Article

The impact of corporate ESG ratings on firm value under risk events—The case of the New Crown Epidemic

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Abstract: As the global ecological and environmental problems become more and more serious, the concept of green finance and sustainable development has been advocated by more and more domestic and foreign experts, scholars and investors, and the Environmental Responsibility, Social Responsibility, and Corporate Governance (ESG) rating has gradually become a hotspot of attention. ESG is a kind of investment concept and a comprehensive assessment criterion of corporate performance for systematic evaluation of enterprises, and it has become an important indicator of the ability of measuring the sustainable development of enterprises. It has become an important indicator of corporate sustainable development capability. In this paper, we investigate the relationship between ESG ratings and cumulative abnormal returns of listed companies' stocks under the impact of sudden risk events. The outbreak of the New Crown epidemic as an exogenous risk event provides an opportunity for this paper. This paper examines the role of firms' ESG ratings and the three sub-dimensions of ratings on the cumulative abnormal returns of listed firms' stocks during the New Crown Epidemic outbreak and verifies the role of ESG ratings on firms in times of crisis. The final regression results prove that under the impact of sudden exogenous risk events, listed firms' ESG ratings have a positive effect on the cumulative abnormal stock returns during the event window. Finally, this paper provides recommendations to help firms and investors prevent and mitigate risks.

Keywords: ESG ratings; cumulative abnormal rate of return; listed company

1. Introduction

The current dual-carbon economy is strongly advocated by the Chinese government, and the dual-carbon policy refers to a green and low-carbon lifestyle, with the goal of achieving carbon peak and carbon neutrality. The 75th United Nations General Assembly has proposed that China should strive to achieve carbon peak by 2030 and carbon neutrality by 2060. Against the backdrop of China's comprehensive green and low-carbon transition with the advancement of the "dual-carbon" goal, where low-carbon development has become the new growth potential, companies should (in some cases mandated by regulation) genuinely fulfil their commitments to mitigate the future environmental impacts of their business activities (Maas, 2018; Moussa et al., 2021) .Enterprises and investors are also gradually aware of the importance of environmental protection, resource conservation and social responsibility, responsible investment, green finance, the concept of sustainable development by more and more domestic and foreign experts, scholars and investors initiatives, ESG investment gradually into the public's field of vision and become the focus of academic research. ESG encompasses environmental, social responsibility and governance, and is an extension and enrichment of the concepts of sustainable

development and responsible investment. The concept of sustainable development dates to 1997 when British scholar John Elkington introduced the triple bottom line theory. This theory emphasizes that enterprises must adhere to the triple bottom line principle to achieve sustainable development. This means that while acquiring resources and pursuing economic benefits, enterprises should also consider the harmony and unity of the environment and society. The 'triple bottom line' performance balance model considers economic, social, and environmental factors. This facilitates stakeholders in making investment decisions accordingly. Elkington (1998) believes that adhering to the triple responsibility is also crucial in the process of enterprise sustainable development. Elkington's Triple Bottom Line theory provides an illustration of the ESG theory, highlighting the role of ESG reporting in current practice. This allows investors and financial analysts to focus on the three layers of environmental, social, and governance factors. The language used is clear, objective, and value-neutral, with a formal register and precise word choice. The text adheres to conventional structure and formatting features, including consistent citation and footnote style. In recent years, Professor Michael Porter of Harvard University has defined shared value as policies and business practices that enhance the competitiveness of an enterprise while improving the economic and social conditions of the community in which the enterprise operates. The transformation of values from 'value creation' to 'shared value creation' aligns more closely with the value perspective of the ESG report and sustainable development theory. The Triple Bottom Line theory and Shared Value perspective provide the theoretical basis for understanding ESG (see **Figure 1** below).

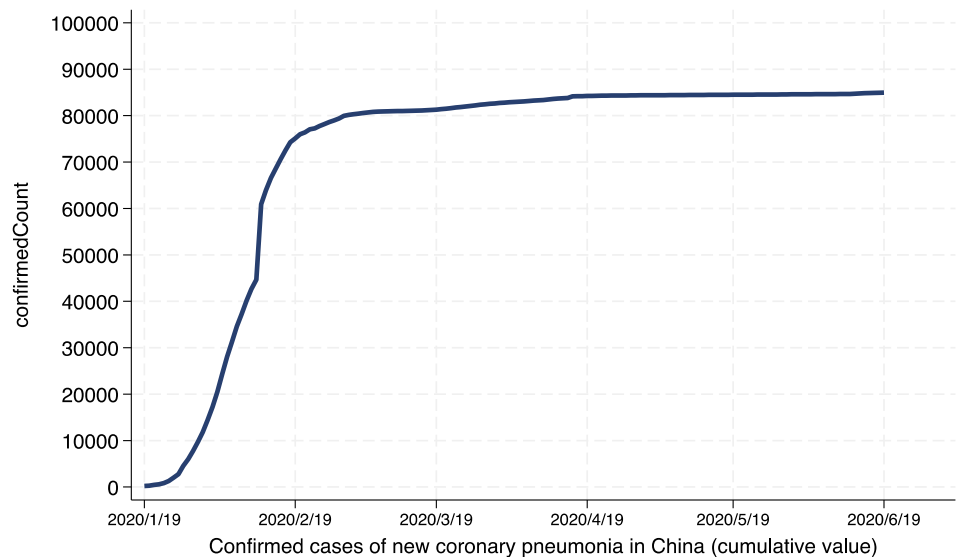**Figure 1.** Number of people diagnosed with the New Crown Epidemic outbreak in China.

In December 2019, there was a sudden outbreak of the New Crown Epidemic, and the epidemic spread rapidly across the country. It swept across the globe in the early 2020's, posing a huge threat to people's lives and safety while also having a major impact on the capital markets. The New Crown Epidemic outbreak was also the

most widespread and influential public health emergency in nearly 100 years. The National Health Commission of the People's Republic of China began real-time monitoring of the number of confirmed cases of the New Crown Epidemic in China on 19 January 2020, and as of 19 June 2020 the cumulative number of confirmed cases of the New Crown Epidemic within China reached 85,000 people. Liu et al. (2020) found that the SSE index, SZSE composite index, and China Securities Index (CSI) 300 index decreased significantly 10 days after the outbreak of the New Crown Epidemic. According to Wind database statistics on 03 February (the first trading day after the holiday) the market fell significantly the SSE index fell 7.72%, the SZSE index fell 8.45%, more than 3000 stocks fell, the biggest drop in China's stock market in 23 years. The sharp fluctuations in the capital market caused both enterprises and investors to suffer huge losses.

The purpose of this paper is to explore whether ESG performance, as an indicator to assess a firm's sustainability, has an impact on firm value under the influence of unexpected events? This paper will explore this query by selecting the 2019 New Crown Epidemic as an example of unexpected events to investigate the impact of corporate ESG performance on firm value during the outbreak of unexpected systemic risk events. It is useful for grasping the path of ESG disclosure behaviour on corporate value enhancement and provides a practical basis for accelerating the disclosure of corporate ESG-related reports, promoting the development of the ESG capital market, and realizing a low-carbon transformation for enterprises.

2. Literature review and research hypothesis

There are similarities between the crisis that resulted from the outbreak and global pandemic of COVID-19 and the global financial crisis that resulted from the subprime mortgage crisis of 2007–2008. In the early days of the 2008 economic crisis, many believed that the impact of that recession would be largely localized and that the economic volatility based on the sub-prime crisis would be a relatively minor issue affecting only the United States, however, the crisis ultimately impacted the global financial system. Several literatures have conducted new discussion and research on ESG performance based on Covid-19. The Centre for Sustainable Economy and Entrepreneurship at the Hong Kong Polytechnic University (2020), based on data from the Business Gateway to Unite Green ratings, found that highly rated firms in China's A-share market outperformed low rated firms in the short term during the New Crown Epidemic. Huang et al. (2020) examined Chinese firms' response to Covid-19 for the crisis and found that firms with higher corporate social responsibility (CSR) ratings suffered less losses and they had shorter recovery times from the blow. Chen et al. (2001) verified the inhibitory effect of CSR/ESG performance on the downside risk of stock price by describing the asymmetry of stock return distribution. Engelhardt et al. (2021) found that stock prices of companies with high ESG ratings exhibit lower stock volatility by examining the relationship between ESG ratings and company stock prices during the New Crown outbreak. Listed companies disclose information about the impact of their business activities on the environment, and the higher the level of disclosure, in terms of significance, quantification, and temporality, the higher the level of disclosure, the higher the positive change in stock price (Wei and Zeng, 2018).

In terms of the impact of social responsibility performance of listed companies on their share price, Dhaliwal et al. (2011) found that companies with good social responsibility performance can reduce the company's cost of equity capital, which in turn increases its share price. The research of Hoepner et al. (2020) shows that companies that take an active role in ESG/corporate social responsibility (CSR), especially those that attach importance to the environment, can reduce their downward risks in a crisis. Mishra and Modi (2013) use empirical analysis to verify that good CSR can help reduce non-systemic risks. These findings support the risk mitigation view that superior ESG performance acts as a defence against risk in the face of exogenous events. Lins et al. (2017) have shown that the impact of CSR during the 2008–2009 financial crisis, firms with good CSR performance had on average 4% to 7% higher earnings compared to firms with poor performance, with the former having higher levels of profitability and sales. The economic disruption caused by Covid-19 was not only disruptive, but also had a spillover effect, as it caused demand and supply shocks in virtually all areas of human activity. Chevrollier et al. (2020) selected 179 listed companies with different models and analyzed them and found that corporate governance is significantly and positively related to ESG performance over time. Chen and Ma (2015) also argue that the improvement of corporate governance plays a positive role in enhancing corporate value and promoting steady corporate development. Takahashi and Yamada (2021), by analyzing the factors affecting the Japanese stock market during the New Crown Epidemic, find that, in terms of the shareholding structure, indirect shareholding of the Bank of Japan through the exchange-traded fund purchasing program has a positive abnormal return Impact.

According to the information asymmetry theory, there exists a certain information asymmetry between investors and investee firms, i.e., investee firms possess more information advantages than investors, while investors are unable to get clear information about the firms' behaviours, which may consequently give rise to problems such as adverse selection. The disclosure of ESG performance can help to improve the transparency of corporate information, ESG performance can help to reduce the information asymmetry between the enterprise and stakeholders, and help investors to strengthen the supervision of the enterprise, and the non-financial information reflected in ESG performance has a very good indication of the future operating conditions of the enterprise, which can help investors to understand the situation of the enterprise more comprehensively, and it has an important value to the investors. Secondly, companies with good ESG performance receive more attention from analysts, and the monitoring mechanism regulates corporate behaviour, raises the cost of corporate management violations, and reduces the uncertainty faced by investors. companies with good ESG performance can more effectively control environmental, social, legal, reputational, operational and regulatory risks, and withstand economic downside risks during financial crises or public emergencies.

Hypothesis H1: Good ESG performance helps firms to withstand unexpected events.

Hypothesis H1a: E-rating is positively related to abnormal stock returns in the event of the New Crown Epidemic.

Hypothesis H1b: There is a positive relationship between S-rating and abnormal stock returns in the event of the New Crown Epidemic.

Hypothesis H1c: There is a positive relationship between G-rating and abnormal stock returns under the New Crown Epidemic shock.

3. Research design

3.1. Sample selection and data sources

Given the availability of ESG rating data and the authority of the rating agencies, the scores of ESG, E, S and G of listed companies in this paper for the year 2019 are from CSI ESG Ratings, and the other raw data are from the Cathay Pacific database. This paper first selects all A-share listed companies in China as the initial sample, and then arranges the sample data according to the following order of processing: exclude problematic companies such as ST and *ST, which often have significant abnormalities in various indicators due to their own operations or other reasons, so these companies are excluded from the sample to avoid affecting the regression results. The sample of enterprises with missing index data is excluded. Excluding companies in the finance and insurance industries. Since the finance and insurance industry is not part of the real economy, these companies are excluded. To avoid the extreme sample values of individual enterprises from causing bias to the empirical analysis results, all continuous variables in this paper are subjected to 1% upward and downward shrinkage to reduce the extreme values. In addition, the empirical part of this paper uses the software Stata18 to complete the data processing, variable analysis and regression analysis of each variable.

3.2. Definition of variables

3.2.1. Implicit variable

Cumulative Abnormal Returns (CAR): the cumulative abnormal returns of the stocks of listed companies in this paper are mainly based on the calculation of the event study method. The event study method mainly studies the impact of specific events, such as corporate mergers and acquisitions, the release of earnings news, the exposure of negative news, etc., on corporate stock prices and financial performance. The sudden outbreak of the New Crown Epidemic is also a sudden and exogenous risk event, and there are no other major events during the outbreak that have any further impact on the entire capital market, so since all the preconditions of the event study method have been met, the event study method can be chosen for this paper to study the impact of ESG ratings of listed companies on stock returns during the New Crown Epidemic.

As a sudden exogenous risk event, the New Crown Epidemic outbreak initially occurred in December 2019, but it did not attract much attention from the community or affect the capital markets in the early stages of the outbreak. Subsequently, on 20 January, it was noted that the outbreak was a very serious epidemic, and on 23 January, China made a decisive decision to 'seal off the city' considering the outbreak situation. Therefore, this paper identifies 23 January as the event date, defined as event $t = 0$. Considering the estimation period, the estimation period of expected return is chosen as 120 trading days before the event date $[-130, -11]$, and the event window is (3, 3), with 3 being the first three trading days and the third trading day after China takes the

measure, and the sample firms in the sample firms on the day when China adopts the measure of 'sealing off the city' and on the day before and after the measure. The cumulative abnormal returns (CAR) of the stocks of the sample firms on the day of China's 'city closure' measure and the three trading days before and after the measure (a total of seven trading days) are used as the explanatory variables (see **Figure 2** below).
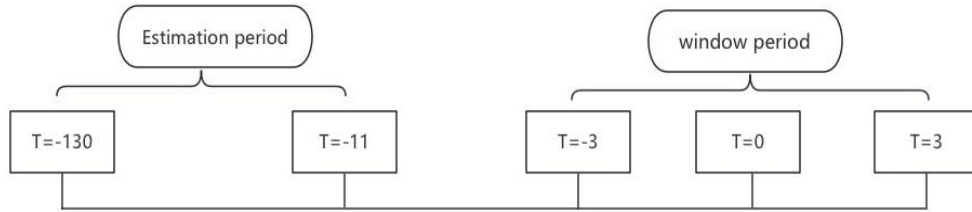

Figure 2. Estimation period and window period definition.

The steps for calculating the cumulative excess return on equity (CAR) are as follows:

1)   Estimation of Normal Rate of Return

The normal rate of return during the window period is the expected rate of return of a stock during the event window period according to the normal market environment if there is no risk event. In this paper, a market model is used to predict the normal rate of return on stocks, which is shown in Equation (1) of the model:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \tag{1}$$

where R_{it} is the return of stock i at time t, α_i is a constant term, β_i represents systematic risk, R_{mt} represents the return of the market portfolio at time t, and ε_{it} represents the residual term of stock i at time t. A least squares regression is performed for each stock based on the actual and market returns of stock i over the 120 trading days of the estimation period to obtain the values of the estimated coefficients α_i and β_i, which leads to a model for estimating the expected normal rate of return for a single stock i. The estimated coefficients are then used to estimate the expected normal rate of return for each stock.

2)   Calculation of Abnormal Rate of Return (AR)

Abnormal return is the difference between the actual return on a stock minus the expected normal return, and it has been suggested that the difference between the two can be used to reflect the impact of a particular event on the stock market. When an event occurs that has a positive impact on the market, the abnormal rate of return (AR) of a company is generally positive, and the greater the impact, the greater the value will be, and vice versa is negative, and the greater the impact, the smaller the value will be. The calculation of abnormal return is shown in Equation (2):

$$AR_{it} = R_{it} - E(R_{it}) \tag{2}$$

AR_{it} represents the abnormal return of the security on stock i at time t, R_{it} is the actual return on stock i at time t, and $E(R_{it})$ is the expected return on stock i at time t calculated using the market model.

3) Cumulative Abnormal Return (CAR)

Based on the AR_{it} calculated in Equation (2) above, the cumulative abnormal return CAR value for stock i over the event window period specified in this paper is calculated using Equation (3), that is, obtained by summing the daily abnormal returns (AR) of the sample firms over the 7-day window period:

$$CAR_i = \sum_{t=-3}^{t=3} AR_{it} \qquad (3)$$

3.2.2. Dependent variable

For ESG rating, this paper chooses CSI ESG rating to evaluate the ESG disclosure level of listed companies. Combining the international mainstream ESG assessment framework, considering Chinese characteristics and specific practical experience, and fully absorbing the opinions of external market experts, CSI has formulated the CSI ESG rating methodology and set 16 themes and 44 key indicators, which is more suitable for researchers to study A-share listed companies. Therefore, this paper selects CSI ESG rating data to examine the comprehensive performance of the sample listed companies in three aspects: Environmental performance, social responsibility, and corporate governance.

3.2.3. Control variables

In terms of control variables, factors such as company size and enterprise nature are considered to have an impact on enterprise value. This paper introduces return on equity (ROA), asset turnover (ATO) and growth rate, firm size (size), debt to assets ratio (Lev), listing age (ListAge), and the ratio of the number of shares held by the first largest shareholder to the number of total share capital at the end of the period (Top1) as control variables.

Return on Equity (ROE): It is a profitability ratio, a measure of profitability that shows how much profit a company can generate from its assets. Profitability ratios indicate how effectively a company uses its assets to generate profits and value for its shareholders.

Asset turnover (ATO): This ratio reflects the operational capacity of the enterprise, i.e. the ability to use its assets to generate profits. It indicates how quickly a business can respond to its capital, as better operational capacity is usually associated with more liquid resources, allowing the business to react to the market and make strategic adjustments more quickly.

Growth capacity: It is an effective indicator of a company's growth rate and development potential, which helps company managers to understand the company's level of operation. The higher the growth capacity of a company, the stronger the company's ability to create value in the future.

Company size: some studies registered that there is a relationship between enterprise company size and firm value, capital structure has a positive effect on firm value, and firm size positively affects the value of the firm.

Debt to Assets ratio: also known as the debt-to-equity ratio, it is the percentage of total liabilities divided by total assets at the end of the period and is a comprehensive indicator of a company's indebtedness. The relationship between financial leverage and the value of a company can be described by the Modigliani-Miller theorem, a definition that assumes, under idealized conditions, that the capital structure of a company is independent of its total market value.

Listed age: The longer a firm operates within the industry, the more qualified it becomes to handle market challenges and draw in investor attention, consequently resulting in an upsurge in overall market value.

Shareholding ratio of the largest shareholder: Equity concentration directly reflects the distribution of the shareholders' claim to the enterprise's surplus value. This paper uses the ratio of the first largest shareholder to measure the equity concentration of listed companies. Because the shareholding ratio of the first largest shareholder has a significant impact on the company's decision-making and operation.

To overcome the endogeneity problem of the variables, one period lag is used for the firm micro characteristic variables. In addition, considering that time-varying factors such as industry characteristics and macroeconomic environment may also affect the value of the firm, in this regard, this paper uniformly adds industry fixed effects and time fixed effects to the model for control. The symbols, definitions and calculation methods of the main variables are shown in the table below (see **Table 1**).

Table 1. Definition chart of explanatory, interpreted and control variables.

Variable type	Name	Nicknames	Define
Implicit variable	Cumulative abnormal rate of return	CAR	$CAR_i = \sum AR_{i,t}$
Independent variable	ESG Indicators	ESG	CSI ESG rating standard
Control variable	Firm growth	Growth	Firm growth = (Current year's operating revenue—Previous year's operating revenue)/Previous year's operating revenue
	Return on Equity	ROE	Return on Equity $= \frac{annual\ profit\ after\ tax}{owne\ rs'\ equity}$
	Asset Turnover	ATO	Asset Turnover $= \frac{sales\ revenue}{total\ assets}$
	Company size	Size	Total company assets (in yuan) taken in logarithms
	Debt to Assets ratio	Lev	Debt to Assets ratio $= (\frac{Total\ liabilities}{total\ assets}) \times 100\%$
	Shareholding ratio of the largest shareholder	Top1	Proportion of shares held by the largest shareholder $\times$ 100%
	Listed age	ListAge	Natural logarithm of the number of years listed up to the current period

4. Modelling

According to the hypothesis, this paper makes the following multiple regression model based on the relevant theory and the setting of variables:

$$CAR_{it} = \alpha_0 + \alpha_1 ESG_{it} + \alpha_2 ROE_{it} + \alpha_3 ATO_{it} + \alpha_4 Growth_{it} + \alpha_5 Size_{it} + \alpha_6 Lev_{it} + \alpha_7 Top1_{it} + \alpha_8 ListAge_{it} + \varepsilon_{it} \quad (4)$$

$$CAR_{it} = \alpha_0 + \alpha_1 E_{it} + \alpha_2 ROE_{it} + \alpha_3 ATO_{it} + \alpha_4 Growth_{it} + \alpha_5 Size_{it} + \alpha_6 Lev_{it} + \alpha_7 Top1_{it} + \alpha_8 ListAge_{it} + \varepsilon_{it} \quad (5)$$

$$CAR_{it} = \alpha_0 + \alpha_1 S_{it} + \alpha_2 ROE_{it} + \alpha_3 ATO_{it} + \alpha_4 Growth_{it} + \alpha_5 Size_{it} + \alpha_6 Lev_{it} + \alpha_7 Top1_{it} + \alpha_8 ListAge_{it} + \varepsilon_{it} \quad (6)$$

$$CAR_{it} = \alpha_0 + \alpha_1 G_{it} + \alpha_2 ROE_{it} + \alpha_3 ATO_{it} + \alpha_4 Growth_{it} + \alpha_5 Size_{it} + \alpha_6 Lev_{it} + \alpha_7 Top1_{it} + \alpha_8 ListAge_{it} + \varepsilon_{it} \quad (7)$$

CAR_{it} is the cumulative abnormal return of stock *i* in period *t* at the time of the New Crown Epidemic, ESG_{it}, E_{it}, S_{it}, G_{it} are the composite score of listed companies in period *t* and the individual scores of the three dimensions, respectively. α_0 is the constant term, $\alpha_1 \dots \alpha_8$ are the regression coefficients of the corresponding variables, and ε_{it} is the random error term.

5. Empirical tests and analysis of results

5.1. Descriptive stats

For hypotheses 1 to 1c, this paper firstly statistically analyzes the data of 3264 listed companies with ESG ratings to understand the basic situation of the variables before regression analysis. Descriptive statistics of cumulative abnormal returns, total ESG scores, scores of each sub-dimension and each control variable of 3264 listed companies were conducted to obtain the minimum, maximum, median, mean and standard deviation of each variable. The results of the analysis are shown in **Table 2**.

Table 2. Descriptive statistics of variables.

Variable	N	Mean	SD	Min	Max
CAR3	3264	0	0.130	−0.360	0.820
ESG	3204	72.91	6.700	41.19	92.93
E	3204	61.07	8.810	34.44	95.16
S	3204	76.38	11.05	14.18	100
G	3204	76.67	9.480	24.33	96.13
ROE	3117	0.0500	0.220	−4.840	0.840
ATO	3117	0.650	0.540	−0.0500	11.98
Growth	3117	0.180	1.920	−1.310	82.79
Size	3117	22.35	1.340	17.95	28.64
Lev	3117	0.420	0.200	0.0100	1.700
Top1	3117	0.330	0.150	0.0300	0.880
ListAge	3117	2.230	0.770	0.690	3.400

As shown in **Table 2**, the maximum value of cumulative abnormal return is 0.82, the minimum value is −0.36, and the standard deviation is 0.13, which shows that the performance of different listed companies' stock returns under the impact of the New Crown Epidemic has a relatively large difference. The mean value of ESG score is 72.91, which shows that China's ESG score has an average performance in general; the minimum value is 41.18, and the maximum value is 92.93, with a standard deviation of 6.7, indicating that the ESG performance of different companies still has a large difference. The minimum value is 41.18, the maximum value is 92.93, and the standard deviation is 6.7, indicating that there are still big differences in ESG performance among different enterprises. The mean value of the environmental responsibility score is 61.07, indicating that our enterprises' performance in the environment is generally bad; the mean value of the social responsibility score is

76.38, the minimum value is 14.18, and the maximum value is 100, which is slightly better than the environmental responsibility, but there is a big difference between the enterprises; and the mean value of the corporate governance score is 76.67, which indicates that the performance of our listed companies in the aspect of corporate governance is still generally comparable. The mean value of corporate governance score is 76.67, indicating that the performance of listed companies in China in corporate governance is generally better. Overall, in the three sub-dimensions of environmental, social and corporate governance, China's listed companies still need to pay more attention to their performance in environmental and social responsibility.

Among the control variables, the mean value of return on net assets is 0.05, the maximum value is 0.84, and the minimum value is −4.84, indicating that the profitability level of the sample companies is generally low and varies widely; the maximum value of gearing ratio is 1.7, and the minimum value is 0.01, which indicates that the leverage ratio varies widely among different listed companies; and the standard deviation of the age of the company's listing is 1.34, which can be seen that there are also there are some differences, indicating that the coverage of the research sample is wider.

5.2. Correlation analysis

To ensure the reasonableness of the model, this paper does correlation analysis on each variable in the model to get the correlation number of each variable before conducting regression to analyze the linear correlation between the explanatory variables and the explained variables. Since the three sub-dimensions of ESG are important components of ESG, the correlation with ESG may be higher, and the results of the correlation analysis test are shown in **Table 3**.

Table 3. Correlation analysis of variables.

	CAR	ESG	E	S	G	ROE	ATO	Growth	Size	Lev	Top1	List Age
CAR	1											
ESG	0.001**	1										
E	0.0200	0.555***	1									
S	0.033*	0.667***	0.339***	1								
G	0.00700	0.748***	0.118***	0.117***	1							
ROE	0.061***	0.241***	0.060***	0.102***	0.263***	1						
ATO	−0.00900	0.038**	0.0130	0.088***	0.0270	0.135***	1					
Growth	0.00700	−0.0140	−0.0140	−0.00500	−0.0110	0.065***	0.036*	1				
Size	−0.0260	0.216***	0.196***	0.152***	0.090***	0.119***	0.045*	0.054***	1			
Lev	−0.107***	−0.051***	0.100***	0.086***	−0.217***	−0.256***	0.104*	0.059***	0.470***	1		
Top1	−0.089***	0.130***	−0.0120	−0.0250	0.214***	0.129***	0.06*	0.024	0.190***	0.0260	1	
ListAge	−0.0250	−0.073***	0.049***	−0.083***	−0.091***	−0.093***	−0.0032	−0.030*	0.429***	0.255***	−0.058***	1

The coefficient of the relationship between cumulative abnormal returns and ESG ratings is positive and significant at 1% confidence level, which initially indicates that

there is a significant positive correlation between the ESG performance of listed companies in the stock market and cumulative abnormal returns, which is consistent with Hypothesis 1 and expectations. The control variables ROE, Lev, Top1 are all significant at 1% confidence level and there is a negative correlation between the age of listed companies and the explanatory variable CAR. In addition, the coefficients of each variable in the table are less than 0.8, which can indicate that the explanatory variables in the empirical model are more independent from each other, and the relationship between the variables will not interfere with the results of the regression.

5.3. Covariance test

To avoid the problem of multicollinearity in the model established in this paper, this paper further conducted a multicollinearity (VIF) test on the empirical model, and the test results are shown in the table. **Table 4** shows the VIF test for hypothesis 1, i.e., the explanatory variable is ESG score; **Table 5** shows the VIF test for hypothesis 1a, i.e., the explanatory variable is environmental responsibility score; **Table 6** shows the VIF test for hypothesis 1b, i.e., the explanatory variable is social responsibility score; **Table 7** shows the VIF test for hypothesis 1c, i.e., the explanatory variable is corporate governance score. From **Table 4** to **Table 7**, the VIF values as well as the mean values are greater than 1 and much less than the critical value of 10, indicating that there is no multicollinearity problem in the model of this paper.

Table 4. VIF test of hypothesis 1.

Variable	ESG	ROE	ATO	Growth	Size	Lev	Top1	ListAge	Mean VIF
VIF	1.15	1.26	1.05	1.02	1.84	1.53	1.08	1.32	1.28

Table 5. VIF test of hypothesis 1a.

Variable	E	ROE	ATO	Growth	Size	Lev	Top1	ListAge	Mean VIF
VIF	1.05	1.24	1.05	1.01	1.77	1.51	1.08	1.29	1.25

Table 6. VIF test of hypothesis 1b.

Variable	S	ROE	ATO	Growth	Size	Lev	Top1	ListAge	Mean VIF
VIF	1.07	1.24	1.05	1.02	1.77	1.51	1.08	1.33	1.26

Table 7. VIF test of hypothesis 1c.

Variable	G	ROE	ATO	Growth	Size	Lev	Top1	ListAge	Mean VIF
VIF	1.18	1.26	1.05	1.01	1.77	1.59	1.10	1.30	1.28

5.4. Regression analysis

Table 8 consolidates the regression results after separately regressing the ESG scores and each of the three sub-dimensions of ratings.

Table 8. Regression results.

Variable	CAR	CAR	CAR	CAR
ESG	0.001(1.78)			
E		−0.000(−1.40)		
S			0.0001**(1.91)	
G				0.001***(2.61)
ROE	0.024**(2.11)	0.022*(1.93)	0.020*(1.78)	0.025**(2.22)
ATO	0.000(0.09)	0.000(0.06)	−0.000(-0.02)	0.000(0.11)
Growth	0.001(0.48)	0.001(0.52)	0.001(0.60)	0.001(0.50)
Size	0.006**(2.52)	0.005**(2.34)	0.004*(1.90)	0.006**(2.54)
Lev	−0.076***(−5.39)	−0.073***(−5.20)	−0.074***(−5.28)	−0.082***(−5.69)
Top1	−0.088***(−5.46)	−0.091***(−5.62)	−0.088***(−5.41)	−0.083***(−5.05)
ListAge	−0.004(−1.21)	−0.003(−1.01)	−0.002(−0.73)	−0.004(−1.18)
_cons	−0.012(−0.25)	−0.029(−0.65)	−0.052(−1.16)	−0.004(−0.08)
N	3117	3117	3117	3117
r2	0.024	0.023	0.023	0.025

t statistics in parentheses = "* $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$".

Table 8 shows that the cumulative abnormal return CAR is correlated with ESG score at 5% confidence level and the coefficient is positive but not significant. The coefficient is positive but not significant, indicating that the ESG scores of listed companies have a positive impact on the cumulative abnormal returns. The higher the ESG score of listed companies, the more they can demonstrate higher risk resistance when facing exogenous risk events, and thus obtain better stock returns. This also verifies that Hypothesis 1 proposed in this paper is correct, and that enterprises actively fulfilling their ESG responsibilities can improve their high resilience to systemic risks. The non-significant results may be because companies do not pay enough attention to ESG ratings.

Regression analyzes were conducted on each of the three sub-dimensions to verify the relationship between the three sub-dimensions of ESG and the cumulative abnormal stock returns, and to explore the importance of the three different dimensions on the stock returns of listed companies in the face of unexpected risk events. The regression results can be obtained from **Table 8,** where the coefficient of the Environmental Responsibility Score (E) is negative, contrary to the expectation of Hypothesis 1a, but is not significant. Since the coefficient is negative, theoretically, the environmental responsibility score is negatively related to stock returns, and the non-significance of this result may be related to the fact that our firms are generally low in terms of their environmental responsibility scores in the Bloomberg database. If companies want to achieve a high score in environmental responsibility performance, they must reduce carbon emissions and other pollutants and reduce the consumption of non-renewable resources. Only in this way can they help to achieve long-term sustainable corporate development.

The coefficient of Social Responsibility Score (S) is positive with a value of 0.0001 and correlates at 1% confidence level, indicating that the better a listed company performs in terms of social responsibility, the greater is the cumulative

abnormal return on the stock. This is the same as the hypothesis in the previous paper. This paper speculates that during a crisis such as the New Crown Epidemic, higher social responsibility scores imply that focusing on employee health and safety can give employees stronger motivation to improve their work, and firms can ensure stability in operations and the proper functioning of their work, which in turn improves the competitiveness of their firms. Therefore, the higher the score of the firm's social responsibility performance, the more it can improve the impact of the epidemic.

The coefficient of corporate governance score (G) is 0.001 and shows a significant positive relationship with cumulative abnormal stock returns at 1% confidence level, which indicates that the better the performance in terms of corporate governance, the higher the stock returns, which is in line with the hypothesis expectations. Firms with higher level of corporate governance will be more organized in the event of a systemic risk event and will be able to quickly formulate a response to the crisis, thus enhancing their resilience to the crisis event.

In summary, the three sub-dimensions of ESG: environmental responsibility has no significant relationship with cumulative abnormal stock returns (CAR) in this paper, social responsibility and corporate governance have a significant positive relationship with cumulative abnormal stock returns (CAR), and the better a listed company performs in social responsibility and corporate governance, the more it can reduce its own risk.

5.5. Stability test

In order to further ensure the reliability of the conclusions of this paper, this section will conduct a robust test of the multiple regression results, replace the explanatory variable CAR, replace the window period of the cumulative abnormal stock returns in the model, and select the cumulative abnormal returns of the five trading days before and after the event day 'sealing off the city', a total of 11 trading days, and test the hypotheses again. The hypotheses are tested again.

From the results in **Table 9**, the correlation coefficient between ESG scores and cumulative abnormal returns is 0.001, again indicating that ESG performance has a significant positive contribution to the cumulative abnormal returns of listed companies' stocks during the New Crown Epidemic. **Table 9** shows that the coefficient of the environmental responsibility factor is negative but still has no significant effect on the cumulative abnormal returns; the coefficient of the social responsibility factor is 0.0001, which is significant at the 5% confidence level, which means that the performance of listed companies in terms of social responsibility has a significant positive effect on cumulative abnormal returns; the coefficient of the corporate governance performance is 0.001, which is significant at the 1% confidence level; and the coefficient of the corporate governance performance is 0.001, which is significant at the 1% confidence level, which means that the performance of listed companies in terms of social responsibility is significant at the 1% confidence level. is 0.001, which is significant and positively related to the cumulative abnormal stock returns at 1% confidence level, indicating that a high level of corporate governance has a significant enhancement effect on improving stock returns under the New Crown

Epidemic. All the above results are consistent with the findings in the previous paper, indicating that the robustness test is passed.

Table 9. Robustness test results.

	CAR	CAR	CAR	CAR
ESG	0.001(1.20)			
E		−0.000(−0.47)		
S			0.0001**(1.97)	
G				0.001***(2.69)
ROE	0.024*(1.84)	0.022*(1.70)	0.020(1.54)	0.027**(2.04)
ATO	0.001(0.27)	0.001(0.25)	0.001(0.12)	0.001(0.30)
Growth	0.001(0.87)	0.001(0.90)	0.001(0.98)	0.001(0.85)
Size	0.006**(2.12)	0.005*(1.93)	0.004(1.52)	0.006**(2.30)
Lev	−0.088***(−5.44)	−0.086***(−5.33)	−0.087***(−5.42)	−0.096***(−5.81)
Top1	−0.112***(−6.07)	−0.114***(−6.14)	−0.110***(−5.93)	−0.105***(−5.61)
ListAge	−0.007*(−1.77)	−0.006(−1.62)	−0.005(−1.25)	−0.007*(−1.83)
_cons	0.006(0.12)	−0.011(−0.22)	−0.037(−0.72)	0.028(0.53)
N	3117	3117	3117	3117
r2	0.027	0.026	0.027	0.028

t statistics in parentheses = "* $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$".

5.6. Heterogeneity analysis

(1) Heterogeneity analysis based on industries

In this paper, whether the industry is a heavy polluter or not is distinguished and analyzed for heterogeneity, with Pollute = 1 representing that the enterprise is a heavy polluter industry and Pollute = 0 representing that the enterprise is a non-heavy polluter. The results of the analysis are shown in the table below.

From the results in **Table 10**, the correlation coefficient between ESG scores and cumulative abnormal returns is 0.001 for non-heavy polluters, indicating that the ESG performance of non-heavy polluters has a significant positive contribution to the cumulative abnormal returns of the listed company's stock during the New Crown Epidemic. However, for heavily polluting industries, the regression results are not significant. Regarding the correlation between governance score and cumulative abnormal returns of non-heavy polluting firms, the coefficient is 0.001, which is significantly correlated at the 1% confidence interval. This indicates that there is a significant and positive correlation between the corporate governance of non-heavy polluting firms and the cumulative abnormal returns of the shares of listed companies. The higher the level of corporate governance, the higher the cumulative abnormal return of the company's stock when faced with unexpected events. This suggests that the more risk-resistant the firm is.

Table 10. Heterogeneity analysis based on industries.

	Pollute = 1	Pollute = 0	Pollute = 1	Pollute = 0	Pollute = 1	Pollute = 0	Pollute = 1	Pollute = 0
ESG	0.000	0.001*						
	(0.30)	(1.90)						
E			0.001	−0.000				
			(1.05)	(−1.54)				
S					−0.000	0.000		
					(−0.62)	(1.59)		
G							0.000	0.001***
							(0.56)	(3.06)
ROE	0.033	0.022*	0.032	0.019	0.036	0.017	0.031	0.024*
	(0.87)	(1.79)	(0.86)	(1.58)	(0.97)	(1.38)	(0.84)	(1.94)
ATO	0.008	0.000	0.007	0.000	0.008	−0.000	0.008	0.001
	(0.91)	(0.09)	(0.83)	(0.05)	(0.94)	(−0.03)	(0.91)	(0.13)
Growth	0.004	0.000	0.004	0.000	0.004	0.000	0.004	0.000
	(0.85)	(0.20)	(0.87)	(0.25)	(0.86)	(0.36)	(0.86)	(0.22)
Size	−0.005	0.009***	−0.005	0.009***	−0.004	0.008***	−0.005	0.009***
	(−1.38)	(3.44)	(−1.47)	(3.30)	(−1.20)	(2.79)	(−1.45)	(3.50)
Lev	−0.031	−0.092***	−0.033	−0.088***	−0.033	−0.091***	−0.029	−0.101***
	(−1.24)	(−5.51)	(−1.35)	(−5.32)	(−1.34)	(−5.46)	(−1.16)	(−5.92)
Top1	−0.012	−0.104***	−0.010	−0.108***	−0.014	−0.104***	−0.014	−0.096***
	(−0.41)	(−5.51)	(−0.34)	(−5.72)	(−0.47)	(−5.47)	(−0.46)	(−4.99)
ListAge	0.008	−0.006	0.009	−0.005	0.007	−0.004	0.008	−0.006
	(1.37)	(−1.57)	(1.46)	(−1.36)	(1.21)	(−1.04)	(1.37)	(−1.58)
_cons	0.069	−0.060	0.055	−0.083	0.087	−0.114**	0.066	−0.043
	(0.91)	(−1.07)	(0.75)	(−1.55)	(1.21)	(−2.11)	(0.89)	(−0.78)
N	675	2442	675	2442	675	2442	675	2442
r2	0.015	0.030	0.017	0.030	0.016	0.030	0.016	0.033

t statistics in parentheses = "* $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$".

(2) Heterogeneity analysis based on the property rights

Firms are categorized based on their ownership into state-owned enterprises (SOEs = 0) and non-state-owned enterprises (SOEs = 1). As can be seen from the results of the analysis in **Table 11**, the ESG scores of SOEs are positively correlated with cumulative abnormal returns and are significant at the 5% confidence interval. The regression coefficient of ESG on CAR is not significant in the group of non-state-owned firms. This suggests that the enhancement of ESG performance on the cumulative abnormal return on firms' stock is mainly found in state-owned firms and fails to show evidence of an effective effect in non-state-owned firms. It can be posited that government intervention impacts the capacity of firms to procure external resources. The formation of a political affiliation with the government has emerged as a pivotal avenue for SOEs to secure resources, thereby conferring them with enhanced advantages in the context of government resource allocation. In the equity heterogeneity analysis, the environmental score of SOEs is significantly negatively

associated with the cumulative abnormal returns of the firm's stock. This may be because environmental regulation by SOEs increases the operating costs of the firms in the short run during unexpected events. In contrast, non-state-owned firms have half the ESG disclosure of state-owned firms and less ESG disclosure, so the results are not significant (see **Table 11** below).

Table 11. Heterogeneity analysis based on property rights.

	SOE = 1	SOE = 0	SOE = 1	SOE = 0	SOE = 1	SOE = 0	SOE = 1	SOE = 0
ESG	0.000	0.001**						
	(0.80)	(2.06)						
E			0.001	−0.001***				
			(1.56)	(−2.72)				
S					0.001*	0.000		
					(1.96)	(0.00)		
G							−0.000	0.001
							(−0.88)	(1.58)
ROE	0.030*	0.018	0.031*	0.015	0.029*	0.013	0.033*	0.016
	(1.70)	(1.18)	(1.76)	(1.01)	(1.68)	(0.86)	(1.88)	(1.10)
ATO	0.010	−0.006	0.010	−0.007	0.009	−0.006	0.011	−0.006
	(1.51)	(−1.11)	(1.48)	(−1.18)	(1.25)	(−1.12)	(1.55)	(−1.06)
Growth	−0.001	0.004*	−0.001	0.004*	−0.001	0.004**	−0.001	0.004*
	(−0.94)	(1.88)	(−0.92)	(1.89)	(−0.93)	(1.97)	(−1.00)	(1.94)
Size	−0.001	0.013***	−0.001	0.013***	−0.002	0.011***	0.000	0.012***
	(−0.35)	(3.90)	(−0.39)	(3.93)	(−0.51)	(3.51)	(0.06)	(3.71)
Lev	−0.052**	−0.086***	−0.054***	−0.080***	−0.054***	−0.081***	−0.058***	−0.089***
	(−2.49)	(−4.56)	(−2.62)	(−4.28)	(−2.62)	(−4.35)	(−2.73)	(−4.62)
Top1	−0.055**	−0.080***	−0.051**	−0.082***	−0.050**	−0.080***	−0.049*	−0.077***
	(−2.16)	(−3.67)	(−2.00)	(−3.76)	(−1.99)	(−3.62)	(−1.91)	(−3.53)
ListAge	0.007	−0.004	0.007	−0.002	0.007	−0.002	0.006	−0.003
	(1.07)	(−0.88)	(1.11)	(−0.52)	(1.21)	(−0.43)	(1.00)	(−0.74)
_cons	−0.011	−0.133*	−0.013	−0.153**	−0.015	−0.179***	0.032	−0.146**
	(−0.17)	(−1.95)	(−0.21)	(−2.37)	(−0.24)	(−2.75)	(0.48)	(−2.16)
N	1038	2079	1038	2079	1038	2079	1038	2079
r2	0.024	0.025	0.026	0.026	0.027	0.023	0.024	0.024

t statistics in parentheses = "* $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$".

6. Conclusions, limitations and recommendations

6.1. Conclusions and limitations

With the development of events, enterprises and investors have gradually realized the importance of environmental protection and social responsibility, and the concept of sustainable development has been recognized by more and more scholars and investors, and the concept of ESG rating has been accepted by enterprises and become the focus of academic research.

In this paper, 3264 listed companies with ESG ratings are selected as samples, and the stock returns of listed companies are calculated, and data regression analyzes are done on the ESG ratings and the scores of three sub-dimensions, namely, environmental responsibility, social responsibility, and corporate governance, and the following conclusions are finally drawn. Under the influence of the New Crown Epidemic, good ESG performance of companies can enhance their stock returns. The positive correlation between ESG scores and cumulative abnormal returns on company shares is particularly significant in state-owned enterprises and non-polluting industries. The regression analyzes of the three sub-dimensions revealed that both social responsibility performance and corporate governance have a positive impact on stock returns, and these results were tested for robustness. The regression results of the environmental responsibility factor in this study are not significant, probably because Chinese listed companies do not pay enough attention to ESG ratings, which leads to low overall scores, and the regression coefficients are negative, but the impact is not significant. However, it is significantly negatively correlated in state-owned enterprises, mainly because this paper considers the impact of emergencies on both, environmental governance needs to change the production mode of the enterprise, which will increase the additional costs of the enterprise in the short term, including production costs and operating. On the contrary, social responsibility has a significant positive effect on stock returns during the New Crown Epidemic, while corporate governance also significantly improves firms' stock returns under the epidemic shock. Companies with high ESG ratings can build a good social image, which enhances their social credibility and investment attractiveness. At the same time, the relatively low risk of such companies can satisfy investors' risk aversion needs. In addition, as sustainable development is increasingly emphasized in China and the government's attention and policy support for environmental responsibility, social responsibility and corporate governance is growing, companies with high ESG ratings are bound to attract more market attention.

6.2. Recommendations

Overall, the ESG ratings of listed companies in China are significantly lower than those of listed companies in mature capital markets such as Europe and the United States, and Chinese companies and investors do not pay enough attention to the performance of listed companies in terms of environmental responsibility, social responsibility and corporate governance. However, with the popularization of the ESG investment concept and the promotion of the green economy and sustainable development concepts. There is also a growing demand for ESG investments from the Chinese government and investors. Based on the conclusions drawn from the empirical analyzes in this paper, and taking into account the current characteristics and development status of China's ESG investment market, the following policy recommendations are proposed for the future development of ESG.

China's current lack of ESG disclosure and the low motivation of listed companies have led to limited data sources for China's ESG evaluation system. China's relevant authorities should continue to standardize the corporate ESG disclosure framework and strengthen institutional constraints. Therefore, it is

recommended that the relevant authorities gradually shift listed companies from voluntary disclosure to semi-mandatory disclosure and then to mandatory disclosure, to lay a solid foundation for the establishment of a rating system. Formulate a unified ESG disclosure framework, establish implementation guidelines for environmental, social and corporate governance disclosure, standardize the content of ESG disclosure for listed companies, ensure the authenticity of the information, and improve the completeness and reliability of ESG reports.

For listed companies, it is important to change the notion that ESG concepts increase the cost of business operations. However, many researches in recent years have shown that as the concept of ESG has gained popularity and the society pays more and more attention to the ESG performance of enterprises, ESG performance management can bring benefits to the operation of the enterprise itself and the maintenance of the market value, and the good ESG performance can realize the win-win situation of the positive externality and the development of the enterprise's own operation. Therefore, enterprises should correct their previous misconceptions and actively maintain and improve their ESG performance.

From an investor's perspective, individual investors can incorporate the financial statements and ESG rating information disclosed by companies into their investment strategies and make full use of the ability and advantages of ESG ratings to select potential companies for investment, thus enhancing the risk-resistant ability and stable returns of their own assets.

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