<div align="center">

ESG Performance Analysis in the S&P 500

By Aashna Dorwal

</div>

Introduction

The S&P 500 is one of the most widely followed stock market indices, representing the performance of large 500 publicly traded companies in the United States. In recent years, Environmental, Social, and Governance (ESG) factors have become a growing focus for investors and analysts looking to assess corporate responsibility and long-term sustainability. ESG scores evaluate companies based on three areas: Environmental (E), which measures impact on climate and resource use; Social (S), which reflects relationships with employees, customers, and communities; and Governance (G), which assesses corporate leadership, transparency, and shareholder rights.

This project explores the ESG score performance of S&P 500 companies. I'm interested in analyzing how companies' ESG scores relate to their financial performance, such as stock returns and revenue growth. By examining ESG data alongside financial metrics, the project aims to understand whether companies with higher sustainability scores tend to perform better financially. The goal is to provide investors and stakeholders with insights into how strong ESG performance might be connected to better business outcomes.

Data

This project uses three primary data sources: ESG performance data for S&P 500 companies[1], market and company-level financial data[2], and year-to-date (YTD) return data[3] scraped from SlickCharts.

The first two datasets were downloaded from Kaggle. The ESG dataset (sp500_esg_data.csv) included variables such as the *company name, ticker symbol, sector, total ESG score, environmental score, social score, governance score, highest controversy level, and overall risk*. The second dataset (sp500_companies.csv) contained company-specific financial and structural data, including *ticker symbol, number of full-time employees, market capitalization, and revenue growth*. I renamed the columns and performed an inner merge on these two datasets using the ticker symbol to ensure consistency and only used the rows with complete information by dropping all missing

---

[1] https://www.kaggle.com/datasets/rikinzala/s-and-p-500-esg-and-stocks-data-2023-24

[2] https://www.kaggle.com/datasets/andrewmvd/sp-500-stocks

[3] https://www.slickcharts.com/sp500/performance

values. This merged dataset was saved as 'sp500_bothmerged.csv'. To add recent market performance data, I used Selenium to scrape YTD return data for each S&P 500 company from SlickCharts. This included *symbol, YTD return, and company*. I renamed the ticker symbol column to match the format of the existing dataset before saving it as 'sp500_slickcharts.csv'.

Finally, I merged the scraped data with the previously combined ESG and financial dataset using the ticker symbol. The final dataset, saved as 'final_merged_sp500.csv', includes ESG scores, company financials, and YTD stock performance for each company. After merging and cleaning, the final dataset contained 408 rows and 13 columns.

Data Dictionary

Table 1 Data Dictionary

| Field	Type	Description
Company Name	Text	The name of the company
Ticker Symbol	Text	The stock ticker symbol
Sector	Text	The industry sector of the company (e.g. Information Technology, Financials)
Total ESG Score	Numeric	Composite ESG performance score
Environmental Score	Numeric	Environmental impact score
Social Score	Numeric	Social responsibility score
Governance Score	Numeric	Corporate governance score
Highest Controversy	Numeric	Highest level of controversy the company has been involved (ESG-related)
Overall Risk	Numeric	Overall ESG risk out of 10
Full-time Employees	Numeric	Number of full-time employees
Market Cap	Numeric	Market capitalization value
Revenue Growth	Numeric	Year-over-year revenue growth
YTD Return	Numeric	Year-to-date stock return percentage

1. *Do ESG scores significantly vary across different sectors?*

The goal of this analysis was to see if ESG scores differ depending on the sector a company belongs to. My hypothesis was that there is a real difference in average ESG scores across sectors in the S&P 500. I expected sectors like Energy and Utilities to have lower ESG scores because of their environmental footprint.

To explore this, I grouped the data by sector and calculated the average ESG score for each group. I then ran an ANOVA (Analysis of Variance) to test whether the differences in ESG scores between sectors were statistically meaningful. This helped confirm whether any variation observed was likely due to actual differences rather than random chance.

The results revealed that Real Estate, Information Technology, and Consumer Discretionary sectors have the **lowest** average ESG scores, suggesting that companies in these sectors may generally have weaker ESG practices. On the other hand, the Energy, Utilities, and Consumer Staples sectors showed the **highest** average ESG scores, indicating stronger ESG performance in these industries (Figure 1). A breakdown of the top 10 and bottom 10 companies based on total ESG scores is provided in Figure 2.
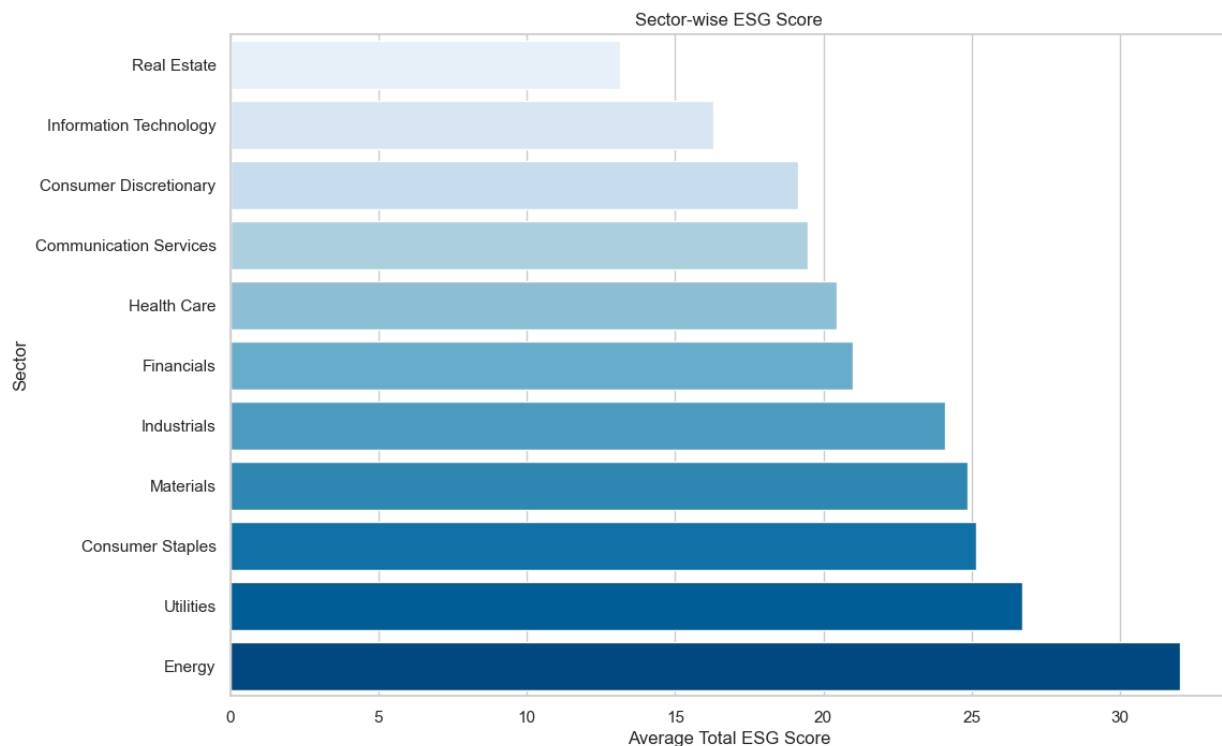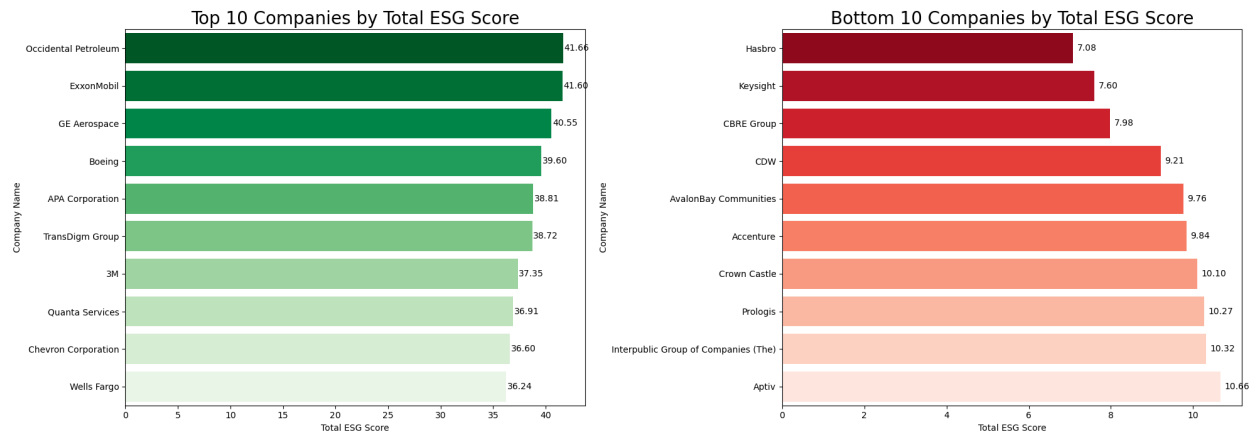

Figure 1

Figure 2

I was particularly interested in comparing the Consumer Staples and Consumer Discretionary sectors, as they reflect different categories of goods and services. Consumer Staples includes essential products like food, beverages, and household items, while Consumer Discretionary includes non-essential products and services such as entertainment, luxury items, and apparel. Given their different operational models and market demands, I hypothesized that their ESG scores would vary.

T-statistics	-4.64
P-value	0.0000

The results supported this hypothesis. The p-value was significantly below the 0.05 threshold, leading me to reject the null hypothesis and conclude that there is a statistically significant difference in ESG scores between the two sectors.

Furthermore, the ANOVA results (**F-statistics of 25.9662 and p-value of 0.0000**) show that the difference in ESG scores across sectors are statistically significant, meaning that the sector a company operates in does indeed impact its ESG score. Figure 3 shows the distribution of ESG scores by sector, giving a clear picture of how scores differ across industries.
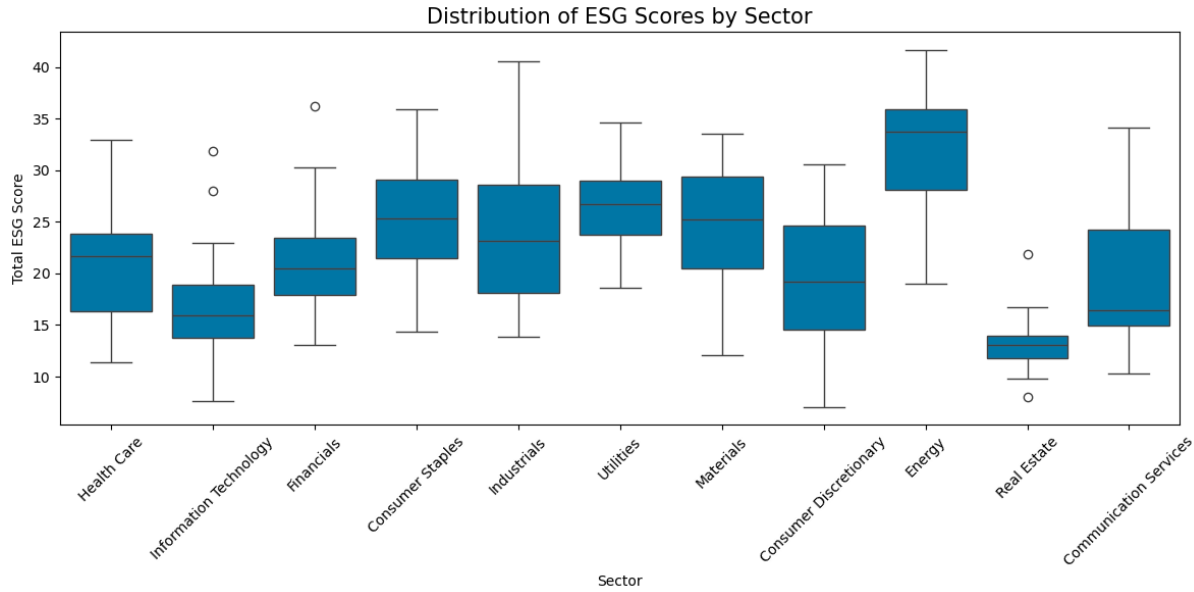
Figure 3

2. *Which ESG factor has the greatest influence on revenue growth?*

I wanted to explore whether ESG factors are related to a company's revenue growth. My hypothesis was that there is a meaningful relationship between these ESG factors and revenue growth, with Governance likely being the most influential. The frequency distribution of ESG scores is shown in Figure 4.
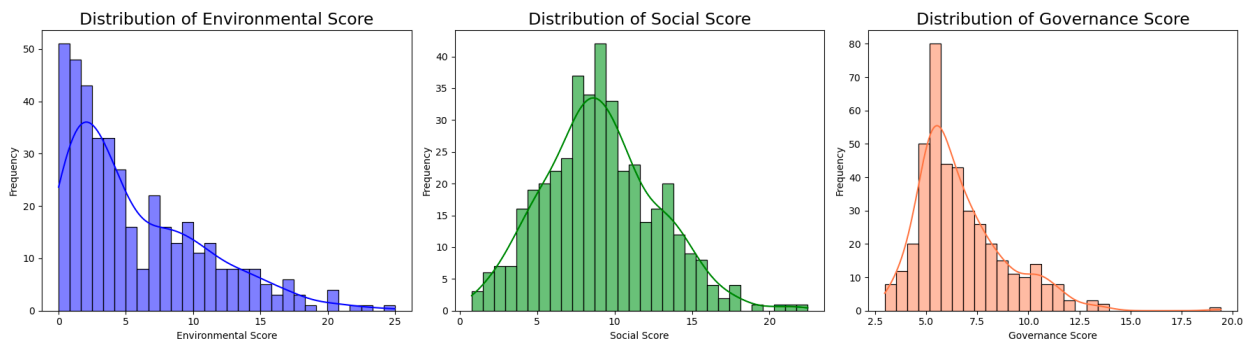

Figure 4

To test this, I used two different models: a regression model and a classification model. For the regression analysis, I used a Random Forest Regressor with *n_estimators=100* and *random_state=42* to predict a company's revenue growth based on its ESG scores. This

approach allowed me to measure how close the model's predictions were to actual revenue growth and to determine which ESG factors were most important. The model performed well, showing a low **Root Mean Squared Error (RMSE) of 0.16**, meaning the predictions were fairly accurate. Among the ESG factors, Governance Score had the strongest influence on revenue growth, contributing **27.3%** to the model's predictive power (Table 2). This suggests that companies with stronger governance practices tend to have higher revenue growth.

Table 2 Feature Importance

Feature	Importance
Governance Score	0.273452
Environmental Score	0.260467
Full-time Employees	0.172077
Social Score	0.166592
Overall Risk	0.071789
Highest Controversy	0.055624

For the classification analysis, I first converted the continuous revenue growth values into a binary category by labeling each company as either "high growth" or "low growth" based on whether its revenue growth was above the median. I then selected a set of ESG-related features as inputs to the model. I used a Random Forest Classifier with *n_estimators=100* and *random_state=42* to ensure consistent results. The data was split into training and test sets (80/20 split), and the model's performance was evaluated using Accuracy, AUC, and F1 score. The classifier achieved an **accuracy of 0.51, an AUC of 0.56, and an F1 score of 0.49**. These results show that the model performed only slightly better than random guessing, indicating that ESG features alone do not strongly separate high-growth from low-growth companies.

Accuracy	0.51
AUC	0.56
F1 score	0.49

This suggests that ESG may have some influence, but it's likely better understood as a complex and continuous effect, and not easily captured in a simple high/low classification.

Next, I wanted to see if there was a clear relationship between a company's Governance Score and its revenue growth. To test this, I used Pearson correlation. The correlation came out to **0.0923**, which shows a weak positive link. Companies with higher governance scores tend to have slightly higher revenue growth. However, the **p-value was 0.0626**, which is just

above the typical 0.05 threshold for significance. This means the result isn't strong enough to confirm a meaningful relationship. Overall, governance might have some influence, but based on this analysis, it doesn't seem to directly drive short-term revenue growth. A larger dataset or a longer time frame might reveal more. This is shown in Figure 5, where the scatter plot and red trendline give a visual of this weak connection.
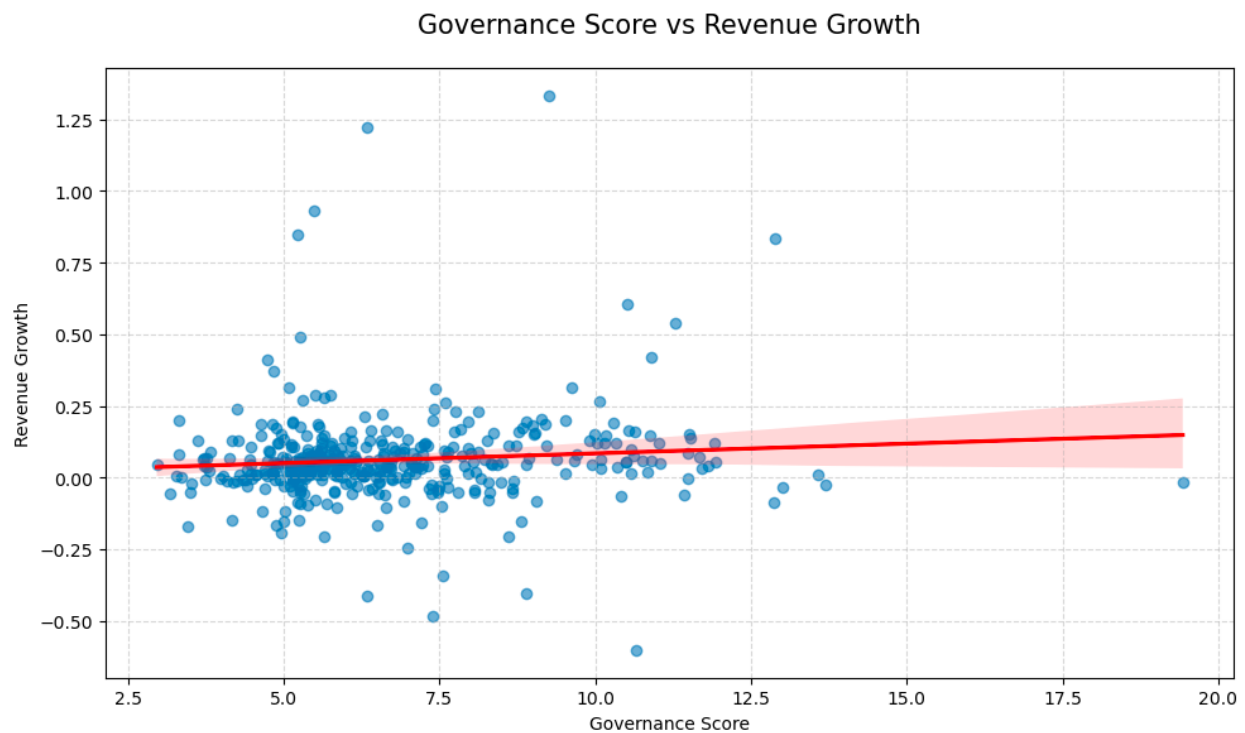

Figure 5

3. *Is there a correlation between year-to-date (YTD) returns and Total ESG scores?*

The goal of this analysis was to examine whether companies with higher total ESG scores tend to perform better in the stock market, specifically if there is a connection between Total ESG Scores and Year-to-Date (YTD) returns.

To explore this, I converted the YTD return percentages into numeric format and used Pearson correlation to measure the relationship. I also ran a simple linear regression to help visualize and understand the direction and strength of this relationship. The results revealed a weak but statistically significant positive correlation. **The correlation coefficient was 0.1257**, and the **p-value was 0.0110**, which is below the commonly used

0.05 threshold for significance. This allowed me to reject the null hypothesis and conclude that there is a meaningful relationship, though not a strong one, between a company's ESG score and its YTD return.

This suggests that companies with better ESG performance may see slightly better market returns, but ESG score alone is not a strong predictor of stock performance. The scatterplot in Figure 6 supports this, showing a wide spread of data points with a slight upward trend marked by the red regression line. Overall, while ESG performance might play a role in market returns, it likely works alongside many other financial and market-related factors.
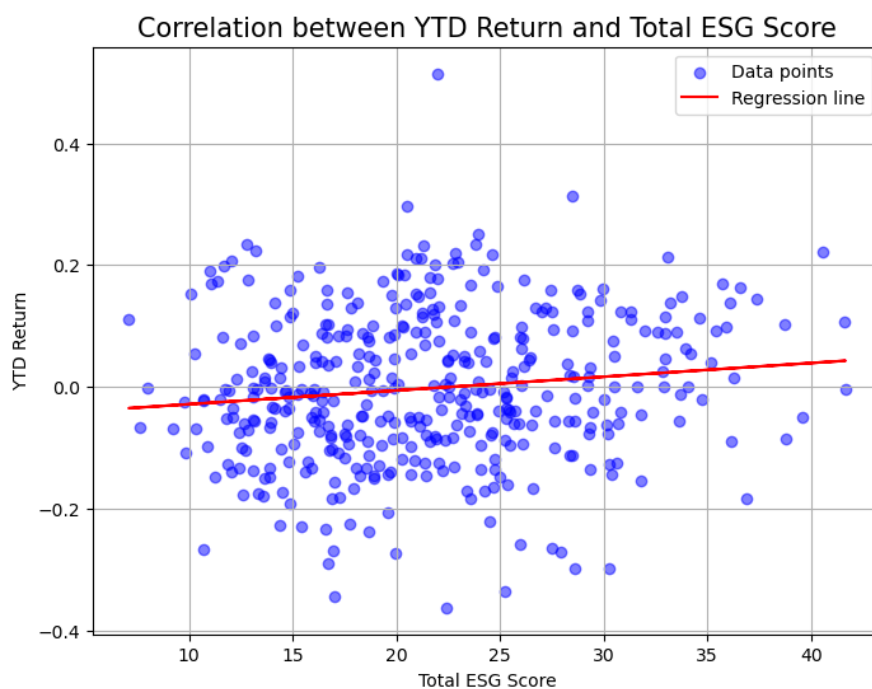

Figure 6

Conclusion

In this project, I explored how ESG (Environmental, Social, and Governance) factors relate to financial performance for companies in the S&P 500. The goal was to see if ESG scores vary across industries, which ESG factor has the biggest effect on revenue growth, and whether there's a link between ESG scores and stock market returns. In summary, from the analysis questions presented in my proposal, I found the following results.

1. ***Do ESG scores significantly vary across different sectors?***

   Yes. The analysis showed clear differences in ESG scores across sectors. Some industries, like Consumer Staples and Consumer Discretionary, had notably different ESG profiles. This suggests that ESG priorities and challenges are shaped by the nature of the sector.

2. ***Which ESG factor has the greatest influence on revenue growth?***

   Governance had the strongest impact on revenue growth. Using a Random Forest model, I found that Governance contributed the most to the model's predictions. This means companies with stronger governance practices tended to have better revenue growth. The model also showed a low prediction error, which supports its reliability.

3. ***Is there a correlation between year-to-date (YTD) returns and Total ESG scores?***

   There was a weak but statistically significant positive correlation between Total ESG Scores and YTD returns. While the relationship wasn't strong, companies with higher ESG scores tended to have slightly better stock returns.

Some limitations include the use of data from a single point in time, which means the analysis doesn't capture how ESG performance and financial results change over the long term. ESG scores were also taken from one rating source, which might differ from others, and additional business factors like company size, market conditions, or leadership decisions weren't considered. These could all influence financial outcomes and may add more context in future analysis.

Overall, this project provided a useful look at how ESG factors relate to business outcomes. While the results weren't always strong, they hint at connections worth exploring further. With more data and deeper analysis, ESG's role in financial performance could become clearer.

GitHub Repository:

https://github.com/aashnadorwal/ESG_PerformanceAnalysis_SP500