DOES TRANSPARENCY PAY OFF FOR GREEN BONDS' ISSUERS? EVIDENCE FROM EU STATE AGENCIES' GREEN BONDS

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ABSTRACT

This paper investigates the impact of transparent allocation of proceeds on green bonds' yields, providing insights to green bonds' issuers for optimizing their financing terms. Using data from the EU state agencies' green bond market, we applied a Prais-Winsten regression model with correlated panels corrected standard errors and common AR(1) to estimate the relationship between green bonds' yields and various factors, including the transparency of proceeds. Transparent allocation of proceeds has a negative effect on green bonds' yields, confirming that investors require lower returns when they are well-informed about a bond's environmental goals. Additionally, higher credit ratings, and shorter remaining maturity are associated with lower green bonds' yields. Transparent use of proceeds significantly influences green bonds' yields, demonstrating that specifying the use of bond proceeds for environmentally friendly projects can lead to more favorable financing terms. Future research direction should provide additional classification of the green bonds' transparency.

Introduction

The global financial landscape has witnessed a profound transformation towards sustainability in the environment of growing concerns about climate change. Within

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this paradigm change, green bonds have become a potent financial tool that aims to balance the demands of capital markets with environmental responsibility. The idea behind green bonds is based on the understanding that traditional financial markets can significantly contribute to solving today's pressing environmental and social problems. Green bonds link investors looking to align their portfolios with sustainability goals and issuers dedicated to fostering a more environmentally responsible and resilient future. Since their inception by the European Investment Bank in 2007, there has been an increasing interest because they are effective methods for financing environmentally sustainable projects. Green bonds differ from traditional ones since their proceeds are limited to financing projects with positive environmental outcomes.

Our research examines how green bonds' proceeds affect bonds' yields to address the question: Does transparent allocation of proceeds lead to decreased bonds' yields, ultimately benefiting bond issuers? This study is motivated by the aspiration to provide valuable insights to green bonds' issuers, aiding them in gaining a deeper understanding of the factors influencing green bonds' yield dynamics. Such insights may assist the issuance of green bonds under more favourable financing terms, ultimately contributing to efforts in combating climate change.

We hypothesize that investors' motivations to choose green bonds differ from those of traditional bond investments. Economic factors that drive investor decisions shaped traditional bond yields theories. However, investors in green bonds are additionally motivated by environmental goals. We assume that when the use of the funds raised by green bonds is clearly defined and aligned with the environmental preferences of investors, it can increase their confidence and willingness to accept lower returns in exchange for contributing to environmental objectives.

Academic interest in green bonds has grown, with one of the central debates related to the existence of a green bond premium (yield discount), which suggests that green bonds may offer issuers certain financial advantages compared to conventional bonds. The literature on the existence of a green bond premium presents a complex and multifaceted picture, where certain studies reported evidence of a green bond premium (Hachenberg and Schiereck, 2018; Bachelet, Becchetti and Manfredonia, 2019; Gianfrate and Peri, 2019; Nanayakkara and Colombage, 2019; Zerbib 2019; Hyun, et al., 2020; Baker et al. 2021; Fatica et al., 2021; Immel et al. 2021; MacAskill et al 2021; Li et al., 2022. In contrast, other research, including Partridge and Medda (2020), Larcker and Watts (2020), Tang and Zhang (2020) and Hyun et al. (2020), have not found substantial support for the existence of such a premium.

This ongoing debate highlights the importance of identifying determinants of green bonds' pricing and yield behaviour and forms another stance of literature. Considering the evolving landscape of green finance and investor preferences, the list of key factors influencing green bonds' pricing and yield behaviour is spreading, and researchers are making significant efforts to identify them. Among the determinants are factors such as regulatory supervision, as demonstrated in the study by Dou and Qi (2019), adherence to the Green Bond Principles, as explored by Nanayakkara and Colombage (2021), and third-party certification of green bonds, as indicated in the research by Wang et al. (2019), Hyun, Park, and Tian (2020, 2021), Nanayakkara and Colombage (2021), and Janković, Kovačević, and Ljumović (2022). Additionally, Li et al. (2020) underlines that higher credit ratings, possession of green certificates, and stronger Corporate Social Responsibility (CSR) scores contribute to reducing the financing costs for green bonds' issuers. Furthermore, factors such as high liquidity (Chang et al., 2021), bond's credit rating, issue size, and maturity (Wang et al., 2019) have been identified as variables that exert downward pressure on green bond yields. Finally, the broader economic context and investor sentiment can impact green bonds' yields (Fatica et al., 2021).

Recent studies argue that the proceeds of green bonds are a principal determinant of pricing/yield behaviour (Russo et al., 2021). It is essential for attracting investors looking for environmentally sustainable investments that align with their values. Examining green bonds issued by corporations and banks, Fatica et al. (2021) found a price premium in the case of corporate green bonds. However, they did not find a similar premium for bonds issued by banks. They concluded that corporations typically issue green bonds to fund specific projects, whereas banks tend to securitize green bonds. With bond baskets used by banks, investors may have uncertainties regarding the allocation of proceeds from the green bonds, which could lead to hesitancy in their investments. Furthermore, transparent use of proceeds may exhibit higher liquidity, contributing to favourable pricing dynamics, as Chang et al. (2021) stated.

Jankovic et al. (2022) have empirically demonstrated a favourable impact on reducing green bonds' yields when these bonds are issued explicitly for financing a single, well-defined, environmentally friendly project. This contrasts with green bonds intended for a broader array of projects or those where the use of proceeds remains unspecified. The authors have introduced the term *Green bond transparency* to categorize green bonds based on their transparency levels. Bonds aimed at funding a particular environmentally friendly project are classified as transparent, while all others fall into the non-transparent category. In a separate study, Su and Lin (2022) analysed the Chinese green bond market and found that, among various factors investigated, the precise designation of the use of proceeds has a notable impact on the liquidity of green bonds. When transparent, specific, and aligned with investor preferences, proceeds can contribute to lower yields and more favourable pricing conditions (Jankovic et al., 2022). While the body of literature regarding green bond transparency remains limited, available research indicates a favourable impact of a specific allocation of proceeds in lowering the yields of green bonds.

This study adds to the existing literature by offering novel perspectives on how designating proceeds affects green bonds' yields. Furthermore, it investigates the concept of green bonds' transparency and introduces a new classification. While Jankovic et al. (2022) categorized green bonds as transparent when they finance a single project, our research defines green bonds as transparent if they fund projects within a single environmental category based on the Climate Bonds Initiative (CBI,

2021) classification. This classification holds practical significance, particularly for financial institutions financing multiple projects, such as EU state agencies.

We provide empirical testing in the green bond market area with limited research attention – EU state agencies' green bonds. There are two reasons for our focus on this segment. Firstly, EU state agencies play a pivotal role in the broader financial landscape, extending beyond the issuance of green instruments. They are key players in financing various critical EU-level projects through diverse channels. Consequently, the transparency aspect of green instruments issued by these institutions holds particular significance compared to smaller corporate or commercial bank issuers, which have been extensively studied. However, the state agency segment of the green bond market has been relatively underexplored until now, prompting our interest in delving into the transparency aspect of these instruments and their broader financial implications. Secondly, our study presented a unique opportunity to investigate the entire population of green bonds issued by a specific category of issuer. As a result, our sample encompasses the entirety of EU state agencies' green bonds, representing the upper limit regarding sample size for this category.

Materials and methods

For this study, we consider green bonds that finance projects falling within one concrete class of environmental projects, following the Climate Bonds Initiative (CBI, 2021), to be transparent, while those that finance different projects or for which the use of proceeds is not predetermined are non-transparent.

We focus on the under-researched EU segment of the green bond market, and to avoid potential bias resulting from different asset classes or mixed geographical areas, we test the whole population of active EU state agencies' green bonds during the period 17 September 2014 – 31 December 2021, including 37 bonds with daily data series. The available data for each bond is taken from the *Refinitiv Eikon* platform. Details on the number of observations for this unbalanced panel dataset are provided in the Appendix (Table A.1).

The description of the variables and their potential impact on bond yields is presented in Table 1.

Table 1. Variables' description and potential impact

Label	Name	Unit of measure	Role	Potential impact
Bid yield	Green bonds' bid yields	Percentages	dependent	
Amount	Amount of green bonds issued	Euros	explanatory	negative
Interest rate	Green bonds' interest rates	Percentages	explanatory	positive

Label	Name	Unit of measure	Role	Potential impact
Rating	Green bonds' credit ratings	1 if a rating is AAA, 0 otherwise	explanatory	negative
Use of proceeds	Specification of green bonds' use of proceeds	1 if a specific project is financed or the projects are in one Climate Bonds Initiative (CBI 2021) investment sector, 0 otherwise	explanatory	negative
Remaining maturity	Green bonds' remaining maturities	Days	explanatory	positive
Euribor	Euro interbank offer rate	Percentages	explanatory	positive

Source: Authors

Table 2 presents descriptive statistics for the dependent and explanatory variables.

Table 2. Descriptive statistics

		Bid yield	Amount (in mill)	Interest rate	Rating	Use of proceeds	Remaining maturity	Euribor
Mean		0.032	869.559	0.609	0.970	0.150	2647.110	–0.371
Median		–0.083	500.000	0.500	1.000	0.000	2594.000	–0.356
Std. Deviation		0.444	926.689	0.575	0.170	0.360	1276.233	0.1432
Skewness		1.363	3.490	0.928	–5.420	1.950	2.309	0.522
Std. Error of Skewness		0.015	0.020	0.015	0.020	0.020	0.015	0.015
Kurtosis		4.200	13.790	0.130	27.400	1.810	11.197	–0.194
Std. Error of Kurtosis		0.030	0.030	0.030	0.030	0.030	0.030	0.030
Percentiles	10	–0.437	500.000	0.000	1.000	0.000	1308.000	–0.528
	20	–0.338	500.000	0.050	1.000	0.000	1695.000	–0.520
	30	–0.259	500.000	0.200	1.000	0.000	2054.000	–0.513
	40	–0.178	500.000	0.375	1.000	0.000	2351.000	–0.468
	50	–0.083	500.000	0.500	1.000	0.000	2594.000	–0.356
	60	0.037	500.000	0.750	1.000	0.000	2815.000	–0.307
	70	0.230	1000.000	0.750	1.000	0.000	3045.000	–0.270
	80	0.440	1000.000	1.000	1.000	0.000	3325.000	–0.245
	90	0.624	2000.000	1.375	1.000	1.000	3570.000	–0.212

Source: Authors' calculations

After defining the initial assumptions, we estimate the linear cross-sectional time series

$$Bid\_Yield_{it} = \alpha + \beta_1 \cdot Amount_{it} + \beta_2 \cdot Interest\_rate_{it} + \beta_3 \cdot Rating_{it} + \beta_4 \cdot Use\_of\_proceeds_{it} + \beta_5 \cdot Remaining\_maturity_{it} + \beta_6 \cdot Euribor_{it} + \varepsilon_{it}$$

where $i = 1, \dots, m$ is the number of groups; $t = 1, \dots T_i$ is the number of periods in group i; andε_{it} is the residual of the model. α is the intercept, and β_j are unknown coefficients, which must be estimated.

Our main research hypothesis is that when green bonds have transparent use of proceeds, it reduces bond yields.

Results

Before estimating the panel regression model, we examined whether there was multicollinearity of the explanatory variables and found none (all tolerance statistics are greater than 0.55, or all VIF values are smaller than 1.82). After using OLS to estimate the panel regression model, we began the model diagnostics by checking autocorrelation in the panel data and using a cross-section dependence test for the residual diagnostics. The presence of autocorrelation in the panel data was tested using Durbin-Watson statistics (DW stat = 0.011) and the Wooldridge test (F(1, 36) = 910.962, Prob > F = 0.000). We tested residual cross-section dependence with Breusch-Pagan LM (Statistic = 222993.8, Prob. = 0.000), Pesaran scaled LM (Statistic = 6091.743, Prob. = 0.000), and Pesaran CD tests (Statistic = 411.2268, Prob. = 0.000). The tests showed autocorrelation and cross-section dependence (correlation) in the panel data.

The suitable model to use when panel data is unbalanced is the Prais-Winsten regression model with correlated panels corrected standard errors (PCSEs) and panel autocorrelation. We estimated panel autocorrelation with common AR(1).

Table 3 shows the results of the defined panel regression model.

Table 3. Prais-Winsten regression with correlated panels corrected standard errors and common AR(1)

Bid_yield	Coef.	Panel-corrected Std. Err.	z	P>|z|	[95% Conf.	Interval]
Amount	–2.40e–11	6.75e–13	–35.5300	0.000	–2.53e–11	–2.27e–11
Interest_rate	0.1180	0.0045	26.3400	0.000	0.1090	0.1270
Rating	–0.7560	0.0252	–29.9000	0.000	–0.8500	–0.7060
Use_of_proceeds	–0.0634	0.00181	–35.0200	0.000	–0.0670	–0.0706
Remaining_maturity	0.000156	0.00000168	93.1100	0.000	0.000152	0.000159
Euribor	1.5100	0.0390	38.8600	0.000	1.4400	1.5900
_cons	0.8710	0.0300	29.0400	0.000	0.8120	0.9300
Observations	27,566					
Adjusted R-squared	0.6029					

Note: The group variable is a number, and the time variable is a date. Panels are correlated (unbalanced). Autocorrelation is common AR(1). Common AR(1) is 0.7937609.

Source: Authors' calculations

The analysis results indicate that the specified use of proceeds has a negative effect on the green bonds' yields. This result goes in favour of our research hypothesis. When investors become familiar with a green bond's investment goals, they require lower returns. In addition, we confirm the positive effect of the interest rate and Euribor on green bonds' yields. At the same time, higher ratings and lower remaining maturity lead to lower bonds' yields, which is under economic logic and the risk-averse behaviour of investors. Bonds with a higher rating and shorter remaining maturity are perceived as lower-risk investments from which investors require a lower return.

Robustness tests

As mentioned, we identified contemporaneous correlation in the analysed panel data, and the panels were not balanced. Hence, the regression with panel-corrected standard errors (PCSE) is the correct approach in this analysis. Within the scope of the analysis, for the sake of robustness testing, we implemented several adjustments. First, instead of common AR(1), we implemented the panel-specific AR(1) autocorrelation. Second, a method for computing autocorrelation, instead of autocorrelation of residuals, is based on Durbin-Watson statistics. Third, we used normalized standard errors by *N-k* (instead of *N*), where *k* is the number of parameters estimated, and *N* is the number of observations. Fourth, we added the explanatory variable, *Maturity,* in panel data estimation. Ultimately, we used *Ask yield* to test the sensitivity of the analysis results instead of the dependent variable *Bid yield*. After all the robustness and sensitivity tests, the results remain the same, and inferences do not change. (For the sake of brevity, we did not provide these results in the paper, but we can provide them to all interested parties upon request).

Discussion

This study offers evidence of determinants affecting the yields on green bonds. Both issuers, who want to get favourable financing terms, and investors, who want to match their portfolios with sustainability goals while maximizing financial returns, should well understand these drivers. Our findings indicate that all analysed determinants had significant impact in the model. While using a sample of bonds from EU state agencies, our results are in line with those reported in the current academic research.

Our study emphasizes the role of the transparent use of proceeds in influencing green bonds' yields, in line with the findings of Russo et al. (2021). The transparent use of proceeds has a negative effect on the green bonds' yields, as in Janković et al. (2022), Fatica and Panzica (2021) and Chang et al. (2021). This finding is partially consistent with Fatica et al. (2021) who found a price premium only in the case of corporate green bonds, while this premium was not identified for bonds issued by banks.

Interest rates, including benchmark rates like Euribor (Euro Interbank Offered Rate), play also important in the pricing and yields' behaviour of financial instruments, including green bonds. Using Euribor as the referent benchmark in the EU state agencies case, we found positive effect on green bonds' yields as is confirmed in Coudert and Salakhova (2020) and Pietsch and Salakhova (2022). Our findings are also aligned with research by Chang et al. (2021), emphasizing the importance of liquidity, which can be influenced by interest rates. However, even though interest rates are often recognized as significant determinants, the extent of their impact may vary based on market conditions and investor sentiment.

As Li et al. (2020) and Wang et al. (2019) noted higher credit ratings contribute to reducing financing costs for green bonds' issuers. Our observations show that higher ratings and lower remaining maturity decrease bonds' yields and are perceived as lower-risk/lower-return investments. This result aligns with economic logic, as longer-maturity bonds typically carry higher yields to compensate investors for the increased risk associated with a longer investment horizon.

Conclusions

Green bonds are new, significant financial instruments which aim to tackle climate change. Our goal was to shed light on green bonds' pricing behaviour. We find empirical evidence that transparency of green bonds' use of proceeds is an important determinant of green bonds' yields. In addition, we investigate other factors affecting government agencies' green bonds' behaviour and conclude that risk-reducing factors such as high credit rating, low remaining maturity, and low level of interest rates result in lower green bonds' yields. Despite their importance, the state agencies' green bonds have received comparatively less attention in previous studies. We believe it is equally relevant for the state issuers to benefit from specifying the use of bonds' proceeds as it enables them to finance environmentally friendly projects under more favourable conditions.

A potential path for future research is to expand the classification of green bonds beyond the current binary distinction between transparent and non-transparent. This could involve the identification of different shades of green transparency through a pooling of green bonds into more than two categories based on the level of detail provided on the use of proceeds and the degree to which they align with specific environmental goals.

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Conflict of interests

The authors declare no conflict of interest.

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Appendix

Table A.1 presents the number of observations for the bonds analysed in the sample (n=37).

Table A1. Number of observations for analysed bonds

Bond	Number of observations
LRENT-1	1,651
AFD-1	1,903
NDLWR-1	1,652
NRWBK-1	1,604
KFW-1	1,466
NRWBK-2	1,337
CDCEC	1,263
KFW-2	1,209
KMUNK-1	1,197
KITUS-1	1,109
NRWBK-3	1,123
CSDPR	852
KFW-3	833
NRWBK-4	915
KMUNK-2	912
IDCOL-1	713
KFW-4	683
NRWBK-5	759
KITUS-2	648
NRWBK-6	579
NDLWR-2	590
KMUNK-3	554
AFD-2	490
IDCOL-2	308
LRENT-2	334
KFW-5	374
SFIL	290
NRWBK-7	489
KITUS-3	318
KMUNK-4	346
IDCOL-3	140
KFW-6	188
NRWBK-8	238
LRENT-3	133
NRWBK-9	113
KFW-7	73
NDLWR-3	180