Heliyon 9 (2023) e16320

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon

Research article

How does ESG performance affect stock returns? Empirical evidence from listed companies in China

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ARTICLE INFO

Keywords:
ESG Performance 1
Stock returns 2
Financial performance 3
Corporate innovation capability 4

ABSTRACT

With the increasing attention to sustainable development, environmental, social, and corporate governance (ESG) investment has become an important vehicle for achieving carbon neutrality worldwide. In this paper, the impact of ESG performance on stock returns and the transmission mechanism are explored. A fixed effect model based on a panel unbalanced data of listed companies in China from 2011 to 2020 is selected for the empirical analysis. The results show that ESG performance of listed companies in China positively impacts stock returns. However, by distinguishing the ownership nature and region to which listed companies belong, this study finds that the relationship between ESG performance and stock returns is particularly significant for non-state-owned companies and those in the eastern region. Further, based on stakeholder theory, financial performance and corporate innovation ability are embedded into the relationship between ESG performance and stock returns. Both financial performance and corporate innovation ability play partial mediating roles in the correlation between ESG performance and stock returns. In addition, the relationship between ESG performance and corporate innovation ability is nonlinear. This paper provides insight for emerging markets into cultivating the value investment concept of investors and improving the ESG information disclosure system.

1. Introduction

In recent years, the worsening of climate change has made the market aware of the importance of environmental protection. The increasing severity of human society's environmental problems has threatened the stability of the economy and society. At the 2020 United Nations General Assembly, China proposed "carbon peak and carbon neutral" as a goal. Despite the difficulty of achieving this objective, the process has created enormous demand and impetus for the development of green finance in China and around the world. It is possible to say that green finance is related to the realization of global sustainable development, on which a consensus has formed. As a crucial component of the green financial system, ESG investment goes beyond the traditional investment concept and framework based on financial indicators. It is considered and evaluated from multiple dimensions, which has garnered significant capital market interest. ESG investors believe that unsupervised negative externalities make it impossible for companies to calculate all production costs, whereas pursuing profits allows companies to have more profound social and environmental impacts. ESG investment refers explicitly to considering environmental, social, and governance factors when making investment decisions, such as the impact of enterprise production on the environment, the coordination between enterprises and stakeholders, the standardization of enterprise

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https://doi.org/10.1016/j.heliyon.2023.e16320
Received 23 November 2022; Received in revised form 8 May 2023; Accepted 12 May 2023
Available online 19 May 2023

ownership structure and business ethics [1]. The rapid growth of ESG investing presents opportunities and risks for professional investors worldwide. Through ESG-related information disclosed by listed companies, investors can gain a clearer understanding of the investee company's responsibility for the environment and society, as well as its adherence to high standards of corporate governance. Consequently, the rating or score based on ESG information disclosure will affect the stock price of listed companies [2]. Tesla, an electric vehicle company, has been underperforming on its financial statements for years and will not achieve full-year profitability until 2020. However, because Tesla manufactures electric vehicles and has designed its factories to be energy efficient and positively impact the environment, it has outperformed the capital markets. In July 2020, Tesla's market capitalization reached $280 billion, surpassing that of General Motors, which had higher profit margins and operating income, by a significant margin. Compared to conventionally fueled vehicles, electric vehicles produce half as much carbon dioxide. Its positive environmental externalities are significant, so it will attract capital market investors' attention and outperform in stock returns.

There are different hypotheses based on different theories regarding the relationship between ESG performance and stock returns. From the perspective of shareholders, the traditional principal-agent theory asserts that modern firms have agency problems due to the separation of ownership and management rights [3]. In this situation, company executives act as proxies for shareholders and are responsible for the daily operations. However, they may engage in activities in their interests, such as participating in costly ESG projects to enhance their reputation. When a company engages in such ESG projects, led by top executives, it pursues its own interests at the expense of shareholders, resulting in a decline in the company's stock returns. Therefore, the agency hypothesis based on the agency doctrine suggests that there is a negative relationship between ESG and corporate value, that is, ESG practices of a firm will reduce stock returns. As research on ESG and corporate value continued to advance, Freeman and Phillips (2002) proposed the stakeholder theory, which argues that the rationality of various stakeholders has been primarily recognized by law and reflected in certain policy regimes and legal provisions [4]. Modern enterprises should recognize the trend of the times and no longer confine themselves to the position of shareholders. Instead, they must assume ESG responsibility for various stakeholders. According to the theory of stakeholders, energy conservation and emission reduction of enterprises help reduce the carbon footprint and mitigate climate change, supply chain labor standards are responsible for suppliers, and product safety is responsible for customers. Overall, the stakeholder theory recognizes that enterprises are not only accountable to their shareholders but also to a range of other groups that are affected by their operations. By fulfilling their responsibilities towards these stakeholders, enterprises can build a sustainable and ethical business that benefits everyone involved. Therefore, when a company engages in stakeholder management, it will gain the support of its stakeholders. Specifically, when a company has excellent ESG performance, banks and other financial institutions include its green development in their credit assessments and offer favorable interest rates, thereby reducing the company's debt costs. Consumers are more likely to increase their investment in a company that has established a positive brand image and social reputation. This is particularly true for environmentally-conscious consumers, who tend to exhibit greater brand loyalty in response to the company's environmental efforts. Investors are confident in companies with strong scientific management and control capabilities, as well as stable income levels, which reduces the likelihood of losses. This, in turn, encourages investors to increase their stock holdings in these companies. A positive corporate culture can increase internal employees' identification and motivation, which ultimately improves the company's performance. Thus, ESG performance is directly reflected in the company's financial performance, which significantly impacts the stock returns [5–8]. In addition, studies have shown that ESG practices can stimulate corporate innovation ability. Porter and Kramer (2006) argued that corporate social responsibility is not just the constraint on corporate behavior but also a source of innovation and a competitive advantage for businesses [9]. Specifically, improving corporate environmental efficiency will align with the government's environmental protection concept of green development, thereby securing government funding and technical support to enhance innovation capabilities. In addition, the good social responsibility performance of corporate is conducive to enhancing industry reputation and brand reputation, which not only broadens financing channels but also strengthens cooperation with upstream and downstream enterprises in the industry chain, and the knowledge spillover effect will also enhance the innovation capability of enterprises. Millennials have become the dominant force in enterprises and have higher expectations for the enterprises' soft environment. Good corporate governance will attract more talented employees, and talent is crucial to enhancing innovation capability. Therefore, improved ESG performance will enhance corporate innovation, impacting stock returns [10–12].

ESG investments are currently concentrated in European markets, and the approach is mostly negative screening, meaning that companies that do not pass the ESG test are excluded from investment portfolios [13]. However, compared to mature markets, ESG investment in emerging markets faces more obstacles, primarily due to a need for more transparency and regulation. There is no conclusive answer to whether ESG investments can achieve more reasonable returns in emerging markets. China, the world's largest emerging market, is shifting from a growth model based on scale and speed to one emphasizing high-quality development. Within the context of sustainable development, the concept and application of ESG offer investors a scientific method and set of tools. As the Chinese government actively promotes green and sustainable development policies, companies are gradually reducing emissions, fulfilling social responsibilities, and improving governance efficiency as development goals [14]. Specifically, in February 2023, the China Securities Regulatory Commission issued rules regarding the comprehensive implementation of the stock issuance registration system, requiring listed companies to increase their disclosure of ESG information and ensure the quality of disclosure. ESG investment will significantly impact China's capital market due to the continued opening of China's capital market, particularly the inclusion of A-shares in relevant international indices such as MSCI and FTSE Russell.

Considering that the rapid growth of the listed companies may induce risks associated with pollution emissions and other serious threats to people's lives, ESG factors should be used as an important indicator to evaluate investment targets and guide the sustainable development of the sector. In this paper, the direct relationship between ESG performance and stock returns is discussed first, taking A-shares listed companies in China from 2011 to 2020 as a case study. Then, useful evidence of heterogeneity is provided and the transmission path between ESG and stock returns is discussed. Finally, suggestions are put forward for investors and managers. The

main results are briefly summarized: Stock returns have a significantly positive effect on the overall performance of ESG. However, the results of state-owned companies and non-state-owned companies are significantly different. Although the ESG performance of non-state-owned companies positively impacts the improvement of stock returns, the results of state-owned companies do not show statistical significance. From the perspective of the regions where listed companies are located, the ESG performance of listed companies in the eastern region significantly improves stock returns. However, the relationship between ESG performance and stock returns of listed companies outside the eastern region is unclear. Most significantly, the mechanism test shows that both financial performance and innovation capability play partial intermediary effects in the impact ESG has on stock returns. In particularly, there is a nonlinear relationship between ESG performance and corporate innovation capability.

The main contributions are summarized in the following: At present, relevant research on ESG mainly concentrates on developed countries, while the practical value of social responsibility in emerging markets has not been studied exhaustively. China's ESG development is in its infancy as a developing country in transition. This paper focuses on China's listed companies, which not only enriches the literature on the relationship between ESG and stock returns in emerging markets, but also deepens investors' understanding of the value investment philosophy. More importantly, this paper presents an examination of the financial performance effect and innovation capability effect of the relationship between ESG performance and stock returns, particularly the nonlinear relationship between ESG performance and corporate innovation capability, thus enriching the literature on the mechanism of ESG and stock returns.

The remainder of this paper is structured as follows: Section 2 presents a review of the relevant literature, Section 3 introduces the research design, Section 4 shows the empirical test and the result analysis, Section 5 draws key conclusions and Section 6 puts forward the limitations and further research.

2. Literature review

With the continuous advancement of the concept of global sustainable development, corporate environmental information disclosure has become increasingly important. Therefore, the correlation between ESG performance and stock returns of listed companies has attracted academic attention.

Before the explicit proposal of ESG-related concepts, scholars primarily focused on investigating the relationship between Corporate Social Responsibility (CSR) investments and corporate value. Hamilton (1995) argued that shareholders may experience negative abnormal stock returns when information about environmental pollution is disclosed first [15]. Russo and Fouts (1997) identified a positive correlation between environmental performance and economic performance. This is due to the fact that consumers tend to recognize and value a company's good social image [16]. Brammer and Millington (2008) employed corporate charitable donations as a metric for evaluating corporate social responsibility, and their research revealed that such donations have the potential to enhance financial performance [17]. After a more detailed division of corporate social responsibility, Inoue and Lee (2011) found that there are short-term and long-term differences in the relationship between corporate performance in different dimensions and financial performance [18]. Based on data from 162 banks in 22 countries, Wu and Shen (2013) confirmed that practice of social responsibility is positively correlated with stock returns [19]. However, Ramchander et al. (2012) further analyzed that in industries with information opacity, stock prices are more responsive to corporate social responsibility [20]. Furthermore, Lins et al. (2017) focused on ESG performance and stock returns following the 2008 financial crisis and confirmed that companies with high social responsibility performance were better able to withstand risks and received higher stock returns than other companies [21].

Following the formal introduction of the ESG concept by the United Nations Environment Programme (UNEP) in 2005, scholars officially embarked on the study of related fields. Halbritter and Dorfleitner (2015) found no significant correlation between ESG rating and portfolio returns [22]. Similarly, Landi and Sciarelli (2018) noted that due to investors' disregard for corporate ethical standards, the Italian capital market does not seem to price the company's shares based on positive ESG performance [23]. Takahashi and Yamada (2021) proposed that the ESG performance of Japan has not been effectively reflected in the stock return during the COVID-19 pandemic [24]. In contrast to the neutrality of the aforementioned results, many studies believe that ESG has positive impact on stock returns. Khan (2019) showed that the quartile of portfolios with the highest ESG scores outperform other portfolios by 17% in terms of stock returns [25]. Kanuri (2020) suggested that ESG portfolios outperform the Global Dow ETF product returns [26]. More specifically, Shanaev and Ghimire (2022) showed that changes in ESG rating of US firms have an asymmetric effect on stock returns [27]. In other words, the rise of ESG rating is not significantly related with stock returns, but downgrading it will reduce stock returns. Several studies have considered the factor of country, and have compared the correlation between ESG performance and stock returns between different economies. Friede et al. (2015) showed that ESG indicators exert a more significant impact on stock returns in emerging market countries compared to developed countries [28]. However, Auer and Schuhmacher (2016) proved that European investors prefer ESG investing over investors in the USA and the Asia Pacific region, but ESG ratings could not provide better stock returns overall [29].

As the international capital market focuses more on corporate ESG performance, China's recognition of the ESG investing concept is gradually strengthening. In 2018, the China Securities Regulatory Commission proposed a mandatory environmental information disclosure system for listed companies. In 2019, the Asset Management Association of China released the *Research Report on ESG Evaluation System for Chinese Listed Companies. The White Paper on ESG Development of Chinese Listed Companies* (2021) reported that the ESG disclosure rate of A-shares in China reached 27% in 2020. Overall, although the number of Chinese A-shares listed companies actively disclosing ESG information increases year by year, there is still a significant gap compared with ESG practices in developed countries. The published research conclusions regarding the relationship between ESG performance and stock returns in China are also controversial. Zhou and Zhou (2021) showed that ESG factors generate excess returns for China's A-share market [30]. Li et al. (2022)

proposed that embedding ESG factors in the portfolio can yield higher returns [31]. Similarly, according to Broadstock et al. (2021), China's high ESG portfolios outperformed low ESG portfolios and mitigated financial risk during the COVID-19 pandemic [32]. Further, Zhang et al. (2022) pointed out that both high and low ESG portfolios in China generate better stock returns, which implies that the relationship between ESG portfolio and stock returns is nonlinear [33]. Amin and Tauseef (2022) also found a non-monotonic relationship between ESG rating and corporate earnings and put forward the concept of an optimal ESG score [34]. In addition, Feng et al. (2022) showed that China's ESG rating can effectively reduce the risk of stock price collapse [35]. However, Ruan and Liu (2021) argued that ESG performance of China's A-shares listed companies exerts a significant negative impact on stock returns [36]. By taking China's power industry as an example, Zhao et al. (2018) suggested that good ESG performance can boost corporate stock returns [37]. According to Baird et al. (2012), different industries have different life cycles, which may lead to the emergence of industry heterogeneity in the impact of ESG performance on stock returns [38]. Similarly, Yoon et al. (2018) also proposed that the impact of ESG performance on stock returns is related to the industry [39].

The above-mentioned studies demonstrate that currently, no consensus on the correlation between ESG performance and stock returns has been reached. Although many studies have shown that improvements in ESG performance exert significant positive impact on stock returns, others have suggested that the correlation between them is negative or even nonexistent. As an emerging market economy, China's ESG system has not been established, and information disclosure standards are still not unified. Therefore, the research on ESG is still in its infancy, especially in the field of the relationship between ESG performance and stock returns, which is why this issue is the focus of this paper.

3. Research design

3.1. Sample selection and data sources

In recent years, with the development of environmental information disclosure of Chinese listed companies, certain domestic third-party rating agencies are actively constructing an ESG rating system. However, as this paper considers the measurement differences between China's indigenous ESG rating system and that of the mainstream international rating agencies, the Bloomberg ESG disclosure scores were selected, which have the earliest start, covering more than 60 countries and over 11,500 companies worldwide. In 2011, China issued the *Green Credit Guidelines*, which clearly required energy conservation, emission reduction, and environmental protection, and also played a positive role in promoting ESG information disclosure for listed companies. Therefore, the empirical data selected in this article ranges from 2011 to 2020, while excluding the financial industry and ST-listed companies. Due to the lack of annual data for some companies, a total of 9,699 ESG rating observations were obtained in the end. The ESG scores for this study originate from the Bloomberg ESG Disclosure Scores, and the rest of the data originate from the CSMAR and Resset databases.

3.2. Definition and description of variables

In this paper, the dependent variable is stock returns (RET), which represents the relative returns investors receive from the purchase of stock. The core explanatory variable is ESG performance (ESG), the Bloomberg ESG disclosure scores are composed of environment (E), society (S), corporate governance (G), and 21 three-level indicators. The final score can be obtained by assigning corresponding weights to each factor. On a scale from 1 to 100, a high score means that the company performs better and is pursuing sustainability, while a low score represents poor ESG performance. Combined with the above theoretical analysis, in this paper, the intermediary effect is tested based on two variables: the returns on assets (ROA), which represents the company's financial performance, and the number of patents obtained by listed companies (PNT), which represents the company's innovation capability. Regarding the control variables, the age of a company (AGE) is measured by subtracting the years of incorporation from the years of observation, and the natural logarithm of this variable is taken. Generally, the longer a company has been established, the more stable the operation can be assumed to be. The company's market value (TQ) is measured by Tobin Q and a higher market value represents better investment prospect. Solvency (LEV) is expressed by the company's asset liability ratio. A low asset liability ratio indicates that the company is stable and suitable for long-term investment. The company's top 10 shareholders are selected to measure the proportion of ownership concentration (TOP10), as the ownership structure is related to the efficiency of supervision by shareholders and the ability of corporate governance, both of which impact stock returns. The property right (OWN) and region (RGN) of listed companies are both represented as dummy variables. Specifically, 1 for state-owned companies and 0 for non-state-owned companies, 1 for companies located in the Eastern region and 0 for companies located in other regions.

3.3. Model setting

This paper uses multiple regression model to construct the following:

$$RET_{i,t} = \alpha_1 + \beta_1 ESG_{i,t} + \gamma_1^{'} \Sigma Control_{i,t} + \mathrm{Year}_t + \mathrm{Ind}_i + \varepsilon_{i,t} \quad (1)$$

According to stakeholder theory and enterprise innovation capability theory, this paper suggests that ESG performance will affect stock returns through financial performance and corporate innovation capability. To identify whether both two mechanisms exist, the following equation is constructed:

$$MED_{i,t} = \alpha_2 + \beta_2 ESG_{i,t} + \gamma_2^{'} \Sigma Control_{i,t} + \text{Year}_t + \text{Ind}_i + \mu_{i,t} \quad (2)$$

Where Year represents time dummy variables and Ind represents industry dummy variables. ε and μ represent the random disturbance terms of the models. Intermediary variables (MED) include ROA and PNT, and other variables are consistent with the above. Specifically, β_1 in Equation (1) represents the total effect of ESG on RET. Equation (2) tests the relationship between ESG and MED. If β_2 is significant, ESG impacts ROA and PNT, that is ESG may have effect on stock returns through financial performance or innovation ability, and vice versa.

4. Empirical test

4.1. Descriptive statistics

The descriptive statistics for main variables are shown in Table 1. Clearly, different variables have diverse effective observed values, but the number of missing values is small compared with the whole sample, which does not affect the empirical results. A positive RET mean indicates that the overall return on stocks in Chinese listed companies performed well over the sample period. However, the standard deviation reveals a significant variation in stock returns among different companies. With regard to the core explanatory variable, the average ESG score is 20.70, with a maximum of 64.11 and a minimum of 1.24. This indicates that there is significant potential for enhancing the overall ESG performance of Chinese listed companies, while the degree of ESG practices varies greatly across industries. The mean value of AGE is 19.85, indicating the long-term characteristics of the listed companies; the mean value of TQ is 1.86, with a maximum of 4.52, indicating that the listed companies, which is developing rapidly in China, offers good investment prospect; LEV has a mean of 46.02, showing that most companies have stable capital structure and good solvency; the mean of TOP10 is 59.4, demonstrating that the listed companies has an overall high equity concentration; ROA has a mean of 4.61, indicating that there are higher effective utilization rates of total assets and better profitability among the listed companies. However, the standard deviation of PNT is 112.4, which implies that the innovation capability among Chinese A-shares listed companies varies greatly and the overall innovation capability needs to be improved.

4.2. Multiple regression

Multiple regression Eq. (1) is used for the analysis, and the results are shown in Table 2. Column (1) is a correlation analysis between the core explanatory variable ESG and the explained variable RET, and the result indicates that the two variables are related. Column (2) shows a simple OLS regression, where a significant positive correlation exists between ESG and RET, and the coefficient is 1.445 at the 1% significance level. The coefficients of AGE and TQ are significantly positive, indicating that the extension of the normal operating life of a company and the improvement of the company market value play a positive role in promoting stock returns. However, the coefficient of LEV is negative at the 1% significance level, indicating that the excessive debt level is not conducive to the realization of the excess returns of stocks. Given the fixed effect of Year and Ind in column (3), it can be concluded that a significant positive correlation exists between ESG and RET, without the requirement for other control variables. In column (4), Year and Firm are also fixed and other factors are controlled at the same time. The ESG regression coefficient of 0.491 is significant at the 5% level, indicating that the ESG performance of listed companies positively impacts stock returns. Specifically, the production and business activities of companies always come with impacts on the environment and society, which are usually not reflected in their financial statements. Companies that are typically unregulated tend to perform poorly because they do not consider the negative externalities generated during their operations in pursuit of profit growth, which refers to the adverse impacts on third parties who are not directly involved in their economic activities. These results can lead to environmental degradation, economic exploitation of upstream and downstream companies in the supply chain, internal corruption, or other illegal activities. Companies with a bad track record will see their value decline due to legal disputes, compensation for damages or fines, and other penalties. Therefore, companies that create negative externalities will face policy risks that new government regulations require companies to account for these costs. Meanwhile, companies that have positive impacts on the environment and society are more attractive to investors. They are perceived as more valuable by ESG investors because of their efforts to reduce the carbon footprint. Therefore, when the ESG performance of listed companies is improved, it means that they are actively practicing sustainable development in areas such as environmental protection, social responsibility, and internal governance, fully embodying the concept of sustainable development. According to information asymmetry theory and value investment theory, the improvement of ESG performance can help cultivate companies' good reputation. In addition, investors will consider that these companies have good risk management capabilities, which can not only attract investors

Table 1
Summary statistics.

Stats	RET	ESG	AGE	TQ	LEV	TOP10	ROA	PNT
N	10788	9699	9699	9989	10788	10604	10788	2157
mean	47.33	20.70	19.85	1.862	46.02	59.40	4.610	71.19
Sd	51.28	7.039	5.623	0.971	19.31	16.06	4.675	112.4
Min	−33.80	1.240	2	0.930	12.94	8.780	−4.604	0
Max	174.7	64.11	55	4.517	78.78	101.2	14.75	434

Table 2
Baseline results.

	(1)	(2)	(3)	(4)
	RET	RET	RET	RET
ESG	1.280***	1.445***	0.783***	0.491**
	(0.168)	(0.172)	(0.220)	(0.210)
AGE		17.300***		17.830
		(4.001)		(14.812)
TQ		10.216***		10.582***
		(0.806)		(0.736)
LEV		−0.658***		−1.147***
		(0.063)		(0.081)
TOP10		1.094***		0.890***
		(0.077)		(0.108)
_cons	24.561***	−83.188***	34.850***	−30.644
	(3.682)	(13.969)	(4.618)	(45.036)
Year	No	No	Yes	Yes
Ind	No	No	Yes	Yes
N	9699	9221	9685	9205
adj. R^2	0.006	0.066	0.622	0.677

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

and reduce financing constraints but also improve the transparency between managers and capital market investors, thereby influencing capital market returns [40].

4.3. Robustness testing

In this paper, two methods are adopted to test the robustness of the above multiple regression model, one is the replacement index, the other is the addition of the Year * Ind interaction effect.

4.3.1. Replacement index

There are multiple methods to calculate stock returns, and this paper uses the stock return (HPY) including non-operating income and non-operating expenses to replace the explained variable (RET). Robustness test of the results shown in Table 2 is carried out, and the results are shown in Table 3. In each equation where the explained variable and explanatory variable are replaced at the same time, the significance level of ESG regression coefficient and the signs of the coefficient are basically consistent with the results in Table 2. This result indicates that the research results have good robustness.

4.3.2. Interaction effects of year * ind

Although the robustness tests for the above replacement indicators have been passed, considering that between 2011 and 2020, China's A-shares listed companies were affected by domestic reform policies, geopolitical events, COVID-19 pandemic, these time-varying factors may affect the significance of the core explanatory variable ESG as well as regression coefficients [41]. Therefore, the interaction effects of Year * Ind were still included, and the results are shown in Table 4. According to a comparison between

Table 3
Robustness: replacement index.

	(1)	(2)	(3)	(4)
	HPY	HPY	HPY	HPY
ESG	1.419***	1.669***	0.835***	0.577***
	(0.168)	(0.161)	(0.227)	(0.197)
AGE		14.650***		15.109
		(3.727)		(13.863)
TQ		8.836***		9.914***
		(0.750)		(0.689)
LEV		−0.677***		−1.246***
		(0.059)		(0.075)
TOP10		0.963***		0.658***
		(0.072)		(0.101)
_cons	15.900***	−74.718***	27.968***	−10.805
	(3.662)	(13.009)	(4.755)	(42.155)
Year	No	No	Yes	Yes
Ind	No	No	Yes	Yes
N	9671	9211	9657	9195
adj. R^2	0.007	0.067	0.599	0.675

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

columns (1) and (3), the significance level and coefficient of ESG remain basically unchanged. According to the comparison between columns (2) and (4), ESG coefficients are significantly positive and similar at the 5% significance level, suggesting that improvements in listed companies' ESG disclosure scores can effectively boost stock returns. Moreover, significance levels and coefficients of control variables remain largely stable, indicating that the empirical results of this study remain robust.

4.4. Heterogeneity test

4.4.1. Heterogeneity test of the ownership nature of listed companies

Based on the ownership nature of listed companies in China, companies are divided into state-owned and non-state-owned companies. However, within the same industry, these two types of companies differ in their motivations and patterns of interest, aspirations, corporate governance, and social responsibility [42]. Therefore, it can be inferred that differences in the results of ESG performance on stock returns may exist among listed companies with different ownership types. The heterogeneity results considering different ownership types are shown in Table 5. The samples used for columns (1) and (2) are state-owned listed companies. Column (2) includes the constant Year * Ind effect based on column (1). However, both results show that the coefficient of the core explanatory variable is not significant; in other words, the effect ESG performance of state-owned listed companies in China on stock returns is unclear. The results of non-state-owned listed companies are calculated via columns (3) and (4). The regression coefficients for ESG performance are all significantly positive, and the significance and regression coefficients of ESG are improved compared with those shown in Table 2. This indicates that the improved ESG performance of non-state-owned listed companies significantly enhances stock returns; in other words, the stock returns of non-state-owned companies are clearer than those of state-owned companies and their performance is more positive under the influence of the ESG disclosure score. When the ESG performance of these non-state-owned listed companies is improved, their stock returns will be better. This paper argues that the difference is caused by the nature of state-owned listed companies in China, which imposes greater political compliance and social responsibility. As a result, the former is prioritized when faced with organizational stability and maximization of shareholder interests. In the corporate governance structure, non-state-owned listed companies outperform state-owned listed companies in terms of staff incentives and the scientific research and innovation level. Therefore, investors and other stakeholders are less sensitive to the superior ESG performance of state-owned listed companies, and they often assume that it is caused by sacrificing shareholders' interests and increasing operating costs. This reduces the significance between ESG performance and stock returns to a certain extent.

4.4.2. Heterogeneity test on the location of listed companies

Based on the regions where Chinese listed companies are located, this paper divides them into eastern and non-eastern regions. As shown in Table 6, the empirical results indicate that the relationship between ESG performance and stock returns is more significant in the eastern region, while the relationship between these two variables in the non-eastern region is not significant. Specifically, column (1) shows that the ESG performance of listed companies in the eastern region has significant positive effect on stock returns at the 1% level, especially when the Year * Ind interaction effect is included, column (2) still maintains similar results. Regarding the significant regional heterogeneity exhibited by Chinese A-shares listed companies, this paper believes that it is mainly due to the developed economy and finance in the eastern region, where the number of listed companies is about twice that of the non-eastern region, and many of them are high-tech and innovative companies. At the same time, the convenient transportation in the eastern region is conducive to communication and cooperation among enterprises. More importantly, the long-term economic development has created good business environment, thereby facilitating the market mechanism. The better ESG performance of companies can be reflected in the capital market, which has a positive effect on stock returns.

Table 4
Robustness: control Year * Ind effect.

	(1)	(2)	(3)	(4)
	RET	RET	HPY	HPY
ESG	0.659***	0.456**	0.678***	0.499**
	(0.224)	(0.213)	(0.235)	(0.202)
AGE		34.811**		29.847**
		(15.338)		(14.563)
TQ		8.489***		8.014***
		(0.780)		(0.741)
LEV		−1.125***		−1.118***
		(0.085)		(0.081)
TOP10		0.804***		0.642***
		(0.113)		(0.108)
_cons	37.579***	−71.553	31.375***	−53.700
	(4.692)	(46.552)	(4.923)	(44.208)
Year	Yes	Yes	Yes	Yes
Ind	Yes	Yes	Yes	Yes
Year * Ind	Yes	Yes	Yes	Yes
N	9633	9146	9604	9135
adj. R^2	0.653	0.705	0.618	0.693

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

Table 5
Heterogeneity test of the ownership nature.

Group	OWN = = 1		OWN = = 0	
	(1)	(2)	(3)	(4)
	RET	RET	RET	RET
ESG	0.209	0.261	0.676**	0.627**
	(0.303)	(0.320)	(0.286)	(0.313)
AGE	19.357	54.737**	6.281	2.680
	(19.438)	(22.715)	(23.794)	(26.090)
TQ	19.920***	17.776***	6.274***	4.438***
	(1.461)	(1.628)	(0.799)	(0.927)
LEV	−1.239***	−1.047***	−0.992***	−0.974***
	(0.127)	(0.140)	(0.104)	(0.124)
TOP10	0.754***	0.632***	0.807***	0.617***
	(0.184)	(0.202)	(0.141)	(0.163)
_cons	−25.412	−129.573*	1.221	27.653
	(59.499)	(68.501)	(72.105)	(78.808)
Year	Yes	Yes	Yes	Yes
Ind	Yes	Yes	Yes	Yes
Year * Ind	No	Yes	No	Yes
N	4777	4681	4409	4277
adj. R^2	0.721	0.761	0.593	0.637

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

Table 6
Heterogeneity test of the location.

Group	RGN = = 1		RGN = = 0	
	(1)	(2)	(3)	(4)
	RET	RET	RET	RET
ESG	0.946***	0.906***	−0.464	−0.036
	(0.222)	(0.226)	(0.436)	(0.488)
AGE	12.155	40.313**	31.641	46.488
	(15.633)	(17.074)	(30.684)	(36.671)
TQ	5.915***	3.949***	23.625***	18.894***
	(0.728)	(0.755)	(1.789)	(2.291)
LEV	−0.938***	−1.072***	−1.524***	−1.213***
	(0.086)	(0.090)	(0.164)	(0.211)
TOP10	0.896***	0.779***	0.880***	0.891***
	(0.115)	(0.121)	(0.222)	(0.258)
_cons	−24.535	−89.367*	−56.659	−114.915
	(47.716)	(51.654)	(92.631)	(110.487)
Year	Yes	Yes	Yes	Yes
Ind	Yes	Yes	Yes	Yes
Year * Ind	No	Yes	No	Yes
N	6106	6038	3099	2956
adj. R^2	0.625	0.684	0.725	0.744

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

4.5. Mechanism analysis

According to existing theories, in this paper, financial performance (ROA) and corporate innovation capability (PNT) are chosen as intermediary variables to test the transmission mechanism between ESG performance and stock returns.

4.5.1. Mechanism analysis of financial performance

Based on the intermediary effect Eq. (2) constructed above, ROA is taken as intermediary index and the results are shown in Table 7. Column (1) and (2) use the intermediate variable ROA as explained variable to study the specific relationship between ESG and ROA. There is a significant positive correlation between ESG performance and ROA, with a coefficient of 0.057. When the Year * Ind interaction effect is added, the significance and regression coefficient of ESG performance remain unchanged. This suggests that there is a transmission mechanism of ROA as an intermediary variable. In other words, financial performance is part of the intermediary effect in the impact mechanism of ESG performance of listed companies in China's pharmaceutical industry on stock returns. This is consistent with stakeholder theory. Specifically, ESG performance significantly improves the company's ROA level. In other words, good social responsibility practice has caused the company's stakeholders to respond positively. The government, investors, and consumers have a positive attitude towards the company's concept of sustainable development. Therefore, companies with high ESG scores may have lower financing costs and higher profitability over the course of operation. This will help to improve financial performance indicators in their financial statements. Based on the above intermediary effect test, it is proposed that the higher the

Table 7
Mechanism analysis (ROA).

	(1)	(2)
	ROA	ROA
ESG	0.057***	0.053***
	(0.017)	(0.018)
AGE	3.527***	3.653***
	(1.232)	(1.338)
TQ	0.639***	0.461***
	(0.061)	(0.066)
LEV	−0.218***	−0.217***
	(0.007)	(0.007)
TOP10	0.082***	0.072***
	(0.009)	(0.010)
_cons	−3.396	−2.734
	(3.745)	(4.041)
Year	Yes	Yes
Ind	Yes	Yes
Year * Ind	No	Yes
N	9205	9146
adj. R^2	0.461	0.507

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

ROA, the more apparent the positive effect of ESG performance on stock returns. Therefore, improving financial performance indicators can further enhance the impact of the ESG level on stock returns.

4.5.2. Mechanism analysis of innovation capability

This paper uses the aforementioned mediation effect model to test the mediating effect of corporate innovation capability (PNT) as an indicator, but the results are not significant. Then, a nonlinear Eq. (3) on ESG is constructed to further verify the relationship between PNT and ESG, which adds the quadratic term of ESG based on Eq. (2).

$$PNT_{i,t} = \alpha_3 + \beta_3 ESG_{i,t} + \lambda_3 ESG^2 + \gamma_3^{'} \Sigma Control_{i,t} + \mathrm{Year}_t + \mathrm{Ind}_i + \eta_{i,t} \tag{3}$$

Based on empirical results presented in Table 8, there is a significant nonlinear relationship between the ESG performance and innovation capability of Chinese listed companies, after including the Year * Ind interaction effect. Specifically, the coefficient of the ESG squared term is significantly positive at the 5% level, while the linear coefficient is significantly negative at the 10% level, indicating a U-shaped curve between ESG and corporate innovation capability. In other words, as the ESG score increases, the innovation capability of companies first declines and then rises again. This study implies that the ESG performance of Chinese listed companies may initially restrict their innovation capability, given that research and development (R&D) usually involves lengthy cycles and high risks. The social and environmental responsibilities that companies undertake to proactively respond to government calls may also come at the expense of R&D expenditures and innovation capability. However, as companies build a positive social image and increase their social financing scale, they can enhance their innovation capability by augmenting their R&D investments and attracting more innovative talents to undertake practical exploration.

5. Conclusion

This paper examines the relationship and mechanisms between ESG performance and stock returns using the Chinese listed companies as a sample. By building an unbalanced panel model, this study shows that: (1) ESG performance of A-shares listed companies in China significantly impacts stock returns. A series of robustness tests show that this result remains basically unchanged. (2) According to heterogeneity analysis, the relationship between ESG performance and stock returns of listed companies is contingent on the nature of corporate property rights and the region to which the enterprise belongs. Specifically, the good performance of ESG in non-state-owned listed companies and these in eastern regions can significantly boost stock returns. In contrast, state-owned listed companies and these in non-eastern regions have not demonstrated conclusive results. (3) Two intermediary variables are used to verify the transmission mechanism between ESG performance and stock returns. The results show that financial performance and corporate innovation capability exert partial intermediary effects to varying degrees. More specifically, the relationship between ESG performance and corporate innovation capability is nonlinear.

This study has important theoretical and practical significance for investors, corporate managers, and national decision makers. The authors argue that: (1) Chinese listed companies should adhere to sustainable development, reduce environmental pollution in production and operation processes, assume social responsibility, and improve internal governance. The risk resistance of the company can be increased by forming good ESG performance through scientific decision-making. Particularly in the current period of China's economic and social transformation, listed companies must strike a balance between economic performance and social responsibility, stimulate corporate innovation through good ESG performance, and coordinate with various stakeholders to promote the company's sustainable development. (2) External company investors must actively practice the ESG value investment concept, particularly in the

Table 8
Mechanism analysis (PNT).

	(1)	(2)
	PNT	PNT
ESG	−14.605	−29.528*
	(10.213)	(17.565)
ESG^2	0.317*	0.596**
	(0.170)	(0.296)
AGE	1854.090***	1216.475***
	(211.499)	(422.841)
TQ	5.782	23.732
	(13.966)	(21.329)
LEV	−0.736	−0.733
	(1.453)	(2.531)
TOP10	3.129*	5.298*
	(1.763)	(2.975)
_cons	−5290.691***	−3410.863***
	(669.019)	(1305.720)
Year	Yes	Yes
Ind	Yes	Yes
Year * Ind	No	Yes
N	1765	1551
adj. R^2	0.573	0.395

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

context of sustainable development. ESG practices can be forced on companies by responsible investment strategies. Investor attention to non-financial indicators such as the environment, society, and internal governance will reshape the company's management and operation mode, increasing the company's ESG ratings. (3) The government must improve ESG information disclosure and evaluation systems of enterprises and implement rewards or penalties based on the ESG performance of enterprises. Enterprises with strong ESG performance should be rewarded with incentives like tax reductions and exemptions, interest rate preferences, and project subsidies. In contrast, regulatory oversight should be increased, and appropriate penalties should be imposed on companies with severe environmental pollution and internal governance chaos. In addition, the government should guide enterprises to improve the authenticity and reliability of ESG disclosure information, learn from international ESG disclosure experience, cultivate investors' confidence in the ESG performance of listed companies, and establish interactive mechanism for the ESG information of listed companies and the capital market.

6. Limitations and further research

In this paper, the relationship between ESG scores and stock returns is only analyzed for A-shares listed companies in China, while companies in this sector that have not yet obtained ESG scores are excluded. Although Bloomberg ESG rating indicators were selected, other studies have shown that different rating agencies arrive at different ESG rating results for the same company. In this paper, the ESG scores of other rating agencies have not been subjected to the robustness test.

Further research may explore the impact and mechanism of ESG ratings on various aspects of the environment, society, and governance. In-depth and detailed discussions on relevant issues in different industries and countries may be conducted by using higher quality and high-frequency data, especially with a focus on emerging markets.

Funding statement

This research is partly supported by Key research project of Shanxi Federation of Social Sciences (SSKLZDKT2022062) Humanities and Social Science Key Research Base project of Higher Education in Shanxi Province (20210110), Shanxi Province Science and Technology Strategy Research special project (202104031402098).

Author contribution statement

Xiao-Na Yin: Performed the experiments; Analyzed and interpreted the data; Wrote the paper.
Jing-Ping Li: Conceived and designed the experiments; Analyzed and interpreted the data.
Chi-Wei Su: Contributed reagents, materials, analysis tools or data; Conceived and designed the experiments; Wrote the paper.

Data availability statement

Data will be made available on request.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] J. Galbreath, ESG in focus: the Australian evidence, J. Bus. Ethics 118 (2013) 529–541, https://doi.org/10.1007/s10551-012-1607-9.
[2] L.H. Pedersen, S. Fitzgibbons, L. Pomorski, Responsible investing: the ESG-efficient frontier, J. Financ. Econ. 142 (2021) 572–597, https://doi.org/10.1016/j.jfineco.2020.11.001.
[3] M.C. Jensen, W.H. Meckling, Theory of the firm: managerial behavior, agency costs and ownership structure, J. Financ. Econ. 3 (1976) 305–360, https://doi.org/10.1016/0304-405X(76)90026-X.
[4] R.E. Freeman, R.A. Phillips, Stakeholder theory: a libertarian defense, Bus. Ethics Q. 12 (2002) 331–349, https://doi.org/10.2307/3858020.
[5] M. Malik, Value-enhancing capabilities of CSR: a brief review of contemporary literature, J. Bus. Ethics 127 (2015) 419–438, https://doi.org/10.1007/s10551-014-2051-9.
[6] N.A. Torugsa, W. O'Donohue, R. Hecker, Capabilities, proactive CSR and financial performance in SMEs: empirical evidence from an Australian manufacturing industry sector, J. Bus. Ethics 109 (2012) 483–500, https://doi.org/10.1007/s10551-011-1141-1.
[7] S. Kotsantonis, C. Pinney, G. Serafeim, ESG integration in investment management: myths and realities, Bank Am. J. Appl. Corp. Finance 28 (2016) 10–16, https://doi.org/10.1111/jacf.12169.
[8] A. Alshehhi, H. Nobanee, N. Khare, The impact of sustainability practices on corporate financial performance: literature trends and future research potential, Sustainability 10 (2018) 494, https://doi.org/10.3390/su10020494.
[9] M.E. Porter, M.R. Kramer, The link between competitive advantage and corporate social responsibility, Harv. Bus. Rev. 84 (2006) 78–92.
[10] C.K. Ho, Corporate governance and corporate competitiveness: an international analysis, Corp. Govern. Int. Rev. 13 (2005) 211–253, https://doi.org/10.1111/j.1467-8683.2005.00419.x.
[11] E.F. Fama, K.R. French, Common risk factors in the returns on stocks and bonds, J. Financ. Econ. 33 (1993) 3–56, https://doi.org/10.1016/0304-405X(93)90023-5.
[12] W. Khan, A. Naz, M. Khan, W.K. Khan, S. Ahmad, The impact of capital structure and financial performance on stock returns "A case of Pakistan textile industry, Middle East J. Sci. Res. 16 (2013) 289–295, https://doi.org/10.5829/idosi.mejsr.2013.16.02.11553.
[13] A. Dyck, K.V. Lins, L. Roth, H.F. Wagner, Do institutional investors drive corporate social responsibility? International evidence, J. Financ. Econ. 131 (2019) 693–714, https://doi.org/10.1016/j.jfineco.2018.08.013.
[14] X. Deng, X. Cheng, Can ESG indices improve the enterprises' stock market performance?—an empirical study from China, Sustainability 11 (2019) 4765, https://doi.org/10.3390/su11174765.
[15] J.T. Hamilton, Pollution as news: media and stock market reactions to the toxics release inventory data, J. Environ. Econ. Manag. 28 (1995) 98–113, https://doi.org/10.1006/jeem.1995.1007.
[16] M.V. Russo, P.A. Fouts, A resource-based perspective on corporate environmental performance and profitability, Acad. Manag. J. 40 (1997) 534–559, https://doi.org/10.5465/257052.
[17] S. Brammer, A. Millington, Does it pay to be different? An analysis of the relationship between corporate social and financial performance, Strat. Manag. J. 29 (2008) 1325–1343, https://doi.org/10.1002/smj.714.
[18] Y. Inoue, S. Lee, Effects of different dimensions of corporate social responsibility on corporate financial performance in tourism-related industries, Tourism Manag. 32 (2011) 790–804, https://doi.org/10.1016/j.tourman.2010.06.019.
[19] M.W. Wu, C.H. Shen, Corporate social responsibility in the banking industry: motives and financial performance, J. Bank. Finance 37 (2013) 3529–3547, https://doi.org/10.1016/j.jbankfin.2013.04.023.
[20] S. Ramchander, R.G. Schwebach, K.I.M. Staking, The informational relevance of corporate social responsibility: evidence from DS400 index reconstitutions, Strat. Manag. J. 33 (2012) 303–314, https://doi.org/10.1002/smj.952.
[21] K.V. Lins, H. Servaes, A. Tamayo, Social capital, trust, and firm performance: the value of corporate social responsibility during the financial crisis, J. Finance 72 (2017) 1785–1824, https://doi.org/10.1111/jofi.12505.
[22] G. Halbritter, G. Dorfleitner, The wages of social responsibility—where are they? A critical review of ESG investing, Rev. Financ. Econ. 26 (2015) 25–35, https://doi.org/10.1016/j.rfe.2015.03.004.
[23] G. Landi, M. Sciarelli, Towards a more ethical market: the impact of ESG rating on corporate financial performance, Soc. Responsib. J. 15 (2019) 11–27, https://doi.org/10.1108/SRJ-11-2017-0254.
[24] H. Takahashi, K. Yamada, When the Japanese stock market meets COVID-19: impact of ownership, China and US exposure, and ESG channels, Int. Rev. Financ. Anal. 74 (2021), 101670, https://doi.org/10.1016/j.irfa.2021.101670.
[25] M. Khan, Corporate governance, ESG, and stock returns around the world, Financ. Anal. J. 75 (2019) 103–123, https://doi.org/10.1080/0015198X.2019.1654299.
[26] S. Kanuri, Risk and return characteristics of environmental, social, and governance (ESG) equity ETFs, J. Index Invest. 11 (2020) 66–75, https://doi.org/10.3905/jii.2020.1.092.
[27] S. Shanaev, B. Ghimire, When ESG meets AAA: the effect of ESG rating changes on stock returns, Finance Res. Lett. 46 (2022), 102302, https://doi.org/10.1016/j.frl.2021.102302.
[28] G. Friede, T. Busch, A. Bassen, ESG and financial performance: aggregated evidence from more than 2000 empirical studies, J. Sust. Finance Invest. 5 (2015) 210–233, https://doi.org/10.1080/20430795.2015.1118917.
[29] B.R. Auer, F. Schuhmacher, Do socially (ir) responsible investments pay? New evidence from international ESG data, Q. Rev. Econ. Finance 59 (2016) 51–62, https://doi.org/10.1016/j.qref.2015.07.002.
[30] D. Zhou, R. Zhou, ESG performance and stock price volatility in public health crisis: evidence from COVID-19 pandemic, Int. J. Environ. Res. Publ. Health 19 (2021) 202, https://doi.org/10.3390/ijerph19010202.
[31] X. Li, F. Xu, K. Jing, Robust enhanced indexation with ESG: an empirical study in the Chinese Stock Market, Econ. Modell. 107 (2022), 105711, https://doi.org/10.1016/j.econmod.2021.105711.
[32] D.C. Broadstock, K. Chan, L.T. Cheng, X. Wang, The role of ESG performance during times of financial crisis: evidence from COVID-19 in China, Finance Res. Lett. 38 (2021), 101716, https://doi.org/10.1016/j.frl.2020.101716.
[33] X. Zhang, X. Zhao, Y. He, Does it pay to Be responsible? The performance of ESG investing in China, Emerg. Mark. Finance Trade 27 (2022) 1–28, https://doi.org/10.1080/1540496X.2022.2026768.
[34] N. Amin, S. Tauseef, Does an optimal ESG score exist? Evidence from China, Macroeconomics Finance Emerging Market Economies 17 (2022) 1–9, https://doi.org/10.1080/17520843.2022.2034280.
[35] J. Feng, J.W. Goodell, D. Shen, ESG rating and stock price crash risk: evidence from China, Finance Res. Lett. 46 (2022), 102476, https://doi.org/10.1016/j.frl.2021.102476.
[36] L. Ruan, H. Liu, Environmental, social, governance activities and firm performance: evidence from China, Sustainability 13 (2021) 767, https://doi.org/10.3390/su13020767.

[37] C. Zhao, Y. Guo, J. Yuan, et al., ESG and corporate financial performance: empirical evidence from China's listed power generation companies, Sustainability 10 (2018) 2607, https://doi.org/10.3390/su10082607.
[38] P.L. Baird, P.C. Geylani, J.A. Roberts, Corporate social and financial performance re-examined: industry effects in a linear mixed model analysis, J. Bus. Ethics 109 (2012) 367–388, https://doi.org/10.1007/s10551-011-1135-z.
[39] B. Yoon, J.H. Lee, R. Byun, Does ESG performance enhance firm value? Evidence from Korea, Sustainability 10 (2018) 3635, https://doi.org/10.3390/su10103635.
[40] C. Flammer, P. Bansal, Does a long-term orientation create value? Evidence from a regression discontinuity, Strat. Manag. J. 38 (2017) 1827–1847, https://doi.org/10.1002/smj.2629.
[41] A. Bossman, M. Gubareva, Asymmetric impacts of geopolitical risk on stock markets: a comparative analysis of the E7 and G7 equities during the Russian-Ukrainian conflict, Heliyon 9 (2023), 13626, https://doi.org/10.1016/j.heliyon.2023.e13626.
[42] Y. He, Y.H. Chiu, B. Zhang, The impact of corporate governance on state-owned and non-state-owned firms efficiency in China, N. Am. J. Econ. Finance 33 (2015) 252–277, https://doi.org/10.1016/j.najef.2015.06.001.