DO GREEN BONDS PERFORM BETTER THAN CONVENTIONAL BONDS?

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ABSTRACT

This study examines the performance of green bonds, utilizing the Standard and Poor's (S&P) Green Bond Index, Bloomberg Green Bond Index, S&P US Aggregate Bond Index, and Bloomberg Barclays US Aggregate Bond Index as benchmarks. Monthly data spanning from July 2014 to February 2023 is analyzed. Key performance ratios including the Sharpe Ratio, Treynor Ratio, and Jensen Performance Ratio are computed for portfolio comparison. Our findings indicate that the S&P Green Bond Index outperformed compared to the Bloomberg Green Bond Index. Furthermore, we calculate and regress the S&P and Bloomberg Barclay's greenium series against the consumer price index, Federal Reserve interest rates, and S&P 500 market returns. The study's findings indicate that higher Federal Reserve interest rates and increased market returns cause a decrease in the yield gap between conventional and green bonds. Moreover, a rise in the Consumer Price Index is caused by a widening of the yield disparity between these two types of bonds. The results highlight an average investor loss of 2% when investing in green bonds, in contrast to conventional bonds.
Keywords: green bond index, greenium, CAPM, Sharpe, Treynor, Jensen.

1 INTRODUCTION

Due to the threats posed by global warming on the world and the fact that the governments of many countries have brought climate change to a more important place on their agenda [1], reducing reliance on fossil fuels and adopting a low-carbon economy is becoming a priority for policymakers in both developed and emerging economies [2]. In order to achieve these targets, for example, investments in fossil fuel extraction and fossil fuel-based conventional electricity generation will need to be significantly reduced, while investments in low-carbon energy production and energy efficiency will need to be increased significantly [3]. The United Nations Environment Program (UNEP) estimates the annual investment to be made until 2025–2030 within the scope of adaptation to climate change as 150 billion USD, and the annual investment to be made until 2050 for the 2°C scenario as 250–500 billion USD [4]. Bonds, stocks and commodities markets that assist businesses in this fight against climate change now offer environmentally friendly financial means under the name of 'green finance' [5]; green finance is essential for raising funds to finance large- scale environmental projects, and its importance in financial assets has increased in recent years [6].

The main objectives of this study are as follows:

- From an investor's perspective, to determine the average return loss of investing in the bonds of companies issuing green bonds compared to traditional bonds;
- To compare the financial performance indicators of issuers in the Bloomberg Green Bond Index and Standard and Poor (S&P) Green Bond Index and calculate their expected returns;
- To identify the variables that affect the yield difference between traditional bonds and green bonds;

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- To identify the variables that narrow or widen the yield difference between traditional bonds and green bonds.

The key features that distinguish this study from others are as follows:

- Comprehensive comparison: İn this study, the green bond indices of Bloomberg and Standard & Poor's were simultaneously evaluated, comparing their performance. This helped us understand the different aspects of these two significant indices in the green bond market;
- Calculation of expected returns: The research calculates the expected returns of these indices, providing investors with more information about future performance. This can be a crucial factor when determining investment strategies;
- Greenium time series: Obtaining greenium time series data for both green bond indices allows for a more detailed examination of the dynamics of the green bond market. Greenium is an important concept resulting from the different pricing of green bonds compared to traditional bonds;
- Impact of Federal interest rates and market returns: The research examines the impact of Federal Reserve interest rates and changes in market returns on greenium. This can assist investors in better understanding the risks and returns in the bond markets;
- Effect of inflation: The study also analyzes the effect of inflation on greenium. Inflation is a significant factor that affects the value of bond investments, and this analysis can provide insight into evaluating future inflation expectations for investors.

2 GREEN BONDS

Countries aiming for a low carbon rate and an economy that is resistant to climate change are making changes in providing the capital necessary for the realization of this target. This aims to take its place in the financing market by directing the revenues to be obtained through green bonds to sustainable assets and as fixed income securities [7]. Although green bonds are seen as one of the youngest segments of the global financial world, it is important that the funds obtained from these bonds are used for ecological purposes. Green bonds are also introduced as 'environmental bonds' in the literature. Besides supporting the environment, the main purpose of green bonds is fixed income, so they do not seem to differ much from their classical equivalents [8]. Public or private sector actors to raise capital or refinance projects can issue green bonds [9].

The feature that distinguishes green bonds from other bonds is that the collected funds are used in green projects. Projects that are beneficial to the environment and climate, which do not pose a threat to the health and living spaces of people and other living things, and that involve the sustainable use of resources are called green projects. According to the new analysis prepared by Climate Economics, it has been confirmed that there is a lot of room for improvement and it is stated that the market is growing dynamically [10].

3 LITERATURE REVİEW

Broadstock and Cheng [11] in their study examined the changing relationships of green and black bonds over time and investigated the determinants of the correlation relationship between them. They concluded that the link between green and black bonds is sensitivity to changes in financial market volatility, economic policy uncertainty, daily economic activity, oil prices, and positive and negative news about green bonds. Elsayed et al. [12] study the portfolio management of green bonds and traditional assets using wavelet multiple correlations and the connectedness approach. The evidence reveals that green bonds and financial markets are highly integrated in the long run. Fernandes et al. [13] analyzed multifractality for green bonds, stock sector indices, and US economic sector bonds. They found that bond indices for consumer staples and equity indices for information technology and the real state sector can be used to hedge investments in green bonds. Pham analyzed the volatility behavior of the green bond market using data on daily closing prices of the S&P green bond indices [14]. Empirical results show that the 'labeled' segment of the green bond market experiences large volatility clustering while the pattern of volatility clustering is weaker in the 'unlabeled' segment of the market.

4 METHODOLOGY AND DATA

In the first stage of the study, the beta coefficient of green bond indices is used in order to apply the Capital Asset Pricing Model (CAPM). Furthermore, in order to compare the performance of green bond indices, Sharpe Ratio, Treynor Ratio and The Jensen Performance Index are calculated. Data collected from Bloomberg and E-views is used to obtain results from the models and equations.

The data used in this study:

rbbgbbt	Bloomberg Barclays MSCI Global Green Bond Index.
rspgb$_t$	S&P Green Bond Index.
rbbagg$_t$	Bloomberg Barclays US Aggregate Bond Index.
rspagg$_t$	S&P U.S. Aggregate Bond Index.
rsp500$_t$	Return of US S&P500 Index.
realrf$_t$	Data is calculated by subtracting consumer price index rate from the yield of the 3 months Treasury Bill Rate.
rbbgreenium$_t$	Difference between the return of conventional bonds index with the green bond index for Bloomberg.
rspgreenium$_t$	Difference between the return of conventional bonds index with the green bond index for S&P.

The formula for calculating the return series:

$$R_i = \log\left(\frac{X_t}{X_{t-1}}\right)100, \tag{1}$$

is used. Also, at the beginning of the stock's names 'R_i' indicates the logarithmic return of series.

A data set is obtained between July 2014 and February 2023. The logarithmic returns of the series indicated that while the mean values are positive for Bloomberg Barclays US Aggregate and S&P US Aggregate Bond indices but negative for the same green bond indices.

4.1 Capital Asset Pricing Model (CAPM)

CAPM is estimated in two stages. In the first step, in order to calculate the betas, we applied two different single index models.

The logarithmic returns of the Green Bond Index regressed to S&P500 market return

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_i \qquad t = 1,2,\ldots, n, \tag{2}$$

where R_{it} is the return on green bond index during the period t, R_m the expected return of the market during the period t, ε_t the error term of the portfolio risk that indicates the unsystematic risk that can be eliminated through well diversification. In the second step, the value of the single index model of the systematic risk of β_i is estimated, explanatory variables are substituted into eqn (2) and the expected return is estimated for green bond index.

$$E(R_i) = R_f + \beta_i(E(R_m) - R_f), \tag{3}$$

where $E(R_i)$ is the expected return of Bloomberg and S&P Green Bond Index for each model, R_f is the risk-free rate, β_i; is the sensitivity of the expected excess index returns to the expected excess market returns, or also

$$\beta = \frac{Cov(R_i, R_m)}{\sigma^2(R_m)}. \tag{4}$$

One of the goals to use CAPM is estimating the expected return. Using eqn (3) above, the expected returns are estimated and listed in Table 1.

Table 1: Expected returns of green bond indices.

Variable	**Beta**	**t-Stat.**	**Prob.**	**R-squared**	**Schwarz Cr.**	**E(ri)**
rbbgb$_t$	0.280	6.943	0.000	0.323	4.131	0.907
rspagg$_t$	0.256	6.934	0.000	0.323	3.956	0.915
Risk premium	(0.700) − 0.990 = (−0.290)					
Risk free rate	0.990					

As presented in Table 1, the beta coefficient of Bloomberg Green Bond Index and r-squared coefficient are higher than those of the S&P Green Bond Index. Beta coefficients are found to be significant for both models. According to the diagnostic test results, both models fulfilled the assumptions. Bloomberg Green Bond Index expected return is slightly higher than that of the S&P Green Bond Index as seen in Table 1.

4.2 Measuring performance of the portfolio

Portfolio performance is determined by comparing the measured risk and return. To calculate the Sharpe ratio in this study, the following formula is used:

$$Sharpe = r_p - \frac{r_f}{\sigma_p}, \tag{5}$$

where r_p is the average return, r_f the risk free average return and σ_p the standard deviation.

To calculate the Treynor ratio in this study the following formula is used:

$$Treynor = r_p - \frac{r_m}{\beta_{pm}}, \tag{6}$$

where r_p is the average return, r_m the risk free average return and β_{pm} Beta coefficient.

To calculate the Jensen Performance Index, the Jensen alpha, in this study, the following formula is used:

$$\alpha_i = R_i - [R_f + \beta_i(R_m) - R_f], \tag{7}$$

where R_i is the mean of the return, R_f the risk free rate and R_m the market return.

According to Table 2, the Sharpe ratio of Bloomberg Barclays Global Green Bond Index is higher than the S&P Green Bond Index, which indicates a relatively better performance. When the result is evaluated in this respect, both green bond indices provide negative values. The related ratio indicates that the green bond indices performed a lower return than a risk-free instrument.

Table 2: Performance ratios of green bond indices.

Sharpe ratio results				
	Mean of the return	**Risk free rate**	**Standard deviation**	**Sharpe ratio**
rbbgb$_t$	−0.170	0.99	2.229	−0.52
rspgb$_t$	−0.146	0.99	2.041	−0.55
Treynor ratio results				
	Mean of the return	**Risk free rate**	**Beta**	**Treynor ratio**
rbbgb$_t$	−0.170	0.990	0.283	−4.098
rspgb$_t$	−0.146	0.99	0.256	−4.437
Jensen performance index results				
	Mean of the return	**Risk free rate**	**Market return**	**Jensen ratio**
rbbgb$_t$	−0.17	0.700	0.7	−1.07
rspgb$_t$	−0.146	0.7	0.7	−1.06

4.3 Modelling greenium

According to diagnostic test, the model has a white noise error term with homoscedastic, non-autocorrelated and normal distributed. According to the Ramsey Reset test, the null hypothesis is accepted so the model has no omitted variables. All the coefficients are significant under the 5% significance level except the consumer price index, which is below 10%.

As observed from the model results presented in Table 3, it was found that a 1 basis point increase in the Fed interest rate leads to a decrease of 0.17 basis points in the S&P greenium and a decrease of 0.19 basis points in the Bloomberg greenium. It was found that a 1 basis point increase in the consumer price index would lead to an increase of 8.94 basis points in the S&P Greenium and an increase of 11.57 basis points in the Bloomberg greenium. The conclusion is thus reached that if the market yield increases by 1 basis point, the S&P greenium would decrease by 0.17 basis points, and the Bloomberg greenium would decrease by 0.18 basis points.

Table 3: Model results of greenium.

	Standard & Poor's greenium model results			**Bloomberg greenium results**		
Variable	Coef.	t-Stat.	Prob.	Coef.	t-Stat.	Prob.
RSP500	−0.171	−6.906	0.000	−0.186	−7.310	0.000
CPI	8.944	1.830	0.070	11.573	2.306	0.023
FED	−0.188	−1.691	0.094	−0.196	−1.723	0.088
C	0.303	1.685	0.095	0.273	1.483	0.141

5 CONCLUSION

Various incentives are offered in industrialized countries to meet the financing needs of renewable energy resources. There are various studies in the literature on the performance of issued financing instruments to mitigate the cost of the changing climate. Studies on the measurement of ‘green bond premium’ called ‘greenium’, which is the cost of depriving investors of the return on conventional investment instruments, while determining this cost by taking the bonds offered to the market by similar issuers as a benchmark, they aim to calculate the difference between the yields of alternative bonds.

In this study, the ‘Bloomberg Barclays US aggregate bond index’, which includes issuers similar to the ‘Bloomberg green bond index’, is included in the study as a conventional index. The ‘S&P US Aggregate Bond Index’, which includes issuers similar to the ‘S&P Green Bond Index’, is also considered as conventional index.

The present findings indicate that the disparity in returns between the S&P conventional bond index and the S&P green bond index amounts to 0.23% per month during the period from July 2014 to February 2023. Similarly, the contrast in returns between the Bloomberg Barclays conventional bond index and the Bloomberg Barclays green bond index stands at 0.26% per month within the same timeframe. In essence, this signifies that individuals who choose to invest in the S&P green bond index actively promote sustainable energy financing while incurring lower costs.

In the study, Sharpe’s single index model is estimated for both conventional bond indices. The beta of the S&P green bond index (0.256) is slightly lower than the Bloomberg green bond index (0.283). These results confirm the conclusion that investors who invest in the Bloomberg green bond index are exposed to more risk and incur more costs. The expected return for both green bond indices are calculated by using the betas obtained from the single index model within the CAPM formula. While the expected return is 0.907% for the Bloomberg green bond index, it is 0.915% for the S&P green bond index.

During the study’s covered period, the Federal Reserve began a gradual increase in interest rates starting from June 2017 and has continued to do so. Consequently, while the risk-free rate of return averaged at 0.99% within this period, the market’s return was 0.70%, leading to a negative risk premium of −0.28. It is noteworthy that during this phase of elevated interest rates, market efficiency experienced partial deterioration.

Due to the negative risk premium during the period covered by the study, Sharpe, Treynor, and Jensen’s performance ratios have negative values. In the study, it has been concluded that when the Federal interest rate and market returns increase, the yield differential between conventional bonds and green bonds narrows. We found that as the Consumer Price Index increases, the yield difference between conventional bonds and green bonds widens.

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