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Analysis of the Impact of ESG Performance on Financial Market Stability from the Perspective of Multivariate Statistical Models



Abstract: - The stability of the financial markets is impacted by environmental, social and governance (ESG) performance, which also lowers the risks associated with social injustice, climate change and poor corporate governance. Companies that prioritize ESG standards have a higher probability of being resilient to market shocks, attracting responsible investors and contributing to long-term sustainable economic growth. By the utilization of multivariate statistical models, we seek to execute thorough analysis in this study to assess the effect of ESG performance on financial market stability. The sample that was selected comprises various categories of companies. Financial in sequence from the stock market is retrieved; include balance sheets, cash flow statement and income statements. An ESG rating is also acquired for the inquiry. The collected data were evaluated using a multivariate regression analytical representation. Our empirical methodology ensures robustness in identifying the complicated relationships between ESG performance and financial market stability, providing expensive insight into the dynamics of Chinese A-share organizations. The result express that increasing the ESG rating reduces financing limitations such as financial insecurity, increases future risk resistance and improve the company’s standing for obtaining a commodities premium. The association determines that an advanced ESG rating leads to enhanced financial market stability, which in turn contributes to the stock market concert. This underscores the essential roles of ESG consideration in attractive market resilience and financial market stability.

Keywords: Environmental, Social and Governance (ESG) Performance, Financial Market Stability, Multivariate Regression, Market Resilience

I. INTRODUCTION

Environmental, social and governance (ESG) standards, which are becoming more and more important, have been used for assessing the social and environmental components of enterprises [1]. For a business, ESG difficulties involve ecological outcomes (carbon dioxide emissions and resource usage), social responsibility (labor procedures and community participation) and structure of the company (board diversity and executive reimbursement) [2]. These are few of the prevalent variables. In Figure 1, the ESG overview is displayed.

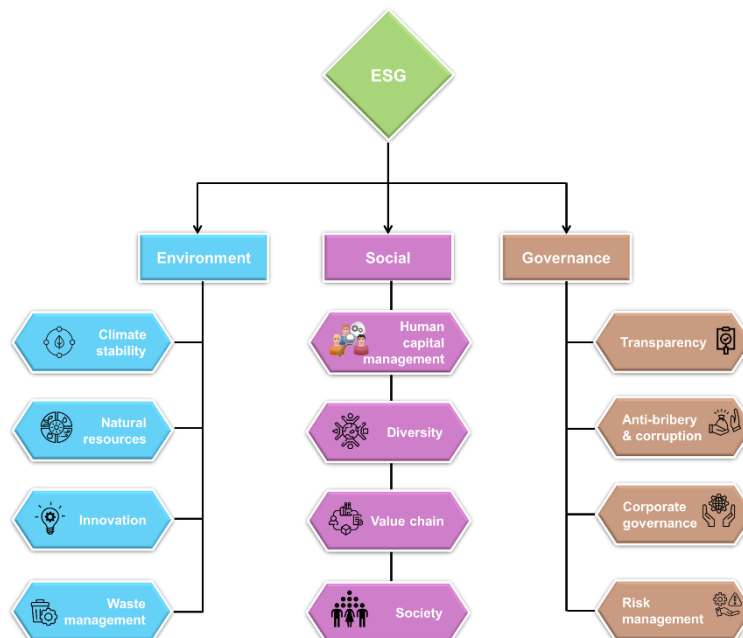


Figure 1: Overview of ESG

Stakeholders and speculators are attractive increasingly aware of the settlement of applying ESG factors to decision-making measures [3]. ESG principles evaluate a company's sustainability and ethics from an ESG

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perspective; they also consider the company's long-term productivity and social impact [4]. ESG analysis is the process of balancing economic, social and environmental considerations while making financial choices [5]. This process goes beyond a standard financial examination by evaluating a company's operation assets on the environment, its organization of relationships with labor, suppliers, customers and the community, as well as the criteria of its internal controls, leadership, audits and shareholder civil rights [6]. Investors commonly use the term ESG to quantify a company's efforts in the areas of governance, social responsibility and the environment [7]. ESG elements are utilized to identify concerns pertaining to company governance, business ethics and corporate social responsibility [8].

They are also regarded as non-financial performance indicators. The process of integrating ESG factors into conventional fundamental evaluation with the context of investment management is known as ESG integration [9]. The concept of ESG issues has gained substantial acceptance among institutional and individual investors [10]. More businesses have recently shown a stronger dedication to ESG initiatives in an effort to be acknowledged as socially conscious. The importance of the ESG concept to the capital market has increased in parallel with the development of the Chinese capital market's regulatory framework and general maturity, emerging as a significant source of corporate signals [11]. There are a number of comparative benefits to taking non-financial aspects into account during the investing process, including increased profitability and better risk management [12]. According to several financial firms, asset management in fixed-income markets can be enhanced by ESG factors. When considering extending a loan to a nation, investors can use its ESG indicators as an additional precaution against losses [13]. Investors should demand a higher interest rate on debt issued by governments with low ESG scores since they represent a greater risk of critical default [14]. This study uses multivariate statistical models that capture the intricate relationship between financial market stability indicators and ESG characteristics to provide an extensive evaluation.

Key contributions:

1. This study aims to analyze in detail how ESG performance affects financial market stability using multivariate statistical models.
2. Various organizational types are represented in the sample that was chosen.
3. An analytical model for multivariate regression was used to assess the collected data.
4. The findings indicate that enhancing a company's ESG rating improves its ability to secure commodities premiums, reduces financing constraints and enhances future risk resistance.

The remaining of the paper is as follows: section 2 describes related work, section 3 investigates study design, section 4 studies model construction, section 5 and 6 illustrates experimental results and discussion as well as section 7 concludes the study.

II. RELATED WORKS

The relationship between ESG and the financial success of businesses aspects was studied in [15]. They specifically investigated the various ESG categories, along with the overall ESG factor, issues and strengths as well as how they affect the profitability and financial risk of corporations. To optimize value and reduce risk, it offered help for ESG integration in portfolio creation and investment management. The factors that influence corporate sustainability performance (CSP) in the banking sector to gain a deeper understanding of the dynamics that underpin it were evaluated [16]. They use data from a worldwide sample of 727 financial institutions operating in 22 nations between 2006 and 2017 to investigate business, country and temporal characteristics that influence CSP, advancing to the ongoing discussion concerning the historical context of CSP. The findings of the study show that financial business ESG achieves were increasing sequentially above time. The study [17] examined at the connection between business tactics, ecological sustainability and bankruptcy threat. It engaged a variety of technique, counting the partial least squares structural equation modelling (PLS-SEM) techniques, to achieve its keywords. The findings demonstrate that as a business implemented a more effective cost leadership strategy, its ESG performance advances. In the Italian banking sector, the impact of social accountability and environmental presentation ESG on bank performance (BP) was studied in [18]. The results indicated that the finance sector's operational and market performance was adversely impacted by ESG regulations, suggesting that strong sustainability rules have not yet been completely embraced by Italian banks. However, when examined separately, the connections between the other ESG aspects were inconsistent.

The investigation [19] used a multivariate ordinal logit model to evaluate the effects of ESG scores on the financial rating of businesses engaged in manufacturing, mining and quarrying, retail and wholesale trade, information and communication, coupled with real estate activities. They discovered that the sustainability factor

that best improves the credit rating model's goodness-of-fit was the Environmental pillar score. It significantly raised credit ratings across the board, but its benefits were more pronounced for businesses engaged in mining and quarrying. Investigated and developed an early warning system (EWS) with a forecasting capability of up to one year [20]. Fisher scores were used to choose features and an interpretable multivariate long-short-term memory (IMV-LSTM) model with focal loss was used to account for class imbalance. According to the study, systemic banking crises were influenced by ESG and the EWS forecasted each crisis a year in advance. The investigation [21] explored the structural connections between accounting and financial data, the research developed a Dynamic Network DEA model. To evaluate the impact of socioeconomic and macroeconomic factors as well as the ESG risk score on firms' financial troubles, the study used a stochastic non-linear model. It found that companies with higher ESG risk scores have fewer financial difficulties.

The impact of structural data on ESG scores as it related to income statement and balance sheet items for listed corporations. They employed a machine learning (ML) approach to assess the significance of structural factors based on the Bloomberg ESG ratings, more precisely, the Random Forest method [22]. They examined how the balance sheet data from the last ten years illustrated the Bloomberg ratings for ESG companies. The investigation [23] investigated the effects of macroeconomic factors on the stock performance of ESG-driven companies in the Eurozone, which was a representative sample of developed economies and a dominant player in the sustainable finance space, in comparison to traditional ones. Businesses that prioritize ESG were thought to be more robust in some ways [24]. The Ohlson framework and the Chow test, which are tests for structural breakdowns, were the foundations of multivariate regression analysis used in this work. The findings suggested that banks' financial information that is a part of CSR indices was typically more value-relevant.

The corporate transformation toward Industry 4.0 (CTTI4.0) was the techniques of computer-aided text analysis that were in use in the UK, according the study [25]. The data demonstrated that CTTI4.0 strategic investment decision-making (SIDM) methods have accelerated with time and differ among industry sectors. Moreover, it proved that ESG norms modify the relationship between financial success and CTTI4.0 disclosure. This implied that businesses with higher ESG performance also generally participated in CTTI4.0 disclosure more regularly and, at the same time, generated improved financial outcomes. The work of [26] evaluated the moderating impact of total quality management (TQM) and a distributed lag regression model was developed to empirically examine the relationship between financial performance and ESG. The results showed that there is a positive correlation between ESG ratings and free cash flow (FCF). The analysis that was multivariate [27] used in the study was correspondence analysis. The study's findings showed that financial institutions had an effect on businesses that have a business plan and these companies affirm their intention to work with the bank and put the banks' suggested ESG risk reduction strategies into action. Nevertheless, businesses without established business plans resist the bank's sway and cooperation.

A. Hypothesis development

Companies engage in ESG governance for two main reasons: first, they can adjust their production, profitability and governance structures for greater efficiency assuming that their ESG performance levels improve. In addition, enhancing environmental performance will also result in green operating needs, which will compel businesses to advance the development of their green products and materials. Larger listed firms with superior financial performance are comprised of companies with an ESG performance that meets or exceeds the China Securities ESG Index evaluation requirement. Their promotion of green governance, social accountability and improving corporate governance in the setting of scarce resources would push out profitable resources. Businesses that prioritize ESG also benefit from increased risk resilience. A higher ESG indicates that an organization generally has better environmental governance than competitors. This is because improved environmental governance significantly lowers the probability that an organization will ever face fines from the environmental department, which would have an impact on cash flow decreases. Second, an improved corporate governance framework improves employee identification with the organization while assisting businesses in maintaining good working relationships with their workforce. It successfully lowers staff churn rates and strengthens the organization's structure. Individuals are more inclined to finance and have greater faith in high-performing ESG businesses. People are more likely to trust high ESG companies, especially during a financial crisis, which results in a 4–7% return on investment for these companies compared to low ESG enterprises. This study offers the following hypothesis on top of the aforementioned analyses.

Hypothesis H1: Stock market performance is enhanced by high ESG ratings because they lower capital costs, foster a positive reputation and lessen future cash flow volatility.

Hypothesis H2: Financial performance will be improved and financing expenses will be decreased by excellent ESG performance.

III. STUDY DESIGN

This study uses regression analysis and multiple linear regressions to examine the link between market performance metrics (Tobin Q, PE, PB, and PS) and ESG ratings across Chinese A-share businesses.

A. Response variable

Tobin Q, PE, PB and PS are the metrics used in this study to evaluate market performance. The market value to replacement ratio, or Tobin Q, accurately captures the disparity between a company's book value and market value. A company's share price and profitability are reflected in PP, net asset value and sales are reflected in PA and the relationship between a company's share price and sales is shown in PS. PP, PA and PS are three distinct ways of valuation. The three distinct methods of valuation have been designed to meet specific industry needs. To give a fuller image of a business's performance in the market, all three approaches are taken into consideration at the same time.

B. Explanatory variables

The ESG score, which was determined by the Wind database using the actual state of the A-share market, serves as the study's independent variable. ESG indicators establish the ESG indicator system in several phases, considering the unique features of the Chinese capital market as well as the ESG rating model of foreign capital markets: Initially variables with a substantial level of disclosure are chosen based on the state of ESG information disclosure in China; second, ESG rating has industry traits; evaluation indicators that correspond to these characteristics are chosen based on the features of industry business models and lastly, ESG indicators that have demonstrated strong investment performance are chosen through retrospective testing. ESG rating includes three dimensions for first-level indicators, fourteen for two-level indicators, twenty-six for three-level indicators and over 130 for four-level indicators.

C. Control variables

By introducing control variables, we can effectively reduce the influence of the explanatory variables and increase the accuracy of the model runs. Based on existing literature and empirical data, we can determine the variables that often affect market performance, such as firm size (SZ), leverage ratio (LEV), autonomous director ratio (Indep), fixed asset (FA) to total asset ratio, cash flow (CF) of operations, duality of and chairman general manager (DCG), Herfindahl-Hirschman Index (HI) and board of directors (BoD). Table 1 depicts the descriptions of the variables.

Table 1: Description of variables

Variable type	Variable name	Description
Explanatory variables	ESG score	ESG rating
Response variable	Tobin Q	The ratio of market value to the replacement value
	PP	Share price divided by share earnings
	PA	Divide the stock price by the book price.
	PS	Market capitalization divided by sales for the entire market
Control variables	SZ	Firm size
	LV	Leverage ratio
	FA	Fixed asset
	CF	Cash flow
	DCG	Duality of chairman and general manager
	HI	Herfindahl-Hirschman Index
	BoD	Board of directors

D. Sample selection

Chinese A-share companies listed between 2009 and 2020 the study sample consists of stocks from the Shenzhen and Shanghai stock exchanges. The China Stock Market and Accounting Research (CSMAR) database

is the source of financial data which includes balance sheets, income sheets and cash flow sheets. Furthermore, the WIND database is used to obtain the ESG rating.

IV. MODEL CONSTRUCTION

In this study, multiple linear regression and correlation coefficients are used for the construction of the model. The multiple linear regression models on Tobin's Q -value and ESG is Equation (1 to 4).

$$\text{Tobin Q} = \beta_0 + \beta_1 \text{ESG} + \beta_2 \text{SZ} + \beta_3 \text{LV} + \beta_4 \text{FA} + \beta_5 \text{CF} + \beta_6 \text{DCG} + \beta_7 \text{HI} + \beta_8 \text{BoD} + \varepsilon \tag{1}$$

$$PP = \beta_0 + \beta_1 \text{ESG} + \beta_2 \text{SZ} + \beta_3 \text{LV} + \beta_4 \text{FA} + \beta_5 \text{CF} + \beta_6 \text{DCG} + \beta_7 \text{HI} + \beta_8 \text{BoD} + \varepsilon \tag{2}$$

$$PA = \beta_0 + \beta_1 \text{ESG} + \beta_2 \text{SZ} + \beta_3 \text{LV} + \beta_4 \text{FA} + \beta_5 \text{CF} + \beta_6 \text{DCG} + \beta_7 \text{HI} + \beta_8 \text{BoD} + \varepsilon \tag{3}$$

$$PS = \beta_0 + \beta_1 \text{ESG} + \beta_2 \text{SZ} + \beta_3 \text{LV} + \beta_4 \text{FA} + \beta_5 \text{CF} + \beta_6 \text{DCG} + \beta_7 \text{HI} + \beta_8 \text{BoD} + \varepsilon \tag{4}$$

The correlation coefficient equations (5) of the factors are,

$$\rho = \frac{\sum wz - \frac{(\sum w)(\sum z)}{M}}{\sqrt{[\sum w^2 - \frac{(\sum w)^2}{M}][\sum z^2 - \frac{(\sum z)^2}{M}]}} \tag{5}$$

The number of observations or data points is denoted by *m*. The variables that compute for the correlation are *x* and *y*. These two variables represent any two from the regression equation, including ESG, Size, Lev and so on.

V. EXPERIMENTAL FINDINGS

The sample is assessed through multivariate statistical models such as descriptive statistical model, correlation coefficient and linear regression to evaluate the effect of ESG performance on financial market stability.

A. Descriptive statistical model

Table 2 presents the descriptive statistics results for each continuous variable used in this study.

Table 2: Descriptive statistics findings

Variable	Mean	SD	Min	Max
Tobin QR	2.053	1.452	0.91	9.90
Tobin QS	2.31	1.62	0.895	11.25
Tobin QY	2.86	1.89	0.93	13.2
Tobin QZ	2.97	2.321	0.798	13.82
ESG	7.518	1.729	1	8
PP	85.722	151.79	5.329	1092.911
PA	3.916	3.525	0.577	27.726
PS	5.624	7.982	0.199	64.082
SZ	23.221	1.452	18.98	27.986
LV	0.521	0.198	0.07	0.892
FA	0.42	0.159	0.003	0.692
CF	0.054	0.089	-0.254	0.287
DCG	0.256	0.351	0	1
HI	0.321	0.10	0.199	0.795
BoD	2.121	0.184	1.598	2.432

The higher value disparity of R-share listed businesses is demonstrated by the TobinQR corporate value mean of 2.053, a minimum of 0.91 and a maximum of 9.90. The PP variation of R-share listed businesses is 151.79, 5.329 as the smallest number and 1092.911 as the greatest value. This indicates a greater gap and higher variance value of PP. In terms of corporate governance, the average leverage of R-share listed businesses is 0.521, suggesting that overall leverage is more manageable. Everything complies with the China Securities Regulatory Commission's mandate that independent directors make up at least one-third of all the directors in existence. Averaging a DCG

score of 0.256, it is evident that Chinese listed businesses exhibit a lower prevalence of the DCG role of general manager and chairman. The average ESG rating of listed corporations is 1.729, falling.

B. Correlation coefficient

Table 3 illustrates the results of the correlation coefficient.

Table 3: Results of the correlation coefficient

Variable	Tobin QR	ESG	PP	PS	PA	LV	CF	DCG	HF
Tobin QR	1								
ESG	-0.044***	1							
PP	-0.057***	0.152***	1						
PS	0.021*	0.00520	0.042***	1					
PA	-0.059***	0.132***	0.058***	0.005	1				
LV	0.092***	-0.059***	-0.041***	0.020*	-0.491***	1			
CF	-0.162***	0.381***	0.232***	0.003**	0.690***	-0.272***	1		
DCG	-0.003	-0.005	-0.003	-0.007	0.028**	-0.008	0.071***	1	
HF	-0.031**	0.275***	0.225***	-0.031***	0.291***	-0.182***	0.282***	0.00920	1

The leverage ratio and the company size's natural logarithm, negative correlations with Tobin's Q and the natural logarithm of firm size the ESG score and the state-owned enterprise indicator has positive correlations. These correlations can fill with possible connections between the data.

C. Multiple regression results

Based on the regression analysis, it is evident that ESG significantly improves Tobin Q (firm value). In particular, employs many Tobin Q measures (Tobin QR, Tobin QS, Tobin QY and Tobin QZ) and the majority of them are yet significant at the 1% coefficient of determination. A company's market value will probably rise by 0.026 to 0.060 if its ESG improves by one unit. Table 4 depicts the outcome of the multiple regression results.

Table 4: Outcome of the multiple regression results

Variable	Tobin QR	Tobin QS	Tobin QY	Tobin QZ
ESG	0.049***	0.032***	0.058***	0.032**
LV	0.094	0.073	-0.921***	-1.025**
SZ	-0.392***	-0.321***	-0.581***	-0.582***
CF	2.721***	3.201***	4.221***	4.751***
BOD	0.089	0.042	0.251***	0.174*
HI	0.285	-0.059	0.325	0.025
DCG	-0.078***	-0.045***	0.281***	0.201***
FA	-0.852***	-1.325***	-1.725***	-2.658***
N	28421	28421	28421	28421
R2	0.325	0.258	0.351	0.351

The enterprise value is tested using various value measures and the PP, PA and PS indices are used to evaluate how robust the regression model is. According to the regression results, there is a significant inverse relationship between ESG and PP and PS with an increase in ESG rating leading to a decline of PE and PS, along with a substantial beneficial benefit for PA, with an enhancement of PB with each unit increase in ESG rating. The indicator is not very useful for reference purposes because the PE of Chinese-listed businesses are often high and the variance is considerable.

D. Robustness test

The test result ultimately led to the adoption of the fixed effects framework, however, the regression results under mixed and random effects (Table 5) will also be presented here and both models demonstrate a significant positive correlation connecting company value to ESG performance.

Table 5: Robustness test

Variable	PP	PA	PS
ESG	-6.120***	0.051***	-0.089**
BOD	9.987*	0.520***	0.410
LV	76.356***	4.951***	-9.261***
DCG	-7.321***	0.205***	0.295***
CF	-312.520***	6.089***	-4.521***
FA	75.258***	-2.582***	-5.985***
SZ	-31.582***	-1.980***	-1.528***
N	28128	28128	28128
R2	0.21	0.412	0.321

The robustness test for PA and PS compounds the above regression results that the growth of ESG increases the market value of companies, but the indicator is not highly significant for reference purposes since the PP of Chinese listed companies is generally high and the variance is large.

VI. DISCUSSION

The primary issue with ESG governance that listed firms have been a lack of attention to governance coupled with a conflict between the company's limited resources and the statistical diversity of agency ratings. Therefore, it has become crucial for A-share listed firms to face the question of how to increase the efficacy of corporate governance with limited resources, achieve higher market ratings as well as expectations and support the company's overall profitability.

A. Environmental Governance

The distribution of importance for environmental governance through listed businesses varies depending on the industry. For instance, manufacturing and biological disciplines have a greater impact on the total ESG rating when it comes to environmental performance. By integrating the ESG reports of publicly traded companies with the mainstream ESG rating agencies. The environmental aspect of governance is into four categories: ecological revelations, sustainable operations, unfavorable event management and ecological opportunity grasp. Green management necessitates that a business truly determines its comprehensive and effective environmental management system, with an overall view of its goals and tactics at its core. This includes developing green manufacturing processes at the research and development end, staff raising environmental awareness, procurement policies that are green at the supply end, along with a broad monitoring of energy consumption and access to green technologies at the production end. The fundamental component of a green management system is the company's actual integration of environmental governance into internal control and the formalization of all pertinent environmental issues in all control activities. Energy consumption, water efficiency and greenhouse gas emissions are the three key environmental disclosures. Since these are clearly quantified, they constitute a large component of ESG evaluations and should be of particular significance to businesses. It is advised that environmental non-financial data be incorporated into the financial disclosure framework. This will lower disclosure costs and aid in the dismantling of information asymmetry. Additionally, it should be disclosed simultaneously how environmental disclosures affect the business status of the corporation. To fulfil the needs of various information consumers and enhance the caliber of information disclosure, the further development of such integrated disclosure can take a number of approaches to disclosing corporate environmental accounting information, such as in annual and board reports. The main goal of negative event management is to test a business's capacity to build a robust pollution control system that reduces externalities from the source, such as air, water and solid waste pollution, as well as weather-related issues. It also assesses the company's ability to improve its compensation mechanism to lessen the

impact of externalities and determines if it can develop a comprehensive disclosure system that enables it to genuinely report the occurrence of relevant pollution events.

B. Social Governance

The foundation of social governance is the concept of corporate social responsibility, which influences a company's reputation generally and, more significantly in a Chinese marketplace that functions well, directly affects commercial operations. Occupational health and safety, together with staff development and training, are the focal points of talent management. To provide a strong driving force for the development and growth of the enterprise, businesses should pay consideration to the growth and development of their employees, value their contribution and dedication, promote their capacity to improve, stimulate them to innovate and assist in improving their knowledge structure through training. The main focuses of talent management include training and development for employees, as well as occupational health and safety. Businesses should recognize their employees' contributions and hard work develop their ability to grow and develop, encourage innovation and support the enhancement of their knowledge base by providing training to create a powerful driving force for the enterprise's development and growth. Businesses can use dynamic supplier management to standardize supplier selection, appraisal and administration while enhancing the effectiveness and quality of procurement. Encouraging supplier improvement through the dynamic administration of all supplier data and performance evaluations; granting some department's access to the tender procurement department's procurement activities.

C. Corporate governance

In essence, corporate governance is the creation of a macro-management framework for businesses. The pertinent concepts of corporate governance in China are meanwhile relatively new and they also have distinct cultural and value characteristics. As a result, corporate governance in businesses must concentrate on fusing Chinese-style socialism with scientific components about corporate governance. The cornerstone of the corporate governance framework as a whole is the board of directors, which is the primary decision-making body of the business. Listed businesses need to be aware of the following: the value of independent directors, whether they make up a majority of the company overall, whether the process for choosing them is fair, open and reasonable, in keeping with corporate interests and objectivity and whether the directors' objectivity and competence are routinely and publicly assessed, with a focus on their knowledge of the law, finance, and industry.

VII. CONCLUSION

In the current Chinese setting, this study examines how ESG rating enhances company performance through the development of a company's reputation, the decrease in financial capital and the decrease in future cash flows, where a better company reputation results in higher prices for commodities and lower labor expenses, the decrease in corporate finance costs and the decrease in future financial flows are immediately impacted by environmental penalties, which makes them more stable. According to the regression model, businesses with higher ESG ratings typically perform better as a whole, which eventually results in increased corporate value. Using data from the Chinese market, this study provides a narrative and in-depth examination of the sequence of events that lead to ESG ratings influencing market value. It also develops the models needed to conduct tests that will provide as a basis for further studies on the relationship between business value and ESG. The direct effect of ESG performance on financial market stability, as determined by this study, appears to be complex and dependent on a number of circumstances, despite the fact that it is becoming more widely acknowledged as a crucial component of corporate sustainability and responsible investing.

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