Master Essay I, Finance (NEKN02)

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Thesis Title:
ESG Rating and Financial Performance: A Comparison Between State-Owned and Non-State-Owned Sectors in the Chinese Stock Market

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Abstract:

Following the adoption of the "double carbon" policy in China, the concept of Environmental, Social, and Governance (ESG) has gained considerable attention within the Chinese market, significantly impacting investor decision-making. This thesis examines the impacts of ESG principles on the overall financial performance of investment portfolios. Through the classification of Chinese A-listed firms into High, Medium, and Low ESG groups, corresponding portfolios are constructed for in-depth analysis. To comprehensively assess the financial performance of these portfolios in relation to ESG, three key metrics—Jensen's alpha, Expected Shortfall, and Sharpe ratio—are selected. By employing the Fama-French Five-Factor model, we uncover that all portfolios exhibit negative alpha, indicating underperformance relative to expected returns based on the model's risk factors. Notably, the High ESG portfolio demonstrates the most significant degree of underperformance, coupled with the lowest Sharpe ratio among all portfolios. The positive expected shortfall of the High Minus Low ESG portfolio highlights the heightened extreme losses experienced by high ESG portfolios compared to their low ESG counterparts. These findings suggest a prevailing preference among investors in the Chinese market for higher ESG scores over superior financial performance following the adoption of the "double carbon" policy. Furthermore, our analysis delves into the distinction in the impact of ESG ownership on the financial performance of portfolios. We identify a notable divergence, with state-owned companies exhibiting no significant excess return over the market, while non-state-owned companies demonstrate a significantly negative Jensen's alpha. Additionally, High ESG portfolios consistently underperform compared to Low ESG portfolios in terms of the Sharpe ratio. Finally, we observe that private ownership generally entails higher risk, as evidenced by elevated VaR and ES/CVaR values across all ESG portfolios.

Keywords: ESG, CSR, Portfolio choice, Sharpe ratio, Expected shortfall, Ownership, Financial performance

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Content

1. Introduction

Environment, social, and governance (ESG) investment plays an increasingly important role in the world economy. Compared to the popularity of ESG investment in European and American markets, ESG investment in the Chinese market only began to take off in the late 2010s (Wang, Z., Liao, K. and Zhang, Y, 2022). However, the advent of ESG criteria did not gain popularity and wide attention until the adoption of the “Double Carbon” policy, officially announced in China in 2020.

The "Double Carbon" policy in China has two main aims, which are “carbon peak” and “carbon neutrality”. It aims to address the pressing issue of climate change by reducing carbon emissions and promoting environmental sustainability. Achieving the goal of carbon peaking by 2030 and carbon neutrality by 2060 marks the beginning of the climate economy era in China (Zhang JT and Zhang L, 2021).

According to Figure A-1 (Appendix), it is obvious that the publications related to ESG from CNKI (China National Knowledge Infrastructure), databases of academic journals, conference proceedings, newspapers, reference works, and patent documents, have increased from 2020 when the "Double Carbon" policy is announced. This phenomenon indicates that the concept of ESG gradually gaining popularity in the Chinese market and more and more research is being conducted about the true impact of ESG. Therefore, a central concern addressed in this essay pertains to the impact of socially responsible investing on their financial performance. Is socially responsible investing truly effective in generating financial gains, or does it primarily serve as a means to feel virtuous, with minimal tangible effects on investment outcomes?

To comprehensively assess Chinese stock financial performance related to ESG scores, we meticulously analyze various portfolios from three key perspectives: returns (Jensen’s alpha), risks (expected shortfall), and the ratio of excess returns to risks (Sharpe ratio). Based on the research from Pedersen, Fitzgibbons, and Pomorski (2021), the market with many type-M investors should demonstrate lower expected excess return and Sharpe ratio in High-ESG portfolios, since type-M investors care about ESG scores and are willing to sacrifice some extent of returns for better ESG performance. Similarly, we wondered that if type-M investors are willing to bear more risks for better ESG performance. Therefore, we also expect that the high-ESG portfolio may demonstrate a higher expected shortfall.

Since according to Pedersen, Fitzgibbons, and Pomorski (2021), the investor type affects ESG returns. It is natural to investigate how firms with different ownership differ. We therefore consider an area still underexplored by comparing the outcomes associated with different ownership structures: state-owned companies and non-state-owned companies.

In contrast to Western economies, China's economy is dominated by state-owned firms, which account for approximately 60% of the country's total market capitalization (Yinan Ni and Yanfei Sun, 2023). The Chinese government implements national strategies and policies through state-owned enterprises, which endow these enterprises with greater responsibility and influence in the Chinese market, including the adoption of the “Double Carbon” policy. Due to their position and influence in the Chinese economy, state-owned enterprises may bear more responsibilities and obligations in implementing the “Double Carbon” policy, and they are also more susceptible to government guidance and influence. While private enterprises are also affected by government policies, they may have relatively more autonomy and flexibility in policy execution and resource allocation compared to state-owned enterprises. Therefore, to further investigate the impact of ESG scores on stock financial performance in the Chinese market, we choose to separately study state-owned enterprises and non-state-owned enterprises to compare whether differences exist in the results. By studying them separately, we can more accurately assess the impact of ESG scores on their financial performance and identify potential differences and special circumstances.

To sum up, this study aims to discuss the following questions: Can investors expect better financial performance by holding higher ESG portfolios in China? Do the impacts of ESG scores vary with ownership structure? To address these questions, our analysis is conducted from these perspectives.

First, we examine the performance of ESG portfolios by comparing the Jensen’s alpha, expected shortfall, and Sharpe ratio of stock portfolios with different ESG scores. We use the dataset of Chinese listed firms in the A-share financial market from Jan 2020 to December 2023. Stocks are categorized into distinct portfolios based on their ESG scores. The equal-weighted returns of each portfolio are then analyzed against a selection of established risk factors through regression in the Fama-French Five-Factor model.

We found that the high-ESG portfolio exhibits the most notable underperformance with the lowest negative Jensen’s alpha, reflected in its lowest Sharpe ratio among all portfolios. Additionally, the positive expected shortfall of the High Minus Low ESG portfolio emphasizes the increased occurrence of extreme losses in high ESG portfolios relative to their low ESG counterparts. These findings indicate a prevalent investor inclination in the Chinese market towards prioritizing higher ESG scores over achieving superior financial performance, particularly in light of the "double carbon" policy.

Second, we categorize all companies listed on the A-share market in China into state-owned enterprises and non-state-owned enterprises, and then conduct further research on each category. Before comparing financial performance under different ownership, we studied the relationship between ESG scores and ownership, and we found that the state-owned companies demonstrate a higher average level of ESG scores. Then Similarly, we adopt three indexes (Jensen's alpha, expected shortfall, and Sharpe ratio) to evaluate the financial performance.

We found that a significant disparity is observed, with state-owned companies showing no significant excess return compared to the market, whereas non-state-owned companies exhibit a notably negative Jensen’s alpha. Moreover, portfolios with high ESG scores consistently underperform those with low ESG scores in terms of the Sharpe ratio. Lastly, our analysis reveals that private ownership typically entails higher risk, as indicated by elevated VaR and ES/CVaR values across all ESG portfolios.

To the best of our knowledge, currently, research into the impact of ESG on stock return is beginning to break down into different industry sectors. However, there are very few studies on the impact of ESG on stock return under different ownership. For instance, regarding the distinction between public and private sectors, Li, H. (2023) discovered that ESG ratings of listed firms in China are more likely to impact the stock returns of non-state-owned companies. This article dives deeper by contributing to providing comprehensive criteria, including risks, return, and return per unit of risk, on the financial differences between state-ownership and non-state-ownership.

The rest of the paper is structured as follows. Section 2 introduces the theoretical framework. Section 3 is the literature review. Sections 4 and 5 introduce data and methodology. Section 6 is the empirical result. Section 7 discusses the results of our empirical analysis and Section 8 concludes.

2. Theoretical framework

2.1 CAPM and Jasen's alpha

In 1952, Markowitz laid the foundation for contemporary portfolio management theory, suggesting that an examination of a portfolio's returns should also consider its associated risk level. Both risk and return are of equal significance; investment decisions cannot be accurately made based solely on high returns or low risk. In essence, the assets that investors ultimately select are those that offer higher returns at the same risk level. The risk and return of an asset can be quantified by its respective variance and mean. state-owed companies An asset is considered to have investment value when its return has a small variance and a high mean.

Sharpe, Lintner, and Mossin, building on the foundation of portfolio theory, have further enhanced the Capital Asset Pricing Model (CAPM). They employed a straightforward linear model to juxtapose the expected returns and anticipated risks of portfolios. As such, the CAPM is a predictive model grounded in the equilibrium of expected returns on risky assets. Its advent has prompted individuals to progressively undertake quantitative research on market risk and to price it appropriately.

Like other theories, the CAPM is also predicated on numerous assumptions. A key presumption is that the market is populated by a substantial number of logical investors, each with varying initial wealth and risk inclinations. The Capital Market Line theory forms the crux of the CAPM model. The effective amalgamation of risk-free securities R_f and the market portfolio forms a ray that connects R_f and the market portfolio, and this line is known as the Capital Market Line (CML, the equation for it is represented as follows:

$$E(r_p) = R_f + \beta_i \left[\frac{E(r_m - R_f)}{\sigma_m} \right] \sigma_p \tag{1}$$

Nonetheless, the Capital Market Line (CML) does not elucidate the risk-return correlation of any security or portfolio. The Security Market Line (SML) encapsulates the study of the relationship between risk and return for any security or portfolio. The SML represents a state of balance where the projected return of a portfolio is directly proportional to the expected return of the market portfolio. The equation for this is represented as follows:

$$E(r_p) = R_f + \beta_i[E(r_m - R_f)]\frac{cov(r_i, r_m)}{var(r_m)} \tag{2}$$

The ratio$\frac{cov(r_i,r_m)}{var(r_m)}$ can be empirically estimated using the data of the market portfolio's return and the return of the asset. Let $\beta_i = \frac{cov(r_i,r_m)}{var(r_m)}$, we get:

$$E(r_i) = R_f + \beta_i[E(r_i - R_f)] + \varepsilon_i \tag{3}$$

The Capital Asset Pricing Model (CAPM) can be expressed in the following manner: Under the presumptions of the CAPM, the anticipated return of a single asset is a linear function of its systematic risk, denoted by β. In a state of equilibrium, the term $\frac{cov(r_i,r_m)}{var(r_m)}$ in the equation denotes the risk compensation that investors demand for bearing the average market risk that surpasses the risk-free return, i.e., the cost of risk.

The CAPM asserts that the expected return rate of a portfolio is exclusively linked to market risk, and the beta coefficient is the exact measure that assesses the level of systematic risk of securities. As a result, the beta value is the only determinant that affects investment returns. From the capital asset pricing model, we deduce that if investors seek to achieve higher returns, they must be willing to take on higher risks. The securities or portfolios they hold must be highly susceptible to market variations. Consequently, the beta coefficient that measures systematic risk will naturally increase with the rise in returns.

The Intercept α_i in CAPM is referred to as Jensen's alpha, a risk-adjusted performance measure employed to evaluate the surplus returns of a portfolio or investment relative to its anticipated returns, given its level of risk as gauged by the CAPM. The CAPM in its excess return form is:

$$r_i - R_f = \alpha_i + \beta_i(r_m - R_f) + \varepsilon_i \tag{4}$$

A positive Jensen's alpha signifies that the portfolio has garnered returns beyond expectations, implying that the fund managers have outperformed the market with their astute selection of stocks. However, a multitude of scholars contend that financial markets are too efficient to maintain positive Alphas unless it occurs by happenstance. Regardless, Alpha continues to be extensively employed to assess the performance of mutual funds and portfolio managers, frequently in conjunction with the Sharpe ratio and Treynor ratio, this provides a comprehensive understanding of the risk and return characteristics of a portfolio or investment. Pedersen, Fitzgibbons, and Pomorski (2021) propose that the relationship between ESG scores and expected returns depends on investors' social preferences and stock market efficiency. They classify investors into three types: Type-A (ESG-aware), Type-U (ESG-unaware), and Type-M (ESG-motivated). Type-A investors utilize ESG information to correct "errors in expectations" and aim to achieve excess risk-adjusted returns by integrating ESG criteria. In contrast, Type-M investors are willing to accept lower portfolio returns for superior social performance. Type-U investors, unaware of ESG scores, focus solely on maximizing their unconditional mean-variance utility.

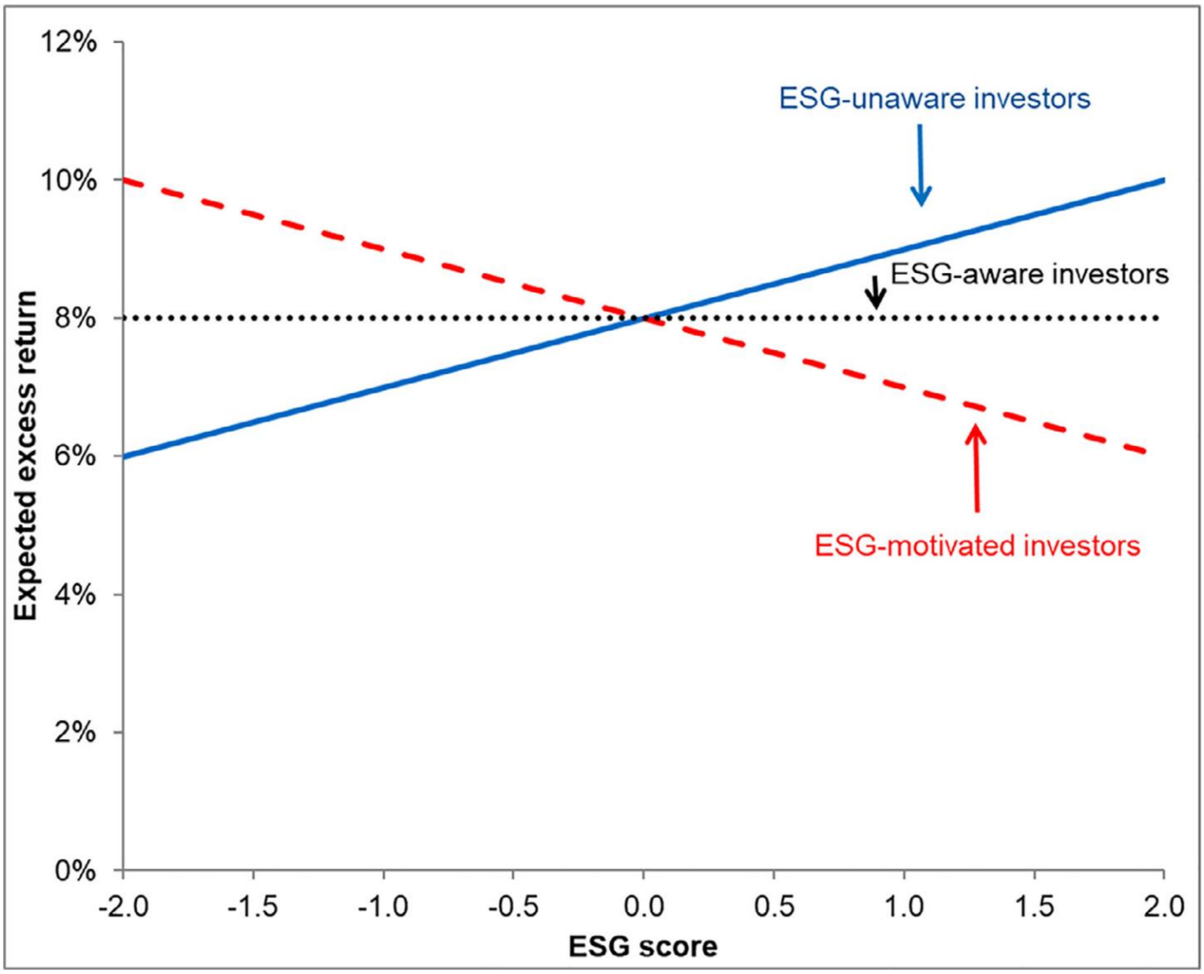
Pedersen, Fitzgibbons, and Pomorski (2021) derive the equilibrium security prices and returns given by an ESG-adjusted CAPM, as seen in Fig. 1. When there are many type-U investors and when high ESG predicts high future profits, high-ESG stocks deliver high expected returns. This occurs because high-ESG stocks are profitable, but their prices are not driven up by Type-U investors, resulting in high future returns. Therefore, in Fig 1, a prevalence of ESG-unaware investors indicates that high ESG scores correlate with high expected excess returns, as the profitability of high ESG is not yet reflected in stock prices, illustrated by an upward sloping line. Conversely, when the economy has many Type-A investors, these investors bid up the prices of high-ESG stocks to reflect their expected profits, eliminating the connection between ESG and expected returns. Therefore, in Fig 1, Many ESG-aware investors lead to no connection (expected profits are priced in), illustrated by a horizontal line. Lastly, negative excess returns (negative Jensen's alpha) may indicate the presence of Type-M investors who prioritize social performance over financial returns. If the economy has many Type-M investors, high-ESG stocks yield low expected returns because ESG-motivated investors are willing to accept lower returns for higher ESG portfolios. Therefore, in Fig 1, there is a negative relationship between ESG scores and expected excess return for type-M investors, illustrated by a downward sloping line.

In the absence of excess returns, it may indicate that investors' focus on ESG factors does not significantly impact the overall returns of their investment portfolios. This could suggest that ESG considerations do not contribute additional value or growth, or alternatively, that the market is highly efficient and cannot generate excess returns through ESG factors.

Figure 1

Environmental, social, and governance-adjusted capital asset pricing model

This graph explains the ESG-CAPM model. It shows how the expected excess return is linked to the ESG score for different kinds of investors. Some investors who don't care about ESG factors believe that a high ESG score means more profit (they haven't factored in the benefits of high ESG into stock prices yet). Others who are aware of ESG factors don't see a connection between them and profits (they've already factored in the expected benefits). However, investors who prioritize ESG considerations tend to think that a high ESG score leads to lower expected profit (they're willing to accept less profit for higher ESG)



Source: Pedersen et al. (2021)

2.2 Expected shortfall

The mean-variance theory proposed by Markowitz (1952) pointed the way to the quantification of financial risk and also marked the first time that mathematical-statistical methods were combined with asset portfolio selection. In this theory, the variance is used to measure the risk of a portfolio. After that, Markowitz (1959) proposed the semi-variance risk measurement method. Semi-variance refers to the portion of investment return lower than the expected rate of return, that is, the part of the risk that the return on investment is lower than the expected rate of return. Since investors are more concerned about the lesser part, the semi-variance is closer to the psychology of investors. After that, some scholars (Konno H, Yamazaki H 1991; Mansini R, Speranza M G 1999) have suggested using absolute deviation and lower semi-absolute deviation for risk measurement. However, the above scholars used an indirect measure of investor's loss represented by variance, which exists in practice with great limitations because most investors tend to care more about their asset losses. Therefore, scholars began to explore the direct measurement of investor losses.

The value-at-risk (VaR) is one of the typical representatives of this kind of risk measurement. It is a financial metric used to estimate the potential loss in value of an investment portfolio over a defined period for a given confidence interval. It quantifies the maximum expected loss over a specified time frame within a given level of confidence.

However, VaR is not perfect. The method only measures the expected maximum loss within a certain probability range, and cannot cover situations where the expected maximum loss is exceeded. Then, in stock market anomalies, where returns behave like "spikes and fat tails", VaR will not be able to measure risks, ignoring extreme events that may cause significant losses. Since VaR also has some flaws of its own, Roekafeller and Uryasev (2000) proposed the Conditional Value at Risk (CVaR), and CvaR which greatly complements the shortcomings of VaR.

Expected Shortfall (ES), also known as Conditional Value at Risk (CVaR), is a risk measure that provides an estimate of the average loss an investment portfolio might experience in the scenarios beyond a specified Value at Risk (VaR) threshold. It tackles certain limitations of VaR by examining the tail of the loss distribution, offering a more holistic perspective on potential extreme losses.

Expected Shortfall (ES) provides some significant advantages over Value at Risk (VaR), particularly in its capacity to encompass tail risk, its status as a coherent risk measure, and its utility in better risk management. Unlike VaR, which only identifies the maximum loss at a given confidence level without considering the potential losses beyond this threshold, ES provides a more precise risk evaluation by taking into account the complete tail of the loss distribution. This means it includes extreme market movements and outliers that can substantially impact a portfolio, making ES particularly useful in stress testing and scenario analysis. Additionally, ES is considered a coherent risk measure because it satisfies the properties of subadditivity, monotonicity, translation invariance, and positive homogeneity. These properties ensure ES behaves in a consistent and theoretically sound manner, promoting diversification, logical consistency, and proper scaling of risk measures. By incorporating the magnitude of extreme losses, ES also enables more robust risk management and capital allocation. It enhances preparedness for financial shocks, allowing institutions to allocate capital more effectively to meet regulatory requirements and ensure solvency during adverse conditions. Furthermore, ES provides a stronger basis for setting risk limits and monitoring compliance, helping institutions implement stricter controls to prevent excessive risk-taking. In performance measurement, ES aids in evaluating risk-adjusted performance, identifying strategies that are not only profitable but also resilient under stress. Overall, ES provides a more comprehensive and insightful approach to risk management, addressing the limitations of VaR and offering valuable tools for handling extreme financial risks.

We prefer to adopt a parametric method to estimate ES instead of a non-parametric method. Parametric methods make the assumption that the data adheres to a particular probability distribution characterized by a finite number of parameters. The simplicity of parametric models allows for easier interpretation of results and understanding of the relationships between variables. With fewer parameters to estimate, parametric models can be more computationally efficient and require fewer computational resources, making them suitable for analyzing large datasets or real-time applications.

Overall, while non-parametric methods have their advantages, such as being distribution-free and requiring fewer assumptions about the data, parametric methods are often preferred in practice due to their simplicity, efficiency, and statistical inference capabilities.

2.3 Sharpe Ratio

Pedersen, Fitzgibbons, and Pomorski (2021) propose a theory suggesting that ESG scores provide insights into firm fundamentals and influence investor preferences. Given that risk and return can be captured by the Sharpe ratio, the optimal solution for balancing risk, return, and ESG characteristics is depicted by an ESG-efficient frontier, which shows the highest Sharpe ratio for each ESG level. This reduces the problem to a trade-off between ESG and the Sharpe ratio. They identify three types of investors: Type-U, Type-A, and Type-M. Type-U (ESG-unaware) investors focus solely on maximizing their mean-variance utility without considering ESG scores. Type-A (ESG-aware) investors also prioritize mean-variance preferences but incorporate ESG scores into their risk and return assessments. Type-M (ESG-motivated) investors value high ESG scores alongside high expected returns and low risk, seeking an optimal balance among these factors.

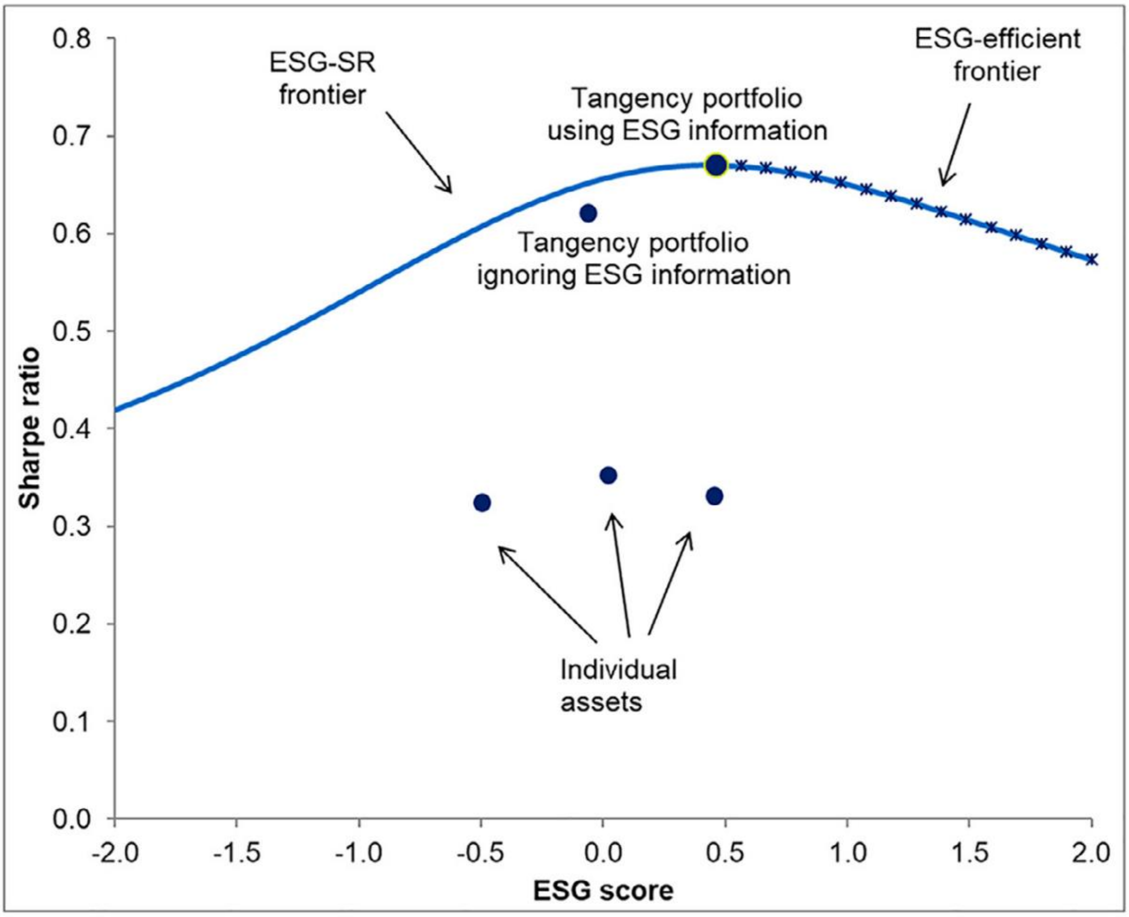
The ESG-SR frontier constructed by Pedersen, Fitzgibbons, and Pomorski (2021) effectively illustrates the investment opportunities available when considering risk, return, and ESG.This frontier depends only on security characteristics; Hence, an investment staff can first mechanically compute the frontier and then the investment board can choose a point on the frontier based on the board's preferences. Further, investors with the same information should agree on the frontier, even if they choose different portfolios along it.

According to Pedersen, Fitzgibbons, and Pomorski (2021), Type-A investors select the portfolio with the highest Sharpe ratio, known as the tangency portfolio using ESG information in Fig. 2. Choosing portfolios below or to the left of the efficient frontier is suboptimal, as investors can improve one or both of the ESG scores and the Sharpe ratio without compromising the other. Nonetheless, Type-U investors may opt for a portfolio below the frontier, as they ignore the ESG-related security information (they condition on less information). Type-M investors, who prefer higher ESG scores, choose portfolios to the right of the tangency portfolio on the ESG-efficient frontier. Specifically, Type-M investors with a slight preference for ESG select portfolios just to the right of the peak, achieving nearly the maximum Sharpe ratio (higher than that achieved by Type-U investors in the example depicted in Fig. 2). Type-M investors with strong ESG preferences choose portfolios on the far right of the ESG-efficient frontier, potentially with lower Sharpe ratios than those chosen by Type-U investors.

Figure 2

ESG-efficient Frontier

This graph illustrates the ESG-SR frontier, which displays the highest Sharpe ratio (SR) possible for a portfolio with a specific ESG score. The Tangency portfolio utilizing ESG data is managed by Type-A investors, representing the portfolio with the highest SR attainable while considering ESG factors. Type-M investors hold portfolios to the right of this tangency portfolio. Conversely, the Tangency portfolio ignoring ESG information is managed by Type-U investors.



Source: Pedersen et al. (2021)

3. Literature review

3.1 ESG versus portfolio financial performance

The quest to understand the relationship between environmental, social, and governance (ESG) criteria and corporate financial performance (CFP) dates back to the early 1970s. Despite extensive research on ESG, controversies persist regarding its impact on stock returns.

Under the framework of stakeholder theory (Freeman 1984b), it's suggested that pursuing ESG strategies could yield additional returns. This theory posits that firms should be accountable to employees, customers, the environment, and shareholders alike, implying that ESG initiatives may enhance firm value. Several studies support this notion, documenting a positive relationship between ESG performance and stock returns. For instance, Friede, Busch, and Bassen (2015) analyzed over 2000 articles and found a modest but positive relationship between ESG and corporate stock returns. Similarly, Lee, Fan, and Wong (2021) and Madhavan, Sobczyk, and Ang (2021), observed a significantly positive correlation between ESG performance and stock returns. In the Chinese market, Chen, Shu; Han, Xiaoyan; Zhang, Zili; Zhao, and Xuejun (2023) provide comprehensive evidence that ESG-focused investors in China can benefit from their choices, with high ESG-scored stocks outperforming those with lower scores.

However, in many researches, scholars have emphasized that the performance of socially responsible investing could vary with time, and specifically, the overperformance of considering ESG would diminish as time passing by. (Borgers, Derwall, Koedijk, & Ter Horst, 2013; Derwall, Koedijk, & Terhorst, 2011; Edmans, 2011). These findings are supported by the errors in expectation theory proposed by Derwall et al. (2011). He suggested that initially investors tend to hold different expectations towards the impact of corporate social responsibility (CSR) and this may result in excess return for socially responsible investment choices. However, as investors gain proficiency in assessing this information, it is anticipated that any abnormal returns linked to corporate sustainability will diminish over time.

In addition, Hong and Kacperczyk (2009) proposed the shunned-stock hypothesis, suggesting that "sin" stocks might yield higher expected returns because institutions constrained by norms often disregard them. Derwall et al. (2011) propose that according to the shunned-stock hypothesis, investors constrained by norms or driven by values typically remove controversial stocks from their portfolios, leading to increased expected returns for these shunned stocks. This impact is expected to endure as investors' ethical and social considerations are unlikely to diminish. Trinks and Scholtens (2017) examined the opportunity cost associated with negative screening in socially responsible investment, discovering that it could diminish the risk-adjusted return of mutual funds. Auer (2016) also observed that positive screening could potentially lead to underperformance of portfolios compared to the benchmark. Di Luo (2022) observed that UK firms in the low ESG quintile outperformed those in the high ESG quintile, suggesting that ESG criteria may not always lead to superior returns.

Moreover, Renneboog, L., J. Ter Horst, and C. Zhang. (2008) found no statistically significant relationship between ESG and stock returns. Zhang, X. Zhao, X. and He, Y. (2022) discovered a non-linear relationship between ESG and portfolio returns, implying that investors cannot achieve excess returns simply by holding high or low ESG-profiled stocks. These findings contribute to the ongoing debate surrounding the relationship between stock returns and ESG scores, especially in China, where ESG investing is still in its early stages.

Pedersen, Fitzgibbons, and Pomorski (2021) suggested that the relationship between ESG and expected returns varies since the market condition is different, proposing that the relationship depends on investors' social preferences and stock market efficiency. This to some extent explains why the controversies are endless. Hence, different regions with different market conditions may exhibit varying relationships between ESG scores and stock returns. Badía, Cortez, and Luis (2020) conducted a worldwide evaluation of ESG investments, analyzing the performance of socially responsible stock portfolios utilizing Environmental, Social, and Governance (ESG) ratings across four regions: North America, Europe, Japan, and Asia Pacific. Their results indicate that the financial effects of socially responsible investing vary depending on geography, evolve over time, and are contingent upon the screening criteria examined.

Regarding the risk represented by Expected shortfall, some of the scholars have incorporated this risk measurement into the evaluation of ESG-related portfolios. Luigi Aldieri, Alessandra Amendola, and Vincenzo Candila (2023) found that the performance of the risk market did not exhibit a positive response to high ESG ratings or a negative response to low ESG ratings, regardless of the tail risk models employed by ESG data providers. There was no indication that this would result in lower performance. Guizhou Liu and Shigeyuki Hamori (2020) assess the potential performance of incorporating various ratios of the ESG index into the portfolio. They assessed criteria such as risk-adjusted return, standard deviation, and conditional value-at-risk (CVaR), finding that the ESG index can effectively reduce potential CVaR while preserving a high return. On the other hand, Chaudhry, S.M. et al. (2023) found that in times of extreme conditions like the global financial crisis and the COVID-19 pandemic, the ESG sector demonstrates the greatest tail risk. Specifically, the ESG sector is highly susceptible to all 10 shocks, with the shock originating from China posing the highest level of risk, compared with other worldwide markets, such as Europe, the Eurozone, the United Kingdom, and the United States.

In terms of methodology, many studies focus on ESG indexes or form portfolios through naïve diversification schemes. For example, Broadstock et al. (2021) compared the performance of high-ESG and low-ESG portfolios during COVID-19 using an equally weighted method.

3.2 ESG and financial performance with different ownerships

3.2.1 The relationship between ESG and ownership

Several studies indicate that state-owned enterprises are actively involved in ESG-related initiatives. Doshi, M. et al. (2024) suggest that "government ownership had a positive and significant impact on the ESG scores of the companies, whereas there is an insignificant relationship with privately owned companies." McGuinness, Vieito, and Wang (2017) find that CSR is significant for Chinese companies with different kinds of ownership. Specifically, they suggest that increased state ownership correlates with greater CSR. Likewise, Hsu, Liang, and Matos (2021) show that state-owned enterprises in emerging markets exhibit a stronger inclination toward addressing environmental and social concerns, though not governance issues. These researches highlighted the relationship between ESG scores and ownership.

Sahasranamam (2020) and Dhanesh (2014) suggest that we can comprehend the influence of state ownership on ESG ratings through institutional theory. This theory posits that government-owned enterprises serve as pivotal institutions with regulatory authority, capable of overseeing firms through legal frameworks and implementing rules and regulations. Additionally, government-owned firms face significant scrutiny from the media and other stakeholders, which prompts increased disclosure of ESG information.

3.2.2 The relationship between ownership and firm performance

Gillan and Wei (2020) note that research commonly regards ownership as a crucial factor influencing both governance and performance outcomes for companies. Yinan Ni and Yanfei Sun (2023) discovered that state-owned firms with larger market capitalizations and better financial and operational performance tend to exhibit better ESG performance. This aligns with the central government's emphasis on high-quality development in China. State-owned enterprises, which hold a significant presence in stock exchanges, are increasingly required to balance financial performance with ESG responsibilities. Buchanan, Cao, and Chen (2018) suggest that institutional owners enhance firm performance by monitoring to ensure alignment between shareholders' and managers' goals, thereby contributing to superior firm performance. Consequently, institutional ownership is expected to positively influence the relationship between ESG and firm performance by addressing agency issues and overinvestment problems through effective managerial oversight and optimal resource allocation.

However, previous studies have demonstrated that excessive governance controls can erode firm value (La Porta et al. 2002). Additionally, institutional involvement may diminish management incentives and integrity (Burkart, Gromb, and Panunzi 1997), potentially resulting in adverse outcomes such as reduced productivity and firm performance.

3.2.3 The impacts of ownership on the ESG-firm performance link are not yet fully discussed

From the literature that we have discussed, we can tell that ownership is a significant determinator when it comes to firm performance and ESG scores. Hence, it is imperative to investigate the ways in which various ownership attributes shape the connection between ESG and company performance within the Chinese markets. Nevertheless, the effects of ownership on the relationship between ESG and firm performance have not been comprehensively explored.

Some scholars have considered studying the impacts of ownership on the ESG-firm performance link. Li, H. (2023) found that ESG ratings of publicly listed companies in China have a greater tendency to influence the stock returns of non-state-owned enterprises. By comparing ESG spillovers and stock returns between samples of state-owned and non-state-owned enterprises, they concluded that non-state-owned firms exhibit a significant and negative correlation with their stock returns. This suggests that within China's financial market, investors may place greater emphasis on the ESG rating scores of non-state-owned firms.

Using ROA as the representative of firm performance, Bilyay-Erdogan, S. and Ozturkkal, B. (2023) found that neither state ownership nor its interaction term has a significant impact, implying that state ownership is not a powerful predictor of a change in ROA and does not moderate the association between ESG and ROA. Except for state ownership and private ownership, Shiyu Wu et al. (2022) focus on executive ownership and institutional ownership. They discovered that executive ownership and institutional ownership play a moderating role in the relationship between ESG performance and firm value, whereas the moderating influence of ownership concentration and equity balance is not deemed significant. These findings enrich the current body of literature on ESG and offer valuable insights for corporations seeking to bolster firm value by enhancing their ESG performance.

To sum up, although there is a lot of discussion about the ownership-ESG link and ownership-firm performance link, the existing literature studying the impacts of ESG scores on financial performance under different ownership is limited and only focuses on a single aspect, such as stock return or ROA. To further and comprehensively investigate this topic and whether the distinction between different ownerships exists, we choose three indexes to analyze the impacts, which are Jensen's alpha (representing abnormal return), Expected shortfall (representing risks), and Sharpe ratio (representing the excess return per risk). In addition, we are going to narrow down the ownership structures into public ownership and private ownership. Hopefully, our studies could make some contributions by providing new insights.

4. Data

In this section, we will establish the sample space, select the sample stocks required for constructing ESG-tiered investment portfolios, and the data needed in the Fama-French five-factor model. All variables used in our empirical analysis are based on daily frequency data.

Our data is primarily sourced from the Wind Financial Terminal, the China Stock Market & Accounting Research Database. The ESG rating data and daily stock data are obtained from the Wind Financial Terminal, while the factors used in the Fama-French models are derived from the China Stock Market & Accounting Research Database. Sector-specific information is gathered from the Thomson Reuters Eikon database.

We will provide a comprehensive summary of the data, emphasizing particularly on the ESG rating data and the data of Fama-French factors in our regression analysis. We will also underscore certain constraints inherent in these data.

4.1 Wind ESG rating

Since the ESG concept's adoption in China's stock market, ESG investing and its quantitative analysis have grown significantly. Apart from some international institutions, China has its own ESG databases including China Alliance of Social Value Investment, SynTao Green Finance and Wind Financial Terminal, etc. We choose to obtain our ESG rating data from one of these local data institutions, Wind Financial Terminal, which is derived from the Chinese local market and offers a more localized perspective.

The Wind ESG Rating amalgamates the policies and existing ESG disclosures of Chinese firms, utilizing its robust abilities in data gathering, analysis, and processing to establish a distinctive ESG rating structure tailored specifically for Chinese enterprises.

Table 1

Percentage of Companies with Wind ESG Rating, 2018-2023

This table presents annual statistics for A-share listed companies from 2018 to 2023, highlighting the number of companies receiving Wind ESG ratings each year. It also shows the proportion of companies rated. The data indicates a general upward trend in both the number of listed companies and those with ESG ratings, with the percentage consistently above 90%.

	2018	2019	2020	2021	2022	2023	Trend
Number of A-Share Listed Companies	3578	3765	4140	4697	5079	5335	
Number of Wind ESG Ratings	3476	3575	3801	4676	4817	5106	
Percentage of Companies with Wind ESG Ratings	97.15%	94.95%	91.81%	99.55%	94.84%	95.71%	

In terms of the rating criteria, the WIND ESG rating structure encompasses the management practices score, the controversial events score, the environmental score, the social score, and the governance score component. These collectively represent the company's enduring ESG fundamental impact and the effect of short-term risk. The ESG score is composed of 3 pillars, 25 issues, and more than 2,000 data points.

Table 2

ESG Rating Index System of Wind

This table provides a detailed categorization of corporate social responsibility into three main aspects: Environment, Society, and Corporate Governance in the Wind ESG Rating Index System, each further divided into subcategories with specific focus areas.

First-level	*Second-level*	*Third-level*
E Environment	E1 Environmental Management	Environmental Management System, Management Goals, Employee Environmental Awareness, Energy and Water Conservation Policies
	E2 Environmental Disclosure	Energy Consumption, Energy Conservation, Water Consumption, Greenhouse Gas Emissions, etc.
	E3 Negative Environmental Events	Water Pollution, Air Pollution, Solid Waste Pollution
S Society	S1 Employee Management	Labor Policies, Anti-forced Labor, Anti-discrimination, Female Employees, Employee Training, etc.
	S2 Supply Chain Management	Supply Chain Responsibility Management, Supervision System, etc.
	S3 Customer Management	Customer Information Confidentiality, etc.
	S4 Community Management	Community Communication, etc.
	S5 Product Management	Fair Trade Products, etc.
	S6 Philanthropy and Donations	Corporate Foundations, Donations and Public Welfare Activities, etc.
	S7 Negative Social Events	Negative Events Involving Employees, Supply Chain, Customers, Society, and Products
G Corporate Governance	G1 Business Ethics	Anti-corruption and Bribery, Whistleblowing System, Tax Transparency, etc.
	G2 Corporate Governance	Information Disclosure, Board Independence, Executive Compensation, Board Diversity, etc.
	G3 Negative Corporate Governance Events	Business Ethics, Negative Corporate Governance Events

4.2 Fama-French Factors Data

We utilize the China Stock Market & Accounting Research Database to get the five factors' data we need for the construction of the Fama-French five-factors model.

For the Market Risk Premium (Rm-Rf), the surplus return of the market portfolio, we use the data of all A-shares outstanding market capitalization-weighted index to represent Rm, as for the Rf, the risk-free rate, we represented it by the One-year deposit rate in Chinese Capital Market. For other factors, we use the data from the database we mentioned directly.

4.3 Data Selection

4.3.1 Determine the sample interval:

Considering the late start of China's ESG investment fund market, the concept of ESG investment has not yet spread in China's capital market in the longer term and investors' understanding of ESG investment is relatively low, Aligned with the Chinese government's "Double Carbon" policy, which aims to achieve carbon peaking and carbon neutrality starting in 2020.

Furthermore, 2020 was the year when the COVID-19 pandemic began in China, presenting considerable challenges in terms of health and safety. This raises the question of whether companies with superior ESG ratings can yield sustainable returns amidst such crises. Furthermore, it is worth investigating whether companies with lower ESG scores demonstrate greater resilience to risks, thereby achieving effective excess returns during this unforeseen 'black swan' event. Lastly, it is crucial to ascertain whether investors exhibit a preference for companies demonstrating superior corporate governance performance.

So we chose to select daily data from 2020 to 2023. covering the entire Chinese Stock Market. After excluding delisted companies, companies with incomplete data due to mid-listing, and companies that have been on ST for a certain period, and getting rid of some companies with missing values and outliers, we are left with a sample of over 2000 companies.

To distinguish state-owned companies, we collected data from the Thomson Reuters Eikon database. Companies whose ultimate parent entity is the Government of the People's Republic of China are classified as state-owned, while those with other ultimate parent entities are classified as non-state-owned.

4.3.2 Summary statistics of selected data

We have conducted an analysis of the descriptive statistics of the ESG data across all chosen periods, as depicted in the subsequent table. The appendix will contain the descriptive statistics of the ESG performance data for each year.

Table 3

2020-2023 Wind ESG Rating Data Descriptive Statistics

We get the mean ESG score for all companies in our sample (2144) for the period 2020-2023, divide them into state-owned and non-state-owned sectors, and made the following descriptive statistics

	N	Median	Max/Min	Std.Dev.	Kurtosis	Skewness
Total	2144	5.93	9.16/3.99	0.69	0.76	0.40
State-Owned	163	6.13	8.65/4.68	0.70	0.73	0.59
Non-State-Owned	1981	5.90	9.16/3.99	0.69	0.76	0.39

Our comprehensive sample encompasses 2,144 listed companies, inclusive of 163 state-owned companies and 1,981 non-state-owned companies. As depicted in Table 3, the average ESG score for the entire sample from 2020 to 2023 is 5.93, with the average ESG score of state-owned companies significantly surpassing that of non-state-owned companies.

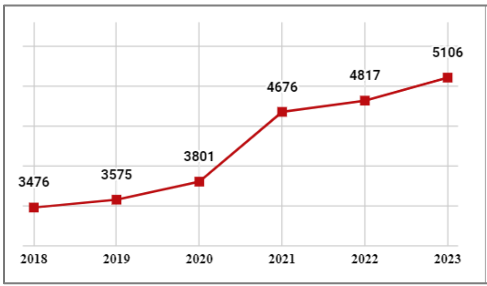
In the context of kurtosis, the overall kurtosis is 0.76, the kurtosis for state-owned companies is 0.73, and the kurtosis for non-state-owned companies is 0.76. The ESG performance distribution for the overall sample and non-state-owned companies is relatively peaked, while the distribution for state-owned companies' ESG performance is comparatively flat. Regarding skewness, the overall skewness is 0.40, the skewness for state-owned companies is 0.59, and the skewness for non-state-owned companies is 0.39. This indicates that the ESG performances for the overall sample, state-owned companies, and non-state-owned companies are all right-skewed, signifying that the majority of the ESG performances are distributed in the lower range, but there are also some higher ESG performances present.

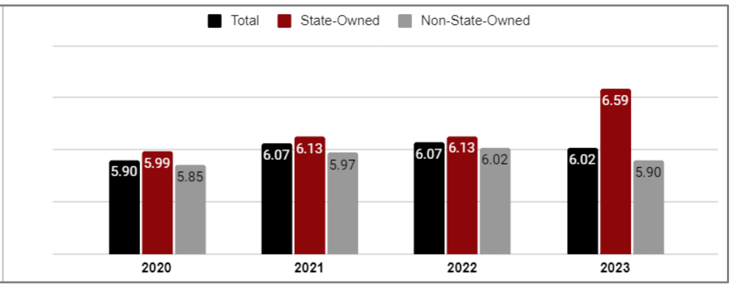
Table 4

Wind ESG Performance in 2020-2023

Panel 1 is the number of listed stocks covered by Wind ESG Rating between 2020-2023

Panel 2 depicts the mean Wind ESG score per firm from 2020 to 2023, factoring in both state-owned and non-state-owned sectors.





As known from Table 4, the number of companies with Wind ESG scores increased significantly between 2018 and 2023, especially after 2020 when it grew by only 1,300. There is a substantial increase in the average ESG scores of state-owned companies between 2020 and 2023, reflecting the efforts of state-owned companies to improve their ESG during the re-period. In contrast, the average ESG scores of non-state-owned companies are flatter on a standardized basis.

We possess a table that delineates the statistical characteristics of the variable in the model. Each variable has 970 observations.

Table 5

Summary of the statistical data related to the risk factors of Fama and French

This table provides a summary of the statistical data related to the risk factors of Fama and French, which are used in the regression analyses from 2020 to 2023. These factors include Mkt-Rf (excess market return), SMB (size factor), HML (value factor), RMW (profitability factor), CMA (investment factor), and the risk-free rate (Rf).

The table provides the number of observations (N), mean (annualized), maximum and minimum values, standard deviation (annualized), skewness, and kurtosis.

	N	Mean	Max/Min	Std.Dev.	Kurtosis	Skewness
Frama-French 5 factors						
Mkt-Rf	970	0.000185	0.0406/-0.0817	0.011748	4.202492	-0.769198
SMB	970	0.000388	0.0277/-0.0405	0.007827	1.698534	-0.283269
HML	970	0.000183	0.0321/-0.0295	0.008148	0.800261	0.341046
RMW	970	-0.000048	0.0372/-0.0396	0.007991	2.244716	-0.006496
CMA	970	0.000134	0.0412/-0.0337	0.008696	1.647362	0.180985
Rf	970	0.000041	-	0.000000	-2.004137	1.001549

4.3.3 Data Limitation

The count of non-state-owned companies in the sample stands at 1981, which significantly outnumbers the state-owned companies, with a count of 163. Therefore, the statistical results of the second group will have a greater impact on the overall sample. This explains why the results of the overall sample are always very close to the results of the group with a larger second sample.

However, this does not mean that the results of the state-owned sector are not important or can be ignored. When analyzing data, we need to consider all information, including those groups with smaller sample sizes. Although they may have less impact on the overall results, they may contain some important information, such as outliers or particular trends. Under the circumstance that we are unable to collect a larger sample size of state-owned companies, we will use these data for further empirical analyses.

5. Methodology

5.1 Hypothesis

First and foremost, to elucidate a correlation between ESG and stock returns in general
The first hypothesis is outlined as follows:

- *H1. Portfolios characterized by higher ESG ratings typically demonstrate negative alpha and anticipate lower stock returns compared to those with lower ratings.*

Additionally, this implies that the Sharpe ratio will be similarly affected. ollowing the implementation of the "double-carbon policy," the majority of investors in the Chinese market are expected to fall into the Type-M category. Therefore, the second hypothesis is formulated as follows:

- *H2. Portfolios characterized by higher ESG ratings ratings lead to a lower Sharpe ratio.*

In addition, regarding the risks represented by the Expected Shortfall, we expect that the higher ESG may come with higher risks. The third hypothesis is:

- *H3. Portfolios characterized by higher ESG ratings lead to a higher Expected Shortfall.*

Finally, it is important to consider the differences between state-owned and non-state-owned companies. Considering that state-owned companies are more likely to react to national policies, it is more likely that state-owned companies will be willing to sacrifice portfolio returns for high ESG, and thus we predict that there should be differences in financial performance, including return, Sharpe ratio and expected shortfall between state-owned companies and non-state-owned companies.

- *H4. There is a significant difference in returns of ESG-related portfolios between state-owned companies and non-state-owned companies*

- *H5. There is a significant difference in the Sharpe ratio of ESG-related portfolios between state-owned companies and non-state-owned companies*

- *H6. There is a significant difference in the Expected shortfall of ESG-related portfolios between state-owned companies and non-state-owned companies*

5.2 Portfolio construction

5.2.1 ESG portfolio construction

Drawing upon the empirical methodology of AHXZ (2006), we construct three distinct types of portfolios, each equally weighted and based on the ESG ratings of the chosen companies. These are ranked from highest to lowest as follows:

High ESG Portfolio: This includes companies within the sector that are in the top 30% in terms of their ESG ratings.

Medium ESG Portfolio: This comprises companies that fall within the median range of ESG ratings in the sector.

Low ESG Portfolio: This encompasses companies in the sector that are in the bottom 30% based on their ESG ratings.

5.2.2 Portfolio Return

Since the stocks are equally weighted in each portfolio, regardless of the size or market capitalization of the company, each stock will contribute the same proportion to the overall portfolio. This approach enhances diversification as smaller companies are accorded the same weightage as their larger counterparts, potentially mitigating the risk linked to any individual stock. The returns for the portfolios are computed as the mean of the returns of the stocks within each portfolio. The daily return, denoted as $r_{i,t}$, for all companies in the portfolios is calculated according to:

$$r_{i,t} = \frac{Close\ price_{i,t}}{Close\ price_{i,t-1}} - 1 \tag{5}$$

In addition to allocating all the selected companies into these three types of ESG rating portfolios, we divided the companies into state-owned and non-state-owned sectors, each with its own ESG rating portfolios. Also, these portfolios require regular rebalancing to maintain equal weights, the ESG ratings are updated annually, resulting in changes to the stocks within each portfolio every year. Consequently, we will create three types of portfolios for all selected companies and each of the two sectors from 2020 to 2023, resulting in a total of 36 portfolios.

5.2.3 HML ESG portfolio

A high-minus-low ESG portfolio (HML portfolio) is a strategy we employ to assess the daily return differential across a range of portfolios. By comparing the daily returns of these two portfolios, we can evaluate the performance of High ESG companies versus Low ESG companies.

6. Empirical result

6.1 Portfolio return: regression models with Jensen's alpha

In this segment, we will delve into the correlation between excess returns and ESG ratings, commencing with the overall sample, and investigate whether the outcomes align with our Hypothesis H1. Portfolios with superior ESG ratings typically display negative alpha and diminished anticipated stock returns in comparison to portfolios with inferior ratings.

Subsequently, we will address the hypotheses in relation to the two distinct sets of results for state-owned companies and non-state-owned companies as per Hypothesis H4. There exists a notable disparity in returns of ESG-related portfolios between state-owned companies and non-state-owned companies.

6.1.1 Preliminary investigation - Correlation test

Prior to executing the regression, we initially employed Spearman's rank correlation coefficient to undertake a preliminary exploration of the relationship between ESG ratings and stock returns. We opt to average the daily returns and ESG ratings of the 2144 companies in the sample over the period from 2020 to 2023 to derive two series for the correlation test. These series are then segregated into the state-owned sector and non-state-owned sector. The outcomes of this analysis are presented in the subsequent table.

Table 5

Correlation test - Spearman's rank correlation coefficient

This correlation matrix provides an initial examination into the association between ESG Score and Stock Return across the Overall, State-Owned, and Non-State-Owned sectors. Both the Overall and Non-State-Owned sectors exhibit a negative correlation, implying that higher ESG scores are linked to lower stock returns. In contrast, the State-Owned sector demonstrates a mild positive correlation. These results underscore the complex interplay between ESG factors and financial performance across distinct sectors. The significance levels for p-values are denoted as *p<0.1,**p<0.05,***p<0.01.

Overall

			ESG Score	Stock Return
Spearman Rho	ESG Score	Correlation Coefficient	1.000	-0.045**
		Sig (two-tailed)		0.024
		N	2144	
	Stock Return	Correlation Coefficient	-0.045**	1.000
		Sig (two-tailed)	0.024	
		N	2144	2144

State-Owned Sector

			ESG Score	Stock Return
Spearman Rho	ESG Score	Correlation Coefficient	1.000	0.028
		Sig (two-tailed)		0.712
		N	163	
	Stock Return	Correlation Coefficient	0.028	1.000
		Sig (two-tailed)	0.712	
		N	163	163

Non-State-Owned Sector

			ESG Score	Stock Return
Spearman Rho	ESG Score	Correlation Coefficient	1.000	-0.043**
		Sig (two-tailed)		0.038
		N	1981	
	Stock Return	Correlation Coefficient	-0.043**	1.000
		Sig (two-tailed)	0.038	
		N	1981	1981

From the table, it is discernible that the overall correlation coefficient between the average daily returns of the companies within the sample and their average ESG scores is -0.0445, with a p-value of 0.0243 and significant at the 5% level, indicating that while the correlation between these two variables is quite low, it is nonetheless statistically significant. This is akin to the result for the non-state-owned sector, which has a correlation coefficient of -0.043 and a p-value of 0.038. In other words, for both the overall and non-state-owned sectors, even though the correlation between these two variables is not strong, there is some correlation. The negative sign before the correlation coefficient suggests that companies with high ESG may have smaller daily returns.

We conducted the same test on the state-owned sector and arrived at a completely different conclusion. For companies in the state-owned sector, the Spearman correlation coefficient is 0.028 with a p-value of 0.712, which is not statistically significant. In other words, we fail to reject the null hypothesis that there is no significant correlation between the average daily returns of the companies in the state-owned sector and their average ESG scores.

However, these findings alone are not sufficient to conclude whether corporate ESG ratings have any impact on stock investment returns. Therefore, we will next use the Jesen's alpha in the Fama-French five-factor model to test whether there are significant abnormal returns for the different ESG-rating portfolios.

6.1.2 Fama-French three-factor and five-factor model

The Fama-French five-factor model, an extension of the Capital Asset Pricing Model (CAPM), suggests that in addition to the market risk premium factor, there are size factors and book-to-market ratio factors that can affect a portfolio's excess return.

Using the Fama-French three-factor model as a reference, we develop a regression model with the goal of determining the excess returns of investment portfolios that have different corporate ESG ratings. The Fama-French three-factor model of the investment portfolio is presented as follows:

$$r_{i,t} - r_{f,t} = \alpha i + \beta i(r_{m.t} - r_{f,t}) + siSMB_{i,t} + hiHML_{i,t} + \varepsilon_{i,t} \tag{6}$$

In the given equation, $r_{i,t} - r_{f,t}$ denotes the excess return of portfolio i over the risk-free interest rate for month t. This is accounted for by the excess return of the market $r_{m.t} - r_{f,t}$, along with the size and value factors represented as $SMB_{i,t}$, $HML_{i,t}$. The coefficient αi is calculated and represents an abnormal return. A significant and positive alpha implies that the portfolio has surpassed its expected return based on the CAPM, whereas a negative value indicates underperformance.

The Fama-French five-factor model extends the three-factor model by incorporating two additional factors: profitability and investment, which are represented by RMW and CMA, The Fama-French five-factor model of the investment portfolio is as follows:

$$r_{i,t} - r_{f,t} = \alpha i + \beta i(r_{m.t} - r_{f,t}) + siSMB_{i,t} + hiHML_{i,t} + riRMW_{i,t} + ciCMA_{i,t} + u_{i,t} \qquad (7)$$

We will employ the Fama-French five-factor model in Equation 7 to probe the presence of abnormal returns as dependent variable is the portfolio excess returns $r_{i,t} - r_{f,t}$. To affirm the robustness of the outcomes, we also corroborate the results utilizing Equation 6, which is the Fama-French three-factor model.

1). Empirical Tests of the Fama and French Five-Factor Model

a. Correlation

Table 6

Correlation Matrix of Fama-French five-factor

This table presents a correlation matrix of five financial risk factors. The matrix provides insights into the relationships among these factors, crucial for financial analysis and investment decisions. the correlation results of the correlation test between the variables have an absolute value of less than 0.8, which leads to the conclusion that the model does not have serious multicollinearity problems.

	Rm-Rf	SMB	HML	RMW	CMA
Rm-Rf	1.000	-0.053	-0.270	0.577	-0.202
SMB	-0.053	1.000	0.201	-0.770	0.610
HML	-0.270	0.201	1.000	-0.480	0.750
RMW	0.577	-0.770	-0.480	1.000	-0.622
CMA	-0.202	0.610	0.750	-0.622	1.000

In the correlation matrix of five factors, Rm-Rf positively correlates with RMW (0.577), indicating that higher market risk in the Chinese stock market may lead to increased profitability. It negatively correlates with SMB, HML, and CMA. SMB negatively correlates with RMW (-0.770) and positively with CMA (0.610), suggesting that smaller firms have lower profitability but higher investment levels. HML positively correlates with SMB and CMA but negatively with Rm-Rf and RMW, indicating that value stocks are small-cap, high-investment, with lower market risk premiums and profitability. RMW negatively correlates with SMB and CMA but positively with Rm-Rf, suggesting high-profit firms are large-cap with low investment levels. Lastly, CMA positively correlates with SMB and HML but negatively with RMW, indicating conservative investment strategies are common in small-cap companies with high book-to-market ratios and lower profitability.

Overall, the correlation results of the correlation test between the variables have an absolute value of less than 0.8, which leads to the conclusion that the model does not have serious problems. The model does not have serious multicollinearity and meets our requirements for conducting the regression analysis.

b. Stationarity

Table 7

ADF test results for sequence stationarity

The table presents the Augmented Dickey-Fuller (ADF) test outcomes, which include the test statistics and their corresponding p-values for the factors in the FF5 model across different groups. Each variable exhibits a significant negative ADF statistic (with a p-value of 0.000), indicating their stationarity and appropriateness for time series analysis. This suggests that the variables are stationary and suitable for time series analysis. The asterisks denote the significance levels for the p-values: * for p<0.1, ** for p<0.05, and *** for p<0.01.

Variable	ADF Statistic	p-value
Ri-Rf (High ESG)	-17.158***	0.000
Ri-Rf (Medium ESG)	-17.063***	0.000
Ri-Rf (Low ESG)	-16.872***	0.000
Rm-Rf	-29.971***	0.000
SMB	-19.856***	0.000
HML	-8.945***	0.000
RMW	-19.315***	0.000
CMA	-20.017***	0.000

To avoid spurious regression, we conducted a unit root test. The smaller the value of the ADF statistic, the stronger the evidence against the null hypothesis that there is a unit root. In our results, we can see that the average values of the ADF test for the three-factor variable data of the portfolios are far less than 0, indicating that the selected sample data have passed the ADF stationarity test and are stationary sequences. Subsequent analysis can be carried out.

2). Empirical results of the F-F three-factor model

a. Overall

Table 8 outlines the outcomes of an extensive regression analysis performed on a variety of firms during the 2020-2023 period in the Fama-French Five Factor model.

The FF5 alpha, an essential element of this model, measures the surplus return of a portfolio over the benchmark, considering these risk factors. In the context of our model, all portfolios with ESG ratings exhibit negative alpha values. This implies that the actual returns of these portfolios are less than the anticipated returns, signifying underperformance.

Interestingly, except for the HML portfolio, all alphas are relatively low and highly significant during the period under consideration, the values of FF alpha in the High ESG and Low ESG portfolios are fairly comparable, with both trailing the Medium ESG portfolio in terms of excess returns. This underperformance is further highlighted by the fact that the HML portfolio displays a negative value, suggesting that the Low ESG portfolio surpasses the High ESG portfolio, this observation is consistent with our initial hypothesis.

However, due to the absence of statistical significance, we cannot conclusively assert that the HML portfolio underperforms the market. Consequently, we find no compelling evidence to indicate a correlation between ESG ratings and stock returns, which suggests that ESG investment strategies may not have a significant influence on investment returns. Therefore, investors and stakeholders should exercise prudence and conduct comprehensive due diligence before making investment decisions based on ESG ratings.

Table 8

The FF5 regression outcomes for the Overall ESG rating portfolios.

In this model we have 970 observations in total, spanning from January 2, 2020, to December 29, 2023. The t-statistic is indicated in parentheses, and the asterisks denote the significance levels for the p-values: * for p<0.1, ** for p<0.05, and *** for p<0.01.

Portfolio	(1)	(2)	(3)	(4)
Variables	High ESG	Medium ESG	Low ESG	HML
FF5 alpha	-0.0001597**	-0.00012*	-0.0001595**	-0.00004
	(-2.1004)	(-1.7854)	(-2.5036)	(-0.4593)
Rm-Rf	1.01331***	1.02089***	0.99081***	0.02250***
	(149.5360)	(177.0515)	(174.0011)	(2.8413)
SMB	0.44783***	0.65223***	0.69842***	-0.25058***
	(26.8549)	(45.9641)	(49.8402)	(-12.8610)
HML	-0.19682***	-0.07566***	0.23171***	-0.42853***
	(-11.6330)	(-5.2552)	(16.2976)	(-21.6779)
RMW	-0.08954***	-0.09722***	-0.03481**	-0.05473**
	(-4.2337)	(-5.4023)	(-1.9588)	(-2.2148)
CMA	0.13914***	0.06766***	0.00256	0.13658***
	(6.0512)	(3.4582)	(0.1324)	(5.0839)
R Square	0.9670	0.9774	0.9758	0.5645
Adj. R Square	0.9669	0.9773	0.9757	0.5623

Our model effectively explains portfolio return variations, as indicated by the R-squared values close to 1 for all four portfolios. The significant coefficients for Rm-Rf, SMB, HML, RMW, and CMA across all portfolios suggest high correlations with market returns, small-cap stock returns, value stock returns, profitability factor, and investment factor respectively.

Drawing upon the table provided, we have meticulously integrated the results of both the FF3 and FF5 models to conduct a robustness test. The table includes two key metrics: FF3 alpha and FF5 alpha, the FF3 alpha considers three factors (Rm-Rf, SMB, HML), while the FF5 alpha considers five factors (adding RMW, and CMA to the FF3 factors). The outcomes affirm the robustness of our findings, which is the tendency for portfolios with diminished ESG ratings to fall short in performance. The implication is that elevated ESG ratings don't always correlate with enhanced performance once market risk factors are taken into account.

Table 9

Overall Robustness tests

This table showcases the FF3 alpha and FF5 alpha (please refer to Table 8 for more details) for the robust test for the overall sample. Each model comprises 970 observations, covering the period from January 2, 2020, to December 29, 2023. The t-statistic is presented in parentheses, and the asterisks denote the significance levels for the p-values: * for p<0.1, ** for p<0.05, and *** for p<0.01.

Portfolio	(1)	(2)	(3)	(4)
Variables	High ESG	Medium ESG	Low ESG	HML
FF3 alpha	-0.00021***	-0.00016**	-0.00017***	-0.0008
	(-2.6855)	(-2.3628)	(-2.6803)	(-0.9342)
FF5 alpha	-0.0001597**	-0.00012*	-0.0001595**	-0.00004
	(-2.1004)	(-1.7854)	(-2.5036)	(-0.4593)

b. The non-state-owned sector

Table 10 provides a comprehensive presentation of the outcomes derived from a Fama-French five-factor model regression analysis. This analysis was meticulously conducted on a select group of non-state-owned firms over a four-year period from 2020 to 2023.

The results of the model indicate that the alpha values for the High ESG, Medium ESG, and Low ESG portfolios are statistically significant. This points to a significant discrepancy between the actual returns and the expected returns for these ESG-rated portfolios. In contrast, the alpha value for the HML portfolio is not statistically significant, suggesting that this portfolio may not deliver a significant excess return. It's worth noting that portfolios with a significant alpha are generally anticipated to yield a negative excess return.

Upon detailed scrutiny of the FF-5 alpha values, we find that all alphas for the ESG-rated portfolios are nearly zero. Among these, the Medium ESG portfolio displays the highest alpha. Interestingly, the alpha of the Low ESG portfolio (-0.00015) exceeds that of the High ESG portfolio (-0.00022). Moreover, the HML portfolio shows a negative figure. These findings imply that within the sector of non-state-owned companies, firms with lower ESG scores are more likely to outperform those with higher ESG scores. This intricate understanding of the relationship between ESG scores and portfolio performance can offer valuable insights for investors and stakeholders.

Table 10

The regression outcomes for the non-state-owned ESG rating portfolios.

In this model we have 970 observations in total, spanning from January 2, 2020, to December 29, 2023. The t-statistic is indicated in parentheses, and the asterisks denote the significance levels for the p-values: * for p<0.1, ** for p<0.05, and *** for p<0.01.

Portfolio	(1)	(2)	(3)	(4)
Variables	High ESG	Medium ESG	Low ESG	HML
FF5 alpha	-0.00022*	-0.00012*	-0.00015***	-0.00003
	(-1.8539)	(-1.6861)	(-3.4022)	(0.3659)
Rm-Rf	1.05337***	1.05160***	1.02989***	0.02348***
	(148.6483)	(161.9492)	(178.0792)	(2.9838)
SMB	0.62161***	0.77861***	0.82622***	-0.20461***
	(35.6453)	(48.7245)	(58.0528)	(-10.5646)
HML	-0.31702***	-0.20410***	0.10916***	-0.42618***
	(-17.9177)	(-12.5886)	(7.5597)	(-21.6888)
RMW	-0.02452**	-0.04810**	-0.02605**	0.00153
	(-1.1087)	(-2.3732)	(-1.4434)	(0.0624)
CMA	0.23291***	0.15189***	0.02948**	0.20343***
	(9.6860)	(6.8936)	(1.5023)	(7.6175)
R Square	0.9690	0.9749	0.9782	0.5073
Adj. R Square	0.9689	0.9748	0.9781	0.5047

We juxtapose the outcomes of the Fama-French three-factor model with those of the Fama-French five-factor model to conduct a robustness test, and the results prove to be robust. This robustness test indicates that portfolios with lower ESG ratings are prone to underperformance. It infers that high ESG ratings do not invariably result in superior performance when adjusting for market risk factors. However, it's crucial to acknowledge that ESG investing also strives to yield a positive societal impact beyond mere financial returns.

Table 11

The non-state-owned sector Robustness tests

This table showcases the FF3 alpha and FF5 alpha (please refer to Table 10 for more details) for the robust test for the non-state-owned sector sample. Each model comprises 970 observations, covering the period from January 2, 2020, to December 29, 2023. The t-statistic is presented in parentheses, and the asterisks denote the significance levels for the p-values: * for p<0.1, ** for p<0.05, and *** for p<0.01.

Portfolio	(1)	(2)	(3)	(4)
Variables	High ESG	Medium ESG	Low ESG	HML
FF3 alpha	-0.00020**	-0.00017**	-0.00023***	-0.00001
	(-2.3731)	(-2.2078)	(-3.6131)	(-0.0923)
FF5 alpha	-0.00022*	-0.00012*	-0.00015***	-0.00003
	(-1.8539)	(-1.6861)	(-3.4022)	(0.3659)

c. The state-owned sector

the ESG rating portfolios in the state-owned sector do not show any significant alpha. The alpha values are not just insignificant but also tend to hover below zero and even though the alpha is quite small we still can observe that the Low ESG portfolio is fell behind the High ESG portfolio and The HML portfolio also displayed a positive alpha. However, in the results of the robust test, the FF3 alpha for the High ESG portfolio turned negative, and the FF3 alpha for the HML portfolio showed a reverse outcome, which is not consistent with FF5 results, which means this sector did not pass the robustness test criteria, suggesting that there might be no evidence to draw a correlation between the ESG ratings of state-owned firms and stock returns.

Table 12

The regression outcomes for the state-owned ESG rating portfolios.

In this model we have 970 observations in total, spanning from January 2, 2020, to December 29, 2023. The t-statistic is indicated in parentheses, and the asterisks denote the significance levels for the p-values: * for p<0.1, ** for p<0.05, and *** for p<0.01.

Portfolio	(1)	(2)	(3)	(4)
Variables	High ESG	Medium ESG	Low ESG	HML
FF5 alpha	0.00000	0.00006	-0.00009	0.00005
	(-0.0116)	(0.4321)	(-0.6084)	(0.2671)
Rm-Rf	1.06148***	1.09023***	1.04488***	0.01660**
	(80.0754)	(86.2995)	(77.8430)	(1.0187)
SMB	0.14008***	0.18886***	0.41364***	-0.27356***
	(4.2939)	(6.0747)	(12.5220)	(-6.8223)
HML	-0.05915**	0.02607**	0.35269***	-0.41184***
	(-1.7870)	(0.8264)	(10.5236)	(-10.1233)
RMW	-0.28834***	-0.36238***	-0.22352***	-0.06481**
	(-6.9694)	(-9.1910)	(-5.3356)	(-1.2746)
CMA	0.20493***	0.19500***	0.01550	0.18943***
	(4.5558)	(4.5487)	(0.3404)	(3.4261)
R Square	0.8868	0.9038	0.8843	0.1859
Adj. R Square	0.8862	0.9033	0.8837	0.1817

Table 13

The non-state-owned sector Robustness tests

This table showcases the FF3 alpha and FF5 alpha (please refer to Table 12 for more details) for the robust test for the state-owned sector sample. Each model comprises 970 observations, covering the period from January 2, 2020, to December 29, 2023. The t-statistic is presented in parentheses, and the asterisks denote the significance levels for the p-values: * for p<0.1, ** for p<0.05, and *** for p<0.01.

Portfolio	(1)	(2)	(3)	(4)
Variables	High ESG	Medium ESG	Low ESG	HML
FF3 alpha	-0.00013	-0.00009	-0.00016	-0.00001
	(-0.8270)	(-0.5717)	(-1.0640)	(-0.0508)
FF5 alpha	0.00000	0.00006	-0.00009	0.00005
	(-0.0116)	(0.4321)	(-0.6084)	(0.2671)

6.2 Portfolio risk: Expected shortfall

In our analysis, we adopt three parametric methods to calculate the Expected Shortfall (ES) for different portfolios: the normal distribution method, the t-distribution method, and the Peaks Over Threshold (POT) method. Each of these methodologies presents unique methods for assessing tail risk, offering a comprehensive perspective on potential extreme losses.

The normal distribution method assumes that portfolio returns follow a normal distribution, characterized by its mean and standard deviation. To calculate the Expected Shortfall (ES) using the normal distribution method, the process involves several steps centered around the properties of the normal distribution. This begins with determining the mean (μ) and standard deviation (σ) of the portfolio returns, which are essential parameters for defining the normal distribution of the returns.

Once the mean and standard deviation are calculated, the next step is to set the confidence level, which in this case is 95%. This confidence level indicates that we are interested in the worst 5% of potential losses. Using this confidence level, we then calculate the Value at Risk (VaR). The VaR at the 95% confidence level is determined using the inverse of the cumulative distribution function (CDF) of the normal distribution. The formula for VaR is given by:

$$VaR_\alpha = \mu + \sigma z_\alpha \tag{8}$$

Here, z_α is the Z-score corresponding to the 95% confidence level.

Following the calculation of VaR, we proceed to determine the Expected Shortfall (ES). ES is the conditional expectation of loss given that the loss is beyond the VaR threshold. For a normally distributed portfolio, the ES at the 95% confidence level can be derived using the properties of the standard normal distribution. The formula for ES is:

$$ES_\alpha = \mu + \sigma \frac{f_{std}(z_\alpha)}{1-\alpha} where f_{std}(z_\alpha) = \frac{1}{\sqrt{2\pi}} \exp\left[-\frac{1}{2} z_\alpha^2\right] \tag{9}$$

This method is straightforward and computationally efficient, making it widely used in practice. However, it often underestimates tail risk because real-world financial returns frequently exhibit fat tails and skewness, which a normal distribution does not capture.

The student t-distribution method addresses some of the limitations of the normal distribution by allowing for heavier tails. The t-distribution, with its additional degrees of freedom parameter, better accommodates the higher likelihood of extreme returns. This makes it a more realistic model for financial data, which often shows higher kurtosis than what the normal distribution can describe.

To calculate the Expected Shortfall (ES) using the t-distribution method, the process involves several key steps that take into account the heavier tails characteristic of the t-distribution, offering a more realistic assessment of financial risk. Initially, we determine the mean (μ) and standard deviation (σ) of the portfolio returns, as these parameters are essential for defining the distribution of the returns. Next, we select the degrees of freedom (ν) for the t-distribution, a parameter that controls the tail heaviness. Generally, fewer degrees of freedom indicate heavier tails, which is frequently observed in financial returns. With the degrees of freedom chosen, we then set the confidence level at 95%. This confidence level indicates that we are interested in the worst 5% of potential losses.

The formula for VaR is given by:

$$VaR_{\alpha} = \mu + \sqrt{\frac{v-2}{v}}\sigma t_{\alpha,v} \tag{10}$$

Once VaR is calculated, we proceed to determine the Expected Shortfall (ES). ES is the conditional expectation of loss given that the loss exceeds the VaR threshold. For a t-distribution, ES at a 95% confidence level is derived using the properties of the t-distribution. The formula for ES is

$$ES_{\alpha} = \mu + \sqrt{\frac{v-2}{v}}\sigma \frac{f_{std}^{*}\left(t_{\alpha,v}\right)}{1-\alpha} \tag{11}$$

$$where f_{std}^{*}\left(t_{\alpha,v}\right) = \frac{\Gamma\left[\frac{v+1}{2}\right]}{\sqrt{v\pi}\Gamma\left(\frac{v}{2}\right)}\left[1+\frac{1}{v}t_{\alpha,v}^{2}\right]^{-(v+1)/2} \tag{12}$$

Finally, the Peaks Over Threshold (POT) method comes from extreme value theory (EVT) and focuses on modeling the tail behavior of the distribution of returns. The POT method fits a Generalized Pareto Distribution (GPD) to the returns that exceed a predefined threshold. This approach is particularly useful for capturing the significant losses at the tail end of the distribution, offering a robust measure of ES that reflects the severity of rare but significant market events.

The first step in applying the POT method involves defining a threshold (denoted as u) above which returns are considered extreme. Once the threshold is determined, the next step is to identify and record all returns that exceed this threshold, commonly referred to as "peaks over the threshold." These exceedances represent extreme events that are of particular interest for risk assessment. Following the identification of peaks over the threshold, a Generalized Pareto Distribution (GPD) is fitted to the exceedances. The GPD is a probability distribution commonly used to model the tails of a distribution, making it well-suited for describing extreme events.

After fitting the GPD to the exceedances, the parameters of the distribution, namely the shape parameter (ξ) and the scale parameter (σ), are estimated using statistical methods such as maximum likelihood estimation (MLE).

$$logL(\xi,\beta) = \sum_{i=1}^{N_\mu} \ln\left[\frac{1}{\beta}\left(1+\xi\frac{l_i-\mu}{\beta}\right)^{-\frac{1}{\xi}-1}\right] \tag{13}$$

VaR and ES are calculated using the properties of the Generalized Pareto Distribution. The VaR at a certain confidence level (α) is obtained from the GPD cumulative distribution function (CDF):

$$VaR_\alpha = \mu + \frac{\beta}{\xi}\left[\left(\frac{N}{N_\mu}(1-\alpha)\right)^{-\xi} - 1\right] \tag{14}$$

The Expected Shortfall represents the mean loss exceeding the VaR threshold. Specifically, ES is derived from VaR, the threshold, and the scale parameter, providing a comprehensive measure of the potential magnitude of losses in extreme scenarios.

$$ES_\alpha = \frac{VaR_\alpha + \beta - \xi\mu}{1-\xi} \tag{15}$$

By adopting the POT method and utilizing the Generalized Pareto Distribution, risk managers gain valuable insights into the tail behavior of financial data and can better assess and control the potential influence of extreme events on their portfolios. This methodology enables a focused analysis of extreme events, enhancing risk management practices and decision-making processes in the financial industry.

By employing these three parametric methods, we can compare the ES estimates and gain a deeper understanding of the tail risk across different portfolios. Each method offers unique insights, with the normal distribution providing a baseline, the t-distribution offering an improved fit for heavier tails, and the POT method delivering a specialized focus on extreme events. This multi-method approach ensures a comprehensive risk assessment, capturing both common and extreme market conditions effectively.

6.3 Portfolio financial performance: Sharpe ratio

The Sharpe ratio was introduced by economist William Sharpe in 1994 who simplified Markowitz's mean-variance model, based on the CAPM model. The Sharpe Ratio is a commonly utilized metric in finance for evaluating the risk-adjusted return of an investment choice, calculated by the formula:

$$S_p = \frac{r_p - r_f}{\sigma_p} \tag{16}$$

S_p is the Sharpe Ratio.

r_p is the expected return of the portfolio

r_f is the risk-free rate of return

σ_p is the standard deviation of the portfolio's return

The Sharpe Ratio essentially measures the excess return of an investment per unit of risk taken. When the Sharpe ratio is positive, then a higher Sharpe Ratio signifies superior risk-adjusted performance, indicating that the portfolio has created greater returns relative to the amount of risk it has undertaken. Conversely, a lower Sharpe Ratio indicates that the portfolio's return is inadequate in proportion to the level of risk it has assumed. On the other hand, when the Sharpe ratio is negative, it suggests that the average rate of return of the portfolio is lower than the risk-free rate of return, and it is not advisable to invest in the portfolio to obtain a meaningful excess return.

7. Analysis and discussion

7.1 Overall expectations of ESG influence on portfolio performance

In this section, we analyze the results of portfolio performance from three metrics (Jensen's alpha, Sharpe ratio and Expected shortfall) for the whole Chinese A-listed market and discuss the implications.

7.1.1 Jensen's alpha

Drawing from the above analysis, Jensen's alpha (also known as FF alpha) measures the portfolio's excess return over the benchmark, taking into account key risk factors. In our model, all portfolios with ESG ratings exhibit negative alpha values, indicating underperformance as the actual returns do not meet the expected returns.

During the period under consideration, except for the HML portfolio, all alphas are relatively low and highly significant. The alpha values of both the High ESG and Low ESG portfolios are fairly similar, with both trailing the Medium ESG portfolio in terms of excess returns. This underperformance is further highlighted by the negative value of the HML portfolio, suggesting that the Low ESG portfolio surpasses the High ESG portfolio. This observation is consistent with our initial hypothesis.

However, due to the absence of statistical significance of the HML portfolio's alpha, we cannot conclusively assert that the HML portfolio underperforms the market. Consequently, we find no compelling evidence to indicate a correlation between ESG ratings and stock returns. This suggests that ESG investment strategies may not have a significant influence on investment returns. Therefore, investors and stakeholders should exercise prudence and conduct comprehensive due diligence before making investment decisions based on ESG ratings.

In conclusion, Jensen's alpha in this model offers a robust measure of portfolio performance, but it also uncovers that ESG ratings may not directly impact investment returns. This is a crucial insight for investors as it underscores the importance of a thorough evaluation when making investment decisions based on ESG ratings.

7.1.2 Sharpe ratio

The table14 presents the annualized Sharpe ratios for different portfolios based on ESG criteria across the whole market, state-owned sectors, and non-state-owned sectors. As shown in the table14, the results largely support hypothesis H2. Overall, the data indicate that portfolios with higher ESG ratings tend to exhibit lower Sharpe ratios (SR) compared to those with lower ratings. Regarding the high-minus-low (HML) portfolios, it compares the Sharpe ratio differences between high ESG and low ESG portfolios. A negative value indicates that low ESG portfolios outperform high ESG portfolios in terms of risk-adjusted returns. This also suggests that prioritizing ESG investments may result in lower risk-adjusted returns compared to investments with lower ESG ratings. These observations indicate that investors who prioritize ESG factors may be willing to accept lower Sharpe ratios, as proposed by Pedersen et al. (2021). This also suggests that in the Chinese market following the adoption of the double carbon policy, many investors are willing to sacrifice a certain degree of financial performance in exchange for higher ESG scores.

Table14.

Annualized Sharpe ratios for all portfolios

Annualized Sharpe ratio:	The whole market:	State-owned sector	Non-state-owned sector:
High ESG Portfolio	0.77	0.88	0.83
Medium ESG Portfolio	1.57	1.77	1.25
Low ESG Portfolio	1.48	1.91	1.43
High Minu Low	-2.57	-2.28	-1.96

7.1.3 Expected shortfall

The table15 provides Value at Risk (VaR) and Expected Shortfall (ES, also known as Conditional Value at Risk, CVaR) values for high, medium, and low ESG portfolios calculated using three different methods: normal distribution, Student-t distribution, and Peaks Over Threshold (POT).

Across all methods, the medium ESG portfolio generally has the highest VaR and ES/CVaR values, suggesting it is perceived to be the riskiest in terms of potential extreme losses. The high ESG portfolio consistently shows lower VaR and ES/CVaR values compared to the medium ESG portfolio, indicating slightly lower risk. The low ESG portfolio has the lowest VaR and ES/CVaR values, indicating it is considered to be the least risky among the three in terms of potential extreme losses. The "High Minus Low" values are positive across all methods and metrics, indicating that the high ESG portfolio has higher risk measures compared to the low ESG portfolio, though the difference is not substantial. The differences are slightly larger for the normal and Student-t distributions compared to the POT method.

The findings indicate that medium ESG portfolios are perceived as riskier in extreme loss scenarios compared to high and low ESG portfolios. High ESG portfolios, while not the least risky, offer lower extreme risk compared to medium ESG portfolios, supporting the notion that high ESG standards might mitigate some risk, though not as much as the low ESG portfolios according to these measures.

Table 15

VaR, ES, and CVaR values for high, medium, and low ESG portfolios were calculated using three different methods

	Normal distribution		Student-t distribution		POT	
	VaR	ES/CVaR	VaR	ES/CVaR	VaR	ES/CVaR
High ESG Portfolio	2.1506	2.6911	2.1526	2.6848	1.9738	2.6319
Medium ESG Portfolio	2.2255	2.7815	2.2276	2.7750	1.9846	2.6274
Low ESG Portfolio	2.1252	2.6555	2.1272	2.6493	1.9016	2.5178
High Minus Low	0.6690	0.8427	0.6696	0.8407	0.6211	0.8231

7.2 Are there any sector differences

In this section, we analyze the difference of portfolio performance from three metrics (Jensen's alpha, Sharpe ratio and Expected shortfall) under different ownerships.

7.2.1 Jensen's alpha under different ownerships

Our analysis offers the following key takeaways about the performance of Jasen's alpha in ESG-rated portfolios for both non-state-owned and state-owned sectors:

In the non-state-owned sector, the alpha values for High, Medium, and Low ESG portfolios are statistically significant, suggesting a deviation between actual and forecasted returns. The alpha values are near zero, with the Medium ESG portfolio showing the highest alpha. The Low ESG portfolio outperforms the High ESG portfolio, as evidenced by its superior alpha value.

In the state-owned sector, none of the ESG-rated portfolios displayed a significant alpha, with values approximating zero. The Low ESG portfolio underperforms relative to the High ESG portfolio, and this sector did not meet the robustness test criteria, indicating no apparent correlation between ESG ratings and stock returns for state-owned firms.

In conclusion, our findings highlight that the correlation between ESG ratings and investment returns may be less evident in the state-owned sector compared to the non-state-owned sector. Therefore, investors should exercise prudence and conduct exhaustive due diligence when making ESG-based investment decisions, particularly in the state-owned sector. ESG investing aims to generate a positive societal impact beyond financial returns, necessitating a thorough evaluation before investment decisions are made.

7.2.2 Sharpe ratio under different ownerships

In the state-owned sector, the low ESG portfolio possesses the highest Sharpe ratio, which means that it performs best in terms of risk-adjusted return. The medium ESG portfolio follows while the high ESG portfolio has the lowest Sharpe ratio. This suggests that in state-owned enterprises, high ESG scores do not correlate with better performance.

In the non-state-owned sector, the low ESG portfolio also has the highest Sharpe ratio, followed by the medium ESG portfolio. The high ESG portfolio again has the lowest Sharpe ratio. This indicates that similar to state-owned enterprises, high ESG scores in non-state-owned enterprises do not lead to better risk-adjusted returns. These results align in different sectors with the overall market.

What we can observe from the table14 is that the Sharpe ratio of state-owned firms is significantly higher than the Sharpe ratio of non-state-owned enterprises, regardless of the type of portfolios. The fact that this pattern holds true across different types of ESG portfolios (high, medium, and low) implies a consistent advantage in risk-adjusted returns for state-owned enterprises. This consistency indicates that the superior performance of state-owned enterprises is not limited to a specific type of ESG investment but spans across various levels of ESG integration.

The negative high minus low ESG difference across all sectors suggests that high ESG portfolios consistently underperform compared to low ESG portfolios. This trend is more pronounced in state-owned firms than in non-state-owned firms. These results may reflect the effectiveness of ESG practices in state-owned versus non-state-owned enterprises. State-owned enterprises typically exhibit lower flexibility because of bureaucracy in implementing effective ESG practices, leading to poorer performance of high ESG portfolios. Non-state-owned enterprises, while also showing underperformance in high ESG portfolios, maybe slightly better at managing and benefiting from ESG practices with their flexibilities and responsiveness.

7.2.3 Expected shortfall under different ownerships

The table16 provides Value at Risk (VaR) and Expected Shortfall (ES/CVaR) values for high, medium, and low ESG portfolios under public ownership, calculated using three different methods.

Table 16

Expected shortfall under public ownership

	Normal distribution		Student-t distribution		POT	
	VaR	ES/CVaR	VaR	ES/CVaR	VaR	ES/CVaR
High ESG Portfolio	2.2783	2.8490	2.2805	2.8423	1.9913	2.7483
Medium ESG Portfolio	2.3642	2.9539	2.3664	2.9471	2.1255	2.8308
Low ESG Portfolio	2.2873	2.8587	2.2894	2.8520	2.1396	2.8534
High Minus Low	1.0235	1.2850	1.0245	1.2820	1.0171	1.3097

The table17 provides Value at Risk (VaR) and Expected Shortfall (ES/CVaR) values for high, medium, and low ESG portfolios under private ownership, calculated using three different methods.

Table 17

Expected shortfall under private ownership

	Normal distribution		Student-t distribution		POT	
	VaR	ES/CVaR	VaR	ES/CVaR	VaR	ES/CVaR
High ESG Portfolio	2.3263	2.9096	2.3285	2.9029	2.1370	2.8222
Medium ESG Portfolio	2.3762	2.9697	2.3785	2.9629	2.1515	2.7985
Low ESG Portfolio	2.2698	2.8373	2.2719	2.8307	2.0299	2.6692
High Minus Low	0.6339	0.7963	0.6345	0.7944	0.6098	0.7801

For both sectors, the general trend is similar to the one in the whole market. Across all methods, the medium ESG portfolio generally has the highest VaR and ES/CVaR values, suggesting it is perceived to be the riskiest in terms of potential extreme losses. The high ESG portfolio shows slightly lower VaR and ES/CVaR values compared to the medium ESG portfolio, indicating a slightly lower risk. The low ESG portfolio has similar VaR and ES/CVaR values to the high ESG portfolio but is generally less risky than the medium ESG portfolio. The "High Minus Low" values are positive across all methods and metrics, indicating that the high ESG portfolio has slightly higher risk measures compared to the low ESG portfolio, though the differences are not substantial. The differences in VaR are quite small across all methods, indicating that the risk levels between high and low ESG portfolios under public ownership are relatively close.

However, there are some differences. Firstly, the consistently higher VaR and ES/CVaR values under private ownership for high and medium ESG portfolios suggest that private companies are perceived to carry higher risk compared to state-owned enterprises. This could be due to the generally higher volatility and less stable nature of private enterprises compared to state-owned entities, which often benefit from government stability. In addition, the "High Minus

Low" values for both VaR and ES/CVaR are lower under private ownership compared to public ownership. This indicates that the differentiation in risk between high and low ESG portfolios is less pronounced in private companies. In contrast, public ownership shows a greater difference in risk between high and low ESG portfolios, indicating that ESG factors may have a more significant impact on risk profiles in state-owned enterprises.

Across both ownership types, the normal and Student-t distributions generally provide higher VaR and ES/CVaR values compared to the POT method. This suggests that using normal or Student-t distribution assumptions tends to result in more conservative risk estimates. The POT method consistently shows the lowest VaR values, indicating a different approach to estimating extreme risk that is potentially less conservative but focused on the tail risk.

The comparison reveals that private ownership generally entails higher risk as indicated by higher VaR and ES/CVaR values across all ESG portfolios. The differentiation in risk between high and low ESG portfolios is more pronounced under public ownership, suggesting that ESG factors might play a more critical role in influencing the risk profiles of state-owned enterprises. These insights can guide investors and policymakers in understanding the risk dynamics associated with ESG investments in different ownership structures.

8. Conclusion

In 2020, the "double carbon" policy was first officially announced in public. It involves setting targets to reduce carbon emissions while simultaneously encouraging the adoption of cleaner technologies and practices. In the realm of Environmental, Social, and Governance (ESG) investing, the "double carbon" policy has profound implications. It aligns closely with the environmental component of ESG criteria, emphasizing the importance of reducing carbon footprints and promoting sustainable practices. As a result, companies operating in regions with "double carbon" policies may face increased pressure to enhance their environmental performance and transparency, aligning with investor expectations for ESG-conscious investments. Therefore, in this essay, we discussed how the ESG scores impact the financial performance of investment portfolios to provide some insights for investors.

We studied the Chinese A-listed companies from 2020 to 2023 when investors increasingly consider ESG in their investing choices. To better investigate the impacts, we evaluate the performance from three aspects, abnormal return (Jensen's alpha), excess return per risk (Sharpe ratio), and risks (Expected shortfall). The theory behind our research is mainly based on the ESG-adjusted Capital Assets Pricing Model proposed by Pedersen, L., S. Fitzgibbons, and L. Pomorski. 2020, in which they divide investors into three types, type-A, type-M, and type-U, and suggest that the relationship between ESG scores and portfolio return is influenced by market efficiency and types of investors.

Based on our empirical results, with the Fama-French Five-Factor model, we found that the significant occurrence of subnormal returns across different portfolios (as indicated by negative alphas) suggests that the portfolios underperformed relative to the expected returns based on the model's risk factors. Specifically, the negative alpha is the lowest for the High-ESG portfolio, which means that there is a negative impact of high ESG scores on portfolio returns. This performance of return matches with the lowest Sharpe ratio in High-ESG compared with other portfolios. Regarding the expected shortfall, although the Medium-ESG portfolio is the worst, with the highest VaR and ES, the positive expected shortfall of the High-Minus-Low portfolio indicates that under adverse market conditions, the high ESG portfolio is more prone to experiencing significant losses compared to the low ESG portfolio. Considering all three metrics collectively, our analysis reveals that High-ESG portfolios generally exhibit inferior performance compared to Low-ESG portfolios. This trend suggests that investors in the market prioritize achieving higher ESG scores over maximizing financial returns. The prevalence of this preference is further supported by the dominant presence of type-M investors in the market. This also implies that our hypotheses 1-3 are valid.

Then we discuss the ownership difference. We divide Chinese A-listed companies into state-owned companies and non-state-owned companies and investigate the impacts of ESG scores on the financial performance of portfolios under different ownership. Based on our empirical results of the Farma-French Five-Factor model for two groups, we found that there is no significant alpha for state-owned companies while there is a significant negative alpha for non-state-owned companies, which implies that the ESG impacts for portfolio return is more obvious for non-state-owned companies. These results closely match the previous findings from Li, H. (2023), Bilyay-Erdogan, S., and Ozturkkal, B. (2023). Therefore, the hypothesis 4 is valid.

Regarding other metrics, the distinction between public ownership and private ownership also exists. State-owned enterprises consistently demonstrate a significantly higher Sharpe ratio compared to privately-owned enterprises across all portfolio types. Furthermore, the negative Sharpe ratio observed in the high minus low ESG differential across both sectors suggests a consistent underperformance of high ESG portfolios relative to low ESG portfolios. This underperformance is notably more pronounced in state-owned enterprises compared with non-state-owned enterprises. These findings likely stem from varying strategies and the effectiveness of ESG adoption practices between state-owned and non-state-owned enterprises. Considering the expected shortfall, the "High Minus Low" values for both VaR and ES/CVaR are lower under private ownership compared to public ownership. This suggests that the differentiation in risk between high and low ESG portfolios is less pronounced in private companies. In contrast, public ownership shows a greater difference in risk between high and low ESG portfolios, indicating that ESG factors may have a more significant impact on risk profiles in state-owned enterprises. Therefore, the hypothesis 5-6 are valid.

By providing a comprehensive metric of portfolio-related ESG, this essay uncovers the current condition of the Chinese market after the adoption of the "double carbon" policy. What’s more, it may provide suggestions to guide investors and policymakers in understanding the financial performance associated with ESG investments in different ownership structures.

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Appendix

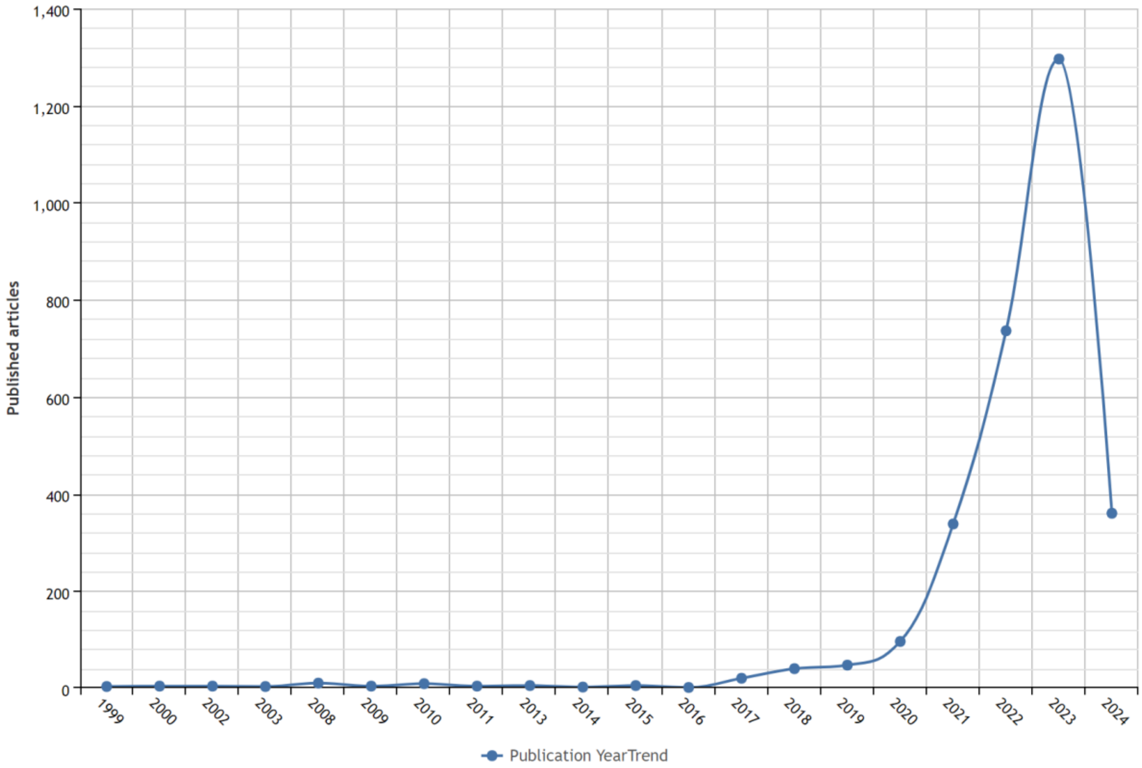

Figure A1. ESG-related Publication year distribution from www.cnki.net

	N	Mean	Max/Min	Std.Dev.	Kurtosis	Skewness
Frama-French 5 factors						
Mkt-Rf	242	-0.000180	0.0196/-0.0201	0.007821	-0.134980	-0.022040
SMB	242	0.000809	0.0223/-0.0209	0.006310	0.476004	-0.105570
HML	242	0.000471	0.0147/-0.0150	0.005558	0.151764	-0.221990
RMW	242	-0.000210	0.0145/-0.0135	0.005406	0.008001	0.135860
CMA	242	0.000703	0.0210/-0.0219	0.006302	1.123016	-0.027690

Table A1 2023 Wind ESG Rating Data Descriptive Statistics

	N	Mean	Max/Min	Std.Dev.	Kurtosis	Skewness
Frama-French 5 factors						
Mkt-Rf	242	-0.000720	0.0364/-0.0605	0.013100	2.353760	-0.597670
SMB	242	0.000515	0.0277/-0.0270	0.008822	-0.017200	-0.105880
HML	242	0.000704	0.0262/-0.0215	0.008931	-0.225930	0.173111
RMW	242	-0.000460	0.0271/-0.0213	0.007279	0.603627	0.254029
CMA	242	0.000710	0.0292/-0.0266	0.008950	0.239002	-0.046970

Table A2 2022 Wind ESG Rating Data Descriptive Statistics

	N	Mean	Max/Min	Std.Dev.	Kurtosis	Skewness
Frama-French 5 factors						
Mkt-Rf	243	0.000485	0.0251/-0.0303	0.010439	0.253037	-0.327080
SMB	243	0.000533	0.0276/-0.0374	0.009255	1.111492	-0.214100
HML	243	0.000393	0.0321/-0.0295	0.010152	0.385680	0.296197
RMW	243	-0.000390	0.0372/-0.0396	0.010685	1.197160	-0.245730
CMA	243	0.000377	0.0412/-0.0305	0.011659	0.685560	0.316753

Table A3 2021 Wind ESG Rating Data Descriptive Statistics

2020

	N	Mean	Max/Min	Std.Dev.	Kurtosis	Skewness
Frama-French 5 factors						
Mkt-Rf	243	0.001154	0.0406/-0.0817	0.014487	5.123509	-1.145480
SMB	243	-0.000300	0.0177/-0.0405	0.006465	6.694184	-1.143800
HML	243	-0.000830	0.0309/-0.0189	0.007153	1.361723	0.790525
RMW	243	0.000862	0.0349/-0.0182	0.007649	2.219705	0.454433
CMA	243	-0.001250	0.0173/-0.0337	0.006700	2.207409	-0.328910

Table A4 2020 Wind ESG Rating Data Descriptive Statistics