing industry is still dominated by the extensive growth mode of "three high and one low", namely, “high mining, high consumption, high emission and low utilization”, which aggravates the bad situation of China’s resource and energy waste and environmental pollution. The country attaches great importance to the healthy growth of the manufacturing industry, establishes the concept of green development, implements “green innovation-driven”, strengthens green manufacturing technology and raises new requirements for the future development of the manufacturing industry. Therefore, for solving the current problems and benefiting the long-term development, it is of profound and important significance promoting the establishment of a green system of energy conservation, consumption reduction and pollution reduction, and realizing the green transformation of the manufacturing industry. The green innovation system takes sustainable development as the goal and includes green scientific and technological innovation, green concept innovation and ecological system innovation.

2. Risk measurement

2.1 The risk of green innovation technology

There are a variety of risks of green innovation technology, which mainly include inadequate technology risk, technology development risk, technology protection risk, technical utilization risk and technology acquisition and transfer risk. Technology risk can be graded and classified according to the definition of engineering project risk and it is usually classified into three grades of low risk, medium risk and high risk. Low risk refers to the risk of which the influence on the project objectives can be identified and monitored; moderate risk refers to the risk that can be identified and will exert great impact on the technical performance, cost or schedule of the engineering system. The possibility of the occurrence of moderate risk is high, such risks are conditionally acceptable events and they need to be strictly monitored. High risk refers to the risk with a very high possibility of occurrence. High risks are unacceptable events and their consequences will exert a great impact on the engineering project. Due to unmatched or immature technologies and imperfect facilities and equipment needed by technological innovation, the applicability, advancement, completeness, feasibility and reliability of innovative technology are affected, resulting in technology risks. Many enterprises are keen on improving their technological level and content and introducing advanced foreign technology and equipment, as a result, they can not indiscriminately adopt foreign things and the equipments are idle and can not create benefits.

2.2 Market competition risk

In the market competitions, the basic motive and goal of competition is to maximize income. However, the expected benefits and goals of the competitors cannot always be achieved. In fact, competition itself will make competitors face the risk of being unable to achieve the expected interests or goals, and they can even suffer losses of economic interests. The possibility of the deviation of actually achieved benefits from the expected interests is the risk faced by the competitors. Risk is the possibility of loss or benefit arising from uncertain factors. In the market competitions, there are a number of uncertainties. Although all the competitors want to achieve their expected benefits and goals, not all of them can succeed, inevitably there will be competitors losing in the competition and suffering the loss caused by competition.

2.3 Risk of green innovation system

System mechanism risk is mainly caused by imperfect formulation, implementation and modification of the system. For example, the formulation of some systems is not scientific or rigorous enough and short of timeliness and has low operability, some of the mechanisms lack mutual support and restriction, the binding role and supervisory role are not obvious, effective routine working measures can not be formed, some systems not adapted to the changing situation can not be timely supplemented, modified or perfected.

2.4 Financial risk

Financial risk refers to the variability of shareholders’ returns and that the enterprise may lose its debt paying ability. With the increase of the proportion of debts, lease and preferred stock financing in the capital structure of enterprises, the fixed expenses of enterprise expenditure will increase, thus the possibility of enterprise losing cash solvency will increase. Another aspect of enterprise financial risk involves the relative deviation from the income that shareholders may gain. In a word, enterprise financial risk includes the variability of shareholders' future benefits and the possibility of enterprise losing the debt paying ability. These two aspects are directly related to the operational risk of an enterprise, that is, the deviation from the expected operating income.

2.5 Financing risk

Financing risk refers to the risk of income variation arising from the financing plan in financing activities. Financing risk is affected by both operational risk and financial risk and mainly includes credit risk, completion risk, production risk, market risk, financial risk, political risk and environmental protection risk.

2.6 Tax risk

Tax risk refers to the possibility of the deterioration of tax fund situation, the weakening of tax adjustment function, the sluggish growth of tax and the eventual failure of tax revenue to meet the functional needs of the government during taxation due to institutional defects, policy and management faults and various unpredictable and uncontrollable factors. Tax risk exists in the whole process and every link of tax administration. As far as its specific content is concerned, tax risk mainly includes tax reform risk, foreign-related taxation risk, tax source supervision risk, tax law enforcement risk and the risk caused by nonstandard taxation administrative enforcement of law and variability of tax policy. There are multiple subjects of taxation administrative enforcement in China, including multiple government sectors such as customs, the ministry of finance, the state tax department and the land tax department, and they often interlay in taxation administrative law enforcement. In addition, administrative bodies are endowed with too much discretionary power in laws, regulations and rules. Given this, even if the taxpayers have sufficient reasons, the tax authorities can easily deny them by stating that the "tax law interpretation power belongs to the tax authorities", thus greatly increasing the tax risk for taxpayers.

3. Model building

Based on consulting and sorting out relevant literatures, the author sent questionnaires to 10 experts to seek their advices, and confirmed the influence factors summarized at the literature research stage. Through literature review and sorting as well as expert investigation and interviews, the author abstracted and summarized the green innovation risk for the manufacturing industry in the global value chain, including green innovation technology risk, market competition risk, green innovation system risk, financial risk, financing risk and tax risk. On this basis, a mathematical model for measuring the green innovation risk for the manufacturing industry in the global value chain is constructed, as shown in Fig.1.

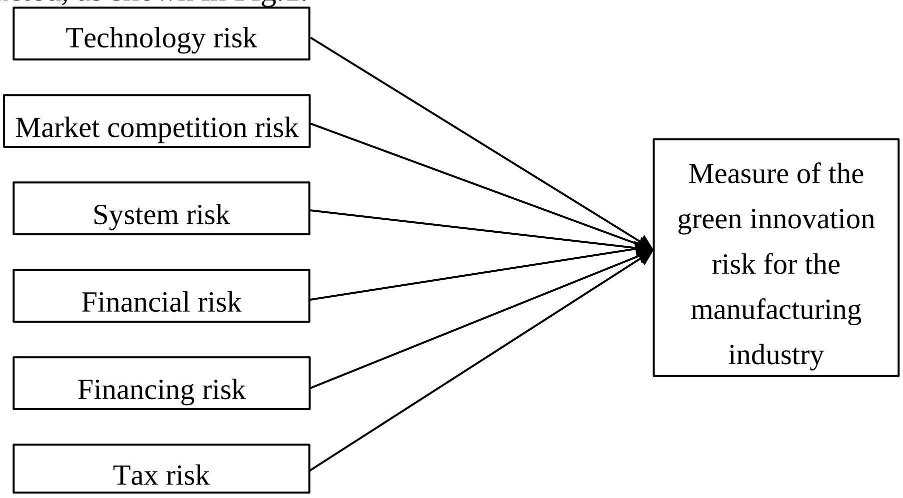

Figure 1. Mathematical Model for Measuring the Green Innovation Risk for the Manufacturing Industry in the Global Value Chain

4. Design and test of questionnaire

4.1 Content of questionnaire

The question items related to correlated variables in this questionnaire are mainly designed by 5-point Likert scale. The questionnaire is divided into three parts. The research model involves six latent variables, each of them corresponds to five measured variables, and there are a total of 30 measured variables. The design content of all the measured variables comes from the maturity scales in Chinese and foreign classic literatures. The respondents select Grade 1-5 to express their consent level according to their actual degree of perception.

4.2 Reliability and validity test

The reliability of the collected data is analyzed to verify the stability and reliability of the data. The reference standards of reliability analysis are as follows: Cronbach's $\alpha>0.90$ indicates that the questionnaire reliability is very high, $0.80<$Cronbach's $\alpha<0.90$ indicates that the questionnaire reliability is good, $0.70<$Cronbach's $\alpha<0.80$ indicates that the questionnaire reliability is acceptable and general, $0.65<$Cronbach's $\alpha<0.70$ indicates the minimum acceptable value and that the questionnaire reliability is not satisfactory and it is necessary to revise anew the scale or delete the problem items, Cronbach's $\alpha<0.65$ indicates that the questionnaire is unvalued and suggested to be abandoned. SPSS23.0 is used to test the Cronbach's α reliability coefficient of the sample data of the research questionnaire, and the overall reliability of the questionnaire is 0.941. It is found through the reliability analysis that the Cronbach's α values of the green innovation technology risk, the market competition risk, the innovation system risk, the financial risk, the financing risk and the tax risk are respectively 0.916, 0.897, 0.914, 0.875, 0.930 and 0.934. It can be concluded from the above data that the reliability of the questionnaire is good.

After the reliability of the questionnaire meets the requirements, the validity of the questionnaire is analyzed. The standards for validity analysis are as follows: 0.5<KMO≤0.6 represents inappropriate, 0.6<KMO ≤0.7 represents barely appropriate, 0.7<KMO≤0.8 represents appropriate, 0.8<KMO ≤0.9 represents quite appropriate, and KMO>0.9 represents very appropriate. The overall KMO value of the questionnaire is 0.907, indicating that the questionnaire is quite appropriate.

5. Empirical study

Using AMOS21.0 software, a mathematical model of green risk measurement for the manufacturing industry in the global value chain is constructed.

5.1 Model fitting

After the mathematical model of green risk measurement for the manufacturing industry in the global value chain is constructed, the first step is to analyze the degree of fitting of the model. The degree of fitting is to test the matching degree between the path relationship of the model hypothesis and the empirical data by comparing the difference between the regenerative covariance matrix and the sample covariance matrix. The common evaluation indexes of the degree of fitting are divided into absolute indexes and relative indexes. The fitting of the model is judged by fit indexes, which are divided into absolute fit indexes, value-added fit indexes and parsimony fit indexes. Thereinto, absolute fit indexes include CMIN/DF, RMR, RMSEA and GFI. CMIN/DF < 2, RMR < 0.08, the smaller the better, RMSEA < 0.08, the smaller the better, GFI≥0.9. The value-added fit indexes include NFI, RFI, IFI, TLI and CFI, NFI > 0.8, RFI > 0.9, IFI > 0.9, TLI > 0.9 and CFI > 0.9. The parsimony fit indexes include PGFI and PNFI, PGFI > 0.5 and PNFI > 0.5. The AIC theoretical model value is smaller than the independent model value and the saturated model value, which is the same for CAIC. AMOS is used to fit the model, and the fitting results show that PGFI and PNFI are lower than 0.5, which does not conform to the judgment criteria, thus the model needs to be adjusted.

5.2 Model correction

Not all the fit indexes of the model meet the requirements, so the model needs to be corrected, and corresponding residual terms should be added to conduct re-fitting until all the fit indexes meet the standards. The index of correlation is expressed by MI (Modification Indices). The closer the correlation between the residual terms is, the greater the MI value will be. MI correction is to connect the residual terms with larger correction coefficients using a double sided arrow, so as to improve the fitting degree of the model. The correction principles are as follows: find out the residual terms of MI value according to the size in turn, and only one correlation path can be corrected each time, as each path is closely related to the verification results, and as long as the path is changed, the results will be affected. According to the correction idea, the first correction is made, that is, deleting the insignificant paths. After the correction, NFI is 0.417, and RFI is 0.469, which do not meet the requirements, so the second correction is made. The maximum value of MI is sought and corresponding residual paths are added. After the second correction, all the data meets the standards. The fit indexes are shown in Table 1.

Table.1. Fit Indexes of the Model after Correction

Fitting type	Fit index	Adaptation standards	Before correction	After correction	Evaluation
Absolute fit indexes	CMIN/DF	<2	1.418	1.366	Up to standard
	RMR	<0.08 the smaller, the better	.066	.060	Up to standard
	RMSEA	<0.08 the smaller, the better	.071	.069	Up to standard
	GFI	≥0.9	.927	.935	Up to standard
Value-added fit indexes	NFI	>0.8	.841	.856	Up to standard
	RFI	>0.9	.937	.946	Up to standard
	IFI	>0.9	.919	.938	Up to standard
	TLI	>0.9	.928	.935	Up to standard
	CFI	>0.9	.918	.927	Up to standard
Parsimony fit index	PGFI	>0.5	.417	.672	Up to standard
	PNFI	>0.5	.469	.709	Up to standard

6. Conclusion

Based on green innovation technology risk, market competition risk, green innovation system risk, financial risk, financing risk and tax risk, this paper constructs a mathematical model for the measurement of green risk in the manufacturing in the global value chain. In today's rapidly developing society, risks always exist. In order to nip risks in the bud, it is necessary to identify potential risks and put an end to them.

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