



Analysis of Risks and Returns of ESG Portfolios under Different Market Conditions

An Empirical Comparison of China, the US, and Europe

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Abstract. This paper explores the risks and returns of ESG (Environmental, Social, and Governance) portfolios under different market conditions in China, the United States, and Europe. By analyzing stock price data from January 1, 2021, to December 31, 2023, this study investigates the comparative performance of ESG investments during bull and bear markets. The results indicate that high ESG-score portfolios exhibit greater resilience and lower volatility in bear markets compared to low-ESG portfolios while delivering competitive returns in bull markets. This finding suggests that ESG investments not only contribute to sustainable development but also offer potential risk mitigation benefits during market downturns.

Keywords: ESG investments, Market conditions, Risk and return analysis, Comparative study, Stock price data.

1 INTRODUCTION

In recent years, ESG (Environmental, Social, and Governance) investing has rapidly gained prominence globally, becoming a mainstream investment philosophy [1]. ESG investing goes beyond financial returns, emphasizing environmental protection, social responsibility, and corporate governance to achieve sustainable economic, social, and environmental development. ESG ratings serve as a critical tool for evaluating a company's performance in these three areas [2]. Substantial progress has been made in ESG investment research both domestically and internationally. In Europe, the 2023 Corporate Sustainability Reporting Directive (CSRD) has standardized corporate ESG information disclosure [3]. Similarly, the U.S. Securities and Exchange Commission (SEC) proposed multiple ESG disclosure drafts in 2022 and 2023, emphasizing climate-related risk disclosures[4];[5]. In China, ESG investment research is gradually unfolding, with scholars developing ESG rating systems suited to the local market and studying their impact on corporate stock performance [6]. Studies have shown that companies with high ESG ratings exhibit strong risk resilience during market fluctuations [7]. Lu

et al. (2024) highlighted that high ESG-rated companies excel in transparency, risk management, and social responsibility, offering potential excess returns [8].

However, current analyses of the risk and return of ESG portfolios under different market conditions are still insufficient. This study will utilize stock data from January 1, 2021, to December 31, 2023, of representative companies in the three major markets, constructing ESG portfolios based on bull and bear market phases and analyzing them using various risk and return metrics.

2 DATA SOURCES & COMPANY SELECTION

The data sources include financial statements, market trading data, and ESG rating data of companies with high and low ESG ratings in the Chinese, U.S., and European markets from 2021 to 2023. The high ESG score group includes Microsoft Corporation (ESG:55, E: 74, S: 43, G: 55) and Deutsche Bank (ESG:55, E: 61, S: 61, G: 49). The medium ESG score group includes Shell plc (ESG:45, E: 43, S: 37, G: 54), Tesla (ESG: 40, E: 53, S: 29, G: 40), Inc., and BYD (ESG:36, E: 36, S: 36, G: 37). The low ESG score group includes Alibaba (ESG: 32, E: 30, S: 31, G: 35) and Bank of China Limited (ESG:29, E: 33, S: 36, G: 32).

3 STOCK PRICE TRENDS UNDER DIFFERENT MARKET CONDITIONS

After completing the ESG rating classification, we began the data analysis for each group. Following data preprocessing in R Studio, we obtained a clean dataset (clean_data.csv). We then divided the study period into bull and bear market phases based on the monthly rate of change in market indices. In R Studio, we utilized the Moving Average (MA) to enhance the visibility of different market conditions.



Fig. 1. Alibaba/BOC Stock Price & MA200 Curve [Yahoo Finance]



Fig. 2. MSFT/DBK Stock Price & MA 200 Curve [Yahoo Finance].

As shown in Figure 1, Alibaba's stock price experienced multiple ups and downs from January 2021 to December 2023. The close alignment with the Moving Average (MA) curve indicates a stable market with low volatility, reflecting a lack of investor confidence despite Alibaba's strong presence in technology and e-commerce. In contrast, the Bank of China's stock price saw several significant fluctuations from 2021 to 2023, reflecting its ESG performance and China's macroeconomic environment. The stock price crossed the MA200 curve multiple times, indicating sensitivity to ESG performance and policy changes. From Figure 2, Microsoft showed strong performance from 2021 to early 2022 and throughout most of 2023. Its stock price frequently exceeded the MA200, reflecting favorable market reactions and investor confidence. Microsoft's stable governance and proactive environmental policies contributed to its stock stability and enhanced investor trust in its long-term profitability. Deutsche Bank's stock price fluctuated often from 2021 to 2023 due to its ESG performance, European market uncertainties, and internal changes. The stock price crossed the MA200 curve multiple times, showing sensitivity to ESG performance and economic conditions.

Comparative analysis shows that companies with high ESG scores perform well in upward markets with better yield stability and lower volatility. In contrast, low ESG score companies show greater volatility during downturns, indicating higher risk.

To gain a more comprehensive understanding of a company's market performance within an ESG investment portfolio, we employ additional evaluation metrics. The Fama-French five-factor model and the Sharpe ratio offer valuable insights for quantifying and comparing portfolio performance. The result shows that high ESG score companies perform well during market upswings and show good risk management during downturns. In contrast, low ESG score companies perform poorly during downturns, with significant stock price fluctuations and declines in returns.

Table 1. FF5-Alpha and Sharpe Ratio for the six companies

Company	Group	FF5-Alpha	Sharpe Ratio	Standard Deviation	Annualized Volatility
Microsoft (MSFT)	High ESG	0.000561203	0.6400233	0.017511052	0.277979338
Deutsche Bank (DB)	High ESG	-8.54027E-05	0.2850157	0.024856942	0.394591721
Alibaba (BABA)	Low ESG	-	-	0.034847953	0.553194098
Bank of China (3988.HK)	Low ESG	5.0066E-05	0.1032715	0.010247618	0.162675899

4 RISK ASSESSMENT OF DIFFERENT ESG RATING GROUPS

To further analyze volatility, we use the STDEV.P function in Excel to calculate the standard deviation of daily returns and then annualize this volatility by multiplying the daily standard deviation by the square root of 252 (the typical number of trading days in a year). The formula for annualized volatility is:

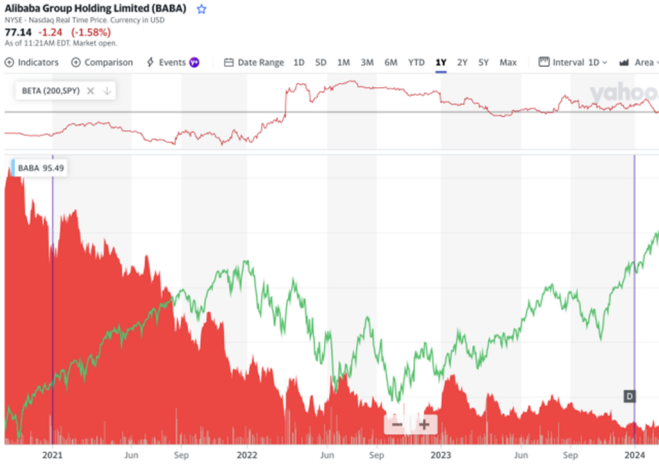
$$\text{Annualized Volatility} = \text{STDEV.P}(G2:G754) * \text{SQRT}(252) \tag{1}$$

Combining graphical representations of market conditions and calculated annualized volatilities (Table 1), Alibaba shows high volatility and significant fluctuations during market swings, especially in downturns, leading to higher investment risks. Despite a low ESG score, Bank of China shows lower volatility and stable performance during market fluctuations due to its status as a large state-owned bank, maintaining investor confidence. Microsoft shows the Lowest volatility, indicating greater stability during market fluctuations, enhancing investor confidence, and reducing investment risk. Deutsche Bank shows moderate volatility, more stable than low ESG score companies but slightly more volatile than Microsoft. Their high ESG scores help maintain better investor confidence and lower investment risks compared to low ESG counterparts.

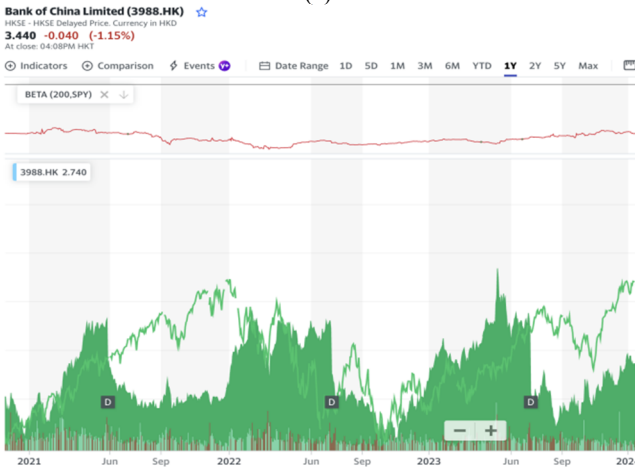
To more precisely analyze the volatility of individual stocks relative to the overall market, we need to introduce the concept of the Beta coefficient

$$\beta = \text{Cov}(r_i, r_m) / \text{Var}(r_m) \tag{2}$$

Among them, r_i is the individual stock return, r_m is the market return, $\text{Cov}(r_i, r_m)$ is the covariance between the individual stock return and the market return, and $\text{Var}(r_m)$ is the variance of the market return.



(a)



(b)

Fig. 3. (a) Alibaba Beta Curve > Low ESG Group, (b) BOC Beta Curve > Low ESG Group



Fig. 4. (a) MSFT Beta Curve > High ESG Group, (b) DB Beta Curve > High ESG Group

Let's first examine the Beta curve of the low ESG score group, starting with Alibaba's Beta curve. Through Figure 3(a), we note that until April 2022, its Beta remained under 1.0, suggesting lower volatility compared to the broader market, indicating its perceived role as a safe haven. However, post-April 2022, the Beta escalated above 1.0, pointing to heightened volatility due to potential policy changes or internal shifts, marking a significant change in market sentiment and possibly increasing speculative investments. Next, let's analyze the Beta curve for the Bank of China, as noted in Figure 3 (b). Despite its low ESG score, the Bank of China is perceived as a stable financial entity with low financial risk, suggesting minimal stock volatility even during economic fluctuations. This perception likely stems from its financial stability and profitability, overshadowing concerns about its ESG shortcomings. The inherent stability of the banking sector, bolstered by stringent regulations and government backing, also supports lower volatility for the Bank of China. As a major state-owned bank, it benefits

from governmental support and regulatory safeguards, helping to stabilize its market presence despite a low ESG score.

Analyzing Microsoft, which holds the highest ESG score in its group, we observe from Figure 4(a) a consistent Beta value above 1.0, indicating a more volatile stock than the broader market. This elevated volatility signifies Microsoft's sensitivity to market changes, with its stock price experiencing larger swings than the market during both rises and falls. This high Beta underscores Microsoft's position as a high-risk, high-return investment, driven by its innovation and leadership in technology. Turning to Deutsche Bank, Figure 4(b) illustrates a variable Beta history. Deutsche Bank's high ESG score likely enhances its appeal to sustainability-minded investors, who may contribute to its stock stability by maintaining their investments through market fluctuations. This support can temper the stock's volatility, reflecting a more balanced view among investors regarding its market risks.

Analyzing risk management and volatility, high ESG-scoring companies like Microsoft and Deutsche Bank, despite higher Beta values and volatility, maintain strong risk-return characteristics over the long term. Their excellence in environmental, social, and governance (ESG) aspects attracts long-term investors, supporting their growth even during market downturns. This shows that high ESG-scoring companies perform well during upturns and retain market confidence and investor support during downturns, thereby mitigating volatility. In comparison, high ESG-scoring companies achieve higher returns in upturns due to sustained investor confidence, while low ESG-scoring companies like the Bank of China show stability in downturns but limited growth in upturns. This highlights the positive effects of high ESG scores on stock performance and profitability across various market conditions.

Based on these results, we will further investigate the performance of high ESG-scoring companies under future market conditions. To achieve this, we will use a time series analysis model to forecast ESG stock price data across the three major markets. Specifically, we will apply the ARIMA model (AutoRegressive Integrated Moving Average), a widely used statistical model for time series prediction.

We use R Studio to implement ARIMA modeling for predicting stock price data. The trend of the graphical prediction results from R Studio is shown in Figure 5:

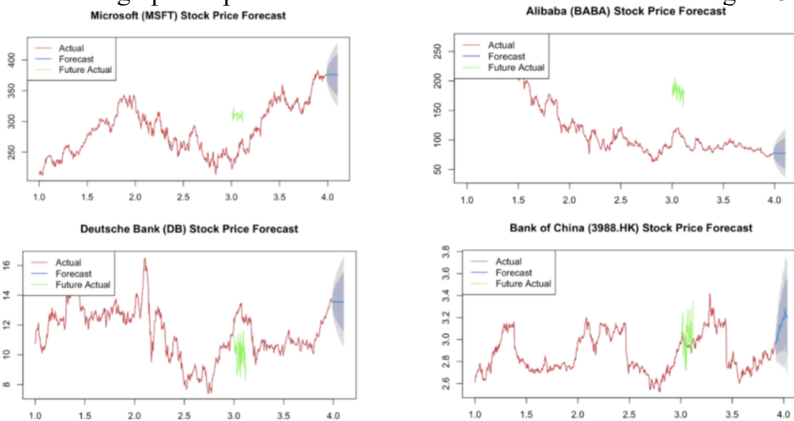


Fig. 5. [MSFT, DB, BABA, 3988.HK] ARIMA Forecast

The forecast of Microsoft (MSFT) shows a consistently stable upward trend with a relatively narrow prediction interval, suggesting low volatility and strong market confidence. The forecast of Deutsche Bank (DB) exhibits some volatility but overall maintains an upward trend. Despite significant historical volatility, the forecast of Alibaba (BABA) shows a stable trend. This is consistent with our findings that low ESG-rated companies have limited return potential during market upswings but tend to perform relatively stably during downturns. The forecast of Bank of China (3988. HK) indicates a stable trend with low volatility, suggesting a stable market outlook for its future performance. Overall, these time series forecast results broadly support our prior analysis.

5 CONCLUSION

This study confirms that ESG portfolios offer notable advantages across different market conditions in China, the United States, and Europe. High ESG-score companies exhibit greater resilience and lower volatility during market downturns, while also delivering competitive returns during bullish markets. This underscores the dual benefits of ESG investments: they contribute to sustainable development and provide effective risk mitigation. Our analysis suggests that integrating ESG criteria into investment strategies not only enhances portfolio stability but also improves long-term performance, making ESG considerations essential for investors seeking sustainable and risk-adjusted returns.

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