

How corporate ESG performance affects green supply chain management

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Abstract. In recent years, corporate green supply chain management has attracted attention from social and environmental dimensions in the issue of global sustainable development. Based on the sample data of Chinese listed companies from 2014 to 2018, this paper studies the relationship mechanism between corporate ESG performance and green supply chain management, as well as the moderating effect of government subsidies. The study found that the ESG performance of enterprises helps to improve their green supply chain management level; government subsidies play a negative moderating role in the improvement of enterprise green supply chain management by ESG performance. According to the results, enterprises should integrate the ESG system into the green supply chain management process to balance the economic, environmental and social benefits of the enterprise. At the same time, the government and investors should also pay more attention to the disclosure of ESG information and force enterprises to take the road of green development.

Keywords: ESG performance; Green supply chain management; Government subsidies.

1. Introduction

Climate change is a common challenge facing the global village, and it bears on the sustainable development and future of all mankind. Promoting the global green transition is a global challenge faced by the international community, and it is also a broad and profound economic and social change. As a responsible developing country, China actively participates in global environmental governance, from the implementation of the "dual carbon" strategy to the practice of the "two mountains" theory to the joint construction of the Green Silk Road, with the greatest efforts to improve the response to climate change and promote the comprehensive green transformation of domestic economic and social development. Environmental, social and governance (ESG) performance is the basis for international climate negotiations and green financing operations, and it is also a bridge for the government, enterprises and the public to achieve positive interactions in addressing climate change (Shen Hongtao, 2022). It can be seen that promoting green and low-carbon transformation and improving corporate ESG performance has important theoretical and practical significance for decarbonization of supply chains and solving sustainable development problems (Wang Yu et al., 2022). In the context of "3060" dual carbon, this paper focuses on whether ESG performance can be transformed into the pressure or driving force for green transformation of enterprises, so as to improve the practice level of green supply chain management of enterprises.

Compared with the traditional supply chain management model, which generally ignores the destructive impact of production and circulation on the environment (Zhu Qinghua et al., 2005), green supply chain management integrates environmental protection awareness into the overall structure of the supply chain, and considers the impact on the environment in the entire life cycle of the product, in order to maximize the efficiency of resource utilization and minimize the negative impact on the environment (Wang Lijie et al., 2014). ESG is an important point to promote sustainable development, so that enterprises should also consider factors such as environmental protection, social responsibility and corporate governance effectiveness in addition to pursuing economic benefits (Li Jinglin et al., 2021). In order to stimulate the enthusiasm of enterprises for green transformation, my country supports enterprises in the form of government subsidies. However, in specific business practice, government subsidies have an important impact on enterprises' green supply chain management (Kong Yue et al., 2021).

Through the sorting and research of relevant literature, this paper uses empirical analysis methods to test the data, and finds that corporate ESG performance can improve the level of green supply chain management, and after introducing the adjustment variable of government subsidies, it is found that government subsidies will weaken the promotion effect of ESG performance on enterprise green supply chain management.

Compared with previous studies, the main contributions of this paper are reflected in the following aspects. First, the existing literature pays more attention to the investment and financing of enterprises when studying ESG (Zhang Lin et al., 19). Few literatures explore the impact of ESG performance on enterprise supply chain management. This paper studies the relationship between the two, expands the research field of ESG performance and green supply chain management, which provides new ideas for the green and low-carbon development of enterprises, and provides more empirical references for the improvement of green supply chain management. Second, from the perspective of supply chain management, we should cut into the perspective of enterprise competitiveness transformation, and explore the relationship from the perspective of corporate social responsibility (Zhou Fangzhao et al., 2020), this paper will explore the relationship between ESG performance and green supply chain management through empirical analysis, so as to provide a theoretical basis for enterprises to optimize supply chain management construction and carry out green supply chain management. Third, from the perspective of government subsidies, this paper innovatively explores the influence of government input on the relationship between ESG performance and green supply chain management.

The structure of this paper is arranged as follows: the second part is the theoretical analysis and research hypothesis, the third part is the research design, the fourth part is the results and analysis, the fifth part is the conclusions and suggestions.

2. Theoretical Analysis and Research Hypotheses

Green supply chain management is a "whole process" supply chain management model that comprehensively considers environmental impact and resource efficiency (Wang Lijie et al., 2014). It reduces the negative impact of products on the environment during production and consumption through supply chain management practices such as green procurement, green production, green products and green management. The existing research on enterprise green supply chain management is relatively rich, mainly focusing on the relationship between green supply chain and enterprise performance and the game analysis of manufacturers, suppliers, retailers and government departments within the supply chain (Tian, et al., 2014), and its impact on corporate performance (Li, et al., 2019). Xie Zhiming et al. (2015) found that environmental coordination and environmental supervision between upstream and downstream enterprises in green supply chain management are positively affecting the performance of manufacturing enterprises, providing a win-win situation for green supply chain management practices to achieve environmental performance and financial performance. Zhu Qinghua et al. (2011) systematically considered government subsidies, product greenness and other factors, and established a three-stage game model between the government and two competitive manufacturers to provide support for the green supply chain management decisions of the government and supply chain manufacturers.

Although existing research has reached a consensus that green supply chain management can promote business performance, there is a lack of research on the influencing factors of green supply chain management. Different from the traditional supply chain system, green supply chain management needs to take into account the triple benefits of economy, environment and society. And in the field of business, corporate environment, society and governance (ESG) is a business practice that incorporates environmental (E), social (S), and governance (G) elements into the business management system. It is not only to meet the requirements of listed companies to disclose ESG reports and environmental information, but also the internal driving force of the company's own development, thus urging itself to pursue high-quality and green development. In terms of the role

and consequences of ESG, existing literature has focused on the impact of corporate ESG performance on market value (Zhang Lin et al., 2019), corporate performance (Aouadi et al., 2018; Li Jinglin et al., 2021), and the impact of investment decisions (Pedersen et al., 2021). Qiu Muyuan et al. (2019) found that enhancing their own ESG performance can reduce financing costs and increase market valuations, deepening the understanding of the relationship between corporate sustainability and corporate financing costs in the context of ecological civilization construction. Zhang Yunmeng (2021) found that better ESG performance can significantly promote corporate green technology innovation, and put forward suggestions for strengthening information disclosure supervision and continuing to promote the development of green markets.

For enterprise supply chain clusters, the most important issue is the sustainable development of green supply chains, which involves economic responsibility, social responsibility and environmental responsibility. The ESG score is to examine the three dimensions of corporate environment, society and corporate governance. Therefore, we speculate that ESG performance can affect corporate green supply chain management, and referring to the existing literature, we speculate that ESG performance affects the green supply chain management of enterprises mainly through "environmental supervision" and internal driving forces of enterprises. The first is that after carrying out ESG evaluation, in order to improve ESG performance, enterprises "promote improvement through evaluation", urge enterprises to improve the weak links that need to be improved and strengthened in ESG practice (Lu Yini et al., 2022), and adopts effective environmental prevention and control measures as a whole (Xie Zhiming et al., 2015) to achieve environmental friendly requirements in the supply chain, and continuously deepens ESG practices in supply chain management links such as design, procurement, and internal operation management. It can be said that ESG performance can be regarded as a kind of "environmental supervision" and can be used as a mechanism to achieve green supply chain management practices of manufacturing enterprises. At the same time, under the dual-carbon strategy, the capital market is paying more and more attention to ESG. As the "signal" that requires listed companies to disclose ESG information is becoming stronger and stronger, various investors tend to hold stocks with better ESG performance (Pástor et al., 2021). Therefore, good ESG performance means that enterprises take more environmental and social responsibilities and improve corporate governance, has a positive impact on corporate value, which will attract more investors and lower financing costs (Qiu Muyuan et al., 2019). This will inevitably prompt those companies with poor ESG performance to pay attention to the sustainability of their own development, improve their environmental reputation and social responsibility, and promote the improvement of the green supply chain management mechanism, to reduce the negative impact of the environment through the synergistic integration of operations and management within the chain and the relationships formed (Wang Yu et al., 2022), attract more investors, and improve corporate valuation. Therefore, this paper proposes the following hypothesis:

Hypothesis 1: ESG performance can promote enterprise green supply chain management.

Government subsidies may cause crowding out effect. As an important signaling behavior, corporate ESG performance can reduce the financing constraints caused by information asymmetry, bring "reputation effect" and "advertising effect" to the company, and transmit favorable information such as good corporate status to the outside world, thereby reducing financing costs and improving operating income (Qiu Muyuan et al. 2019). This will help to obtain more external financial support for the green supply chain management of enterprises, and also help to obtain more government resource support such as government R&D subsidies. Green supply chain management includes the integration of green innovation in various parts of the chain. However, the government's subsidy encouragement to enterprises may cause enterprises to be content with the status quo and not seek to improve their original ESG performance, or they will be overly optimistic about green innovation research and development (Yang Jingjing, 2022). After receiving government subsidies, enterprises reduce their own input accordingly, forming the crowding-out effect of government input on enterprises' own input (Tommy, 2009). And they are no longer eager to achieve results and reducing

the efficiency of green R&D activities, thus weakening the promotion effect of ESG performance on enterprise green supply chain management. Therefore, this paper proposes Hypothesis 2:

Hypothesis 2: With the increase of government subsidies, the role of ESG performance in promoting green supply chain management of enterprises weakens.

3. Research Design

3.1 Sample selection and data sources

This paper selects 2014-2018 Shanghai and Shenzhen A-share listed companies as the primary selection samples, and processes the data as follows: (1) Eliminate samples with missing ESG data and control variables; (2) Eliminate samples from the financial and real estate industries; (3) Eliminate ST samples; (4) Eliminate samples whose asset-liability ratio is greater than 1. After the above screening, 8160 sample observations are finally obtained. Relevant data sources are as follows: ESG data comes from the SynTao Green Finance ESG database and Wind Huazheng ESG database within CSMAR, the relevant financial data comes from the CSMAR database, and green supply management data comes from the demonstration list of green manufacturing enterprises of the Ministry of Industry and Information Technology and is collected by hand. To reduce the influence of extreme values, all continuous variables were Winsorized at the upper and lower 1% quantile levels.

3.2 Model Construction and Definition of Main Variables

Table 1. Related variables and their definitions

variable category	variable name	variables identify	illustrate
Explained variable	Green Supply Chain Management	GSCM	The enterprise actively carries out and insists on implementing green supply chain management, take 1, otherwise take 0
Explanatory variables	ESG performance	ESG	SynTao Green Finance Environmental, Social and Governance (ESG) Rating Score
Moderator	Government subsidies	Sub	Natural logarithm of government subsidies
Control variables	Company size	Size	The natural log of total assets at year-end
	Company age	Age	Company listed years = observation year -IPO year
	Financial leverage ratio	Lev	Debt ratio = total liabilities / total assets
	Growth opportunities	Growth	Tobin's Q = market capitalization / total assets
	Cash flow position	Cash	Net cash flow from operating activities / total assets at the beginning of the period
	Board size	Bds	Number of directors

In order to test the proposed hypothesis, the following regression model is established for testing:

$$SCM_{i,t} = \beta_0 + \beta_1 ESG_{i,t} + \beta_2 Controls_{i,t} + \varepsilon_{i,t} \quad (1)$$

Among them, $GSCM_{i,t}$ is the green supply management of company i in the t-th fiscal year. $ESG_{i,t}$ is the ESG score and this paper adopts SynTao Green Finance ESG total score, including E score, S score and G score. $Controls_{i,t}$ is a Series of control variables. $\varepsilon_{i,t}$ is the residual term. The relevant variables and definitions are shown in Table 1.

For GSCM, in order to accelerate the promotion of green manufacturing, from 2017 to 2019, the Ministry of Industry and Information Technology of the People's Republic of China released four batch of green green supply chain demonstration lists. The selected enterprises are all qualified, representative, and have long-term participation and implementation of green supply. Therefore, this paper screened the list, listed companies that were actively engaged in and insisted on implementing

green supply chain management are assigned a value of 1, and other listed companies that were not on the list were assigned a value of 0.

$$SCM_{i,t} = \beta_0 + \beta_1 ESG_{i,t} + \beta_2 Sub_{i,t} + \beta_3 ESG \times Sub_{i,t} + \beta_4 Controls_{i,t} + \varepsilon_{i,t} \quad (2)$$

In order to explore the moderating effect of government subsidies, the adjustment model is introduced, where Sub represents the government subsidies of company *i* in the *t* fiscal year. The model cares about the coefficient of β_3 , and the definitions of other variables are consistent with model (1).

4. Results and Analysis

4.1 Descriptive statistics

Table 2 shows the descriptive statistics of each variable. In the sample data, the mean value of Green Supply Chain Management (GSCM) is 0.055, indicating that fewer enterprises actively implement green supply chain management, with a standard deviation of 0.228. The mean value of ESG performance (ESG) is 48.188, the minimum value is 30.875, the maximum value is 67.625, and the standard deviation is 5.69, indicating that there are large differences in ESG scores among different companies. In terms of control variables: the average company size is 24.425, the average company age (Age) is 13.198, the average financial leverage ratio (Lev) is 49.4%, the average growth opportunity (Growth) is 2.128, and the average cash flow status (Cash) is 0.083, and the average size of directors (Bds) is 9.363. From the standard deviation point of view, there is a certain degree of difference in the control variables of the characteristics of each enterprise, and the green supply chain management of enterprises may be affected by this difference.

Table 2. Descriptive statistics

variable	mean	sd	min	p50	max	N
GSCM	0.055	0.228	0.000	0.000	1.000	8160
ESG	48.188	5.690	30.875	47.375	67.625	8160
Sub	18.160	1.966	8.294	18.358	23.115	7692
Size	24.425	1.329	21.080	24.250	28.520	8160
Age	13.198	6.072	2.000	14.000	26.000	8160
Lev	0.494	0.193	0.034	0.510	0.895	8160
Growth	2.128	1.985	0.764	1.531	26.818	8160
Cash	0.083	0.086	-0.249	0.073	0.640	8160
Bds	9.363	2.178	5.000	9.000	18.000	8160

4.2 Analysis of regression results

Table 3 shows the regression results of the impact of ESG performance on green supply chain management. The results of regression (1) show that the ESG coefficient is 0.016 and is significantly positive at the 5% level, indicating that there is a significant positive correlation between ESG performance (ESG) and corporate green supply chain management (GSCM), which verifies Hypothesis 1. The possible reasons for this regression are: (1) The performance of ESG rating has improved, and enterprises urge themselves to minimize the negative impact of supply chain operations on the environment through "environmental supervision", thus prompting enterprises to deepen the implementation of green supply chain management. (2) With good ESG performance, the company has undertaken more social responsibilities, improved the company's positive social image and corporate value, which is conducive to attracting more resources to the company, thus prompting companies with poor ESG performance to pay attention to the improvement of the green supply chain management mechanism.

Among the control variables, the regression coefficients of company age (Age), financial leverage ratio (Lev), cash flow position (Cash) and board size (Bds) are significantly positive, which means that the older the company, the higher the financial leverage ratio, the better the cash

flow position, and the larger the number of directors, the more likely it is to improve the green supply chain management level of the company.

Table 3. Model multiple regression results

VARIABLES	GSCM	GSCM
ESG	0.016** (2.08)	0.703*** (6.89)
Sub		2.243*** (8.13)
ESG*Sub		-0.035*** (-6.78)
Size	-0.026 (-0.47)	-0.467*** (-6.69)
Age	0.028*** (3.27)	0.041*** (4.44)
Lev	1.073*** (2.98)	1.400*** (3.59)
Growth	-1.131*** (-8.08)	-1.294*** (-8.38)
Cash	3.698*** (5.51)	3.687*** (5.05)
Bds	0.107*** (5.19)	0.085*** (3.9)
Constant	-3.552** (-2.37)	-35.741*** (-6.85)
Observations	8,160	7,692
Pseudo. R2	0.0972	0.1506

Note: The z-values are in brackets; ***, **, * represent significance at the level of 1%, 5%, and 10%, respectively.

In order to confirm whether the promotion effect of ESG performance on green supply chain management is affected by government subsidies, the interaction term (ESG*Sub) between ESG performance and government subsidies is added into regression (1), and its coefficient is 0.703 and significantly negative at 1% level. It shows that government subsidies have a negative moderating effect on the relationship between ESG performance and green supply chain management, that is, government subsidies have a certain negative effect on the progress that ESG performance promotes enterprises to actively implement green supply chain management. Hypothesis 2 is valid. The explanation for this is that government subsidies may make managers complacent and overly optimistic, leading to the crowding out effect. While enterprises without government subsidies are more rational in green supply chain management activities, and the efficiency of green innovation is higher.

4.3 Robustness test

Substitution variable method

Since the entire ESG rating standards have not been unified, the conclusions of this study may be affected by the different scoring standards of ESG scoring agencies. Therefore, this paper conducts robustness tests by replacing variables. In the text test, SynTao Green Finance ESG score data is used to measure the ESG performance of enterprises. In order to ensure the robustness of the research conclusions, referring to the research of Wang Yu et al. (2022), the SynTao Green Finance ESG score is replaced by the China Securities ESG rating. China Securities ESG comprehensive rating is mainly divided into nine grades: "AAA, AA, A, BBB, BB, B, CCC, CC, C", we assign "9-1" respectively,

other variables remain unchanged, and re-run multiple regression on model (1) (2). The regression results after variable substitution are substantially consistent with the regression results before substitution, and the conclusions are still robust. The specific results are shown in Table 4.

Test for endogeneity

The findings of this paper may overlook possible inter-causal issues. Therefore, in order to control the potential endogeneity problem, this paper refers to the common practice in existing research, selects appropriate instrumental variables and uses two-stage least

Table 4. Substitution variable regression results

VARIABLES	GSCM
ESG	0.708*** (9.63)
Size	-0.143** (-2.37)
Age	0.022** (2.46)
Lev	1.444*** (3.92)
Growth	-1.221*** (-8.49)
Cash	4.963*** (6.82)
Bds	0.106*** (5.10)
Constant	-5.417*** (-3.33)
Observations	8,040

Table 5. Endogeneity test results

VARIABLES	ESG (1)	GSCM (2)
ESG_1	0.990*** (509.67)	
ESGhat		0.001* (1.94)
Size	0.039*** (3.52)	0.012*** (4.67)
Age	0 (0.2)	0.001*** (3.39)
Lev	-0.078 (-1.04)	0.064*** (3.61)
Growth	0.002 (0.31)	-0.004** (-2.48)
Cash	0.096 (0.71)	0.115*** (3.59)
Bds	0.001 (0.21)	0.007*** (5.71)
Constant	-0.357 (-1.35)	-0.408*** (-6.53)
Observations	7,851	7,851
r ² _a	0.972	0.0276
F	39477	32.83

squares regression to alleviate the endogeneity problem. We select the last-period performance of each company's ESG as an instrumental variable. The results of the endogeneity test are shown in Table 5. In the regression results of the first stage, the coefficient of the ESG performance of the enterprise in the previous period and the ESG performance of the enterprise in the current period is significantly positive. In the second stage, the company's ESG performance in the previous period and green supply chain management are positive at 10% significance, indicating that the company's

ESG performance still has a significant positive impact on green supply chain management, and the hypothesis is still valid.

4.4 Further inspection

Differences in corporate asset size may have different impacts on the relationship between ESG performance and green supply chain management. Therefore, this paper further subdivides the whole sample into large enterprises and small enterprises, and compares and analyzes the impact mechanism of ESG performance of enterprises with different asset scales on green supply chain management. Table 6 lists the regression results of the small enterprise sample and the large enterprise sample respectively. It can be seen from the results that there is a 1% significant positive correlation between the ESG performance and green supply chain management of small companies with relatively small assets, while the relationship between the two is not significant in large companies. This shows that the ESG performance of small companies can better promote green supply chain management than large companies. In this regard, it can be explained that large enterprises with large

Table 6. Regression results of different groups of asset sizes

VARIABLES	GSCM (1)	GSCM (2)
ESG	0.053*** (2.61)	-0.004 (-0.42)
Age	0.140*** (7.17)	0.013 (1.48)
Lev	1.309*** (2.64)	-0.181 (-0.59)
Growth	-0.567*** (-5.64)	-0.523*** (-5.63)
Cash	-0.006 (-0.01)	5.077*** (5.93)
Bds	-0.012 (-0.19)	0.103*** (5.19)
Constant	-8.381*** (-7.14)	-2.840*** (-4.88)
Observations	4,104	4,056
Pseudo R2	0.1055	0.0445

assets are generally older, and compared with small enterprises, their operation management is more complete, and their supply chain management activities are more stable and planned, so it will not be significantly affected by other factors.

5. Conclusion and Suggestion

As the key players in realizing the green economy, enterprises should actively practice green concepts, carry out green actions, and pursue high-quality development. This paper takes the A-share listed companies in Shanghai and Shenzhen from 2014 to 2018 as a sample to study the relationship between ESG performance and corporate green supply chain management, so as to exert ESG information disclosure's "environmental supervision" role and "stimulating the endogenous power of companies" role, to help enterprises to develop sustainably. The study found that the ESG performance of enterprises has a significant positive correlation with green supply chain management, and government subsidies weaken the positive effect of ESG performance on green supply chain management. According to the above conclusions, the following enlightenment can be obtained.

From the enterprise level, enterprises should blend in ESG indicators and evaluation system of supply chain management process, build the sustainable development of green supply chain

management mechanism, strengthen the tracking of every link of supply chain green behavior, analysis and monitoring, giving full play to the advantages of green supply chain management, help enterprise balancing economic, environmental and social benefits. As far as the government is concerned, from the historical process of building the ESG policy system, the "signal" that requires listed companies to disclose ESG information is getting stronger and stronger. Therefore, under the promotion of supervision and policies, the government should gradually establish a standardized and unified ESG evaluation system and a mandatory ESG disclosure system, and at the same time improve the ESG-related legislation, increase the cost of negative performance of enterprises, and improve the awareness of green transformation of enterprises. From an investor's perspective, listed companies with better ESG performance have higher enterprise value and a more stable return on investment. Investors should incorporate corporate ESG performance into the investment decision-making framework, and examine companies more comprehensively and scientifically, so as to improve investment returns and reduce investment risks. At the same time, investors' emphasis on corporate ESG performance will also force companies to pursue sustainable development road.

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