

The Relationship between ESG Scores and Equity Risk Premiums - A Study through Portfolios

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ABSTRACT

The purpose of this paper is to explore the impact of ESG (Environmental, Social, Governance) scores on the stock risk premium of U.S. companies. The study selects ESG scores, stock returns and other data of 4533 U.S. companies from 2013-2023, and by constructing 5×5 portfolios based on ESG scores and market capitalisation sizes, and conducting regression analyses using the Fama-French three-factor model, the CAPM model, and the Carhart four-factor model, it explores whether companies with high ESG scores can provide risk-adjusted additional returns. The results show that the risk premiums of different ESG score and market capitalisation portfolios differ, but overall do not show significant excess returns; high ESG score portfolios have lower systematic risk (β -value), yet they do not translate into significant returns; high ESG scores in small-capitalisation firms may show some positive risk-adjusted returns, while the impact of ESG scores is weaker in large-capitalisation firms. Taken together, the impact of ESG scores on portfolio risk-adjusted returns is complex and limited, and investors need to combine other factors to make rational decisions.

KEYWORDS

ESG score; Equity risk premium; Fama-french three-factor model; CAPM; Carhart four-factor model

1 Introduction

1.1 Background and significance of the study

As the world pays more and more attention to sustainable development and environmental protection, the importance of ESG factors in investment decision-making has become more and more prominent. The goal of "carbon neutrality" and the concept of sustainable development have prompted the transformation of enterprises and the economy in the direction of more environmentally friendly and socially responsible, and ESG investment has shifted from the level of ethics to the level of investment strategy. At this stage, there is a lack of theoretical research on the impact of ESG scores on company stock performance. This study systematically analyses the impact of ESG scores on the risk premiums of US companies' stocks, constructs portfolios based on ESG scores, conducts regression analyses using the Fama - French three-factor model and the Carhart four-factor model to provide empirical evidence for the deepening and improvement of ESG investment theories, reveals the differentiation of the risk-adjusted returns of ESG scores among companies with different market capitalisations, and provides an understanding of the impact of ESG factors and the risk-adjusted returns. impact of ESG scores on risk-adjusted returns among companies with different market capitalisation, providing a new perspective to understand the relationship between ESG factors and financial market performance.

Meanwhile, given that financial market volatility and correlation pose challenges to risk management, and society's emphasis on sustainable development has made ESG investments popular, this study explores the impact of ESG factors on risk premiums under market-capitalisation-weighted portfolios using the Fama-French three-factor model from the dual perspectives of the relationship between ESG factors and equity risk premiums and constructing U. S. stock portfolios, and conducts Time-series and Long-Short analyses are conducted to provide scientific basis for investment decision-making, help investors rationally and comprehensively assess the investment value of companies, promote the development of ESG investment strategies and market awareness, and guide companies to pay attention to ESG performance to enhance their sustainable development ability. It also helps market regulators to formulate more effective regulatory policies and maintain a fair and transparent market.

1.2 Literature review and synthesis in related fields

1.2.1 Development and Importance of ESG Scoring

ESG investment can be traced back to the 17th-18th centuries, and in the early days, it was dominated by negative screening, such as religious groups refusing to invest in industries such as alcohol, tobacco, and arms. Nowadays, socially responsible investment has been upgraded: investors are more proactive and take more environmental factors into consideration, shifting from negative screening to positive screening, and from moral and ethical level to investment strategy level.

Studies at home and abroad have shown that ESG is important for corporate and economic development under the concepts of "carbon neutrality" and sustainable development. Zhang Zhiguo (2023) argues that ESG is a core element for

enterprises to achieve sustainable development and an important guarantee for steady economic growth, but the current ESG disclosure rate is low. Li Jinglin et al. (2021) found that the performance of companies significantly improved after good fulfilment of their ESG responsibilities. Zhangfang (2024) pointed out that ESG factors are becoming increasingly important in the global abrasives market, including consumer attitudes, risk-opportunity assessment, and related corporate practices.

1.2.2 The impact of ESG factors on equity risk premiums

In response to the question "whether there is an ESG risk premium in the market", Jane Li (2021) found that the average return on the stock of unrated companies is higher relative to that of rated companies, i.e., there is an ESG risk premium in the market by constructing a Fama-French three-factor model. Hoelscher et al. (2024) found a higher ESG risk premium for the stock of unrated companies relative to that of rated companies by using a valuation model to find that firms with higher ESG risk have higher required returns and that there is an ESG risk premium. Jeongseok Bang and Doojin Ryu et al. (2023) argue that ESG itself is a special kind of risk, that investors expect to be compensated for taking on the risk of ESG controversies, and that the ESG controversy factor has an additional explanatory power on the cross-section of expected stock returns, which can result in risk premiums and stock price volatility.

Aman Kim and Ling Shih Hsien (2024) argue that there are higher additional capital returns for ESG-disclosing and high ESG-performing firms in green finance pilot cities and the ESG risk premium is more significant as the number of green policy pilot cities increases, but the effect is short-term. Thanh Nam Vu and Juha-Pekka Junttila et al. (2024) point out that in response to social (S) and governance (G) issues, the market reaction to ESG news is short-term, stock prices are affected by ESG in the short term, and the market reacts more strongly to negative ESG news. Kumar et al. (2016) found that high ESG-rated firms can build a good social image, have green financial policy support, and have relatively low ESG risk, which can satisfy the investors' need for risk aversion, and therefore their stocks may earn additional gains. However, at the same time, Aman Jin and Shih-Hsien Ling (2024) also argue that the market shows greater distrust of information about high ESG performance due to more regulations and green policies, which increases the market's judgement of the risk of "greenwashing" for high ESG-performing firms and leads to negative risk premiums for ESG assets in the current period. While some studies in the existing literature have found that companies with high ESG scores typically have lower risk premiums because they may face fewer social and environmental risks, other studies have suggested that companies with high ESG scores may have higher operating costs due to their additional investment in environmental and social responsibility, which may increase their risk premiums.

1.2.3 Use of ESG factors in portfolio management

Portfolio selection is a hot topic of research in financial academia and practice, examining how to effectively diversify investments to manage risk and enhance returns. Existing studies disagree on whether decision-making methods based on ESG investment concepts can achieve superior financial and sustainable performance. Ballesterio et al. (2011) incorporate ethical factors into the classical uncertainty utility theory to construct a portfolio selection model that encompasses both financial and ethical criteria, and the numerical results show that strong green portfolios face higher financial and economic risks compared to weak green portfolios, and financial risks compared to weak green portfolios. Yan Haibo et al. (2024) based on the Vine Copula_CVaR risk metric study found that ESG portfolios have the role of stabilising returns and avoiding risks, and portfolios with higher ESG ratings have lower risks and higher returns. However, Feng Ling et al. (2024) used a mixed-measures model and found that the ESG negative screening strategy reduces the diversification of optimal portfolios, leading to an increase in investment risk and making sustainable investment performance poor, so investors should be cautious about adopting the ESG negative screening strategy.

1.3 Research objectives

Although existing studies have preliminarily explored the relationship between ESG scores and stock risk premiums, there are still the following technical gaps and research opportunities: ① Most focus on the unidirectional relationship between ESG scores and risk premiums, and lack of in-depth analyses on the interactions between market capitalisation size and ESG scores, especially the differences in the performance of high ESG scores in companies with different market capitalisations are not clear yet. ② Insufficient exploration of the dynamics of the relationship between ESG scores and risk premium, failing to capture the real-time impact of changes in the market environment on the relationship between the two. (iii) In portfolio construction, the method of applying ESG factors has not yet formed a unified standard, and the mechanism of the impact of different screening strategies on the risk-return characteristics of portfolios needs to be further clarified.

This study aims to investigate the impact of ESG scores of U. S. companies on equity risk premiums. That is, by constructing portfolios with different ESG scores and analysing the risk premium (alpha) of the portfolios using the Fama-French model, we compare the performance of high ESG score portfolios with low ESG score portfolios, and explore whether high ESG score firms can provide additional returns after risk adjustment.

2 Materials and methods

The data required for this study covers ESG scores, monthly stock returns, and related market data for U.S. companies over the period from 2013 to 2023. Among them, the ESG score data comes from Refinitiv ESG database, which covers the performance of Environmental, Social and Governance, with a scale ranging from 0 to 1, with higher scores indicating that a company is performing better in terms of sustainability. In order to ensure the rigour of the study, companies with missing ESG scores were excluded from the study, and finally 4,533 U.S. companies were selected as the study sample. Monthly stock return data were obtained from the CRSP database. The historical monthly returns of each stock were calculated from these data and used for subsequent portfolio construction and regression analysis. In addition, data on the market risk premium, firm size (SMB), and book-to-market ratio (HML) factors required for the Fama-French model, and the robustness test uses the replacement of the Carhart four-factor to check the risk premium situation, which are obtained directly from the Fama-French Library at Dartmouth College.

3 Empirical analyses

3.1 Portfolio construction

In the portfolio construction process, this study first sorts all sample companies based on each company's ESG score in the previous year. After sorting, all companies are divided into five equal subgroups (Q1 to Q5), each containing about 20% of the sample companies respectively. group Q1 contains the 20% of companies with the lowest ESG scores, while group Q5 contains the 20% of companies with the highest ESG scores. This methodology aims to compare the difference in stock market performance between high ESG scoring companies and low ESG scoring companies. Market capitalisation-weighted portfolios are constructed for each group of companies and monthly returns are calculated for each portfolio. In constructing the portfolios, the market-capitalisation-weighted approach ensures that differences in the size of companies within a portfolio are reflected by setting the weight of each stock as a proportion of its total market capitalisation to the market capitalisation of the portfolio as a whole. Specifically, for each portfolio, the monthly return is calculated as:

$$R_t = \sum_{i=1}^n w_{i,t} * Rs_{i,t}$$

where R_t denotes the portfolio's return in month t , $w_{i,t}$ denotes the market capitalisation weight of the i th stock in month t , and $Rs_{i,t}$ denotes the return of the i th stock in month t . In order to capture changes in market conditions over time, the portfolios are re-grouped and the market capitalisation weights are adjusted at the beginning of each year based on the latest ESG scores, thus ensuring that the portfolios reflect current ESG performance and market conditions. The monthly return of the portfolio is recalculated after each rebalancing. This grouping and portfolio construction methodology allows this study to analyse the risk premium (alpha) of portfolios with different ESG scores within the framework of the Fama-French model and to explore whether high ESG scoring companies provide additional returns after adjusting for factors such as market and size.

3.2 Constructing a 5×5 portfolio

In this paper, we construct 5×5 portfolios by dual-categorising stocks by market capitalisation size and ESG score. Each portfolio represents the average monthly returns under different combinations of market capitalisation and different ESG scores. Stocks were first categorised into five equal groups (from 1 to 5) based on their market capitalisation size (Market) and then into five equal groups (from 1 to 5) based on their ESG scores to form 25 portfolios. The table below shows the monthly mean returns of these portfolios.

Table 1 Stock return group by ESG and size(5X5)

Quantiles of ESG		1	2	3	4	5
Quantiles of Market Value	1	0.0124	0.0143	0.0124	0.0078	0.0123
	2	0.0103	0.0103	0.0103 0.0103	0.0133	0.0126
	3	0.0107	0.0106	0.0107 0.0106	0.0129	0.0105
	4	0.0083	0.0091	0.0091	0.0091 0.0101	0.0123
	5	0.0119	0.0147	0.0121	0.0120	0.0104

From an ESG scoring perspective, returns within the different scoring groups similarly do not show a strong trend towards monotonicity. For example, in Market Capitalisation Group 2, returns are relatively flat across ESG score groups, ranging between 0.0103 and 0.0133. The impact of ESG scores varies across market capitalisation groups, with higher ESG scores not always corresponding to higher returns. Overall the highest monthly mean return is for the portfolio with the smallest market capitalisation and ESG score of 2 (0.0143), while the lowest is for the portfolio with the smallest market capitalisation and ESG score of 4 (0.0078). These results suggest that the interaction of market capitalisation and ESG

scores has a complex and variable effect on returns, and further regression analyses are needed to delve deeper into the underlying relationships.

3.3 FAMA-FRENCH three-factor model regression of risk premiums

This paper regresses and compares the alpha values of five types of portfolios through the Fama-French three-factor model, with a particular focus on the portfolios with the highest (Q1) and the lowest (Q5) ESG scores, to determine whether the high ESG score portfolios have higher alpha values relative to the low ESG score portfolios. The specific formula is as follows:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_1 (R_{m,t} - R_{f,t}) + \beta_2 \text{SMB}_t + \beta_3 \text{HML}_t + \varepsilon_{i,t},$$

where $R_{i,t}$ is the return of the i th portfolio in month t , $R_{f,t}$ is the risk-free rate (usually the U.S. Treasury yield) in month t , $R_{m,t}$ is the return of the market portfolio in month t , SMB_t is the return spread between small-capitalisation stocks and large-capitalisation stocks in month t , HML_t is the return spread between high-book-to-market-ratio stocks and low-book-to-market-ratio stocks in month t , and α_i is the risk premium for the i th portfolio, which represents the portfolio's outside of the model's interpretation of the Returns.

First, a Fama-French regression analysis is performed on each of the above 25 portfolios to obtain the average monthly alpha coefficient of each portfolio in order to measure the extent of the risk premium of different portfolios. The regression results show that the alpha coefficients differ significantly across portfolios, reflecting the impact of market capitalisation size and ESG scores on portfolio risk-adjusted returns.

Table 2 Portfolio alpha group by ESG and size(5X5)

Quantiles of ESG		1	2	3	4	5
Quantiles of Market Value	1	0.0035	0.0046	0.0041	0.0041 -0.0007	-0.0003
	2	-0.0008	0.0007	0.0004	0.0026	0.0018
	3	-0.0001	0.0001 -0.0005	-0.0010	0.0016	0.0016 -0.0021
	4	-0.0039	-0.0017	0.0017 -0.0019	-0.0010	0.0010
	5	-0.0016	0.0015	0.0002	0.0013	0.0002

These results suggest that the "small cap + low ESG" portfolio still earns a positive risk-adjusted premium. In contrast, the alpha coefficients of the largest market cap portfolios (Market 5) are generally small and insignificant, with low volatility, suggesting that ESG scores have a weaker impact on risk premiums for large-cap companies. Overall, however, the distribution of alpha coefficients does not show a clear unidirectional trend.

3.4 ESG Portfolio analysis

In order to further explore the impact of ESG scores on stock risk premiums, all stocks are grouped into five portfolios based on their ESG scores (ranked in descending order) and Fama-French regression analyses are performed on these portfolios in order to obtain the average monthly alpha coefficients and the corresponding t-statistics for each portfolio. The regression results are presented below:

Table 3 Portfolio alpha group by ESG (Fama french three factor)

Quantiles of LagESG	Alpha	T statistic
Portfolio1	-0.00220097	-0.98587728
Portfolio2	0.00036646	0.14045995
Portfolio3	-0.00001126	-0.00789503
Portfolio4	0.00113757	1.4328802
Portfolio5	0.0003683	0.40011281
Portfolio5-1	0.00256927	1.1006243

The results show that the alpha values of the five groups grouped by ESG score are not significant. In addition, the alpha coefficient of Portfolio5-1 (i.e., the difference portfolio between the high ESG score group and the low ESG score group) is positive but also does not reach the significance level. The above results suggest that although ESG scores have a positive effect on risk-adjusted returns in some portfolios, this effect is not significant enough to conclude that high ESG score firms have a significant advantage in risk-adjusted returns.

3.5 Further capm-based analyses

In order to gain deeper insight into how ESG scores affect risk characteristics, this paper conducts regression analysis based on CAPM with the following formula:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_i (R_{m,t} - R_{f,t})$$

where β_i represents the magnitude of systematic risk of portfolio i (β is 1 for the market portfolio). Based on this, this paper

analyses the β values and R^2 coefficients of five different ESG portfolios to reveal the significant impact of ESG scores on portfolio risk characteristics. The results obtained are presented in the table below.

Table 4 Portfolio beta and R^2 group by ESG (Fama french three factor)

Quantiles of LagESG	β	R^2
Portfolio1	1.191	0.863
Portfolio2	1.152	0.782
Portfolio3	1.087	0.905
Portfolio4	1.014	0.963
Portfolio5	0.966	0.947
Portfolio5-1	-0.225	0.526

As can be seen, the β values of the portfolios show a clear downward trend as the ESG scores increase, suggesting a gradual decrease in their exposure to market volatility. The R^2 coefficients further support this trend, with the R^2 coefficients of the portfolios with high ESG scores (Portfolios4 and 5) being close to 1 at 0.963 and 0.947, respectively, suggesting that these portfolios are more highly correlated with market performance. However, the lower beta of these high ESG scoring portfolios suggests that they offer relatively low systematic risk and exhibit more stable returns despite their strong correlation with market performance.

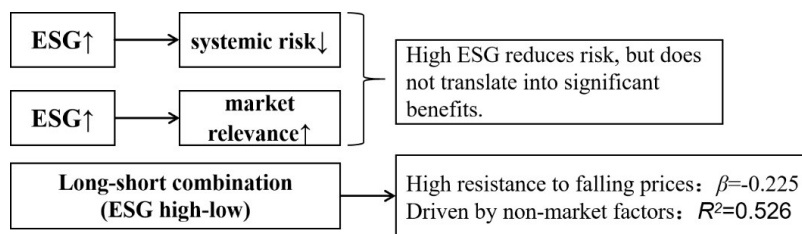


Figure 1 ESG influence risk characterisation findings

Long-Short Portfolio (Portfolio5-1), i.e. comparing a high ESG scoring portfolio (Portfolio5) with a low ESG scoring portfolio (Portfolio1). The portfolio has a Beta of -0.225, suggesting that the portfolio has an inverse relationship with the overall market trend, and through a series of longs and shorts may be able to achieve positive returns on market declines. The lower R^2 coefficient suggests that the performance of this portfolio is influenced by more market external factors, such as company-specific ESG strategies and governance factors. Overall, ESG scores significantly affect their risk characteristics, with high ESG scoring companies typically exhibiting greater risk tolerance, and Long-Short strategies can leverage these characteristics to achieve better risk-adjusted returns in different market environments.



Figure 2 Portfolio long short time series

This graph shows the change in net worth of the Long-Short Portfolio (high ESG score minus low ESG score) based on ESG scores over the period 2013 to 2023. From the chart, we find that the net value of the portfolio hovers around 1 for most of the time, suggesting that there is little difference in the performance of high ESG-scoring stocks relative to low ESG-scoring stocks. In particular, the net value change is smoother and less volatile until 2020. Despite the slight outperformance of high ESG-scoring stocks during certain time periods, overall this portfolio does not achieve significant excess returns over the 2013-2023 period.

4 Robustness test - carhart four-factor regression

In this paper, a regression analysis of portfolios based on ESG scores is carried out using the Carhart four-factor model to verify the robustness of the results of the aforementioned Fama-French model. The Carhart four-factor model adds a

momentum factor (MOM), which is designed to capture the momentum effect of the portfolios.

Table 5 Portfolio alpha group by ESG (Carhart model)

Quantiles of LagESG	Alpha	Alpha(T statistic)
Portfolio1	-0.0013	-0.6071
Portfolio2	0.0017	0.7105
Portfolio3	0.0007	0.4893
Portfolio4	0.0015	1.9973
Portfolio5	0.0008	0.9876
Portfolio5-1	0.0021	0.9153

The regression results show that the alpha coefficients of the five portfolios and the Long-Short portfolio (Portfolio 5-1) still do not reach the statistically significant level. Therefore, even with the introduction of the momentum factor, the regression results of Carhart's four-factor model still do not show a significant excess return for the portfolios based on ESG scores, which suggests that ESG scores still have a limited impact on the risk-adjusted returns of the portfolios.

5 Conclusion

Despite the differences in risk premiums across ESG scores and market capitalisation portfolios, they do not show significant excess returns overall. Within the framework of the Fama-French three-factor model, high ESG scores do show some positive risk-adjusted returns among small-cap companies, suggesting that these companies may be somewhat risk-resistant and able to generate additional returns after adjusting for factors such as market and size. However, ESG scores have a more limited impact among large-cap companies, possibly because these companies are already widely recognised by the market and their ESG performance contributes less to their risk-adjusted returns.

From a long-term investment perspective, these results suggest that investors should remain cautious when considering ESG factors. While ESG scores may be informative in portfolio risk management, their actual investment value may not be as significant as theoretically expected. Therefore, when integrating ESG factors into investment strategies, investors should conduct more comprehensive analyses in conjunction with other financial indicators and market factors to ensure the effectiveness and robustness of their investment decisions. Future research can further explore other factors that may affect the relationship between ESG scores and investment returns, such as industry characteristics and changes in economic cycles, in order to more fully understand the impact of ESG scores on investment decisions.

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