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The impact of ESG Performance on Corporate Financial Performance with Green Technological Innovation Capability as a Moderator Variable

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Abstract: Good ESG performance reflects corporate responsibility to society and the environment, conforms to the trend of the times and promotes long-term corporate development. In this thesis, the hypothesis that excellent ESG outcome has a significant enhancing influence on corporate performance is verified by regression analysis with Stata16.0 utilizing the data of 2014-2023 A-share listed companies in Shanghai and Shenzhen obtained from CSMAR database. Then through the regression analysis of moderating role, the green technology innovation capability (GTIC) playing a significant moderating role of negative inhibition in the impact of ESG performance on financial performance can be found. This thesis explores the factors affecting the strength of the relationship between ESG and financial results, and the conclusions of the study provide informative and guiding suggestions for enterprises to improve their financial return.

Keywords: ESG Performance; Financial Performance; Green Technological Innovation Capability; Moderator

1. Introduction

Currently, China's economy faces challenges such as resource constraints and ecological degradation, which has driven the introduction of targets and related policies for 'peak carbon' and 'carbon neutrality', greatly promoting green development. Amid growing domestic and international emphasis on corporate social responsibility, ESG performance, consisting of environmental, social, and governance, has become a key indicator for measuring corporates' comprehensive performance, concerning their long-term sustainability and directly impacting market reputation, brand image, and investment decisions. It also supports companies in carrying out various innovation activities, including green technological innovation. As investors, consumers, and regulatory agencies increasingly focus on ESG performance, how companies can enhance their competitiveness and financial performance through ESG outcome has been a focal point for academia. A substantial body of research suggests that effective ESG practices may optimize resource allocation and boost operational efficiency, positively affecting financial result. While GTIC, closely related to corporates' ESG performance and financial performance, is also becoming more attractive. It refers to innovative activities undertaken by companies to achieve goals such as energy conservation, emissions reduction, efficient resource utilization, and environmental protection. To some extent, it will reduce corporate costs and improves production efficiency. As consumer demand for green products increases, green technological innovation will also enable companies to develop new products, meeting market demands and enhancing competitiveness, thereby positively impacting financial return. However, there's still a lack of research on how GTIC affects the link between ESG and corporate financial return. The majority of existing studies mostly examine the direct impact between the two variables and draw a conclusion of positive promotion. Thus, the study is aimed at filling this research gap by empirically analyzing whether the GTIC plays a moderating role between the ESG and financial performance, and how does the moderating role affect the strength of the relationship between the two variables. This thesis will select the A-share

listed companies on the Shanghai and Shenzhen Stock Exchanges (2014-2023) as research samples, collect relevant data on their ESG performance, green technological innovation capacity and financial results, and then employ statistical analysis and econometric methods.

2. Literature Review

2.1 ESG Performance & Green Technological Innovation Capability

There are few direct studies on the connection between ESG and green technology innovation capability, most of which are related studies. (Liu, Z. et al., 2018)[1] constructs a panel threshold model to empirically test the nonlinear relation between environmental regulation and GTIC. The research shows that with the intensity of regulation from medium to high, the direction of environmental regulation on the latter changes from positive to negative. While a close link between environmental regulation and ESG can be analyzed, with environmental regulation providing legal and policy safeguards for ESG performance and the latter provides a concrete path for the former. (Li, J. et al., 2022)[2] examines the impact of China's environmental protection tax on corporate ESG performance and GTIC. The results show that ESG performance plays a partial mediating role in promoting enterprises' GTIC. Regarding the link between ESG and innovation, (Fang, X. et al., 2023)[3] finds that ESG outcome brings about significant improvement of enterprises' innovation output in terms of both quality and quantity, involving utility model patents, design patents and the number of applications for invention patents.

2.2 Green Technological Innovation Capability & Corporate Financial Performance

Regarding the impact of GTIC on financial performance, most scholars believe that it can enhance corporate financial performance, while some scholars have concluded that the two are negatively correlated or even not particularly significant. According to research by Russo & Pogutz (2009)[4], a company's green technological innovation behavior can improve its financial performance in the short term and help increase market value. Ki-HoonLee & ByungMin (2015)[5] found through their study of Japanese manufacturing companies between 2001 and 2010 that green R&D investments not only reduced carbon emissions but also significantly enhanced firm value. Additionally, (Adam Ryszk, 2016)[6]'s data analysis based on 292 Polish companies showed that a strategy combining technological innovation with environmental protection effectively strengthened corporate performance and was significant for achieving sustainable development environmentally and economically.

Nonetheless, some scholars believe that green technological innovation by enterprises will impose a financial burden, and excessive investment will not lead to value enhancement, which will have a certain negative impact on enterprise value. (Yang, J., 2015)[7] takes all listed companies in Jiangsu Province as the research sample, and after the corresponding statistical analysis, concludes that GTIC is not conducive to the growth of financial return, i.e., the relationship between the two is negatively correlated. Soltmann et al. (2015)[8] take manufacturing companies as the object of study and focus, and come up with a more different viewpoint than other scholars, that is, the relation between GTIC and performance is not linear, but rather presents an inverted "U"-shaped non-linear relationship.

2.3 Existing deficiency

Despite the progress has been made, there are still shortcomings. A primary issue is the inconsistency in measurement standards across studies, including metrics for ESG performance, methods for evaluating Green Technological Innovation Capability, and criteria for assessing financial performance, which limits comparability of results. There is a need for future research to adopt more consistent and standardized approaches. Furthermore, most studies have focused on direct effects, overlooking underlying mechanisms like the role of green technological innovation capability as a moderator variable. Specifically, the pathways through which green technological innovation capability affect the ESG and corporate financial performance remain to be elucidated through this thesis.

3. Study Design

3.1 Study Hypothesis

3.1.1 Hypothesis on the influence of ESG performance on financial return

Recently, increasing number of studies have shown that good corporate ESG rating can enhance corporate brand image, increase investor confidence, reduce financing costs, and ultimately promote corporate financial performance. Therefore, the thesis proposes the hypothesis as follow:

H1: The impact of corporate ESG performance on financial performance is significantly positive.

3.1.2 Hypothesis on the moderating effects of green technological innovation capabilities

Based on previous studies, GTIC is a key factor for enterprises to achieve sustainable development, and enhancing product greening and production process cleanliness through technological innovation can enhance enterprises' financial results to a certain extent. However, green technology innovation is often accompanied by high R&D investment, technological uncertainty, market acceptance risk, etc., and these factors may cause enterprises' financial costs to rise and profits to fall in the short term, thus inhibiting the positive effect of ESG on financial return to some extent. Hence the study makes the following hypothesis:

H2: Green technology innovation capability has a positive effect on firms' financial performance, but it may negatively inhibit the positive relation between ESG and financial performance due to factors such as high R&D investment and technology risk.

3.2 Study Sample and Data Source

The study uses A-share listed companies on China's Shanghai and Shenzhen stock exchanges between 2014 and 2023 as samples. After excluding ST, *ST, PT, financial industry firms, enterprises with discontinuous years and those with missing financial data, there were ultimately 1528 valid analytical samples. Due to extreme values potentially exerting significant impacts on regression analysis, winsorization was applied at the 1% and 99% levels. Financial data used in this thesis originates from the CSMAR database, ESG rating data for listed companies from 2014 to 2023 was obtained from Hua Zheng ESG rating in Wind database, while green tech innovation data comes from the CNRSD dataset. Subsequent data analysis will be conducted using Stata16.0.

3.3 Variable Definition

3.3.1 Dependent variable

Referring to Wen S.et al.(2008)[9], this study selects the Return On Assets (ROA) as the dependent variable to reflect the enterprises' financial performance. ROA is a highly comprehensive financial indicator that encompasses multiple aspects of financial performance, such as profitability, production efficiency, sales efficiency, and financial leverage.

3.3.2 Explanatory variable

Environmental, Social, and Governance Performance (ESG). This report evaluates a company's ESG performance adopting the Huazheng ESG rating system's nine-grade scoring method, which ranges from C to AAA, with each level corresponding to a specific score from 1 to 9. Higher scores indicate superior environmental, social, and governance practices. The thesis utilizes the comprehensive ESG scores of the three aspects as the measurement variable of ESG performance of enterprises.

3.3.3 Moderator variable

Total quantity of green patent applications processed (EnvrPat). Green patents disclose innovations, while the number of applications measures leverage. In this study, green innovation and green utility model applications in CNRSD dataset are summed up as the total number of green patent applications, and then takes the natural logarithm of the value obtained by adding one to this number as the moderating variable, EnvrPat, through which these A-shared listed companies' GTIC can be assessed.

3.3.4 Control variable

Referring to previous studies (Zhu, N. et al., 2014)[10] (Wang, B. et al., 2022)[11], this thesis selects control variables such as Firm Size (Size), Net Profit Growth Rate(Growth), and Leverage Ratio (Lev).

3.4 Research Methodology

This study is aimed at exploring the effect of ESG performance on corporate financial return of A-share listed companies in Shanghai and Shenzhen (2014-2023) through the collected data, and to further investigate the relationship between the two by taking GTIC as a moderating variable, i.e., whether the GTIC

has a significant impact on the relationship between ESG performance and financial performance, and whether it is positive or negative. To address the above issues, the model design of this study is as follows:

$$ROA_{i,t}=\alpha+\gamma ESG_{i,t}+\delta EnvrPat_{i,t}+\theta Inter_{i,t}+\beta 1Size_{i,t}+\beta 2Growth_{i,t}+\beta 3Lev_{i,t}+\varepsilon_{i,t} \quad (1)$$

In the equation above, α is the intercept term, γ, δ, θ, and β1~β3 represent the regression coefficients of the variables in each model, and ε represents a random disturbance term in the model. The i in the model represents the ith firm in the sample and t represents the different years.

4. Results and Analysis

4.1 Descriptive Statistics

Table 1 presents the descriptive statistics of the main variables of the sample companies. The dependent variable ROA has a mean value of 0.0367, existing a large gap with the maximum value 0.254, i.e., there is a large difference in the financial performance of listed companies in the sample data during the period of 2014-2023 and that the overall level of the variable is low; the mean value of the explanatory variable ESG rating is 4.209, and the difference between the minimum value 1 and the maximum value 8 is 7, meaning that there is a certain degree of variability in the disclosed ESG data, and the overall performance is average; the moderator variable EnvrPat has a mean value of 1.132 and a gap between the maximum value 7.380, i.e., there is a large difference in the number of green patent applications among listed companies in the sample data.

Among the control variables, Size has a mean value of 22.74, and the range is 5.8, which can preliminarily judge that the enterprise scale is expanding year by year; the minimum value of net profit growth rate (Growth) is-0.653, which indicates that some enterprises have weak growth ability; in terms of enterprise financial ability; leverage ratio (Lev)'s mean value is 0.438, indicating that the overall leverage ratio of A-share listed companies in Shanghai and Shenzhen is on the high side.

Table 1. Descriptive Statistical Analysis.

Variables	N	mean	sd	min	max
ROA	15,280	0.0367	0.0598	-0.375	0.254
ESG	15,280	4.209	0.973	1	8
EnvrPat	15,280	1.132	1.360	0	7.380
Growth	15,280	0.130	0.366	-0.653	3.808
Size	15,280	22.74	1.315	19.64	26.44
Lev	15,280	0.438	0.195	0.0490	0.925

4.2 Correlation Analysis

From the correlation test in Table 2, the correlation coefficient between financial performance and ESG is 0.185, being significant at the 1% level, indicating that ESG outcome has a positive promotion effect on financial results; the coefficient between the number of green patent applications and financial return is 0.019 which is significant at the 5% level, revealing that this variable does directly affect the enterprises' financial performance; the controllable variables' correlation coefficients such as the growth rate of net profit (Growth), firm size (Size) and leverage ratio (Lev) with ROA are -0.240, 0.067 and -0.309 respectively, all of which are significantly correlated at the 1% level; different variables have correlation coefficients less than 0.700. In summary, the correlation between the main variables is strong. Besides, the maximum value of VIF 1.86 is much smaller than the limiting value of 10 according to Table 3, showing that there is no multiple covariance problem, hence the data are suitable for empirical research.

Table 2. Correlation Test.

	ROA	*ESG*	*EnvrPat*	*Growth*	*Size*	*Lev*
ROA	1					
ESG	0.185***	1				
EnvrPat	0.019**	0.198***	1			
Growth	0.240***	-0.0100	0.031***	1		
Size	0.067***	0.309***	0.465***	0.038***	1	
Lev	-0.309***	0.00500	0.245***	0.025***	0.526***	1

Note: *, **, *** indicate significant at the 10%, 5%, and 1% levels, respectively.

Table 3. Multiple Covariance Test.

Variables	VIF	1/VIF
ESG	1.16	0.859
EnvrPat	1.28	0.779
Size	1.86	0.538
Growth	1.00	0.996
Lev	1.44	0.695

4.3 Regression Analysis of the Moderating Effect

This thesis GTIC as a moderator variable, draws on the model and method of (Wen, Z. et al.,2005)[12], and explores the impact of GTIC on the relation between ESG performance and corporate financial

performance through hierarchical regression analysis. The outcome of the specific regression analysis are as follows:

Table 4. The Moderating Role of GTIC on the Link Between ESG & Financial Performance.

Variables	m_1	m_2	m_3	m_4
	ROA	*ROA*	*ROA*	*ROA*
ESG	0.002***	0.002***	0.003***	0.002***
	(3.142)	(3.259)	(3.975)	(3.347)
Size	0.024***	0.025***	0.025***	0.025***
	(20.748)	(20.991)	(20.984)	(20.984)
Growth	0.034***	0.034***	0.034***	0.034***
	(34.065)	(34.103)	(34.107)	(34.107)
Lev	-0.186***	-0.186***	-0.187***	-0.187***
	(-43.754)	(-43.816)	(-43.851)	(-43.851)
EnvrPat		-0.002***	0.002	-0.002***
		(-3.189)	(1.031)	(-3.071)
Inter			-0.001**	
			(-2.279)	
c_Inter				-0.001**
				(-2.279)
_cons	-0.421***	-0.435***	-0.438***	-0.435***
	(-16.723)	(-17.027)	(-17.137)	(-17.025)
N	15280	15280	15280	15280
R^2	0.215	0.216	0.216	0.216

Note: Standard errors in parentheses
* p < 0.1, ** p < 0.05, *** p < 0.01

From Table 4 the moderating effect of EnvrPat is analyzed through four models. m1 includes the explanatory variable (ESG), m2 adds the moderator variable (EnvrPat) on the basis of m1, m3 adds the interaction term (the product of the explanatory and the moderator variable) on the basis of m2, and m4 decenters ESG and EnvrPat. As can be seen in Table 4, green technology innovation capability as a moderator variable does have a moderating effect. The main effect regression coefficient in Model 4 after decentralization is 0.002, which is positively significant at the 1% level, revealing that ESG outcome and financial results are significantly positively correlated, that is, the better ESG the enterprise has, the better the financial return will be. This thus verifies the validity of hypothesis H1. Moreover, the regression coefficient of the interaction term (Inter) between ESG and GTIC is -0.001 ($p<0.05$), so it can be concluded that GTIC has a significant negative moderating effect on the strength of the relation between ESG and corporate financial performance. The hypothesis H2 is therefore verified.

4.4 Robustness Test

To ensure regression robustness, this thesis conducts robustness test by replacing the core variable method. The regression analysis of the moderating effect is re-run by utilizing return on equity (ROE) instead of ROA in the measure of financial performance amount. From Table 5, ESG and ROE have the regression coefficient of 0.0238 and significant at 1% level, showing that good ESG can effectively and positively enhance financial performance. The coefficient of the interaction term between ESG and EnvrPat is -0.0016 and significant at 5% level, revealing that GTIC does play a moderating role between the explanatory variables and the dependent variables and is negatively inhibitory. Through the robustness test, the hypotheses of this paper can be further verified.

Table 5. Robustness Test Utilizing ROE.

Variables	(1)	(2)
	ROE	*ROE*
ESG	0.0219***	0.0238***
	(0.0010)	(0.0013)
EnvrPat	0.0038***	0.0111***
	(0.0007)	(0.0032)
Inter’		-0.0016**
		(0.0007)
_cons	-0.0364***	-0.0443***
	(0.0042)	(0.0054)
N	15280	15280
adj. R^2	0.0373	0.0376

Note: As above

5. Conclusions and Deficiency

5.1 Conclusions

The thesis empirically examines the moderating role of green technology innovation capability in the link between ESG and financial performance with a research sample of 1528 listed companies in Shanghai and Shenzhen A-shares with a total of 15,280 observations from 2014 to 2023. It is found that both ESG performance and GTIC have positive contribution to short-term financial performance. Further analysis of the moderating effect of GTIC reveals its negative inhibitory moderating effect between ESG and financial return, which may imply that the characteristics of high investment and long cycle of green technology innovation increase the operating cost in the short term, thus

temporarily inhibiting the enterprises from obtaining financial performance improvement through ESG performance. Another possible reason is that some firms in specific industries will face financial pressure in green technology innovation because high technological difficulty and market uncertainty may lead to difficulties in translating into significant financial returns in the short term. However，when examined from a long-term perspective, GTIC might indeed foster a positive relationship between ESG and financial performance, as it will enhance market competitiveness, boost efficiency, and attract investments to some extent. Hence further studies are still needed. Based on these study findings, the thesis proposes the following policy recommendations:

First, while pursuing ESG performance, enterprises should reasonably assess the input-to-output ratio of green technology innovation capability to avoid blind investment, which leads to impaired financial return in the short term, and develop long-term planning in a relative manner to ensure that green technology innovation is in line with the overall strategy of the enterprise.

Secondly, enterprises should optimize the allocation of resources to ensure that green technology innovation projects are supported by additional surplus funds, technologies and resources. Through internal tapping and external cooperation, they should vigorously reduce the cost of innovation so as to alleviate the financial pressure.

5.2 Deficiency

Green indicator selection is single and not comprehensive and representative enough, this paper only through the quantity of green patent applications for the measurement of GTIC, but for the definition of green technology innovation capacity there are a variety of indicators, so further reference to authoritative literature for a variety of indicators is imperative, making the result of the research be more reliable.

The small number of control variables selected makes the accuracy of the results decrease, more relevant control variables should be selected to enhance the authenticity of the conclusions of the article.

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