ESG RATINGS AND STOCK PRICE VOLATILITY: AN EMPIRICAL ANALYSIS AMIDST THE COVID-19 PANDEMIC

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Abstract

This study, grounded in the framework of environmental, social, and governance (ESG) integration theory, systematically explores the relationship between ESG scores and stock price volatility of Chinese enterprises during the COVID-19 pandemic. Utilizing a multivariate linear regression model, it explores how ESG ratings influence stock price dynamics across different sectors. Findings suggest a negative correlation between higher ESG ratings and stock price volatility, indicating ESG as a mitigating factor. Additionally, the study examines the moderating effects of company size and industry variations on this relationship. Contributions include providing insights into the role of ESG in risk management and guiding policy formulations to enhance corporate ESG performance amidst market uncertainties.

Keywords: ESG Integration Theory, Stock Price Volatility, ESG Scores, COVID-19 Pandemic, Chinese Enterprises, Multivariate Linear Regression Model

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1. INTRODUCTION

The global financial landscape has weathered numerous crises, each leaving an indelible mark on sustainable finance, public health, and the subsequent evolution of global governance. Events like the Asian financial crisis of 1997 and the global financial crisis of 2008 have underscored the susceptibility of stock markets to external shocks, fostering potential overreactions from investors. Notably, high stock market volatility, identified as a prominent crisis indicator, has garnered attention in crisis-induced situations (Lim et al., 2008; Luchtenberg & Vu, 2015).

The recurring incidence of global financial crises, exacerbated by the unprecedented impact of the COVID-19 pandemic on the global economy, has heightened corporate awareness of risk management. Simultaneously, it has intensified investor scrutiny of environmental, social, and governance (ESG) performance in shaping investment decisions. Gao et al. (2022) posit that robust ESG performance acts as a mitigating force against stock crashes, volatility, and market risk.

Amid the COVID-19 pandemic, research further suggests that high-quality corporate social responsibility (CSR) becomes a strategic asset in navigating challenges. Companies actively engaged in social responsibility activities demonstrate resilience in facing pandemic-induced disruptions (Ding et al., 2021; Engelhardt et al., 2021). These findings underscore the pivotal role of ESG factors in contemporary business considerations.

The COVID-19 pandemic has unequivocally demonstrated that ecological considerations must not be sacrificed to pursue economic development. In response, initiatives like China's "dual carbon" goals have emerged, emphasizing peak carbon emissions by 2030 and carbon neutrality by 2060.

Traditionally, investors predominantly focused on financial metrics; however, recent trends indicate a change in thinking, with non-financial metrics, particularly ESG ratings, assuming a central role in investment decisions. ESG ratings offer a holistic evaluation encompassing environmental performance, social responsibility, and corporate governance, providing investors with a comprehensive understanding of a company's sustainability and growth prospects.

Within the conventional framework, information disclosure aimed to mitigate informational asymmetry, a potential source of market inefficiency. ESG ratings, as a form of non-financial information disclosure, address this asymmetry, facilitating better-informed investment decisions. Attention to ESG ratings effectively supervises and constrains managerial behaviour, thereby enhancing the quality of corporate growth and reducing the likelihood of crises.

As the literature on traditional financial indicators and conventional information disclosure approaches saturation, the significance of non-financial information, particularly ESG ratings, in influencing securities markets becomes pronounced. Despite existing research exploring the relationship between ESG ratings and stock price volatility, inconclusive findings persist. Additionally, a shortage of in-depth exploration exists, especially during the COVID-19 pandemic, considering moderating factors such as company size and industry differences.

In light of these considerations, this paper, guided by ESG integration theory (Cappucci, 2018; Huang, 2022; Kotsantonis et al., 2016), endeavours to contribute to a nuanced understanding of the intricate interplay between ESG ratings and stock price volatility. The research seeks to unravel the moderating effects of company size and industry variations during the COVID-19 pandemic. By doing so, this study aspires to furnish investors and companies with more precise information, aiding in informed risk management.

The subsequent sections delve into a comprehensive literature review (Section 2), outlining the research design (Section 3), presenting test results (Section 4), and concluding with a synthesis of findings, research limitations, and avenues for future exploration (Section 5).

2. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

2.1. Background

In recent years, due to various issues such as the COVID-19 pandemic and the crash of the United States (U.S.) stock market, the extreme importance of ESG factors has been increasingly recognized globally (Li et al., 2021). According to the Principles for Responsible Investment (PRI), incorporating ESG factors into investment decisions and ownership strategies has become a priority. Greening and Turban (2000) suggest that companies focusing on CSR and sustainability can enhance their future competitive advantage by attracting and retaining top talent. Other research also indicates that investments in reducing environmental pollution can mitigate reputational risks, surpass other companies, improve long-term operational performance, increase revenue, market share, and profitability, and stimulate market demand and customer loyalty (Chopra & Wu, 2016; Kassinis & Soteriou, 2003; Peloza, 2006).

There are numerous studies on factors affecting financial reporting and their impacts on organisations' values, growth and performances (Daryaei et al., 2022; Eghbal et al., 2023; Nassirzadeh et al., 2023; Pouryousof et al., 2023; Pouryousof et al., 2022; Tileal et al., 2023; Zadeh et al., 2023). Much research supports ESG as an investment philosophy aimed at long-term value growth. High-quality CSR strategies enable better financing from a stakeholder's perspective and promote long-term growth, thus creating corporate value (Daugaard & Ding, 2022; Li et al., 2021; Tsang et al., 2022). Specifically in China, given the dual carbon goals of peak carbon and carbon neutrality and the need for sustainable development, the importance of ESG performance has been underscored (Zhou et al., 2022). That is, it can ensure companies' continuous progress on sustainable development. Much research suggests that ESG can foster sustainable growth and enhance corporate economic performance. For instance, using a regression model of ESG ratings published by Bloomberg and a sample of Chinese listed companies, Chen and Xie (2022) found that ESG disclosure can improve a company's financial performance by attracting ESG investors. Simultaneously, good CSR performance can reduce the cost of equity capital, increase corporate value significantly, and substantially decrease future financial distress and compliance risks (Boubaker et al., 2020). Garcia et al. (2017) focused on companies in Russia, Brazil, China, India, and South Africa, analysing data from these firms from 2010 to 2012. The results show a positive correlation between a company's financial status and good ESG performance. In another study, de Lucia et al. (2020) applied machine learning and logistic regression models to demonstrate the positive impact of ESG performance on financial indicators. It can also enhance a company's reputation in the stock market. This increase in importance builds a protective mechanism for the company, especially as continuous investments from stakeholders are found to provide support during challenging times (Godfrey, 2005).

2.2. Stock price volatility: Influential determinants and their impact

Stock price volatility refers to the intensity of fluctuations within a defined period, impacted by trading days' supply and demand conditions (Li et al., 2020; Meng et al., 2022). Characteristically, this volatility manifests as repeated rises and falls in stock price, representing a prominent feature of the stock market dynamics and becoming evident through price oscillations. Market observers, investors, and scholars demonstrate high interest in the volatility of stock prices, frequently denoting it with the symbol "σ."

The volatility of stock prices most directly reflects market and investor assessments of a company's value, revealing market evaluations of a company's current state and future expectations. This volatility impacts a company's operations and

affects investor interests and capital markets' stability and development trends. Understanding the factors influencing stock price volatility aids investors in making superior investment decisions (Hossain, 2020).

Firstly, macroeconomic factors like gross domestic product (GDP), inflation, interest, exchange, and unemployment rates significantly influence stock price volatility (Li, Wang, et al., 2022; Muhammad et al., 2021). For example, in Zimbabwe's stock market, the inflation rate was found to have a positive correlation with stock price volatility (Mupondo, 2022). Moreover, a significant relationship was discovered between the money supply and stock price volatility (Jensen & Johnson, 1993). Furthermore, changes in interest rates severely affect stock price volatility (Spiro, 1990).

Secondly, a company's financial health is crucial to stock price volatility. For example, a company that suffers significant losses due to a failed hedging strategy may see substantial decreases in its group net profit and stock price (Zhang, 2022). Additionally, dividend policy can also affect stock price volatility. A study in Sri Lanka found that the dividend yield significantly impacts stock price volatility, while dividends per share have a significant adverse effect (Kengatharan & Ford, 2021).

Lastly, company size significantly negatively impacts stock price volatility (Cheung & Ng, 1992). Studies from the "leverage effect" perspective found that company size restrains stock price volatility, indicating that smaller stocks are more likely to experience volatility.

Together, these factors provide a comprehensive understanding of the influences on stock price volatility. Recognizing these elements can enable investors, company management, and policymakers to make more informed decisions and strategies concerning investment, corporate operations, and macroeconomic policy. As the field of finance continues to evolve, additional factors may emerge that influence stock price volatility. Therefore, continuous research in this area remains essential to navigate the dynamic landscape of financial markets.

2.3. The correlation between environmental, social, and governance and stock price volatility: A review of relevant research

Environmental, social, and governance factors have gained considerable attention in the financial realm due to their effects on stock market volatility. Researchers are increasingly recognizing the significance of these non-financial factors in assessing company performance and their impact on stock market volatility.

Lins et al. (2017) explored the relationship between CSR and firm stock returns during the 2008 economic crisis. They found that firms with higher CSR ratings demonstrated better stock return performances during the crisis. Albuquerque et al. (2020) incorporated ESG ratings into cross-sectional regressions of stock prices. They discovered that firms with better ESG ratings had higher stock price performance, lower return volatility, and higher operating profits. Ding et al. (2021) found that companies implementing CSR activities before the pandemic were better equipped to deal with its emergence. This can be attributed to the fact that CSR activities enhanced the company's relationships with stakeholders, thereby retaining high-quality employees, suppliers, and customers, helping companies better face COVID-19. Zhou and Zhou (2022) investigated the relationship between ESG ratings and stock volatility during COVID-19 and found that incorporating ESG factors could help mitigate investment risks. Companies with high-quality ESG practices were observed to have relatively lower stock price volatility. Gao et al. (2022) discovered in a study of Chinese samples that high-quality ESG reduced the likelihood of a stock crash by improving analyst forecasting and discipline behaviour and enhancing the attention of green investors.

Although the above literature indicates a strong correlation between ESG factors and stock price volatility, the extent of this relationship varies due to industry differences, as Ashwin Kumar et al. (2016) pointed out. Further exploration may be needed to understand the complex relationship between ESG factors and stock price volatility under different circumstances.

On the other hand, other research reports have presented different results. Qiu et al. (2016) studied the relationship between a company's ability to disclose environmental and social information and its profitability and market value. They found no direct correlation between environmental information disclosure and profitability. Whether investors value environmental information disclosure remains unclear, as they may be more concerned with the social performance aspects of information disclosure. Disclosing social performance can help companies reap genuine value benefits.

Moreover, as the level of CSR information disclosure improves, the stock price volatility of the American banking industry becomes higher, possibly due to the significant cost increase associated with focusing on CSR activities (Tasnia et al., 2021). One study found that high ESG ratings did not necessarily yield substantial additional benefits for stock investors (Auer & Schuhmacher, 2016). Actively selecting stocks with high or low ratings could not offer particular risk-adjusted liquidity compared to passive stock market investments in geographical areas, industries, or ESG standards.

In summary, although some evidence suggests that high ESG ratings can reduce stock price volatility, this relationship is complex and may depend on various factors. Further research is needed to fully understand the relationship between ESG ratings and stock price volatility.

2.4. Hypotheses development

The preceding literature review reveals that ESG factors and CSR have garnered scholarly attention, primarily because they can impact business performance, stock prices, profitability, and market value through different mechanisms. Furthermore, ESG ratings have become a primary tool for researchers and investors to quantify a company's ESG performance.

Despite these insights, the literature review also reveals that empirical research has offered

controversial views on the relationship between ESG and stock prices. The outbreak of the COVID-19 pandemic has fostered increased academic discourse in this area. In the earlier part of this paper, we acknowledged that China, having substantial influence within the global economic framework and experiencing the economic disruption of COVID-19, saw fluctuations in its stock prices. In such a volatile environment, enhancing investors' ability to forecast stock price fluctuations becomes increasingly critical. The enormous volatility in ex-ante stock price fluctuations can escalate investment risks for market participants (Schwert, 1989).

Given these observations and their substantial impact on investment decisions and risk management, we propose the following hypothesis:

H1: There is a negative correlation between ESG ratings and stock price fluctuations during the COVID-19 pandemic.

This hypothesis draws from the prevalent discourse in the literature and acknowledges the impact of the pandemic on the global and Chinese stock markets.

Furthermost, the earlier literature review recognizes sectoral differences in the influence of ESG factors on stock prices. We believe that, despite companies' broad advantages in ecological investment, industrial sectors such as manufacturing must pay close attention to environmental issues. These industries face enormous environmental challenges, primarily pollution emissions, as they often produce more pollutants, such as exhaust gases and wastewater, causing irreversible ecological and ecosystem damage (Du & Li, 2021; Wang et al., 2022).

Additionally, the literature indicates that these industrial enterprises bear greater social responsibilities (Li et al., 2023). Meanwhile, the existing literature emphasizes that manufacturing enterprises must recognize the importance of investors' rising interest in corporate ESG practices (Li, Zhang, & Zhao, 2022). This is crucial because investor sentiment can influence investments in the stock market (Baker & Wurgler, 2006, 2007; Tetlock, 2007).

Moreover, the impact of the COVID-19 pandemic on the economy varies across different sectors (Möhring et al., 2021). Some sectors have suffered significant setbacks, while a few have been minimally impacted or have even benefitted. For example, Medhat et al. (2021) emphasize in their research the magnified importance of information technology applications during the COVID-19 pandemic, suggesting that reliance on the IT sector can enhance sustainability and improve performance efficiency in most sectors. On the other hand, the retail industry was particularly hard hit due to the person-to-person transmission characteristics of COVID-19 (Pilawa et al., 2022).

Considering the pivotal role of manufacturing and the diverse impacts experienced by other sectors during the COVID-19 pandemic, we propose the following hypothesis:

H2: During COVID-19, there were differences in ESG performance and stock price fluctuations between different industries.

Finally, drawing insights from the research of Lerner and Fryxell (1988) and Udayasankar (2008), we can hypothesize that larger companies are more inclined to allocate more resources to CSR initiatives, thus promoting their performance in ESG factors. This proposition implies that the size of a company plays a crucial role in enhancing its ESG performance.

Although firm size significantly impacts ESG performance (Shakil, 2022), existing research does not provide evidence for the moderating role of firm size on the relationship between ESG and stock price volatility.

Contrarily, Abdi et al. (2022) present a different view, where they found that company size plays an essential moderating role in the relationship between ESG disclosure, company value, and financial performance. This finding suggests that under different market conditions, the size of a company may influence the relationship between ESG and stock price volatility in various ways. Particularly in a market like China, with a wide disparity in firm sizes, the moderating role of firm size could provide a new perspective in understanding the relationship between ESG factors and stock price volatility. Given these discussions, we propose the following hypothesis:

H3: Firm size moderates the relationship between ESG ratings and stock price volatility.

This hypothesis is based on two crucial observations: firstly, a company's size might influence its investment and improvement in ESG aspects, and secondly, this influence may manifest differently under varying market conditions. By studying companies of different sizes in the Chinese market, we may gain new insights into the relationship between ESG and stock price volatility.

3. RESEARCH METHODOLOGY

3.1. Data sources

This study utilizes the Wind database as a crucial data source for its investigation. The Wind database offers a comprehensive financial and economic data repository relevant to Chinese enterprises, including stock price information and ESG scores. Leveraging this database allows the researchers to access real-time and historical data, facilitating a meticulous analysis of the interplay between ESG ratings and stock price volatility. By utilizing the Wind database, the paper ensures robustness and reliability in its empirical analysis, enabling a nuanced understanding of how ESG factors influence stock market dynamics amidst the challenges posed by the COVID-19 pandemic.

Given that Wind began providing ratings in 2018, our data incorporates ESG ratings of all A-share listed companies from 2018 to 2022. We have removed entries with missing items, and the data does not include special treatment stocks. Typically, special treatment stocks refer to companies facing financial or operational challenges and are listed by the China Securities Regulatory Commission for special treatment. These companies tend to encounter heightened risk and uncertainty.

Regarding industry selection, we have carefully identified and chosen industries that might have experienced significant economic impacts during the COVID-19 period and those that could have encountered minimal effects or even benefited from

the economic implications of the COVID-19 pandemic due to sample limitations. These industries include the financial sector, software and information technology (IT) services, courier-related industries (transportation, storage and postal services), pharmaceutical manufacturing, distribution sector (wholesale and retail), and the manufacturing sector, which exhibits high demand for ESG performance.

Data of A-share listed companies, including Tobin Q, firm size, and return on equity (ROE), mainly come from the CSMAR database. The data underwent rigorous filtering and pre-processing using Excel and Stata 17. Empirical analysis was conducted using regression analysis in Stata 17.

3.2. Variable selection

3.2.1. Explained variable: Stock price volatility

Considering that China adhered to a zero-COVID policy for an extended period, transitioning from closure to the announcement of eased pandemic measures, with a whole opening taking nearly three years. Additionally, the impact of ESG ratings on stocks requires time accumulation to manifest. To gauge the effect of ESG ratings more accurately on stock price volatility, this study adopts long-term stock price volatility as the explanatory variable.

Analogous to Turner and Weigel (1992), Chen (1993), and Kotze (2005), and referencing Zhong (2022), this paper measures stock price volatility (*VOL*) as the annual standard deviation of individual company stock returns, factoring in the reinvestment of all daily cash dividends within a year. The equation is as follows:

$$VOL_{R_{ij}} = \sqrt{\left(\frac{1}{n-1}\right)\sum_{t=1}^{n}[R_{it} - \bar{R}_{it}]^2} \quad (1)$$

In this case, $VOL_{R_{ij}}$ is the annual standard deviation of individual stock returns for a company over a year, considering the reinvestment of cash dividends. R stands for the daily return of the company's stock, assuming the reinvestment of cash dividends, i represents the company, j signifies the year, and t indicates a day. Further, since the calculated VOL represents a small value, it has been magnified tenfold from its original basis for analysis.

Moreover, it is essential to note that the monthly individual stock returns, considering the reinvestment of cash dividends in the CSMAR database, are defined under the assumption that an investor holding the stock reinvests all received cash dividends back into the stock. Thus, the rate of return is generated from this reinvestment of cash dividends. This return is utilized instead of the yield in this study for ease of calculation.

3.2.2. Independent variable: Environmental, social, and governance rating

ESG rating evaluates the environmental, social, and governance aspects of a company or an investment portfolio. These factors are critical in determining a company's sustainability, influence, and managerial practices. Rating agencies assess a company's ESG performance based on established criteria and methods and then rate them accordingly. ESG ratings are incredibly useful for investors to understand the sustainability and risk of their investment portfolios and also serve as an indicator of a company's managerial and governance practices. Examples of ESG rating agencies include MSCI ESG, Sustainalytics, ISS ESG, and Vigeo Eiris, among others.

With the development of green finance and the dual carbon economy, there is increasing understanding and support for ESG investments. While ESG rating is a relatively new field in China, the Chinese ESG rating criteria integrate localized characteristics and align with the development of China's ESG disclosure policy.

This empirical study uses the environmental, social, and governance rating (*ESG*) as the dependent variable. The higher the ESG value, the better a company's performance in CSR. The primary source of ESG ratings is Wind ESG data. Wind is a well-known financial data provider in China with high market recognition and credibility. Wind's ESG rating system is based on an in-depth study of international standards and guidelines, including International Organization for Standardization (ISO) 26000, Sustainable Development Goals (SDGs), Global Reporting Initiative (GRI) standards, Sustainability Accounting Standards Board (SASB) standards, Task Force on Climate-related Financial Disclosures (TCFD) recommendations, etc. Wind's ESG rating indicator system is based on three dimensions: environmental, social, and governance, covering 27 issues and over 300 specific indicators. It also evaluates controversial events based on news sentiment, regulatory penalties, legal litigations, etc., to reflect the level of ESG management practices and significant sudden risks. In terms of specific ratings, Wind's ESG ratings categorize companies from AAA to CCC and quantify the ratings into 1–10 levels, providing detailed ratings for ESG dimensions.

3.2.3. Control variables

The following sections will elaborate on the specific contents of the control variables used in our analysis, the reasons for their selection, and the measurement methods. We aim to provide a rigorous explanation of the control variables, as their selection is often based on specific considerations related to the nature of the study. Additionally, we will clarify the techniques used to quantify these variables, as the measurement methods significantly influence the validity of the results. These control variables play a crucial role in enhancing the robustness of our model by controlling unrelated factors. Hence, their careful selection and accurate measurement contribute to obtaining reliable and meaningful results.

Multiple factors influence stock price volatility, including the company and the market. To more accurately and comprehensively investigate the impact of ESG ratings on stock price volatility, this paper refers to Zhou and Zhou (2022) and Shakil (2022). It introduces other variables to control other possible factors, making the results of this paper more genuine and reliable. To sum up, this paper selects the following control variables:

Firm size (*Size*). Empirical research has documented the impact of firm size on stock volatility. A study conducted in South Korea showed that small-cap stocks are more susceptible to

the influence of adverse news than large-cap stocks (Lee & Lee, 2016). Larger companies usually have more considerable total assets and are less affected by external information; thus, their stock prices are relatively stable. Furthermore, large companies typically have more complex internal governance and operational management systems and robust profitability and risk-aversion capabilities. These companies are subject to more market scrutiny and attention; their stock prices are less likely to be manipulated by internal and external forces, and therefore, their volatility may be smaller. The firm size data in this paper is obtained directly from the CSMAR database.

Leverage ratio (*LEV*). This indicator reflects a company's long-term debt-paying ability and financial risk level. Scholars have found some evidence that an increase in financial leverage is associated with an increase in stock market volatility, such as Christie (1982). Suppose a company has poor solvency and high financial risk. In that case, it may reduce the confidence of investors, bondholders, and other stakeholders in the company, leading to increased frequency of stock trading, difficulties in company financing, and other aspects, eventually triggering stock price volatility. The calculation equation for financial leverage is as follows:

$$LEV = DEBT_i/EQUITY_i \quad (2)$$

where $DEBT_i$ denotes total debt for the year i and $EQUITY_i$ denotes shareholders' equity for the year.

Tobin Q (*TOBINQ*). This indicator measures the difference between a company's market value and its book value to determine whether it is overvalued or undervalued. Using Tobin Q as a control variable in studying stock price volatility can control the influence between stock price volatility and company market value. In other words, the impact of market factors on volatility is excluded, allowing for a more accurate study of the influence of other factors on stock price volatility. Tobin Q values are collected directly from the CSMAR database.

Return on equity (*ROE*). This indicator reflects the profit a company earns per unit of net assets. The higher the *ROE*, the higher the company's profit. A high level of profitability is good news. It can enhance market confidence, help the company obtain more capital support, improve its ability to resist risks and contribute to stock price stability. *ROE* values are collected directly from the CSMAR database.

Book-to-market ratio (*BM*). The higher this ratio, the higher the investment value of the company's stock. This ratio represents the company's growth and can be used to measure the type of enterprise development. Different types of companies have different stock price volatilities, so using the book-to-market ratio as a control variable is necessary. The calculation equation for *BM* is as follows:

$$BM = TA_i/TMV_i \quad (3)$$

where TA_i represents the total assets of the company i and TMV_i represents the total market value of the company i.

Following our discussion, a comprehensive representation of all variables, including control variables, is provided in Table 1.

Table 1. Summary and measurement of the control variable

Variable types	*Variable name*	*Variable code*	*Variable definition*
Explained variable	Stock volatility	*VOL*	Annual standard deviation of individual share returns considering reinvestment of cash dividends
Independent variable	ESG ratings	*ESG*	Quantitative scores given by Wind ESG index
Control variables	Return on equity	*ROE*	Net profit / net assets
	Leverage ratio	*LEV*	Total liabilities / total assets
	Firm size	*Size*	Total assets of listed companies at the beginning of the year
	Book-to-market ratio	*BM*	Total assets / total market capitalisation
	Tobin Q	*TOBINQ*	Company market capitalization / total assets

3.2.4. Construction of the regression model

To test the impact of ESG ratings on stock price volatility and the moderating role of company size in this relationship, drawing upon existing literature, we constructed the first model to test our first research hypothesis:

Model 1

$$VOL_i = \beta_0 + \beta_1 ESG + \beta_2 ROE + \beta_3 LEV + \beta_4 Size + \beta_5 BM + \beta_6 TOBINQ + \varepsilon_i \quad (4)$$

In a similar fashion to Shakil (2022), we have added an interaction term, *ESG* * *Size*, to Model 1 to examine the moderating role of company size:

Model 2

$$VOL_i = \beta_0 + \beta_1 ESG + \beta_2 ROE + \beta_3 LEV + \beta_4 Size + \beta_5 BM + \beta_6 TOBINQ + \beta_7 ESG * Size + \varepsilon_i \quad (5)$$

Model 1 is employed to test *H1* and *H2*, while Model 2 is utilized to examine *H3*. Here, *VOL* represents stock price volatility, and *ESG* represents ESG ratings. The remaining control variables, already discussed in the section on control variables, are all sourced from the CSMAR database.

4. EMPIRICAL ANALYSIS

4.1. Descriptive statistical analysis

Table 2 provides descriptive statistics for all data used in this study. Table 2 shows that the total number of sample data points is 7,725, with 1,545 sample companies. The maximum value of stock price volatility (*VOL*) is 25.3, the minimum value is 0.0485, and the average is 0.285, indicating substantial variability and differences in stock price volatility among different companies. The average *ESG* ratings is 6.22, suggesting that the *ESG* ratings of evaluated companies in China are generally above average. However, there is still a considerable disparity in *ESG* ratings, as seen from the maximum value of 9.55 and the minimum value of 3.6.

Regarding control variables, there is a pronounced discrepancy in the *ROE*, with some companies achieving a *ROE* of 501% while others have a negative *ROE*. The company's *Size*, with the total assets of listed companies as the reference indicator, ranges from a minimum of 6.27E + 07 to a maximum of 3.52E + 13, indicating significant differences in the size of listed companies on the A-shares market in China. The Tobin Q value, representing the market value ratio to replacement cost (asset value), indicates investment value. In this study, the *TOBINQ* value of selected companies ranges from a minimum of 0.0413 to a maximum of 28.22, with an average of 1.881, showing substantial differences between companies.

The average leverage (*LEV*) ratio is 0.449. Generally speaking, the leverage ratio of less than 50% is considered relatively healthy, indicating that the company's debt is low relative to its assets and that there are enough assets to pay off liabilities. Therefore, the average leverage ratio of the sample companies selected in this study is close to the standard value of 0.5, with a standard deviation of 0.203, indicating a reasonable asset structure and lower financial risk. The *BM* ratio, which reflects the value characteristics of a company, has a maximum value of 1.601 and a minimum value of 0.0348, demonstrating the diversity of company values in the current Chinese capital market.

Table 2. Descriptive statistics

Variables	*N*	*Mean*	*St. dev.*	*Min*	*Max*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*
Stock code	7,725	304,232	263,448	1	603,998
Year	7,725	2,020	1.414	2,018	2,022
ESG	7,725	6.22	0.794	3.6	9.55
VOL	7,725	0.285	0.296	0.0485	25.3
ROE	7,725	0.0193	2.097	-174.9	5.013
LEV	7,725	0.449	0.203	0.0143	2.471
TOBINQ	7,725	1.881	1.748	0.0413	28.22
BM	7,725	0.675	0.271	0.0348	1.601
Size	7,725	1.40E + 11	1.44E + 12	6.27E + 07	3.52E + 13
Industry code	7,725	14.66	5.34	1	21

4.2. Correlation analysis

A Pearson correlation analysis was conducted on the critical variables in this study to provide a preliminary test of multicollinearity between the explanatory variables. The results are presented in Table 3.

Table 3. Correlation analysis

	VOL	*ESG*	*ROE*	*LEV*	*TOBINQ*	*BM*	*Size*
VOL	1						
ESG	-0.056***	1					
ROE	-0.003	0.025**	1				
LEV	-0.031***	0.069***	-0.020*	1			
TOBINQ	0.070***	-0.048***	-0.023**	-0.299***	1		
BM	-0.094***	0.102***	0.022*	0.385***	-0.723***	1	
Size	-0.045***	0.063***	0.004	0.191***	-0.064***	0.119***	1

*Note: *** p < 0.01, ** p < 0.05, * p < 0.1.*

The strength of the correlation between variables can be determined by the absolute value of the correlation coefficient. The greater the absolute value, the stronger the correlation. The sign of the correlation coefficient indicates the correlation's direction, whether positive or negative. Based on the provided table, it can be seen that the absolute values of the correlation coefficients for the variables selected in this paper are mainly controlled below 0.6. Generally speaking, a correlation coefficient with an absolute value greater than 0.8 indicates a strong correlation, implying a significant multicollinearity between variables. Conversely, when the correlation coefficient falls within the range of 0.5–0.8, it shows a moderate correlation between the two variables, necessitating further evaluation of potential collinearity problems. Therefore, in such a case, additional analysis and judgment are required.

Our study findings (Table 3) reveal a negative correlation between ESG ratings and stock price volatility, aligning with the anticipated hypothesis. This outcome underscores the potential mitigating effect that robust ESG performance can exert on stock market fluctuations. Companies boasting higher ESG ratings appear to demonstrate more excellent stock price stability than those with lower ESG ratings.

However, it's essential to recognize the limitations of this simplistic correlation analysis. It solely scrutinizes the bilateral relationship between variables without delving into the unidirectional influence of independent variables on the dependent variable or controlling for other potential factors. Thus, conducting a comprehensive empirical analysis is imperative to derive more precise and insightful conclusions. Such an analysis can offer a more nuanced understanding of the complex interplay between ESG ratings and stock price volatility, considering various moderating and mediating factors within the market landscape. By incorporating additional control variables and employing sophisticated analytical techniques, researchers can enhance the robustness and validity of their findings, contributing to a deeper comprehension of the intricate dynamics governing ESG performance and its implications for financial markets. This empirical scrutiny serves as a vital

step toward making informed decisions and devising effective strategies for investors, corporations, and policymakers alike, particularly in navigating the challenges of the contemporary business environment.

4.3. Analysis of regression results

4.3.1. Impact of environmental, social, and governance ratings on share price volatility during COVID-19

To verify the relationship between ESG ratings and stock price volatility, we conducted a regression analysis using Model 1, with the results presented in Table 4. The data in the last column of the table represent the variance inflation factor (VIF), indicating whether there is multicollinearity among the explanatory variables. As can be seen, the VIF values range from 1 to 3, all below 5. This demonstrates that the explanatory variables have passed the multicollinearity diagnosis.

Table 4. The relationship between ESG ratings and share price volatility during COVID-19

Variables	*VOL*	*VIF*	*1/VIF*
ESG	-0.009***	1.08	0.92207
	(-7.49)		
ROE	0	1.03	0.97533
	-0.17		
LEV	0.067***	1.43	0.70137
	-11.93		
TOBINQ	-0.004***	2.21	0.45275
	(-4.60)		
BM	-0.152***	2.78	0.35994
	(-27.25)		
Size	-0.000***	1.24	0.80772
	(-8.45)		
Constant	0.444***		
	-41.02		
Fix effect	Yes		
Observations	4,635		
R-squared	0.308		

*Note: *** p < 0.01, ** p < 0.05, * p < 0.1.*

Our comprehensive regression analysis examined the relationship between ESG ratings and stock price volatility. Using fixed-effects regression analysis, we could control for variables such as year and industry. Table 4 illustrates the results derived from Model 1, clearly indicating a significant negative correlation between ESG ratings and stock price volatility. This correlation was confirmed at the 1% significance level, with a regression coefficient of -0.009, demonstrating the overall statistical correlation of the regression equation. This finding validates our initial hypothesis that companies with higher ESG ratings exhibit greater stability in their stock prices. This implies that listed companies with commendable ESG performance have a higher likelihood of maintaining the stability of their stock prices. To elucidate further, for every point increase in a company's ESG score, its stock price volatility decreases by 0.009.

The implications of these findings are profound. A high ESG rating is considered a symbol of exceptional corporate performance, capable of attracting investors oriented towards enhancing corporate value and mitigating potential risks. In other words, a high ESG rating can reduce stock volatility, which is advantageous for investors. Our conclusions are consistent with those of Zhou and Zhou (2022) and Shakil (2022), who also found a negative correlation between ESG ratings and stock price volatility. Although our research methodology may be slightly affected by sample selection bias, the conclusions drawn are consistent with previous studies after adjusting for other potential factors.

Our hypotheses allow us to infer that companies with high ESG ratings are likely to experience less stock price volatility. There are several plausible explanations for this observation.

A high-quality ESG performance may indicate the company's exceptional risk management capabilities (Guo, 2023). This can help to reduce risk exposure for high-risk companies and curb excessive risk-taking tendencies (Zhao, 2022). For instance, a proactive response to environmental issues can minimize environmental risks, and a stellar social responsibility record can reduce social risks. This ability can help companies avoid high-risk events that may cause substantial stock price fluctuations. Additionally, companies with high ESG ratings typically display higher returns, smaller implied volatility, lower likelihood of credit default, and fewer instances of financial restatement (Aslan et al., 2021; Chen et al., 2023; Steen et al., 2020; Zhang et al., 2021). These qualities attract more long-term investors, who typically exhibit greater stability than short-term investors, thus helping reduce stock price volatility. In addition, an admirable ESG rating can enhance a company's public image — a component of corporate reputation — thereby contributing to improved performance. Companies operating on CSR principles utilize their resources to benefit society, offering moral and financial support to those most in need and helping to address issues that government entities may be unable to solve (Bychkova & Naneishvili, 2021). This can help mitigate the impact of negative news on stock prices, reducing stock price volatility. Lastly, a high ESG rating reflects competent corporate governance (Kuntadi & Putri, 2023; Thoha et al., 2022). Effective corporate governance can ensure more stable company operations, which may help reduce stock price volatility. These factors may have contributed to the ESG ratings' dampening effect on stock price volatility, even during COVID-19.

Simultaneously, we segmented the entire sample into three years: 1) 2020, 2) 2021, and 3) 2022 and performed annual regressions on each to verify if the relationship between ESG ratings and stock price volatility exhibited a time-dependent trend during the pandemic, using only the industry as a fixed effect. Table 5 displays the results of the regressions. As can be seen from the results, in 2020 and 2022, the ESG coefficients were -0.011 and -0.009, respectively, both highly significant. However, in 2021, the ESG coefficient was -0.004 and statistically insignificant, presenting a declining trend compared to the ESG coefficients of 2020 and 2022.

One possible explanation for this is that the onset of COVID-19 in late 2019 to early 2020 may have prompted ESG measures to initially stabilize stock prices to some degree during the developing phase of the pandemic. As time went on, the effectiveness of ESG measures in maintaining stock stability may have gradually diminished as investors' preferences potentially shifted and

the stock market became more efficient. Once the stock market is highly efficient, market participants can promptly access all available information and respond accordingly (Fama, 1970). Under these circumstances, information about ESG ratings may have already been adequately reflected in stock prices, thus weakening the relationship between ESG ratings and stock price volatility.

Alternatively, the stock market may be influenced by noise trading and sentiment effects (Shleifer & Summers, 1990). These could cause increases in stock price volatility independent of ESG ratings. Investor behaviour and sentiments in the market can lead to short-term fluctuations in stock prices, which may not directly relate to the long-term impacts of ESG ratings. Therefore, this study conjectures that in the face of a pandemic for which the market was unprepared, stock price volatility would be significantly affected by ESG ratings. Still, this impact may gradually weaken over time. However, ESG ratings correlate negatively with stock price volatility, consistent with *H1*.

Table 5. Yearly regression between ESG ratings and share price volatility during COVID-19

Variables	*VOL*		
	2020	*2021*	*2022*
ESG	-0.011***	-0.004	-0.009***
	(-5.66)	(-1.52)	(-4.84)
ROE	0.001	-0.002	-0.010*
	-0.95	(-0.58)	(-1.77)
LEV	0.048***	0.080***	0.069***
	-5.53	-7.23	-7.52
TOBINQ	-0.007***	0	-0.006***
	(-5.80)	(-0.14)	(-3.25)
BM	-0.154***	-0.163***	-0.139***
	(-17.68)	(-14.59)	(-15.55)
Size	-0.000***	-0.000***	-0.000***
	(-6.32)	(-3.70)	(-5.12)
Constant	0.442***	0.420***	0.433***
	-25.79	-20.89	-24.58
Fix effect	Yes	Yes	Yes
Observations	1,545	1,545	1,545
R-squared	0.35	0.354	0.316

*Note: *** p < 0.01, ** p < 0.05, * p < 0.1.*

4.3.2. The moderating role of firm size in the relationship between environmental, social, and governance ratings and share price volatility

Our empirical research thoroughly investigates the relationship between ESG ratings and stock price volatility. Furthermore, this study examines the role of firm size in this relationship, positing *H3*. Specifically, we hypothesize that the negative correlation between ESG ratings and stock price volatility weakens as the firm size increases.

To verify this, we introduce an interaction term, *ESG * Size*, into our regression model. This interaction term represents the moderating effect of firm size on the relationship between ESG ratings and stock price volatility. The regression results are displayed in Table 6. By performing regressions on samples across three periods, we find the coefficients of the interaction term to be insignificantly different from zero in all instances. This result indicates that, regardless of whether it is during the COVID-19 period, based on our sample, there is no evidence to support that firm size moderates the relationship between ESG ratings and stock price volatility.

The outcome of the interaction term is opposed to *H3*, signifying that firm size does not indeed moderate the relationship between ESG ratings and stock price volatility. According to these findings, this paper conjectures that even small firms, if they perform excellently in terms of ESG, can achieve high ESG ratings. Conversely, large firms with poor ESG management may receive negative impacts on their ESG ratings. Therefore, ESG risk is not always proportional to firm size, rendering firm size incapable of acting as a moderator in the relationship between ESG ratings and stock price volatility.

Table 6. Regression results after adding the interaction term ESG*SIZE

Variables	*VOL*		
	2018–2022	*Pre-COVID (2018–2019)*	*Post-COVID (2020–2022)*
ESG	-0.018***	-0.032***	-0.009***
	(-4.07)	(-2.95)	(-7.40)
ROE	0	0	0
	(-0.02)	(-0.01)	-0.17
LEV	0.036*	-0.008	0.067***
	-1.86	(-0.18)	-11.93
TOBINQ	0.001	0.007	-0.004***
	-0.37	-1	(-4.60)
BM	-0.098***	-0.009	-0.152***
	(-4.96)	(-0.18)	(-27.24)
Size	0	0	0
	(-0.21)	(-0.13)	(-0.66)
*ESG * Size*	0	0	0
	(-0.04)	-0.03	(-0.20)
Constant	0.456***	0.457***	0.443***
	-11.62	-4.66	-40.86
Fix effect	Yes	Yes	Yes
Observations	7,725	3,090	4,635
R-squared	0.017	0.014	0.308

*Note: *** p < 0.01, ** p < 0.05, * p < 0.1.*

4.3.3. Differences between environmental, social, and governance ratings and stock price volatility across sectors in the COVID-19 crisis

Both managers and investors have acknowledged the diversity required by industries. This recognition originates from the understanding that some industries may inherently lack a relationship between ESG ratings and stock price volatility. Furthermore, the far-reaching impacts of the COVID-19 pandemic on various sectors, inducing severe setbacks in some and rapid growth in others, could influence the relationship between ESG ratings and stock price fluctuations. This study selected sample companies, ultimately choosing six representative industry categories: 1) manufacturing, 2) software and information technology services, 3) trade industry (wholesale and retail), 4) courier-related industries (including transportation, warehousing, and postal services), 5) pharmaceutical manufacturing, and 6) finance.

Subsequently, industry classifications from the CMSAR and Wind databases were employed to categorize the 1545 sample companies, resulting in 873 samples from 2020 to 2022. This research segment conducts a regression on industry sample companies based on Model 1 while removing industry control variables. This part of the study aims to reveal potential differences between ESG ratings and stock price volatility across different

sectors. This also lays the groundwork for subsequent analysis of whether COVID-19 strengthens or weakens the relationship between ESG ratings and stock price volatility in various industries. Table 7 provides the descriptive statistical information for the target sample.

Table 7. Descriptive statistics for various industries, 2020–2022

Variables	*N*	*Mean*	*St. dev.*	*Min*	*Max*
Courier-related industries					
Stock code	156	457,043	253,814	99	603,885
Year	156	2,021	0.819	2,020	2,022
ESG	156	6.477	1.046	4.67	8.87
VOL	156	0.227	0.0705	0.103	0.462
ROE	156	0.0344	0.242	-2.095	0.581
LEV	156	0.464	0.18	0.0594	0.927
TOBINQ	156	1.248	0.574	0.625	4.061
BM	156	0.904	0.255	0.246	1.601
Size	156	5.62E + 10	8.37E + 10	8.11E + 08	4.14E + 11
Financial industry					
Stock code	150	445,031	257,235	1	601,998
Year	150	2,021	0.819	2,020	2,022
ESG	150	6.698	0.861	4.69	8.46
VOL	150	0.209	0.0775	0.0485	0.455
ROE	150	0.0803	0.0546	-0.114	0.33
LEV	150	0.775	0.163	0.197	0.929
TOBINQ	150	1.29	1.114	0.868	10.68
BM	150	0.918	0.202	0.0937	1.152
Size	150	3.81E + 12	7.78E + 12	1.98E + 09	3.52E + 13
Trade industry					
Stock code	213	364,306	280,558	19	603,970
Year	213	2,021	0.818	2,020	2,022
ESG	213	6.078	0.8	4.82	8.88
VOL	213	0.271	0.0756	0.103	0.458
ROE	213	0.0505	0.269	-3.151	0.587
LEV	213	0.557	0.201	0.0548	0.925
TOBINQ	213	1.349	0.578	0.731	4.7
BM	213	0.831	0.235	0.213	1.369
Size	213	2.64E + 10	5.84E + 10	8.34E + 08	6.03E + 11
Software and IT services					
Stock code	285	259,943	192,675	158	603,636
Year	285	2,021	0.818	2,020	2,022
ESG	285	6.489	0.693	3.97	8.14
VOL	285	0.312	0.0677	0.179	0.549
ROE	285	-0.0273	0.671	-10.99	0.282
LEV	285	0.376	0.177	0.0487	0.887
TOBINQ	285	2.66	1.662	1.012	11.72
BM	285	0.48	0.199	0.0853	0.988
Size	285	5.32E + 09	4.94E + 09	4.57E + 08	3.14E + 10
Pharmaceutical manufacturing					
Stock code	336	263,648	247,494	153	603,998
Year	336	2,021	0.818	2,020	2,022
ESG	336	6.513	0.678	4.37	8.62
VOL	336	0.288	0.08	0.107	0.546
ROE	336	0.0734	0.124	-0.67	0.578
LEV	336	0.329	0.166	0.0143	0.802
TOBINQ	336	2.722	2.738	0.715	22.57
BM	336	0.541	0.244	0.0443	1.398
Size	336	9.80E + 09	1.24E + 10	8.07E + 08	9.33E + 10
Manufacturing					
Stock code	2,622	278,819	261,178	8	603,997
Year	2,622	2,021	0.817	2,020	2,022
ESG	2,622	6.175	0.737	3.66	9.55
VOL	2,622	0.302	0.0718	0.116	0.641
ROE	2,622	0.0475	1.004	-45.74	1.26
LEV	2,622	0.428	0.176	0.0384	2.471
TOBINQ	2,622	2.19	1.615	0.681	22.56
BM	2,622	0.599	0.257	0.0443	1.468
Size	2,622	1.58E + 10	3.86E + 10	6.27E + 07	4.50E + 11

To discern the differences more intuitively among the selected industries in this paper, particularly regarding the relationship between ESG and stock price volatility during COVID-19, Table 8 summarizes the regression coefficients and statistical significance for all industries from 2020 to 2022. We can see that during the COVID-19 period, in industries such as manufacturing and software and IT services, ESG ratings were able to curb stock price volatility. However, for finance, trade sector (wholesale and retail), pharmaceutical manufacturing, and courier-related industries, there is no evidence based on our sample to suggest a correlation between ESG ratings and stock price volatility during COVID-19.

The conclusions drawn verify our third hypothesis, which postulates differences in the relationship between ESG ratings and stock price volatility among various industries during the COVID-19 period. Additional validation tests are required to verify whether COVID-19 caused this phenomenon.

Table 8. Regression coefficients and statistical significance of ESG ratings concerning stock price volatility across different industries (2020–2022)

Industry	*Period*	*Regression coefficient*	*Level of significance*
Manufacturing	2020–2022	-0.005***	1% level statistic significant
Financial industry	2020–2022	0	Not significant
Trade (wholesale and retail)	2020–2022	-0.007	Not significant
Software and IT service	2020–2022	-0.010*	10% level statistic significant
Pharmaceutical manufacturing	2020–2022	-0.006	Not significant
Courier-related industries	2020–2022	-0.002	Not significant

*Note: *** important at 1%, ** important at 5%, * important at 10%.*

4.3.4. The impact of COVID-19 on the relationship between environmental, social, and governance ratings and stock price volatility across sectors

To further examine the impact of COVID-19 on the relationship between ESG ratings and stock price volatility across different industries, this paper, based on the same company sample, collected relevant data from 2018–2019 and labelled them as pre-COVID samples, while data from 2020-2022 were labelled as post-COVID samples. This step divides the samples into pre- and after COVID-19. It builds upon Model 1 to examine the difference in the relationship between ESG ratings and stock price volatility across different industries before and after COVID-19. Table 9 summarizes the changes in the relationship before and after COVID-19. In contrast, Table 10 summarises the relevant regression coefficients and statistical significance for different industries, enabling a more intuitive understanding of the change in this relationship.

Table 9 shows that the regression coefficient of ESG ratings increased from -0.032 to -0.009, maintaining a statistical significance at the 1% level. Based on these regression results, we posit that the advent of COVID-19 weakened the restraining effect of ESG ratings on stock price volatility. COVID-19 has profoundly affected the global economy, altering the business environment for companies and the decision-making patterns of investors. Below are several possible reasons why COVID-19 could have weakened this relationship:

First, market uncertainty significantly increased during the COVID-19 period. Under such circumstances, investors might focus more on a company's fundamentals and the current economic situation rather than long-term ESG factors, potentially weakening the restraining effect of ESG ratings on stock price volatility.

Second, the pandemic has compelled companies and investors to focus on short-term survival and operations. For example, with the acceleration of digital technology applications due to the pandemic (Varga et al., 2022), companies may shift their attention to enhancing their digital technology applications, and investors may focus more on the changes companies make in the short term. The pandemic has caused declines in sales, production capacity, and distribution difficulties for businesses (Purwanto et al., 2020). As a result, companies may need to devote more attention to short-term survival. On the other hand, investors may consider a company's short-term operating conditions rather than long-term ESG ratings when choosing investment targets.

Lastly, Table 10 shows that, during the pandemic, ESG ratings could still curb stock price volatility in manufacturing, software, and IT services industries. However, this restraining effect disappeared in the finance, courier-related, and trade sectors (wholesale and retail). In the pharmaceutical manufacturing industry, whether during the pandemic or not, ESG ratings could not curb stock price volatility. The underlying reasons require further analysis in conjunction with existing literature.

Table 9. Comparison of regression coefficients and statistical significance of ESG ratings and stock price volatility across pre- and post-COVID-19

All firms	*Period*	*Regression coefficient*	*Change in relationship*
Overall company	Pre-COVID	-0.009***	Increased coefficient remained statistically significant.
	Post-COVID	-0.032***	

*Note: *** important at 1%, ** important at 5%, * important at 10%.*

Table 10. Comparison of regression coefficients and statistical significance of ESG ratings and stock price volatility across various industries pre- and post-COVID-19

Industry	*Period*	*Regression coefficient*	*Change in relationship*
Manufacturing	Pre-COVID	-0.013***	Increased coefficient remained statistically significant.
	Post-COVID	-0.005***	
Financial industry	Pre-COVID	-0.013*	Significance disappeared.
	Post-COVID	0	
Trade (wholesale and retail)	Pre-COVID	-0.015**	Significance disappeared.
	Post-COVID	-0.007	
Software and IT service	Pre-COVID	-0.014**	Increased coefficient remained statistically significant.
	Post-COVID	-0.010*	
Pharmaceutical manufacturing	Pre-COVID	0.004	Significance disappeared.
	Post-COVID	-0.006	
Courier-related industries	Pre-COVID	-0.708***	Significance disappeared.
	Post-COVID	-0.002	

*Note: *** important at 1%, ** important at 5%, * important at 10%.*

Impact of COVID-19 on the relationship between environmental, social, and governance ratings and stock price volatility in the manufacturing sector

Table 10 shows that although the regression coefficient for the manufacturing industry increased from -0.013 to -0.005, it still maintains significance at the 1% level. This means that even during the COVID-19 period, ESG ratings could still suppress the stock price volatility of manufacturing companies. The profound impact of COVID-19 on the global economy, especially on the manufacturing industry, is undeniable. COVID-19 has disrupted the production of raw materials and spare parts in manufacturing and frustrated logistics, preventing market demands from being met (Cai & Luo, 2020). Issues such as supply chain disruptions and production line stoppages in the production and operation of the manufacturing industry bring unprecedented challenges to the business environment (Agrawal & Jain, 2022). Despite this, the negative correlation between ESG ratings and stock price volatility in the manufacturing industry over the three years of the pandemic underscores the importance of ESG ratings. This phenomenon will be explained from multiple perspectives.

Initially, this finding could be attributed to the emphasis in the report of the 19th National Congress of the Communist Party of China. The Chinese government stressed in the statement that Chinese manufacturing enterprises must upgrade towards being environmentally friendly (People's Daily, 2022). Studies show that national policy can, to some extent, influence investor preferences (Yang et al., 2023). Such emphasis likely heightened investors' focus on environmental protection, leading them to incorporate ESG ratings into their investment decisions regarding manufacturing companies. These investors often prioritize companies' long-term stability and sustainability over short-term stock price volatility. Strengthened by government declarations, these investor preferences likely contributed to the observed negative correlation between ESG ratings and stock price volatility.

Furthermore, manufacturing companies faced various risks during the pandemic, including the lack of integrity in the supply chain due to closure and macro-environmental constraints (Hasan et al., 2022). In other words, the COVID-19 pandemic underscored the need for effective risk management in manufacturing supply chains. Risk management helps identify risks, determine their priority, and design strategies to mitigate their impact. Studies suggest that manufacturing companies should implement risk management strategies to minimize the adverse effects of supply chain disruptions (Kristiana et al., 2020). Moreover, research shows that companies with strong CSR performances usually demonstrate robust risk management and compliance practices in their operations and supply chains (Godfrey et al., 2009). Additionally, companies with commendable ESG performances often have better reputations and lower default probabilities (Aslan et al., 2021). This emphasis on risk management enhances the resilience of manufacturing companies, mitigates the impact of the pandemic on their businesses, and thus stabilizes their stock prices.

Impact of COVID-19 on the relationship between environmental, social, and governance ratings and stock price volatility in the financial sector

Table 4–9 shows that before COVID-19, the regression coefficient was -0.013 and significant at the 10% statistical level. This suggests that before COVID-19, ESG ratings could suppress stock price volatility in the financial industry. However, our research findings provide no evidence that ESG ratings could still suppress stock price volatility in the financial industry following the onset of COVID-19. Based on this result, we propose several factors that could lead to this outcome.

Firstly, the intrinsic characteristics of the financial industry could serve as one influencing factor. Stock prices in the financial sector are susceptible to market sentiment (Bognár, 2016). In other words, although ESG ratings reflect a company's environmental, social responsibility, and corporate governance performance, due to high market noise and increased market sentiment volatility during COVID-19, ESG performance might not directly impact short-term stock price fluctuations.

Secondly, the uniqueness of China's financial market could also be a potential factor. Despite being the world's largest emerging market, the Chinese financial market still exhibits unique characteristics. Research confirms that ownership concentration is a critical factor in China's financial market, and it can positively or negatively impact company performance, depending on the specific circumstances (Ali et al., 2022; Luo & Jackson, 2012; Xinyuan et al., 2017). Additionally, the Chinese government wields significant influence over the financial market. Studies indicate that, unlike in other countries, the government plays a crucial role in China's domestic financial market, with different policies implemented at various stages, all eliciting responses from the financial market (Wang et al., 2017).

Moreover, information asymmetry, a common issue in China's financial market, could trigger herd behaviour among investors. Research shows that even implementing the Shanghai-Hong Kong Stock Connect policy hasn't changed herd behaviour in China's stock market. These unique aspects of China's financial market might obscure the influence of ESG ratings on stock price volatility in the financial sector during COVID-19.

Lastly, during the COVID-19 pandemic, the pandemic exacerbated the volatility, non-linearity, asymmetry, and non-stationarity of the financial markets (Boateng et al., 2022). COVID-19 has also been described as a "black swan" event, triggering collective hysteria in the global financial market (Morales & Andreosso-O'Callaghan, 2020). The pandemic introduced tremendous uncertainty, affecting the behaviour of market participants, which in turn increased the volatility of financial markets. In such circumstances, while ESG ratings can influence the risk exposure of financial institutions to a certain extent, this influence might not be fully reflected in stock price fluctuations.

Impact of COVID-19 on the relationship between environmental, social, and governance ratings and stock price volatility in the pharmaceutical manufacturing industry

From Table 10, it can be observed that, whether during the COVID-19 period or not, there is no evidence indicating an association between ESG ratings and stock price volatility in the pharmaceutical manufacturing industry. This paper suggests that this may be due to the high concentration of pharmaceutical manufacturing in China. Research shows that the overall specialization level in Eastern China is higher than in Western China but lower than in Central China. The regional specialization level over three periods presents a "low-high-low" pattern, while the spatial concentration of China's pharmaceutical manufacturing industry follows a "diffusion-concentration-diffusion" rule (Ji, 2013). This high market concentration may enable large pharmaceutical manufacturing enterprises to decisively influence the industry's stock price volatility. Thus, even if some companies improve their ESG ratings, they might not significantly affect the overall industry's stock price volatility.

Furthermore, the pharmaceutical manufacturing industry is already subject to strict regulations or supervisory bodies. For instance, Morales and Andreosso-O'Callaghan (2020) noted in their research that health authorities oversee the production and distribution of all drugs. Under these circumstances, pharmaceutical manufacturing enterprises may have already met most of the requirements for ESG ratings, potentially weakening ESG ratings' impact on stock price volatility.

Additionally, for the pharmaceutical manufacturing industry, core competencies such as patent technology, research and development capacity, and product value quality, which are likely not adequately considered by ESG ratings, may inhibit their ability to reflect a company's actual situation accurately and subsequently influence stock price volatility.

Impact of COVID-19 on the relationship between environmental, social, and governance ratings and stock price volatility in express-related industries

Table 4–9 shows that before COVID-19, ESG ratings could suppress stock price volatility for the courier industry, and the suppressive effect was quite potent. However, post-COVID-19, no evidence suggests continuing this suppressive effect. This paper believes that this outcome may be due to the following reasons:

Firstly, the unique circumstances of the courier-related industry during the pandemic could be a significant factor. The lockdowns implemented worldwide to counter the pandemic led to a surge in demand for remote work and online shopping. This resulted in a sharp rise in demand for courier-related industries. A study on Taiwan's largest agricultural e-commerce platform indicated that the need for online food shopping services, including grains, fresh fruits and vegetables, and frozen foods, significantly increased, attracting more and more consumers to use online shopping platforms (Chang & Meyerhoefer, 2020). The research also showed that during the pandemic, the demand for courier companies increased (Moise et al., 2021). Given that supply and demand of stocks are vital determinants of stock prices, which are influenced by various factors, particularly a company's finances and performance, current economic conditions, and market trends (Elmasry & Abbas, 2021), the surge in demand for the transportation industry could affect stock price volatility through its impact on supply and demand. For industries like courier-related businesses, where demand has surged, the influence of ESG ratings on stock price volatility may be minimized or even non-existent.

Additionally, the pandemic has caused significant disruption to the freight sector (Castillo et al., 2022; Gubin et al., 2021; Karam et al., 2022), including courier and logistics companies, leading to shortages of transport resources, increased costs, and congestion at airports and seaports (Gubin et al., 2021; Karam et al., 2022). At the same time, reductions in human mobility have significantly reduced COVID-19 infections and deaths, impacting courier and logistics companies (Benita, 2021). Therefore, courier companies must balance meeting customer demands and ensuring staff safety, which could complicate the relationship between a company's ESG rating and stock price.

In conclusion, the market may focus more on the courier-related industry's short-term response to the COVID-19 pandemic rather than their ESG ratings. During the pandemic, the courier industry may need to prioritize business continuity and survival issues. Compared to ESG indicators, they may be more concerned about dealing with the operational pressure and market changes brought about by the pandemic. Under such circumstances, a company's ESG rating may temporarily not influence its stock price significantly.

Impact of COVID-19 on the relationship between environmental, social, and governance ratings and stock price volatility in the software and IT services sector

As observed in Table 10, for the software and information technology services industry, the relationship between ESG ratings and stock price volatility changes similarly to the manufacturing industry. Although the suppressive effect has diminished, it remains present.

This paper posits that this could be closely related to innovation capabilities. Being innovative and forward-looking is crucial for high-tech industries like software and IT services. Companies with high-quality ESG performance can often promote the quantity and quality of corporate innovation by reducing financial constraints, financing constraints, and agency costs (Chen & Shen, 2022; Tang, 2022). In other words, companies with high ESG ratings tend to be more innovative, which leads to more stable growth trajectories and less stock price volatility.

Impact of COVID-19 on the relationship between environmental, social, and governance ratings and stock price volatility in the trade sector (wholesale and retail)

As can be observed from Table 10, for the wholesale and retail industry, the regression coefficient significantly changes from -0.708 at the 1% level to an insignificant -0.002. This suggests that, before the emergence of COVID-19, ESG ratings could suppress stock price volatility in the wholesale and retail sectors. However, during COVID-19, no evidence indicates that ESG ratings can mitigate stock price volatility in this industry.

Several fundamental factors may have led to this outcome. Firstly, the wholesale and retail sectors are most severely affected by COVID-19. Some countries have enforced closures of non-essential shops to mitigate virus transmission (Palod et al., 2021). Meanwhile, consumers spend more time shopping online and utilizing contactless payment and receipt methods (Brzhozovskyi & Gudkova, 2021; Chaveesuk et al., 2021). Frequent lockdowns and social distancing measures have disrupted the normal operations of the retail industry. Many retail businesses have suffered significant losses (Iswati et al., 2022), leading to increased volatility in their stock prices. In comparison, the profound changes brought about by the pandemic may have rendered the impact of ESG ratings on stock prices negligible.

Viewed from a different perspective, given the severity of the industry-wide impact, it becomes particularly critical for the wholesale and retail sector to seek novel measures to mitigate the effects of the COVID-19 pandemic. These strategies encompass social and physical distancing, protective and sanitary practices, distribution and communication channels adaptation, and more evident retailers' communication (Lopes & Reis, 2021). Such demands undoubtedly necessitate digital transformation in the wholesale and retail industry. Under these circumstances, investors may focus more on how firms manage crises, their operational resilience, and fiscal health. These elements might not be fully encapsulated within ESG ratings.

4.4. Discussion

This paper provides valuable insights into the relationship between ESG ratings and stock price volatility amidst the COVID-19 pandemic in China. The findings contribute theoretically and managerially to understanding how ESG factors influence market dynamics during crises. Firstly, the study confirms a significant negative correlation between ESG ratings and stock price volatility, indicating that companies with higher ESG ratings experience lower stock price volatility. This empirical validation of the ESG Integration Theory emphasizes the importance of incorporating sustainability practices into corporate strategies to mitigate market risks and enhance investor confidence. Additionally, examining the moderating role of firm size enriches our understanding by revealing that company size does not mediate the relationship between ESG ratings and stock price volatility, suggesting that the benefits of strong ESG performance in reducing volatility are consistent across firms of varying sizes.

Furthermore, the nuanced analysis of industry-specific impacts during the pandemic highlights the heterogeneous relationship between ESG ratings and stock price volatility. While specific sectors exhibit a clear correlation, others show variations in this relationship, underscoring the need for tailored approaches to ESG integration based on industry characteristics. These findings offer actionable insights for investors and corporate decision-makers, emphasizing the importance of considering industry dynamics when evaluating ESG performance and its implications for financial outcomes.

5. CONCLUSION

In alignment with the principles of ESG integration theory, this study meticulously investigates the repercussions of ESG ratings on stock price volatility for China's A-share listed companies during the tumultuous period from 2020 to 2022, marked notably by the challenges posed by the COVID-19 pandemic. The empirical findings, derived from rigorous regression tests and data analysis, yield several salient conclusions.

Firstly, the study reveals a substantial negative correlation between ESG ratings and stock price volatility. Higher ESG ratings indicate superior environmental management, social responsibility, and corporate governance performance. Companies endowed with elevated ESG ratings demonstrate heightened capabilities in these domains, contributing to a notable reduction in stock price volatility. Moreover, such companies tend to cultivate better public reputations, enjoy increased investor favour, and garner enhanced support within the market.

Secondly, the analysis refutes the notion of company size as a moderator in the relationship between ESG ratings and stock price volatility. Large and small companies, boasting high-quality ESG ratings exhibit comparable efficacy in mitigating stock price volatility.

Thirdly, the nuanced impact of ESG ratings on stock price volatility during the COVID-19 pandemic is discerned across diverse industries. While delivery-related industries, buoyed by increased demand, show no correlation between ESG ratings and volatility, pandemic-affected sectors, such as wholesale and retail finance, exhibit intricate ESG-stock price relationships. Manufacturing, particularly subject to environmental regulations, witnesses a more pronounced effect of ESG ratings on stock price volatility due to heightened stakeholder attention. Conversely, pharmaceutical manufacturing, characterized by industry uniqueness, displays no such correlation.

The study underscores the imperative for enterprises to integrate ESG principles into their core philosophies, emphasizing ESG information disclosure alongside economic performance. Recommendations extend to China's enhancement of ESG information quality, prioritizing ESG performance in environmental efficiency, social responsibility, and corporate governance. Investors are advised to discern industry characteristics when considering ESG ratings, necessitating an augmented

emphasis on ESG information disclosure through diverse media.

Acknowledging the multifaceted nature of stock price volatility influenced by market data, performance, sentiment, and more, the study incorporates relevant control variables. However, it acknowledges the presence of unconsidered macro factors, signalling the prospect for future research incorporating additional controls to enhance result precision. Limitations imposed by a restricted number of ESG rating agencies and evaluated companies in China influence sample size and result precision. Future research endeavours are encouraged to expand ESG rating systems and consider a broader spectrum of firms, allowing for more comprehensive and rigorous analysis. Moreover, while the study delves into industry differences in ESG-stock price impact across six sectors, a call is made for future research to encompass a more extensive array of industries, enabling detailed investigations into industry-related impact mechanisms and outcomes validation, thus contributing to the advancement of ESG integration theory.

However, several limitations should be acknowledged. The reliance on data from a limited number of ESG rating agencies and evaluated companies in China may constrain the generalizability of the findings. Future research could address this limitation by expanding the sample size and incorporating data from more diverse sources. Additionally, the study focuses on six specific sectors, potentially overlooking nuances present in other industries. A more comprehensive examination across various sectors could provide a more holistic understanding of industry-related impact mechanisms. Despite these limitations, this study lays a solid foundation for further exploration into the complex interplay between ESG factors and stock market dynamics, offering valuable insights for academic research and practical decision-making in sustainable finance and corporate governance.

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