

Multivariate Linear Regression Method Based on STATA Analyze The Relationship Between ESG Ratings and Stock Market Performance

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Abstract. With the increasing problems of climate change, environmental pollution, employee conditions, and corporate responsibility. Non-financial indicators are becoming increasingly important for analyzing enterprise value. In recent years, academic research on ESG has been intensifying, but the chain of influence between ESG rating and stock market performance has not been clearly demonstrated. In this article, the author uses a multivariate linear regression method based on STATA to analyze the relationship between ESG rating and stock market performance and how it affects. This paper finds that an increase in ESG rating leads to a decrease in financing constraints, an increase in future risk resistance, and an increase in the company's reputation to obtain a commodity premium. By doing so, the company achieves that a higher ESG rating leads to better financial performance, which ultimately affects the company's stock market performance. This study enriches the literature on the consequences of ESG from the perspective of stock market performance and provides implications for regulatory bodies, investors, and listed firms.

Keywords: Multivariate linear regression, ESG rating, A-share stock, financial performance, stock market performance

1 Introduction

ESG is an acronym formed by the words 'environment, social, and governance', which is a quantitative indicator to measure the non-financial performance of listed companies from three dimensions. Some scholars also refer to it as corporate social responsibility (CSR) and corporate social performance (CSP). ESG first originated from ethical investment in the early 18th century [4], when trade unions called on companies not to operate in highly polluting industries such as chemicals and leather, which may pollute the environment and endanger the health of neighbors. In 2006, the United Nations released the Principles for Responsible Investment on the New York Stock Exchange, which further integrated issues related to socially and internationally responsible investment. The principle of responsible investment is based on the hope that capital should not only focus on the business value of enterprises but also pay more attention to the social value of enterprises so as to promote the sustainable development of society by forcing the upgrading of enterprises with high pollution, poor governance and low social responsibility with the guidance of capital diversion.

With the increasing problems of climate change, environmental pollution, employee conditions, and corporate responsibility [1], the international community, governments, and investors are

gradually paying attention to ESG system indicators. In the international community, the Equator Principles were released in 2003 to develop a set of indicators for identifying, assessing, and managing environmental and social risks involved in project financing. To date, 135 financial institutions from 38 countries worldwide have officially adopted the Equator Principles, with project financing accounting for 85% of the global total. The emergence of the Equator Principles has raised higher management standards for companies seeking financing. In other words, companies that perform better in all three ESG dimensions can effectively reduce financing costs [3].

In addition, the Paris Agreement, signed in 2016 by 178 countries, provides a unified arrangement for the global response to climate change after 2020. In this climate agreement, the future temperature increase and greenhouse gas emissions are stipulated. After the Paris Agreement, many countries around the world have announced their timetables for future energy transition and have imposed sanctions and penalties on companies with high emissions and high energy consumption. This also makes companies with poor environmental management have certain business risks in the future and may face regulatory penalties, thus affecting the stability of future cash flows. Plumlee et al. said that better environmental disclosure provides information about a company's practices related to protecting the environment and can reduce government regulation and the resulting compliance costs, potential litigation, and/or pollution remediation costs [5]. This further affects a company's financial performance and, ultimately, its listing value.

For individual countries, take China as an example. On June 15, 2018, the China Securities Regulatory Commission (CSRC) released a revised version of the Code on Governance of Listed Companies, which for the first time, explicitly requires listed companies to focus on ESG information disclosure [2]. The release of the guidelines has raised investors' expectations of the social responsibility of listed companies. In addition, as the construction of ecological civilization is incorporated into the "five-in-one" general layout of China's future development and the successful launch of "carbon neutral and carbon peak", it has become a historical trend to change the future economic model from a high energy consumption and high emission development model to a low energy consumption and sustainable development model. It has also become an inevitable trend in history. This also makes how to reduce the pollution level of enterprises, practice social responsibility, and improve the governance ability become a mandatory course for every enterprise.

Research on the ESG field dates back to the 1990s [6], but for a long time, it has been challenging to make corresponding progress in this field due to the lack of sufficient data and corresponding mathematical models [7]. In recent years, with the continuous improvement of databases and mathematical models, the research framework in the field of ESG is being improved, and the gaps left by previous authors are being filled incessantly.

At this stage of research on ESG, some scholars focus on the impact of ESG rating on corporate financial performance. Eccles et al. found that companies with high sustainability are more likely to establish stakeholder engagement processes and exhibit a better quality of non-financial content disclosure [8]. These have a positive guide to the future financial performance of the company and its market performance. Broadstock et al. using the example of China after the covid-19 outbreak demonstrates that companies with high ESG ratings are more resilient to risks during economic downturns and have better financial performance than their peers [9]. Ahmad

et al. takes UK-listed companies as an example and examines the impact of the three dimensions on financial performance in more depth [10]. All the above scholars believe that a high ESG rating is beneficial to improve financial performance. On the contrary, other scholars believe that a high ESG rating may lead to the misallocation of resources, resulting in lower benefits than costs. Friedman argues that spending on CSR does not bring any monetary benefits to the company and takes away funds that would otherwise be used for upgrading or developing core technologies, making it impossible for the company to complete industrial upgrading and development [11]. Sen et al. suggest that better CSR performance will increase employees' and consumers' perceptions and their willingness to choose companies and products [12]. However, in reality, people's awareness of corporate social responsibility is low (only 17%), so the benefits of increasing social responsibility investment do not necessarily cover the costs.

In addition, some scholars focus on the mechanism of ESG performance in the company. Lee and Faff suggests that companies with high CSR have lower idiosyncratic risk [13]. Plumlee et al. suggests that better CSR performance reduces the likelihood of future fines and, therefore, future corporate stability can be determined [5].

In summary, the above studies have better enriched the ESG research framework, but the existing studies on the impact of ESG rating and its financial performance have not yet sorted out the impact chain, and the impact factors are still missing. In this paper, we will start from this point and do a systematic review of how ESG rating affects the financial performance of companies, and test the hypothesis with a sample of Chinese A-share listed companies.

The remainder of this paper is organized as follows: Section 2 Literature Review and Hypothesis Development, Section 3 Research Design, Section 4 Empirical Results, Section 5 Conclusion.

2 Literature Review and Hypothesis Development

Developed countries have experienced shapely growth in productivity and economy since the revolution of industries. The living standards of residents are greatly improved. But the limitless development brings pollution of the environment and ecological imbalance at the same time. So, in recent years, Countries around the world are gradually paying attention to the role of sustainable development in social progress. Different institutions and countries are gradually starting to issue policies on green development. For example, The United Nations implements the United Nations Framework Convention on Climate Change, which regulates the greenhouse gas emissions of individual countries in the form of legislation. Gradually, with the promotion of government and the popularity of social green investment. More and more companies around the world are engaging in CSR and integrating it into all aspects of their business [14].

There has been a long, confusing meaning of CSR. Lots of people attempt to define the exact meaning of CSR. The proliferation of different meanings has led to an increase in confusion [14]. Expressions like “corporate social re-responsibility” (CSR), “sustainability”, “corporate responsibility”, “corporate governance” (CG), “environmental, social governance” (ESG), and “corporate citizenship” (CC) normally express the responsibility of a company toward stakeholders [15]. The World Bank Council for Sustainable Development defines CSR as “the continuing commitment by business to behave ethically and contribute to economic development

while improving the quality of life of the workforce and their families as well as of the local community and society at large.”

Following CSR gradually playing an important role in society, more academic research attempt to find whether CSR influences stock market performance, and how CSR enhances or weak stock market performance.

The existing literature that provides support for the positive view of CSR includes studies that firms which with better CSR rankings exhibit cheaper capital financing. In particular, employee relations, responsible environmental policies, and responsible product strategies substantially contribute to reducing their cost of capital [16]. On the one hand, ESG provides more information to investors in several ways, reducing the information asymmetry between companies and investors [17]. In addition, ESG provides non-financial information, which enhances the transparency of companies and reduces investors' uncertainty [18], so investors are more willing to invest in companies with high ESG rankings. On the other hand, Better ESG performance is beneficial to lower debt financing costs [19], and as countries around the world attach importance to green development, enterprises with high ESG tend to enjoy better policy preferences and bank loan facilities. For example, in China, with the implementation of the dual carbon policy and the requirement of green and sustainable development, the government requires commercial banks to consider the environmental risks of enterprises and projects when granting loans [20], and withhold loan support to enterprises and projects with high energy consumption and environmental pollution. Conversely, to give low-interest rate loan support to enterprises with low energy consumption and green environmental protection. Additionally, according to CBI data, global green bond issuance will reach \$500 billion in 2021, up 46% from last year. As investors' appetite for green bonds increases, companies that focus more on environmental protection and industrial upgrading will have better access to financing.

Generally, our study of company value is more about tangible assets. Most applications of value relevance have focused on accounting variables [21]. However, the gap between book value and stock market value has gradually led to the belief that the use of accounting information alone is of limited validity in analyzing the market valuation of companies and their movements [22]. Thus, more and more scholars tend to do research on non-financial information. Such as the company values the relevance of reputation [23].

Until now, numerous studies have explained how high ESG helps companies enhance company value by promoting the reputation of the company. El et al. content that social responsibility may enhance a company's reputation, allowing it to trade less costly implicit costs for expensive explicit requirements [24]. Hussainey and Salama observed a positive impact of a good corporate environmental reputation on current annual stock returns as well as current and future annual gains [25]. On the other hand, some scholars argue that a better reputation increases the premium of the firm's goods and reduces the price of labor. Fombrun and Shanely content that Customers may be willing to pay higher prices for products from companies with better reputations because reputation is a signal of product quality [26]. Employees should be more willing to work for a company with a good reputation.

Another advantage is that companies with better ESG have better resilience to risk. Firstly, higher ESG means that they have better environmental governance than their peers in most cases, and better environmental governance greatly reduces the possibility that they will be subject to environmental department penalties in the future, which in turn will affect cash flow

declines. Secondly, a better corporate governance system helps companies maintain positive relationships with their employees, and enhances employee identification with the company at the same time [27], which effectively reduces employee turnover rates and makes the company structure more stable. Thirdly, people show more trust in high ESG companies and are more willing to provide financing for them. Especially during the financial crisis, people are more willing to trust high ESG companies, which makes them gain more 4-7 percentage points return than firms with low ESG during the financial crisis [28]. Based on the above analyses, this paper proposes the following hypothesis.

H1: High ESG ratings increase stock market performance by building up a great reputation, reducing the cost of capital and reducing the volatility of future cash flow

3 Research Design

3.1 Sample selection and data sources

Our sample consists of Chinese A-share firms listed on the Shanghai and Shenzhen stock exchanges during the period of 2009-2020 [29]. Our sample begins with year 2009 because the Huazheng index can only be collected on WIND after 2009, ending in 2020. I exclude: (1) firms with financial difficulties or listing suspension (ST, PT firms); (2) firms with no available ESG data via WIND;(3) firms with no available financial data via CSMAR; (4) firms in the finance industry. Finally, I got 27929 observations.

Financial data, including balance sheet, income sheet and cash flow sheet, is retrieved from the China Stock Market and Accounting Research (CSMAR) database. In addition, the Huazheng ESG rating is obtained from WIND database.

Table 1 shows the results of descriptive statistics of all continuous variables in this paper, and the author has done the upper and lower 1% tail reduction for all continuous variables. In terms of corporate value, the mean value of TobinQA is 2.072, the minimum value is 0.87, and the maximum value is 9.894, which shows that the value gap of A-share listed companies is larger. The variance of PE is 149.609, the minimum value is 5.539, and the maximum value is 1056.851, which gives a larger gap and higher variance value of PE of A-share listed companies. From the perspective of corporate governance, the mean value of Lev of A-share listed companies is 0.414, and the overall leverage is more controllable, but there are still listed companies with as high as 0.956. The mean value of Indep is 0.374, and the minimum value is 0.333. All comply with the requirement of the China Securities Regulatory Commission that independent directors account for at least 1/3 of the total number of directors. The mean value of Dual is 0.277, and it can be seen that the phenomenon of the duality of chairman and general manager is less present in Chinese listed companies. In terms of ESG rating, the average value of ESG of listed companies is 6.498, which is between BBB and A.

Table 1. Descriptive Statistics (Table credit: Original)

variable	N	Mean	SD	Min	max
TobinQA	25555	2.072	1.372	0.87	9.894
TobinQB	27929	2.278	1.571	0.904	11.347

TobinQC	27929	2.659	1.969	0.853	12.7
TobinQD	27929	2.918	2.222	0.889	14.382
ESG	27929	6.498	1.069	1	9
PE	27929	84.642	149.609	5.539	1056.851
PB	27929	3.786	3.465	0.607	27.656
PS	27929	5.594	8.001	0.207	65.063
Size	27929	22.114	1.302	19.52	26.086
Lev	27929	0.414	0.206	0.05	0.956
Indep	27929	0.374	0.053	0.333	0.571
PPE	27929	0.21	0.161	0.002	0.708
CFO	27929	0.049	0.071	-0.187	0.247
Dual	27929	0.277	0.447	0	1
HHI	27929	0.287	0.12	0.202	0.829
Board	27929	2.135	0.198	1.609	2.708

3.2 Multiple regression models

$$TQ = \beta_0 + \beta_1 ESG + \beta_2 Size + \beta_3 Lev + \beta_4 Iedep + \beta_5 PPE + \beta_6 CFO + \beta_7 Dual + \beta_8 HHI + \beta_9 Board + \varepsilon \quad (1)$$

$$PE = \beta_0 + \beta_1 ESG + \beta_2 Size + \beta_3 Lev + \beta_4 Iedep + \beta_5 PPE + \beta_6 CFO + \beta_7 Dual + \beta_8 HHI + \beta_9 Board + \varepsilon \quad (2)$$

$$PB = \beta_0 + \beta_1 ESG + \beta_2 Size + \beta_3 LEV + \beta_4 Iedep + \beta_5 PPE + \beta_6 CFO + \beta_7 Dual + \beta_8 HHI + \beta_9 Board + \varepsilon \quad (3)$$

$$PS = \beta_0 + \beta_1 ESG + \beta_2 Size + \beta_3 LEV + \beta_4 Iedep + \beta_5 PPE + \beta_6 CFO + \beta_7 Dual + \beta_8 HHI + \beta_9 Board + \varepsilon \quad (4)$$

3.3 Variable

Dependent variable.

In this paper, Tobin Q, PE, PB, and PS are chosen to measure market performance [30][31][32]. Tobin Q is the ratio of market value to replacement value, which can well reflect the difference between the market value and book value of a company. PE, PB and PS are three different valuation methods, PE reflects the relationship between a company's share price and profitability, PB reflects the relationship between a company's share price and net assets, and PS reflects the relationship between a company's share price and sales. The three different valuation methods are adapted to different industries. The three methods are considered simultaneously to provide a more comprehensive measure of a company's market performance.

Independent variable.

The independent variable of this study is represented by the Huazheng ESG score obtained by Wind database with the actual situation of the A-share market.

The ESG rating of Huazheng covers three dimensions in first-level indicators, fourteen dimensions in two-level indicators, twenty-six dimensions in three-level indicators and more than 130 dimensions in four-level indicators. Huazheng ESG indicators take into account the ESG rating model of overseas capital markets and the special characteristics of the Chinese capital market and establish the ESG indicator system in three steps: firstly, based on the current reality of ESG information disclosure in China, indicators with a high degree of disclosure are selected; secondly, Huazheng ESG rating has industry characteristics, and corresponding evaluation indicators are selected according to the characteristics of industry business models; finally, ESG indicators with good investment performance are selected through retrospective testing. The ESG rating index system of China Securities not only takes into account the current status of ESG disclosure in China and excludes the indicators that are not available but also adds more indicators that fit the development stage in China, such as the quality of information disclosure, CSRC penalties, rural revitalization, etc.

Control variables.

In order to improve the accuracy of the model runs, we introduce some control variables to effectively reduce the influence on the explanatory variables; according to the empirical and available literature, we can obtain the variables that frequently affect the market performance as: firm size (SIZE), leverage ratio (LEV), independent director ratio (Indep), the proportion of fixed assets to the total asset (PPE), cash flow of operating (CFO), Duality of chairman and general manager (Dual), Herfindahl-Hirschman Index (HHI), board of directors(Board).

Table 2. Variable Definitions (Table credit: Original)

Type of variable	Name	Definition and measurement
Dependent	Tobin Q	Market cap + total liabilities, divided by total assets
	PE	Price per share divided by earnings per share
	PB	Stock price divided by book price
	PS	Total market cap divided by sales
Independent	ESG	Huazheng ESG rating
Control	SIZE	Natural logarithm of firm size
	LEV	Natural logarithm of leverage ratio
	Indep	Independent director ratio
	PPE	The proportion of fixed Assets to total assets
	CFO	Cash flow of operating
	Dual	Duality of chairman and general manager
	HHI	Herfindahl-Hirschman Index, a composite index measuring industry concentration
	Board	Natural logarithm of board of directors

4 Empirical Results

According to the regression results, we can get that ESG has a significant enhancing effect on TobinQ (firm value). Specifically, we use different measures of TobinQ (TobinQA, TobinQB, TobinQC, and TobinQD), and most of them can remain significant at the level of coefficient

1%. If a company's ESG improves by one unit, it will likely bring 0.026-0.060 increase in corporate value.

By using the STATA software, the experimental data are analyzed by multiple linear regression analysis. The results are as follows.

Table 3. Baseline Results (Table credit: Original)

	(1)	(2)	(3)	(4)
	TobinQA	TobinQB	TobinQC	TobinQD
ESG	0.051*** (7.30)	0.026*** (3.13)	0.060*** (6.71)	0.027** (2.55)
Size	-0.422*** (-39.24)	-0.432*** (-35.28)	-0.612*** (-45.57)	-0.625*** (-41.53)
Lev	0.083 (1.41)	0.062 (0.89)	-0.895*** (-12.09)	-1.006*** (-11.84)
Indep	1.108*** (6.88)	1.094*** (5.96)	2.012*** (9.48)	2.038*** (8.47)
PPE	-0.787*** (-13.98)	-1.275*** (-19.29)	-1.654*** (-22.86)	-2.267*** (-27.26)
CFO	2.674*** (18.99)	3.109*** (19.60)	4.104*** (22.26)	4.687*** (22.85)
Dual	-0.068*** (-3.90)	-0.068*** (-3.39)	0.162*** (6.88)	0.182*** (6.85)
HHI	0.167 (0.98)	-0.064 (-0.31)	0.248 (1.10)	0.004 (0.01)
Board	0.074 (1.64)	0.035 (0.68)	0.182*** (3.06)	0.133* (1.95)
Constant	10.730*** (45.84)	11.550*** (43.48)	15.202*** (52.38)	16.236*** (49.92)
Industry	YES	YES	YES	YES
Year	YES	YES	YES	YES
N	27929	27929	27929	27929
R ²	0.277	0.273	0.383	0.379

Using different value measures to test the enterprise value, the previous regression model is tested for robustness with the help of PE, PB, and PS indicators, and according to the regression results we can obtain that ESG has a significant negative correlation with PE and PS, with each unit increase in ESG rating bringing a decrease of -5.830 PE and -0.090 PS; for PB, there is a significant positive correlation benefit, with each unit increase in ESG rating bringing an increase of 0.049 PB. Since the PE of Chinese listed companies is generally high (mean 84.642) and the variance is large (149.609), the indicator is not very meaningful for reference purposes,

while the robustness test for PB, PS compounds the above regression results that the growth of ESG enhances the market value of companies.

Table 4. Robustness tests (Table credit: Original)

	(1)	(2)	(3)
	PE	PB	PS
ESG	-5.830*** (-6.63)	0.049*** (2.75)	-0.090** (-2.17)
Size	-32.794*** (-29.76)	-1.400*** (-43.91)	-1.436*** (-22.50)
Lev	77.526*** (11.82)	5.072*** (24.68)	-8.616*** (-21.03)
Indep	123.940*** (6.09)	3.276*** (8.40)	6.441*** (6.77)
PPE	77.000*** (10.57)	-2.739*** (-17.86)	-6.000*** (-16.74)
CFO	-293.493*** (-21.44)	6.047*** (16.99)	-4.498*** (-6.04)
Dual	-7.445*** (-3.88)	0.199*** (4.71)	0.295*** (2.90)
HHI	31.689 (1.62)	0.106 (0.26)	1.575* (1.65)
Board	10.197* (1.76)	0.460*** (4.14)	0.313 (1.16)
Constant	763.991*** (27.58)	30.807*** (48.11)	40.504*** (29.29)
Industry	YES	YES	YES
Year	YES	YES	YES
N	27929	27929	27929
R ²	0.13	0.315	0.252

5 Conclusions

This paper discusses how ESG rating in today's Chinese context improves corporate performance through the building of corporate reputation, the reduction of financing capital, and the reduction of future cash flows, where higher corporate reputation brings a premium for goods and a reduction in labor costs; the reduction of corporate financing costs, and the reduction of future environmental penalties (based on higher levels of governance) directly affects the future cash flows, making them more stable. According to the discounted future cash flow model, these

actions better increase the future value of the company. The regression model shows that companies with higher ESG ratings tend to have better corporate performance, which ultimately translates into higher corporate value. This article provides a complete overview and narrative of the chain of ESG ratings affecting market value using data from the Chinese market and builds the models to make tests that will help provide a basis for future literature on the relationship between ESG and corporate value. In addition, this paper still has shortcomings in the following contents. 1. this paper is based on the data of Chinese listed companies for regression testing. It is still unclear whether the theory is applicable to other developed countries. 2. the financial data of listed companies use annual data, which may not have as much data as monthly and quarterly data, and the granularity is not as clear as they are. 3. the indicators used in this paper for testing the value of enterprises may be scarce and not as comprehensive.

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