Certificate in Python Data Analyst

Study of the Relationships between Listed Companies' Environmental, Social and Governance (ESG) Reporting, Company Value and Investment Risk in Hong Kong

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Abstract

This study explores the relationship between Environmental, Social, and Governance (ESG) performance and stock price volatility in the Hong Kong market during 2020-2023. With the growing prominence of ESG investment, understanding its impact on financial performance is crucial. Our analysis focuses on companies listed on the Hong Kong Stock Exchange, utilising Morningstar ESG risk scores as the primary independent variable and share price volatility as the dependent variable. Employing a multilinear regression model, we identify substantial correlations ($R2>40\%$) across various sectors, notably Consumer Defensive, Communication Services, and Utilities. The findings reveal mixed results: while higher ESG risk scores correlate positively with volatility in certain sectors, others show a negative relationship, suggesting complexities in how ESG factors influence investment risk. Additionally, regulatory changes have positively influenced ESG performance among Hong Kong companies. The study highlights the importance of sector-specific analyses and the role of regulatory changes in shaping ESG performance providing insights for policy-makers and corporations of integrating ESG considerations into financial decision-making.

Introduction

The global market for ESG investment funds has attracted a net inflow of US$29 billion as of the first quarter of 2023, accounting for 30% of total assets worldwide, with China emerging as the largest sustainable fund market in Asia. [1]

ESG investing considers environmental, social, and governance factors in companies to make better investor decisions. It rests on a recognition of these factors, usually captured by third-party ratings, that shape a company's risk outlook and future opportunities. As such, ESG-aligned investment decisions can theoretically improve long-term returns by looking at more resilient and responsible businesses. Case in point: a recent study found companies that scored highly on "crisis response" measures based on human capital, supply chain, and ESG sentiment were linked to 1.4–2.7% higher stock returns during the COVID-19 pandemic [2]. ESG portfolios with long investment horizons offer better downside protection during economic and social crises.

It is important to note that the purpose of ESG integration is to manage investment risk and improve returns. A company's impact on the environment and society is not necessarily relevant to ESG measures unless they are deemed financially significant to the company's returns. This evaluation is in part why one may observe fossil-fuel energy and mining industries within ESG equity funds [3], as these companies may have exceptional performance in managing ESG-related risks.

Companies strive for better ESG performance as an indicator of better internal control. A recent meta-analysis has found consensus on better ESG performance being positively linked to better corporate financial performance in terms of greater operating metrics in return on assets, return on equity, or stock returns [4, 5]. Regional studies also indicate higher ESG performance being associated with reduced stock price volatility. For instance, studies on A-share listed companies in China and the S&P 500 in the United States have found strong ESG performance significantly lowers volatility, suggesting that firms with robust ESG practices are better positioned to manage market fluctuations [6,7].

Firm characteristics have also shown a positive correlation to ESG performance, specifically the company size and financial leverage [5]. These high debt-to-total-asset ratios are typical characteristics of larger firms, which are more competitively profitable than small-medium enterprises [8] and have shown better ESG performance than small-medium enterprises. This can be explained by the legitimacy theory, where larger firms have a social contract with the wider society, which, if broken, leads to reduced consumer demand and increased attention from regulatory authorities. Larger companies are constantly under pressure to provide more details to establish credibility, thus seeing better ESG performance.

This being said the relationship between environmental, social, and governance (ESG) performance and corporate financial performance can be complex and multifaceted. Substantial differences between different rating providers [5], a broad definition of what classifies as an ESG investment, and a lack of a clear channel for how ESG performance translates to better corporate performance are just a few examples of the limitations of these studies.

The objective of this study is to narrow the focus of aggregate research to the Hong Kong market, aiming to generate more insightful conclusions and enhance the broader understanding of ESG impacts on financial performance. Specifically, the question at hand is **can we project volatility in stock returns using ESG data in Hong Kong?**

Hypothesis and Methodology

We establish the main hypothesis of our study: companies with higher ESG performance in the Hong Kong market will experience greater control over investment risks.

Hypothesis 1: The ESG Risk Score (independent variable) is positively correlated with share price volatility (dependent variable).

This hypothesis is investigated by analysing the ESG risk scores of companies listed on the Hong Kong Stock Exchange and their corresponding share price volatility. The study will utilise historical data from 2020 onwards, following regulatory changes on ESG performance mandate, to assess the impact of ESG performance on financial market behaviour. Statistical regression analysis will be employed to determine the correlation between ESG risk scores and share price volatility. We will include the following control variables: profitability, financial leverage, and company size to account for other possible influences on stock volatility.

The following multi-linear relationship is constructed,

$$y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4$$

where; Y is the dependent variable, share price volatility, X_1 is the independent variable, ESG risk score, $X_{2,3,4}$ are the control variables (profitability, leverage and company size), α is the intercept and $\beta_{1,2,3,4,}$ are the respective calculated coefficients for each independent variable.

The independent variables are normalised between -1 and 1 by dividing every observation by its maximum absolute value for comparability.

Additionally, we examine how this relationship between ESG risk scores and share price volatility varies across different sectors. This sector-specific analysis aims to identify which industries are more sensitive to ESG factors and how these sensitivities impact stock volatility.

We also analyse changes in ESG risk scores over this period to determine whether enhanced regulation has led to improved ESG performance in Hong Kong. This analysis aids in understanding the influence of regulatory changes on ESG compliance and whether they have effectively enhanced corporate sustainability practices.

In addition to the quantitative analysis, we include qualitative insights from journal reviews and relevant studies to provide further context for our findings. This mixed-method approach ensures a comprehensive understanding of how ESG performance influences investment risk management in the Hong Kong market.

Data collection

Price Volatility (Dependent variable): Stock price volatility acts as a proxy for investment risk in our study. Volatility is defined as the standard deviation of daily change in share price and is collected from publicly available sources in Python Yahoo Finance API.

ESG risk score (Independent variable X1): There are six major ESG score providers, each with differing methods for its evaluation of ESG performance. We identified one offering ease of access and contains comprehensive data covering most stocks within the Hong Kong Stock Exchange. These limitations on our ESG data collection will be further discussed later in the report. The source of this ESG score comes from Morningstar, a public investment research firm in the US, and is accessed through the Python Yahoo Finance API. This ESG risk rating is presented as an absolute quantitative score, calculated from a firm's ESG risk exposure and risk management capabilities. It represents how risky and how effective a firm is in managing risks. The higher the score, the riskier or less effective the firm is in managing ESG-related risks. [9]

Leverage (control variable X2): Higher leverage is associated with higher financial risk, which leads to greater stock price volatility. Companies with more debt may be more sensitive to changing market conditions, as investors question a firm's ability to repay its increased debt obligations. Leverage is measured by total debt / invested capital (total debt + common shareholder equity) and data is collected from a firm's latest balance sheet each year, through the yfinance API.

Profitability (control variable X3): Higher profitability is associated with stronger financial performance, leading to lower stock price volatility. A strong performance boosts investor confidence in a firm's ability to weather market shocks, as firms are more likely to be in better financial health. Profitability is measured by return on invested capital, Pre-tax Income / invested capital, collected from a firm's latest balance sheet and income statement of each year, through the yfinance API.

Company size (control variable X4): Large companies tend to exhibit lower volatility compared to smaller firms. Large companies may benefit from economies of scale, hold more bargaining power and often have diversified operations generating stable flows of income. Size is measured by the number of employees, collected through company information in yfinance API and the firm's annual reports.

Data Analysis and Discussion:

We obtained data on 150 companies on the exchange, with few that have been excluded due to delisting or missing data for the period of 2020 to 2023. We labelled the companies by their sector definition and found 11 sectors. We present data from 2023 to highlight the current landscape of ESG scores and the latest trends in market volatility.

Observation 1: ESG risk scores are higher in non-service sectors, environmental risk scores contribute the most.

Fig 1: Pie chart on the proportion of companies in each sector

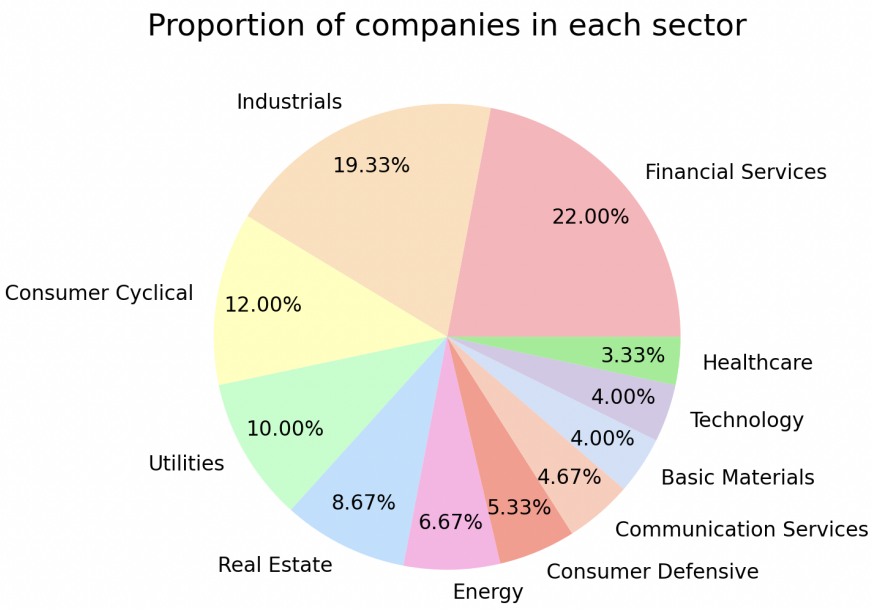
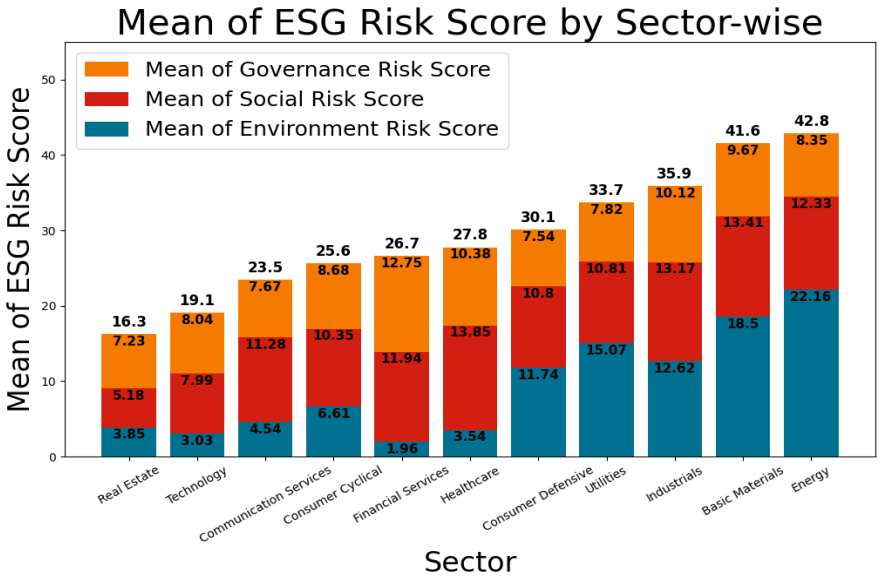


Fig 2 : Stacked bar chart on the total ESG risk score broken down to the individual mean E,S,G score for each sector 2023



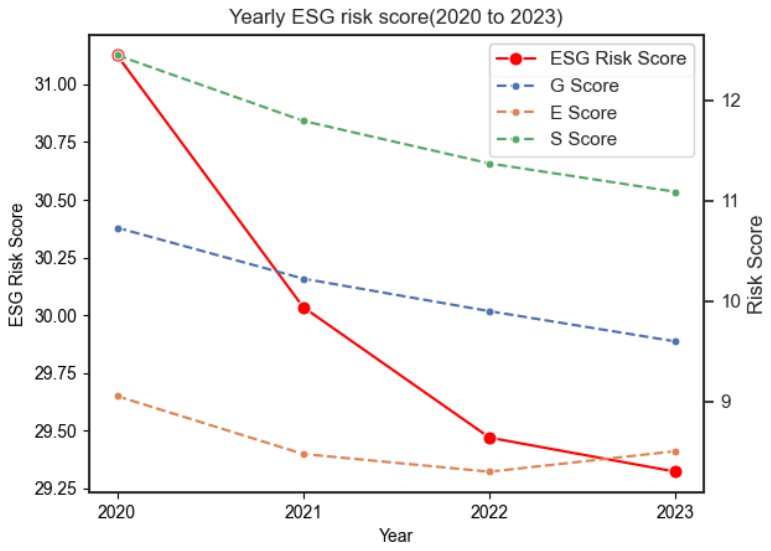
We find the Financial Services and Industrial sectors have the largest representation in our data and note that the lower representation sectors like Healthcare and Technology (<5%) may limit their accuracy in later analysis.

The Energy, Basic Materials, Industrials, Utilities, and Consumer Defensive sectors exhibit some of the highest average ESG risk scores, with their environmental risk components contributing significantly to the overall scores. These sectors are heavily reliant on resource extraction or manufacturing, making them inherently more susceptible to environmental risks. As regulations surrounding environmental controls become stricter, these sectors may face challenges in transitioning to more sustainable practices, such as adopting renewable energy sources. Thus, they will likely need to invest more time and resources into managing their environmental risks effectively and may see higher risk scores in the short term.

Trends in Social and Governance risk scores exhibit considerable variability across the sectors, highlighting the unique challenges each sector faces in managing these individual risks. Some sectors such as Financial Services, Healthcare, and Industrials show notably higher Governance and Social risk scores than others, suggesting these sectors may need to focus more on enhancing their corporate governance practices and addressing social issues to improve their overall ESG performance.

Observation 2: New regulation sees improved ESG performance in Hong Kong.

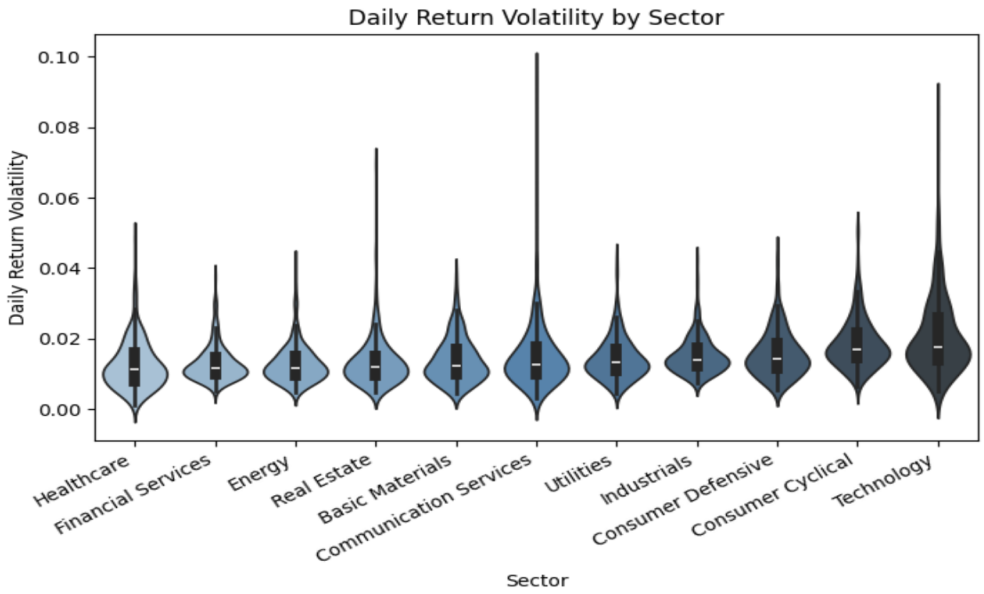
Fig 3: Line graph of mean ESG total risk score and its constituent score across 2020 to 2023



An overall downward trend observed in the ESG risk score from 2020 to 2023 indicates an improvement in ESG risk management within HK. This decline suggests that companies are increasingly adopting sustainable practices and effectively addressing ESG challenges. The social score remains the largest component of the overall risk score, highlighting that firms may struggle with managing social risks or face persistent challenges in this area.

Notably, there is an uptick in the environmental score from 2022 to 2023, which corresponds with a slowdown in the overall decline of the ESG risk score. This suggests while companies may have adapted to new regulatory changes implemented in 2020, heightened scrutiny of their practices may be needed. Stricter regulations or more transparent reporting standards could further attract long-term capital investment by lowering cost of equity [10] and increase the companies' value in terms of share prices, to motivate companies to improve their ESG risk management.

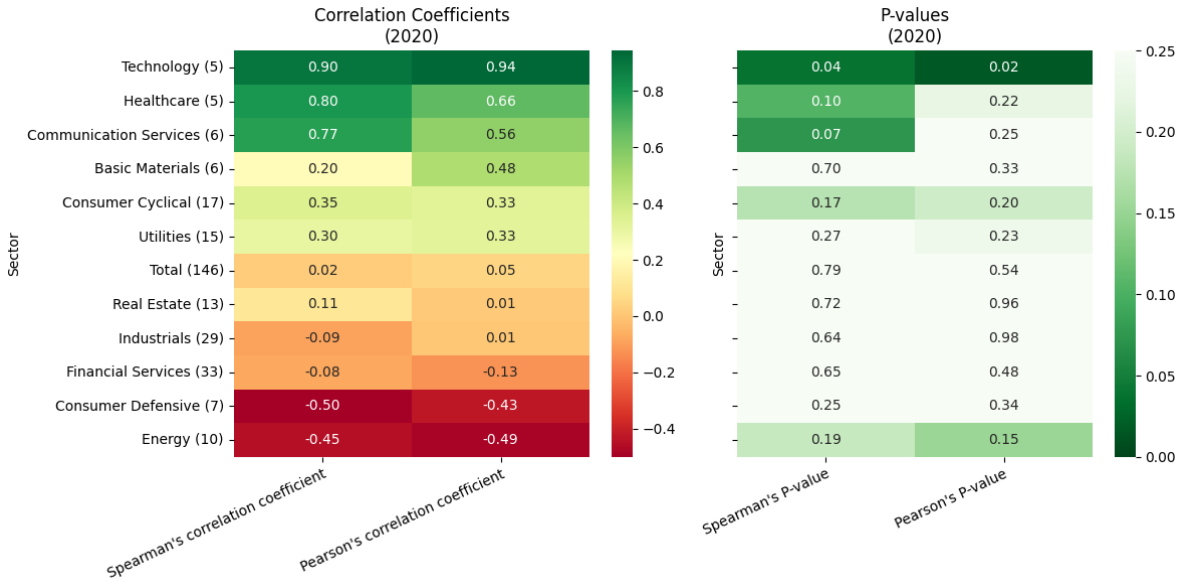
Fig 4: Violin plot on sector price volatility 2023

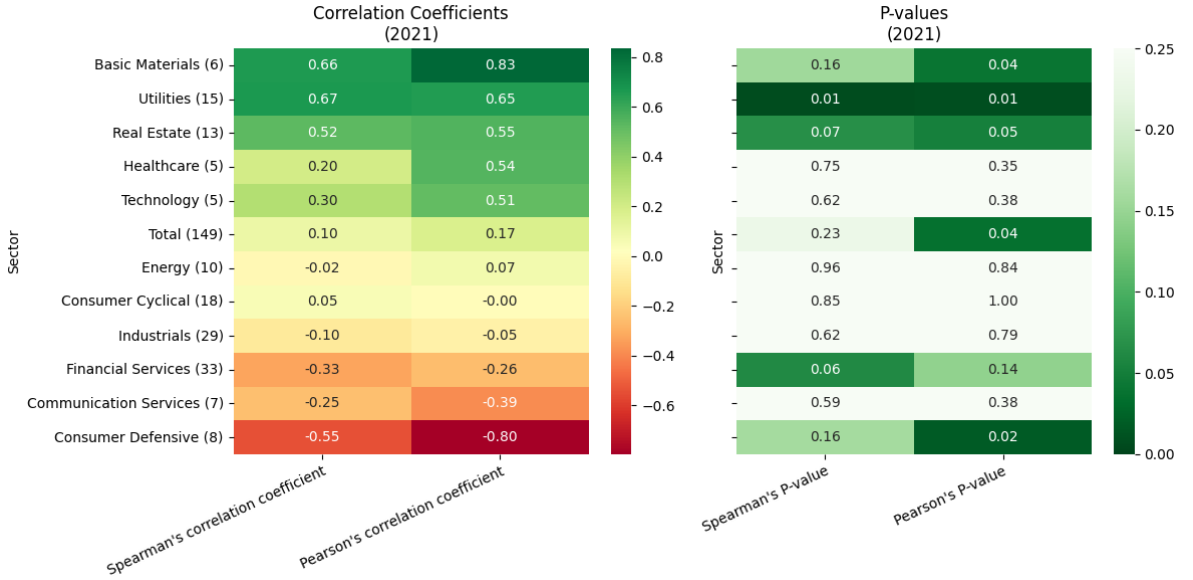


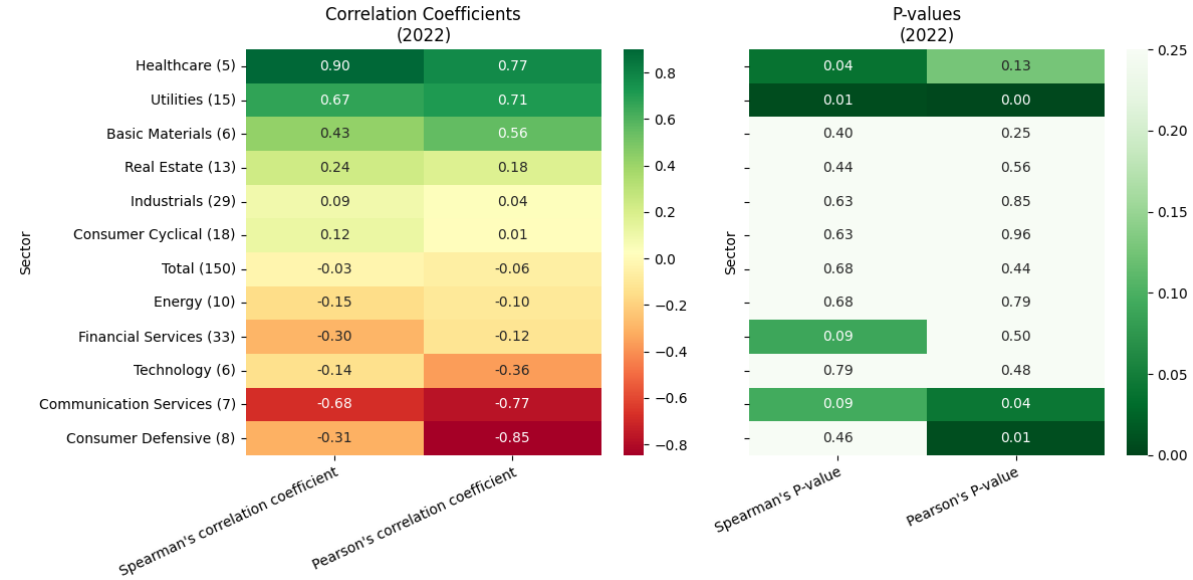
A snapshot of the most recent share prices reveals that most sectors exhibit similar levels of volatility. Healthcare and Financial Services sectors show relatively low volatility, indicating stable performances and lower risk in daily returns in the current market, likely due to consistent consumer demand or earnings. The Technology and Consumer Cyclical sectors demonstrate the highest volatility ranges, suggesting that these sectors are more sensitive to external factors such as market trends, innovation, and changes in consumer demand.

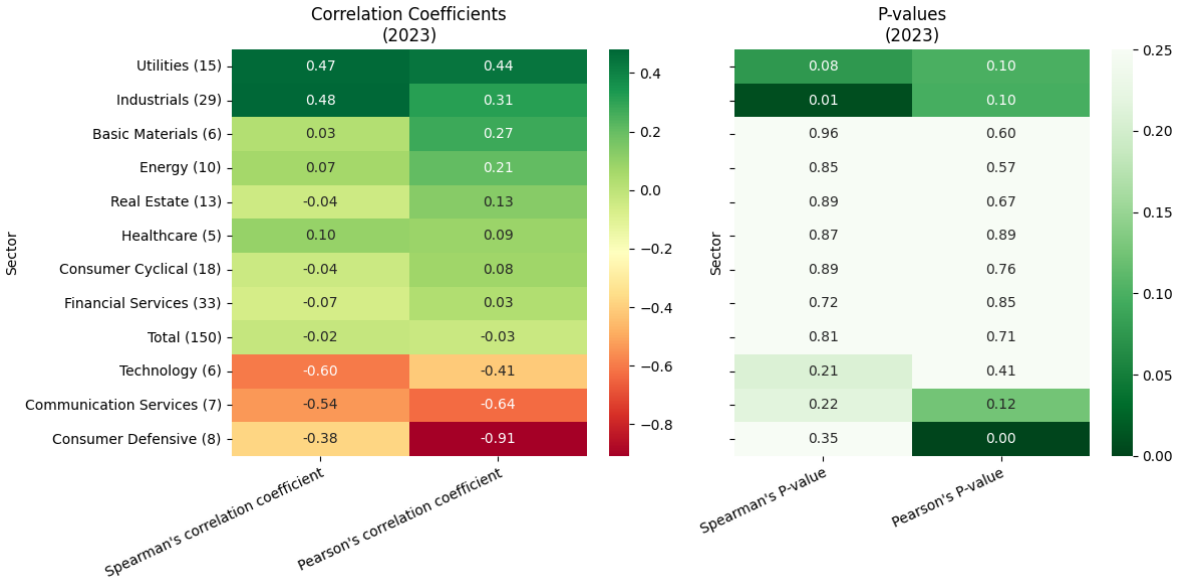
Notably, we observed higher volatility spikes in the Technology, Communication Services, and Real Estate sectors, suggesting that certain companies within these industries experience fluctuations significantly above the sector average. This heightened volatility could result from specific company-related factors, such as unforeseen changes in earnings, mergers and acquisitions, or new unique challenges faced. Further investigation into these factors may provide a deeper understanding of the underlying causes of volatility in these sectors.

Fig 5: Spearman Correlation and Pearson Correlation coefficient in each year




Correlation Coefficients
(2021)
Sector
Basic Materials (6) 0.66 0.83
Utilities (15) 0.67 0.65
Real Estate (13) 0.52 0.55
Healthcare (5) 0.20 0.54
Technology (5) 0.30 0.51
Total (149) 0.10 0.17
Energy (10) -0.02 0.07
Consumer Cyclical (18) 0.05 -0.00
Industrials (29) -0.10 -0.05
Financial Services (33) -0.33 -0.26
Communication Services (7) -0.25 -0.39
Consumer Defensive (8) -0.55 -0.80
Spearman's correlation coefficient
Pearson's correlation coefficient
0.8 0.6 0.4 0.2 0.0 −0.2 −0.4 −0.6
P-values
(2021)
Sector
0.16 0.04
0.01 0.01
0.07 0.05
0.75 0.35
0.62 0.38
0.23 0.04
0.96 0.84
0.85 1.00
0.62 0.79
0.06 0.14
0.59 0.38
0.16 0.02
Spearman's P-value
Pearson's P-value
0.25 0.20 0.15 0.10 0.05 0.00


Correlation Coefficients
(2022)
Sector
Healthcare (5) 0.90 0.77
Utilities (15) 0.67 0.71
Basic Materials (6) 0.43 0.56
Real Estate (13) 0.24 0.18
Industrials (29) 0.09 0.04
Consumer Cyclical (18) 0.12 0.01
Total (150) -0.03 -0.06
Energy (10) -0.15 -0.10
Financial Services (33) -0.30 -0.12
Technology (6) -0.14 -0.36
Communication Services (7) -0.68 -0.77
Consumer Defensive (8) -0.31 -0.85
Spearman's correlation coefficient
Pearson's correlation coefficient
0.8 0.6 0.4 0.2 0.0 −0.2 −0.4 −0.6 −0.8
P-values
(2022)
Sector
0.04 0.13
0.01 0.00
0.40 0.25
0.44 0.56
0.63 0.85
0.63 0.96
0.68 0.44
0.68 0.79
0.09 0.50
0.79 0.48
0.09 0.04
0.46 0.01
Spearman's P-value
Pearson's P-value
0.25 0.20 0.15 0.10 0.05 0.00


Correlation Coefficients
(2023)
Sector
Utilities (15) 0.47 0.44
Industrials (29) 0.48 0.31
Basic Materials (6) 0.03 0.27
Energy (10) 0.07 0.21
Real Estate (13) -0.04 0.13
Healthcare (5) 0.10 0.09
Consumer Cyclical (18) -0.04 0.08
Financial Services (33) -0.07 0.03
Total (150) -0.02 -0.03
Technology (6) -0.60 -0.41
Communication Services (7) -0.54 -0.64
Consumer Defensive (8) -0.38 -0.91
Spearman's correlation coefficient
Pearson's correlation coefficient
0.4 0.2 0.0 −0.2 −0.4 −0.6 −0.8
P-values
(2023)
Sector
0.08 0.10
0.01 0.10
0.96 0.60
0.85 0.57
0.89 0.67
0.87 0.89
0.89 0.76
0.72 0.85
0.81 0.71
0.21 0.41
0.22 0.12
0.35 0.00
Spearman's P-value
Pearson's P-value
0.25 0.20 0.15 0.10 0.05 0.00

Prior to carrying out the multilinear regression analysis, we looked at the simple regression analysis on Spearman and Pearson correlation between price volatility and ESG risk score, to observe if any trends can be observed before control variables are introduced.

The overall trend suggests complexity in the relationship between ESG risk score and price volatility with no clear trends in the majority of sectors. With exceptions from Utilities showing consistent positive linear relationships, while Consumer Defensive show consistent negative relationships. These two sectors also maintain relatively high statistical significance ($p<0.05$), implying the observed linear relationship between ESG risk and price volatility is likely not due to random chance.

Observation 3: ESG risk score is a significant predictor of share price volatility of the Consumer Defensive, Communication Services and Utilities sectors.

Fig 6: Statsmodel multi-linear regression model results, correlation coefficients are expressed with confidence intervals of 95%, the most significant coefficient is highlighted orange and sectors that failed the F-test (model validity) are coloured grey. Positive and negative ESG risk correlation coefficients are highlighted in green and red in the sectors.

Sector	Adjusted R^2	Probability F-test	β1 (ESG Risk) (CI: 95%)	β2 (Debt to Capital) (CI: 95%)	β3 (Return on Invested Capital) (CI: 95%)	β4 (Number of employees) (CI: 95%)
Consumer Defensive	0.598	6.89E-06	-0.5486 ± 0.341	-0.1399 ± 0.138	-0.1584 ± 0.148	0.0878 ± 0.176
Communication Services	0.463	9.04E-04	-0.4677 ± 0.583	-0.6462 ± 0.326	-0.1417 ± 0.304	-0.5175 ± 0.281
Utilities	0.448	1.68E-07	0.6307 ± 0.241	0.3308 ± 0.185	0.2604 ± 0.203	0.0421 ± 0.125
Real Estate	0.364	3.76E-05	-0.1217 ± 0.238	0.2981 ± 0.138	0.0407 ± 0.148	0.0022 ± 0.131
Energy	0.234	9.08E-03	-0.0883 ± 0.462	0.3155 ± 0.195	0.1184 ± 0.209	-0.0896 ± 0.207
Basic Materials	0.165	1.16E-03	0.3217 ± 0.343	0.1114 ± 0.199	0.0648 ± 0.248	0.0091 ± 0.277
Industrials	0.112	1.70E-03	0.1761 ± 0.162	0.0444 ± 0.113	0.2265 ± 0.162	-0.1604 ± 0.101
Consumer Cyclical	0.033	1.84E-01	0.0653	0.0573	-0.0765	0.1163
Financial Services	0.058	2.04E-02	-0.0262	0.014	-0.0083	-0.1276
Healthcare	0.169	1.52E-01	0.5017	-0.0931	-0.25	0.1967
Technology	-0.081	6.87E-01	-0.0041	0.0735	-0.1122	-0.0933

We identified seven sectors with statistically significant results in our multilinear regression model. Among these, four sectors exhibited negative correlations between ESG risk and observed price volatility, while three sectors showed positive associations. Notably, the Consumer Defensive, Communication Services, and Utilities sectors demonstrated significant explanatory power ($R^2 > 40\%$), highlighting the practical relevance of our analysis. Therefore, we will focus our examination on these sectors.

The multilinear regression analysis conducted reveals mixed insights into the relationship between ESG risk scores and share price volatility across sectors. The observed positive correlation supports **Hypothesis 1**, which posits that companies with lower ESG risk scores (indicating better ESG performance) demonstrate stronger internal controls. This, in turn, may lead to greater investor confidence and higher market valuations, reflected in reduced stock price volatility.

In our findings, the Utilities sector showed a consistent positive correlation in agreement with our initial hypothesis. The sector itself has inherent high ESG risk due to the nature of its business operation, which suggests stock prices would change more sensitively to negative news regarding ESG performance, in other words, as ESG risk score increases, volatility would tend to rise. A similar study on the S&P 500 supports this general view [5], and we will use a case study with Beijing Enterprises Water Group Limited (0371.HK) here to illustrate this point. Following a news report on January 7, 2020, regarding compliance failures and governance issues, the company experienced stock price fluctuations, although not directly causation of effect, this can offer insight into the impact of ESG-related news on market behaviour. [11]

Theoretically, the stakeholder theory provides a robust social science framework that effectively captures and explains this relationship. This theory advocates for companies to consider the interests of all stakeholders—both internal (employees, management) and external (customers, suppliers, communities, and the environment)—rather than focusing solely on shareholders. Companies that adopt stakeholder theory tend to take a more holistic approach to their decision-making process. In the context of ESG, a meta-analysis has shown new sustainability initiatives implemented by corporations contribute to better financial outcomes [4]. This improvement is attributed to factors such as enhanced risk management and increased innovation, ultimately leading to better financial performance in markets.

However, there are observed negative correlations that contrast with our main hypothesis, suggesting, somewhat counterintuitively, that as ESG risk scores increase, stock price volatility decreases. Possible explanations for this finding can be viewed through the lens of market inefficiency and behavioural investing. Market inefficiency may indicate that investors have not fully priced ESG risks, leading to lower volatility as the market gradually adjusts to these factors. Another plausible reason is risk aversion. Investors might generally shy away from sectors with high ESG risk scores, such as the consumer defensive sector in our example, as these scores can signal long-term instability. This avoidance could result in lower investor interest and reduced trading volumes, contributing to a stabilisation of price volatility.

More likely, however, is the idea that ESG disclosure metrics could not effectively predict financial performance. A study found a similar negative regression relationship to our study, it finds that ESG disclosure, when considered in isolation, was associated with a decrease in firm value [12]. In contrast, data based on actual ESG performance, such as quantifying reductions in greenhouse gas emissions, has been found to correlate positively with financial performance [4].

Regarding the use of ESG risk score as a predictor for investment risk, our model identifies sectors in Hong Kong where ESG factors may provide significant insights into potential future volatility changes, specifically in **Consumer Defensive, Communication Services and Utilities**. We emphasise that while ESG practices can be beneficial, their effects are not uniformly applicable across industries. It is therefore essential to examine a company's actions as highlighted in their sustainability reports, including investments, initiatives, and changes in internal policies, as these may offer further insights into improvements in a firm's operational efficiency, risk management, and innovation.

Limitations and Recommendations

Several limitations must be acknowledged in this study:

Data Availability: The reliance on a single set of ESG performance measurements introduces potential biases. It would be more effective to aggregate data from multiple rating agencies to obtain a comprehensive view of ESG performance. However, this approach may be hindered by the lack of coverage for all listed firms on the exchange.

Temporal Scope: The analysis is confined to data from 2020 to 2023, which may not capture long-term trends or the full impact of evolving ESG practices and regulations. One could conduct longitudinal studies on a particular sector to provide deeper insights into the long-term effects of ESG integration on financial performance and volatility, considering evolving market conditions.

Sector Representation: Certain sectors, such as Healthcare and Technology, have limited representation in our dataset, potentially skewing results and limiting the generalizability of findings.

Multicollinearity: We observe a correlation between our independent variables (See Appendix) This makes it difficult to determine the individual effect of each independent variable, leading to less reliable statistical inferences. It makes it challenging to find which variables are truly significant predictors of the dependent variable (volatility). Further research could include other control variables and remove ones with high correlation, or combine highly correlated variables using principal component analysis as a composite variable.

Control Variables: Control variables such as profitability, leverage, and company size were included, other factors influencing volatility, such as macroeconomic conditions or investor sentiment, were not accounted for in this analysis. Although adding additional control variables would lead to a more accurate model, this risks overfitting the model and losing a sense of generalisability to compare to other datasets as it becomes too tailored for the HK market.

Conclusion

In conclusion, this study sheds light on the intricate relationship between ESG performance and stock price volatility in the Hong Kong market. Our findings indicate that the impact of ESG risk scores on volatility varies significantly across different sectors, with Consumer Defensive, Communication Services, and Utilities demonstrating notable correlations. While the positive correlation in some sectors supports the hypothesis that better ESG performance can lead to reduced volatility and increased investor confidence, the observed negative correlations in others suggest that not all industries respond uniformly to ESG factors.

Moreover, our analysis reveals that regulatory changes have contributed to improved ESG performance among companies in Hong Kong, indicating a positive trend toward sustainable practices. However, the complexities of ESG metrics and their different effects across sectors require careful interpretation of the results.

In light of these insights, we emphasise the need for investors to consider sector-specific dynamics when integrating ESG factors into their investment strategies. Ongoing examination of corporate actions and investments, as outlined in sustainability reports, is essential for understanding how firms manage ESG-related risks and opportunities. This study ultimately contributes to the broader discourse on ESG investing, highlighting its potential benefits while acknowledging the challenges and complexities involved in measuring its impact on financial performance.

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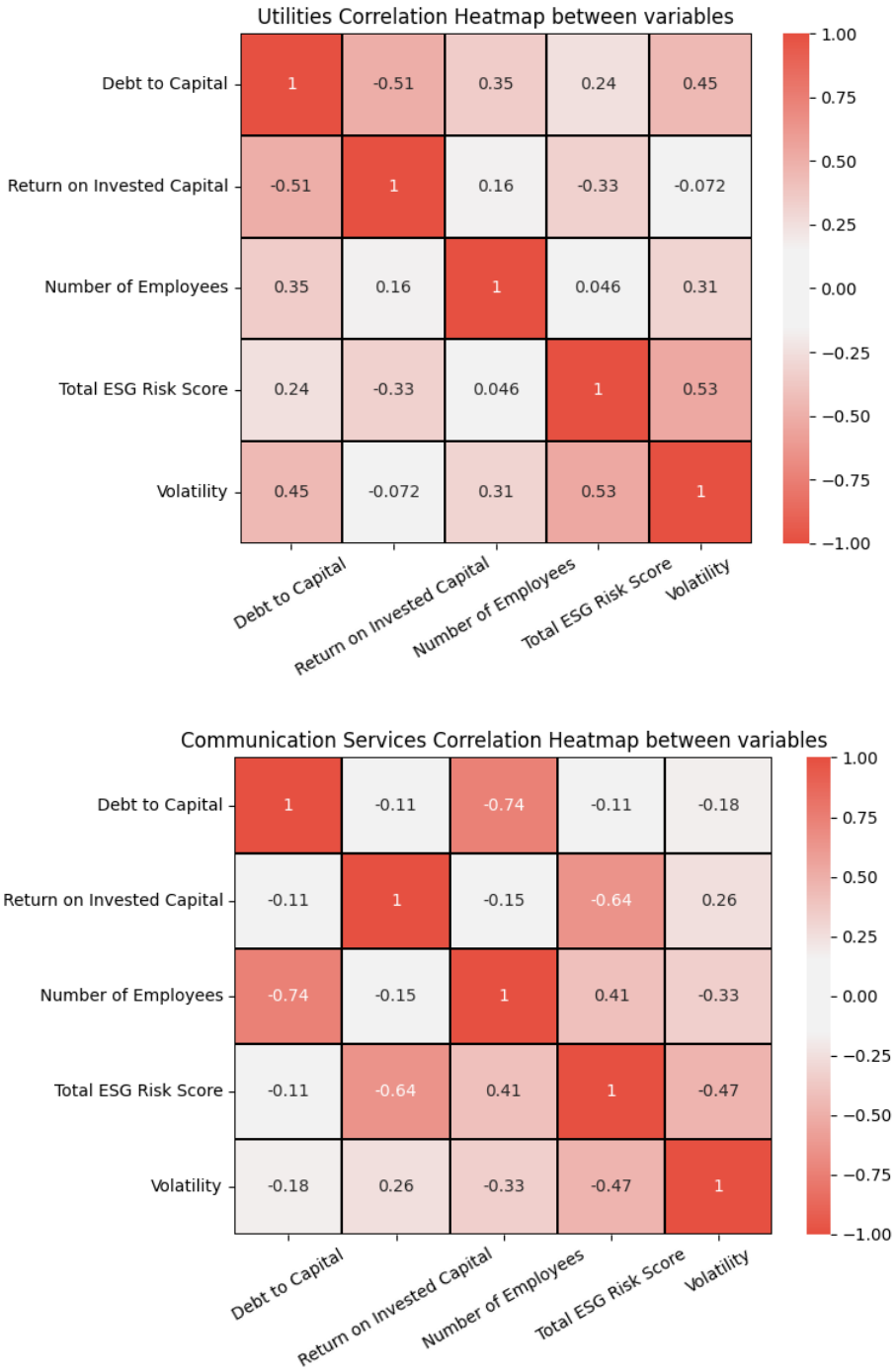
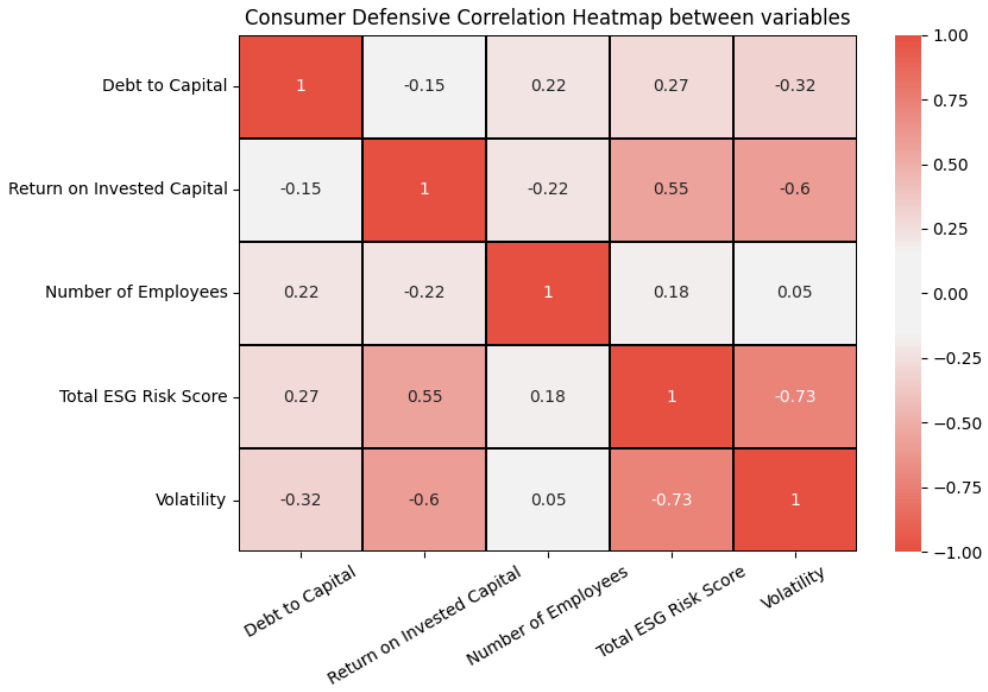
Appendix:

Fig 7: Correlation Matrix Heatmap for Utilities, Communication Services and Consumer Defensive Industry




Consumer Defensive Correlation Heatmap between variables
Debt to Capital
Return on Invested Capital
Number of Employees
Total ESG Risk Score
Volatility
1
-0.15
0.22
0.27
-0.32
-0.15
1
-0.22
0.55
-0.6
0.22
-0.22
1
0.18
0.05
0.27
0.55
0.18
1
-0.73
-0.32
-0.6
0.05
-0.73
1
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00