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Research article

Short-term stock market reaction to the announcement of green bond issue: evidence from Nordic countries

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Abstract: Green bond issues and markets are growing rapidly worldwide every year. Green bonds are used for financing environmentally friendly projects. Their issue is an important event in a company, with a huge impact not only on the protection of the environment but also on the management practice and financial performance of the company. This event is a signal to a stock market that is interpreted by shareholders differently: positively for eco-friendly investors and negatively for traditional investors, as it increases additional capital expenditures and financial risk. This paper aims to assess the short-term stock market reaction to the announcement of green bond issues in Nordic public companies and to determine whether the characteristics of green bond issues and issuers are significant determinants of stock cumulative abnormal return (CAR). The total sample was composed of 197 green bonds issued during 2017–2024. Sweden had the highest number of green bond issues (60.9%). Denmark and Finland had a very similar share, with 20.3% and 18.8%, respectively. The stock market reaction was assessed by applying an event study methodology. CAR dependence on the characteristics of green bond issues and issuers was determined using a heteroskedasticity-corrected regression model. The findings revealed a negative stock market reaction to the announcement of green bond issues. Such reaction may not only be due to increased capital expenditures and financial risk but also to the shift of investments from stocks to green bonds, as the majority of green bonds were issued during the COVID-19 pandemic and the Russian–Ukrainian war. We highlight that CAR is more sensitive to the characteristics of green bond issuers than those of issues.

Keywords: green bond issue; stock market; cumulative abnormal return; characteristics of green bond issues; characteristics of green bond issuers

JEL Codes: G10, G14

Abbreviations: CAR: cumulative abnormal return; CAPM: capital asset pricing model

1. Introduction

More and more countries are doing their part to improve the environment by tackling the effects of climate change, mitigating its negative impacts on nature and society, and preserving environmental diversity. This is one of the reasons for the increased popularity of green bonds. According to the data of Statista[1] in 2023, China issued the highest amount of green bonds worldwide (nearly 84 billion U.S. dollars). Second in the ranking was Germany with 68 billion U.S. dollars. The United States was third with green bond emissions worth 60 billion U.S. dollars.

The rapid development of the green bond market encourages market participants to invest in financial instruments to finance environmental projects and thus ensure economic sustainability. Deschryver and de Mariz (2020) described the growth in green bond markets and emphasized that the issuance of green bonds will gain scale when issuers perceive a clear financial incentive. Financial markets react to the issue of green bonds. Companies can increase their leverage by issuing bonds among other instruments. On the one hand, raising debt capital to finance investments increases financial risk, which can send a negative signal to the stock market (Roslen et al., 2017). On the other hand, news of green project financing is a positive signal for the stock market as it is evidence of the issuer's business strategy, which focuses on the sustainability of its operations and its ambition to remain among the leading companies in the same industry (Cioli et al., 2021; Laborda and Sánchez-Guerra, 2021). Not only the green bond issue itself but also all the information related to it (purpose, volume, coupon rate, initial or repeated issue) are important for financial market participants. Companies that issue green bonds must report, after the issue, the proper use of the funds.

Recently, scholars have become more and more interested in the field of sustainable finance. Friede et al. (2015) reviewed the findings of approximately 2200 individual studies. The results showed a large majority of studies reporting positive ESG (environmental, social, and governance) criteria impact on corporate financial performance (CFP). This impact appears to remain stable over time. The studies of Possebon et al. (2024) and Aleknevičienė and Stralkutė (2023) revealed a statistically significant negative relationship between ESG scores and cost of capital. Ul Hag and Doumbia (2022) examined sustainability-linked bonds (SLB) and revealed that their structures allow issuers to weaken the link between sustainability and financial outcomes, rendering SLB less effective. Issuers may issue these bonds as an effective strategy to lower the cost of capital for the firm, with little thought toward sustainability.

The impact of the green bond issue on stock price performance is currently one of the hottest topics in academic literature. Issuers and investors are interested in this effect to maximize returns. The positive impact of green bond issues on stock returns has been found by Zhang et al. (2024), Fan et al. (2023), Verma and Bansal (2023), Wang and Jiang (2023), Jin and Zhang (2023), Flammer (2021), Cioli et al. (2021), Laborda and Sanchez-Guerra (2021), Tang and Zhang (2020), Wang et al. (2020),

1 Leading countries in terms of value of green bonds issued worldwide in 2023. Available at: https://www.statista.com/statistics/512030/share-of-green-bond-market-value-globally-by-major-country/

Baulkaran (2019), and Zhou and Cui (2019). Negative stock market reactions to the green bond issue have been demonstrated by Lebelle et al. (2020) and Roslen et al. (2017).

Zhang et al. (2024) found a substantial reduction in stock price crash risk after the issue of green bonds. According to the authors, this event can reduce stock price crash risk by addressing information asymmetry and alleviating financing constraints. Wang and Jiang (2023) revealed that the green bond issue significantly improves stock price informativeness by increasing information transparency and sustainable performance, which play a mediating role. It should be pointed out that the research was done considering the long-term impact. Wang et al. (2020) applied an event study and revealed the positive impact of the announcement of the green bond issue on stock returns. The researchers based such results on the stakeholder value maximization theory: corporate engagement in sustainable financing practices increases its value in the long term and thus is favored by shareholders. Zhou and Cui (2019) claimed that the green bond issue plays an active role in improving companies' profitability, operational performance, and innovation capacity, and increasing stock prices. Shareholders consider green bonds as value-added financing tools (Baulkaran, 2019), and green bond issues lead to positive sentiments among investors (Verma and Bansal, 2023). Fan et al. (2023) found both short-term and long-term positive stock market reactions to the announcement of the green bond issue and stated that investors ignore the unlabeled green bonds in the short term. Similar results were obtained by Kuchin et al. (2019), who evidenced that a positive reaction does not depend on the presence of a green label.

Flammer (2021) proved that a positive response is stronger for first-time issuers and bonds certified by third parties. She argued that issuers improve their environmental performance post-issue and experience an increase in ownership by long-term and green investors. Her findings are consistent with a signaling argument: companies, issuing green bonds, credibly signal their commitment toward the environment. Similar to Flammer (2021), Cioli et al. (2021) also demonstrated significant stock price increases around the announcement date of first-time green bond issues. For the second issue, the positive stock price reaction to eco-friendly initiatives decreases and completely disappears for the subsequent issues. The researchers argued that decreasing marginal benefits is related to the market awareness about the company's commitment to green projects. Tang and Zhang (2020) also found that stock market reactions are stronger for first-time issuers than for repeated issuers. Moreover, they and Jin and Zhang (2023) proved a stronger positive impact for corporations than for financial institutions as issuers.

The issue of green bonds as a negative signal for the stock market was identified by Lebelle et al. (2020) and Roslen et al. (2017). Lebelle et al. (2020) argued that operational and capital expenditures to make companies more sustainable might be interpreted by investors as providing uncertainty about the profitability of new business models; investors still consider green bonds as quite new and unknown financial instruments and perceive the risk of greenwashing and its potential consequences on the stock market. In addition, researchers showed that developed markets react more negatively to green bond issues than emerging markets. This particular result might indicate that developed market issuers are likely to face higher legal constraints on transparency than emerging market ones. An issuer using the green bond proceeds for greenwashing would then be easily identified by investors, conveying a higher reputational risk, which would make investors adapt their investment strategy consequently and "punish" such practices by divesting, resulting in a negative market reaction. Roslen et al. (2017) found negative cumulative abnormal returns (CARs) for 10 days surrounding the green bond announcements. They stated that debt will increase companies' probability of default. Moreover, green bonds are unsecured where there is no collateral backing for the loan. These financial instruments are evidence of legal commitment by issuing companies to pay interest and principal as the bond comes due.

The literature review revealed that very little attention has been paid to the dependence of CAR on the characteristics of green bond issues (Kuchin et al., 2019) and green bond issuers (Lebelle et al., 2020; Kuchin et al., 2019). CAR dependence on the order of green bond issue was examined by Flammer (2021), Cioli et al. (2021), and Tang and Zhang (2020). So, the research gap related to statistically significant determinants of CAR still exists.

This study aims to determine the impact of the green bond issue on stock returns in the Nordic countries that belong to the European Union: Finland, Sweden, and Denmark. The choice of Nordic countries is based on several considerations. First, these have rather ambitious policies for environmental protection and low-carbon development (Hildingsson et al., 2019). According to Gyamerah and Asare (2024), economic policy uncertainty has a strong impact on green bonds, and its intensity depends on location. Khan et al. (2021) examined strategies for greening the economy in three Nordic countries (Denmark, Norway, and Sweden). They indicated the presence of a transformative Nordic model for greening the economy, in which the state plays an active role in supporting innovation and technology development. Second, the literature review revealed a dominant positive effect of the green bond issue on stock returns. In contrast, Lebelle et al. (2020) argued that the negative impact of the green bond issue on stock returns is more pronounced in developed than in emerging economies. Hence, the dominance of the positive impact of the green bond issue on stock returns in the research results highlights controversial aspects. Third, Ammann et al. (2006) found that the announcement effects of convertible bonds and exchangeable bonds of Swiss and German listed companies are associated with significantly negative abnormal returns, while Hemmingson and Ydenius (2017) revealed negative announcement effects of convertible bonds in Nordic countries. Fourth, the three Nordic countries selected are united by legislation, directives, and standards in force in the European Union such as the proposal of the European Commission on an EU Green Bond Standard and sustainable finance strategy adopted by the European Commission in the context of the European Green Deal of December 2019 (Fatica et al., 2021). Finally, Nordic green bond issuers overall are positive toward the EU Green Bond Standard (Björkholm and Lehner, 2021).

The paper is organized as follows: In Section 2, we present the main characteristics of the sample of green bond issues, event study methodology, regression models, and the research hypotheses. In Section 3, we assess the stock market reaction to the announcement of the green bond issue, reveal the main characteristics of green bond issues and issuers that influence CAR, and check the robustness of the findings. In Section 4, we develop a scientific discussion. Finally, we present the main conclusions of our research in Section 5.

2. Materials and methods

2.1. Sample of green bond issues

Data on green bonds issued between 1 January 2014 and 12 March 2024, as well as issue and issuer characteristics, are compiled from the Bloomberg database. All companies' bonds labeled *green* in the Bloomberg database were selected. A total of 615 green bond issues were chosen for analysis. Unfortunately, the lack of companies' stock market data reduced the set of green bond issues from 615 to 197. This number has been issued by 35 Swedish, 10 Finnish, and 6 Danish public companies, banks, and financial services companies. Sweden has the highest number of green bond issues (60.9%). Denmark and Finland have a very similar share of 20.3% and 18.8%, respectively. The lack of

companies' stock market data also shortened the study period. The data in Figure 1 shows that only two green bond issues were studied in 2017 and 2018. Thereafter, the sample of green bond issues surveyed increased until reaching 62 in 2023. In 2023, compared to 2022, the largest jump in green bond issues was observed in Finland, while there was a decrease in Sweden.

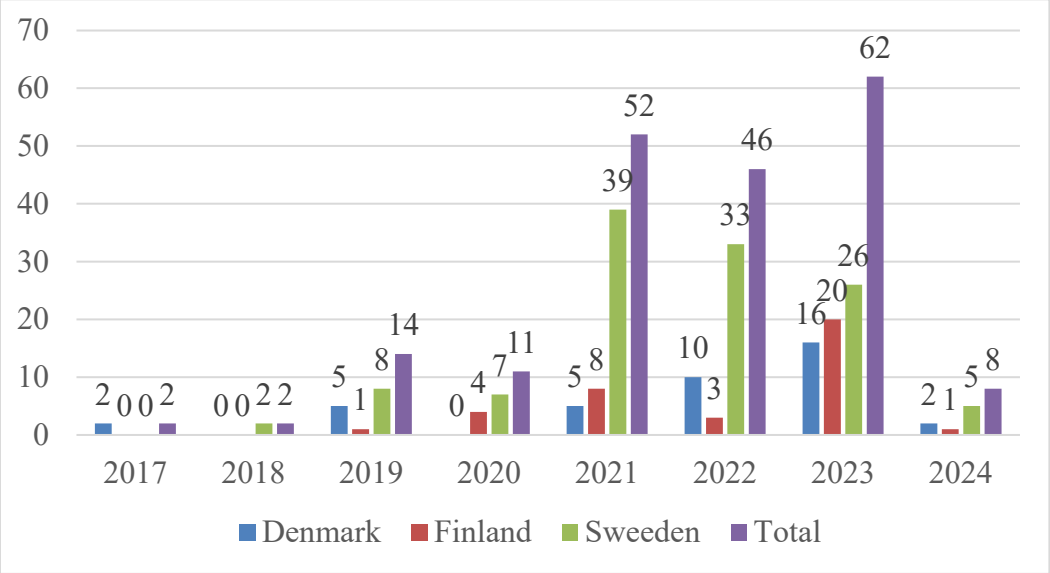

Figure 1. Distribution of samples of green bond issues by year and country.

Green bond issues by Nordic public limited companies and their distribution by sector and main characteristics are shown in Table 1.

Table 1. Distribution of green bond issues according to countries, sectors, and main characteristics.

	Denmark	**Finland**	**Sweeden**	**Total**
Sector				
Financial institutions	0	6	62	68
Industrial	6	19	39	64
Banks	16	11	16	43
Utility	18	0	0	18
Telecommunication	0	1	3	4
Maturity				
1–5 years	14	20	90	124
>5 and <10 years	13	13	26	52
>10 years	7	2	2	11
Perpetual	6	2	2	10
Issue order				
First-time issues	7	13	42	62
Repeated issues	33	24	78	135
Bond cancellation right				
Noncallable	2	15	87	104
Callable	38	22	33	93
Total	40	*37*	*120*	*197*

The research sample is dominated by financial institutions (34.5%) and industrial companies (32.5%). In terms of maturity, the largest share is accounted for by short-maturity (1–5 years) green bonds (62.9%). From the entire sample, 26.4% of bonds are issued for over 5 years but not exceeding 10 years, and 5.6% of issues have a long maturity (more than 10 years). A similar proportion of bonds are perpetual. It should be noted that bonds with a maturity of 1000 years are also included in this category. Green bonds with this maturity have been issued by a Danish utility company and an industrial company. First-time issues of green bonds account for 31.5% of the total number of issues, while repeated issues account for 68.5%. More than half of the green bonds issued have bond right cancellation. These rights cost the issuer a slightly higher coupon rate but offer incomparably greater flexibility to reduce the cost of borrowing when the market is in a downward trend in interest rates.

To investigate stock abnormal returns and the characteristics of green bond issues and issuers that lead to them, the overall research sample is split into two: industrial, utility, and telecommunication companies, and banks and financial institutions. This grouping is due to the different objectives of the green bond issues. Industrial, utility, and telecommunication companies make real investments. Banks and financial institutions finance green projects of business enterprises or invest in green market indices or green financial instruments, i.e., indirect investments. This rationale is important for studying the impact of both green bond issue and issuer characteristics on the cumulative abnormal return (CAR) of stocks. Another aspect is also relevant for studying the impact of the characteristics of green bond issuers on the CAR of stocks: the financial indicators of banks and financial institutions differ substantially from those of industrial, utility, and telecommunication companies.

2.2. Event study methodology

The impact of the announcement of the green bond issue on stock returns is determined by applying an event study method. Using this method, we need actual, expected, abnormal, average abnormal, cumulative abnormal, and average cumulative abnormal returns. Actual stock returns in the event windows are calculated as the natural logarithm of the ratio of the current stock market price ($P_{i,t}$) to the previous stock market price ($P_{i,t-1}$):

$$R_{i,t} = \ln\left(\frac{P_{i,t}}{P_{i,t-1}}\right) \quad (1)$$

The capital asset pricing model (CAPM) is usually used to calculate expected stock returns assuming a zero risk-free interest rate. This market model was applied by Flammer (2021), Cioli et al. (2021), Laborda and Sánchez-Guerra (2021), Wang et al. (2020), and Roslen et al. (2017). Tang and Zhang (2020) and Lebelle et al. (2020) showed that regardless of the chosen market model (CAPM or Fama-French multifactor models), very similar results were obtained. The CAPM for the estimation window is as follows:

$$r_{i,t} = \alpha_i + \beta_i \times R_{m,t} + \varepsilon_{i,t} \quad (2)$$

where $r_{i,t}$ is the expected return of company i on day t for the estimation window; β_i measures the sensitivity of $r_{i,t}$ to the market; $R_{m,t}$ is the market return on day t; α_i is the intercept; and $\varepsilon_{i,t}$ is the error term. Leading stock market indices of OMX Copenhagen 25, OMX Stockholm 30, and OMX Helsinki 25 are selected for Nordic companies.

We then use the estimated CAPM parameters α_i and β_i to predict the expected stock returns $E(R_{i,t})$ for each day t belonging to the event window as follows:

$$E(R_{i,t}) = \alpha_i + \beta_i \times \hat{R}_{m,t} \quad (3)$$

where $\hat{R}_{m,t}$ is the market return for each day t belonging to the event window.

The abnormal return of company i on day t is calculated as the difference between the actual and expected return:

$$AR_{i,t} = R_{i,t} - E(R_{i,t}) \quad (4)$$

The average abnormal return on day t is the following:

$$AAR_t = \frac{1}{N}\sum_{i=1}^{n} AR_{i,t} \quad (5)$$

where N is the sample of companies from 1 to n.

The CAR of company i for the event window T [t_1, t_2] is:

$$CAR_{i,T} = \sum_{t=t_1}^{t=t_2} AR_{i,t} \quad (6)$$

where t_1 and t_2 are the start and the end of the event windows, respectively.

The average CAR for the event window T [t_1, t_2] is:

$$ACAR_T = \frac{1}{N}\sum_{i=1}^{n} CAR_{i,T} \quad (7)$$

Estimation windows usually ranged from 200 to 252 days in previous studies. We chose a 250-day estimation window. The last day of the estimation window before the event usually ranges between 50 and 10 days. We chose 50 days, trying to avoid the impact of private information before the event as much as possible. Three event windows were chosen: one basic [−1,1] and two additional [−5,5]; [−10,10]. We use t-statistic and non-parametric Wilcoxon signed-rank test to determine the significance of the average CAR.

The event study method is applied for two groups of companies separately: the companies operating in industrial, utility, and telecommunication sectors; and financial institutions and banks.

The event study method is used to test Hypotheses H1 and H2:

H1: The impact of the announcement of the green bond issue on CAR is negative for the companies operating in the industrial, utility, and telecommunication sectors.

H2: The impact of the announcement of the green bond issue on CAR is negative for financial institutions and banks.

Although most previous research evidenced negative short-term market reaction to the green bond issue, we formulate an opposite H1. The formulation of H1 is based on the following arguments: the announcement and issue of green bonds signal to the market the increased capital and operational

expenditures and decreased earnings before interest and taxes; the announcement and issue of green bonds signal to the market an increased financial risk and higher required rate of return; some scientists (Lebelle et al., 2020) revealed that developed markets react more negatively to the announcement of green bond issue than emerging markets; some scientists (Hemmingson and Ydenius, 2017) found negative announcement effects of convertible bonds on CAR in Nordic countries.

2.3. Regression models

Regression models are applied for the estimation of CAR determinants. All determinants are divided into two groups: characteristics of green bond issues and characteristics of green bond issuers. The ordinary least square (OLS) model is applied to cross-sectional data. The regression model for characteristics of green bond issues and issuers is the following:

$$\begin{aligned} CAR_i = {} & \beta_0 + \beta_1 IO_i + \beta_2 CPN_i + \beta_3 MT_i + \beta_4 CR_i \\ & + \beta_5 IA_i + \beta_6 SIZE_i + \beta_7 TG_i + \beta_8 LEV_i + \beta_9 RG_i + \beta_{10} ROE_i + \beta_{11} TOBINQ_i \\ & + \beta_{12} PB_i + \gamma_1 D_1 + \gamma_2 D_2 + \varepsilon_i \end{aligned} \quad (8)$$

where β_0 is the intercept; IO is the issue order; CPN is the coupon rate; MT is the maturity; CR is the cancellation right; IA is the issue amount; i is the issue (note: the issue order and the cancellation right are dummy variables: first-time issues take value 0, repeated issues take value 1; noncallable bonds take value 0, callable bonds take value 1; natural logarithm is used for maturity term and the issue amount); SIZE is the natural logarithm of assets; TG is the asset tangibility; LEV is the financial leverage; RG is the revenue growth; ROE is the return on equity; TOBINQ; PB is the price-to-book ratio; country dummy D_1 takes value 1 if the observation is from Finland and 0 otherwise; and country dummy D_2 takes value 1 if the observation is from Denmark and 0 otherwise.

White and Breusch tests revealed that the data are heteroscedastic. For this reason, the OLS models were changed to heteroscedasticity-corrected linear regression models. They are applied to two groups of companies separately: the companies operating in the industrial, utility, and telecommunications sectors; and financial institutions and banks.

Regression models are used to test H3 and H4:

H3: The characteristics of the green bond issue and issuers are statistically significant determinants of CAR for the companies operating in the industrial, utility, and telecommunication sectors.

H4: The characteristics of the green bond issue and issuers are statistically significant determinants of CAR for financial institutions and banks.

3. Empirical results

3.1. The impact of green bond issues on CAR

CAR is calculated following the event study methodology. The descriptive statistics and statistical significance of the CARs of industrial, utility, and telecommunication companies are presented in Table 2. The data in the table shows that the average CAR is negative in all event windows. This indicates a negative reaction of equity investors following the announcement of the green bond issue. The highest average negative CAR is recorded in the longest event window (0.43%) and the lowest in the medium event window (0.07%). The medians are different from the means and indicate the asymmetry of the

CAR. Moreover, they are positive in two event windows: [−1,1] and [−5,5]. The standard deviation depends on the length of the event window: the longer the event window, the higher the amplitude of the CAR variation. The maximum and minimum values indicate relatively large ranges of CAR variation from the baseline to the medium event window. The maximum CAR value decreases as the event window shortens and varies between 32.2% and 7.7%. In contrast, the minimum CAR value increases as the event window shortens and varies between −20.0% and −9.5%.

Table 2. Descriptive statistics and statistical significance of CAR in companies operating in industrial, utility, and telecommunication sectors.

	CAR [−1,1]	**CAR [−5,5]**	**CAR [−10,10]**
Mean	−0.0018	−0.0007	−0.0043
Median	0.0041	0.0016	−0.0032
Standard deviation	0.0300	0.0659	0.0850
Max value	0.0769	0.3088	0.3216
Min value	−0.0947	−0.1819	−0.2001
t-statistic	−5.4369	4.4692	−6.1509
p-value	0.0322	0.0012	0.0000
Wilcoxon signed-rank test	−1.6234	2.6228	−3.7191
p-value	0.1145	0.0087	0.0002
Total observations	86	86	86

Note: For t-statistic, the null hypothesis is that the sample mean does not differ from zero, while for Wilcoxon signed-rank, the null hypothesis is that the sample median does not differ from zero.

Two tests are used to test the statistical significance of the differences between actual earned and expected CARs in the event windows: the t-statistic test and the Wilcoxon signed-rank test. Both tests confirmed a statistically significant difference between actual earned and expected CARs in the event windows [−10,10] and [−5,5] with a 1% confidence level. Meanwhile, in the shortest event window, the test results were contradictory: the t-statistic test confirmed a statistically significant difference with a 5% confidence level, while the Wilcoxon signed-rank test refuted it.

In summary, equity investors perceive the issue of green bonds as a negative signal. This treatment is statistically significant over a longer event window, so it is likely that certain information reaches the market before the announcement of a green bond issue. Subsequently, the differences between earned and expected CARs disappear.

Descriptive statistics and statistical significance of CARs of financial institutions and banks are presented in Table 3. The data show that the average CAR is negative in all event windows. As in the first group of companies, it is also the most negative in the longest event window. Although the average CAR in financial institutions and banks is significantly different from the average CARs in industry, utility, and telecommunication, the standard deviations are very similar, indicating a smaller spread in the data. Jin and Zhang (2023) showed a stronger positive impact for corporate than financial institution issuers. Our findings evidenced a stronger negative impact for financial institutions and banks than for corporate issuers with statistically significant CAR in the longest and medium event windows.

Table 3. Descriptive statistics and statistical significance of CAR in financial institutions and banks.

	CAR [−1,1]	CAR [−5,5]	CAR [−10,10]
Mean	−0.0001	−0.0037	−0.0137
Median	−0.0019	0.0002	−0.0107
Standard deviation	0.0294	0.0619	0.0851
Max value	0.0948	0.1230	0.1596
Min value	−0.1237	−0.2669	−0.2655
t-statistic	−1.6975	−11.8184	−7.9785
p-value	0.2317	0.0000	0.0000
Wilcoxon signed-rank test	−0.6090	−2.8896	−3.9971
p-value	0.5437	0.0038	0.0000
Total observations	111	111	111

Note: For t-statistic, the null hypothesis is that the sample mean does not differ from zero, while for Wilcoxon signed-rank, the null hypothesis is that the sample median does not differ from zero.

Negative CARs are statistically significant in the longest and medium event windows with a 1% confidence level. In contrast, in the shortest event window, both tests negated the statistical significance of CARs. Even though we did not find a statistically significant negative impact of the announcement of green bond issues on CAR in the shortest window, we accept hypotheses H1 and H2. This statement is based on the proposition that investors receive information about the green bond issue before the announcement. We also suppose that information before the announcement is more private than public in comparison to the information before the green bond issue.

We observed a statistically significant negative impact of the green bond issue on CAR in both groups of companies in the longest and medium event windows. Cioli et al. (2021), Flammer (2021), and Laborda and Sánchez-Guerra (2021) found a statistically significant positive impact of green bond issues on CAR only in the shortest event windows such as [−2,1], [−1,1], [−1,0], [−5,5]. Tang and Zhang (2020) applied only two event windows, [−10,10] and [−5,10]. They revealed a statistically significant positive impact of green bond issues on stock's CAR in both event windows for corporates but not financial institutions. Wang et al. (2020) found a statistically significant positive impact in event windows [−10,10], [−3,3] but insignificant in [−1,1]. Roslen et al. (2017) proved a statistically significant negative impact in the shortest window before the announcement [−1,0], while Lebelle et al. (2020) found a negative impact in the longest event window [20, 20] and close to the announcement [−1,1], [0,1]. A comparison of research results revealed that stock market reactions to green bond issues are quite different. The differences can be argued for various reasons: research period, scope and characteristics of countries, economic sectors covered, market efficiency, etc. Market efficiency plays an important role when scientists choose to examine the impact of green bond announcements and issues on CAR in companies of more than one country with different levels of efficiency.

3.2. Dependence of CAR on the characteristics of issues and issuers of green bonds

Table 4 shows the results of the regression models investigating the impact of green bond issues and issuers' characteristics on CARs in industrial, utility, and telecommunication companies. The data in the table show that the characteristics of green bond issues are statistically significant in determining CAR in the shortest [−1,1] and longest [−10,10] event windows. All characteristics are statistically

significant, with the exception of issue order in the shortest event window and coupon rate and cancellation right in the longest event window. The CAR decreases with increasing maturity. Maturity increases risk, which weakens investors' interest in acquiring the stocks, and declining demand lowers the price and return. An inverse effect is also observed between the CAR and the bond cancellation right. This shows that the CAR is lower when a callable bond is issued. On the one hand, the cancellation right provides issuers with financial flexibility, while on the other hand, its coupon rate is higher than that of a conventional bond. It should be noted that a higher CAR is generated when green bond issues are larger. Even though larger issues save operating costs, companies' financial risk, investment, and operating costs increase significantly, which is a negative signal for equity investors. However, investors ignore this signal, and this provides an opportunity to formulate new scientific approaches.

Table 4. Dependence of CAR on the characteristics of green bond issues and issuers in the companies operating in the industrial, utility, and telecommunication sectors.

	CAR [−1,1]		**CAR [−5,5]**		**CAR [−10,10]**	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Intercept	−0.297	−3.390***	−0.100	-0.700	-0.418	-2.349**
Issue order	−0.007	−1.779*	0.017	1.674*	0.015	1.113
Coupon rate	0.003	2.682***	0.005	1.887*	0.009	2.580**
Maturity	−0.004	−2.589**	−0.003	−0.642	−0.004	−0.757
Cancellation right	−0.013	−2.220**	−0.013	−0.903	0.076	3.844***
Issue amount	0.009	3.780***	0.009	1.310	0.005	0.641
Size	0.006	2.252**	−0.002	−0.301	0.012	1.619
Asset tangibility	0.036	1.144	−0.037	−0.676	−0.035	−0.558
Financial leverage	0.123	3.958***	0.145	1.852*	0.118	1.206
Revenue growth	0.000	0.130	−0.001	−0.636	−0.000	−0.815
ROE	0.000	0.948	0.001	1.315	0.001	0.528
TOBINQ	0.027	2.313**	0.046	2.486**	0.040	1.779*
Price-to-book ratio	−0.017	−2.462**	−0.030	−2.666***	−0.030	−2.219**
Country dummy 1	0.009	1.320	0.024	1.191	0.001	0.349
Country dummy 2	−0.004	−0.419	0.013	0.648	0.000	0.018
Adjusted R^2	0.6909		0.1697		0.3872	
p-value	0.0000		0.0139		0.0000	

Note: Confidence level: *** 1%; ** 5%; * 10%.

Among the characteristics of green bond issuers in all event windows, only TOBINQ and price-to-book ratio are statistically significant. Although TOBINQ and price-to-book ratio both indicate overvaluation or undervaluation of equities, their impact on equity CARs is in different directions, with TOBINQ having a positive effect and price-to-book ratio a negative effect. The numerators of both indicators are driven by investors' expectations, but their denominators reflect fundamentally different information. The denominator of TOBINQ changes because of investments being made, while the denominator of the price-to-book ratio changes because of changes in retained earnings, which are not necessarily reinvested. Financial leverage and size are statistically significant characteristics only in the shortest event window. On the one hand, as leverage increases, financial risk increases. On the other hand, an increase in leverage leads to an

increase in return on equity, which sends a positive signal to the market. CAR is higher in large companies and vice versa.

The statistically significant characteristics of green bond issues and issuers determine 69.1% of the CAR in the shortest event window [−1,1], 17.0% in the medium one [−5,5], and 38.7% in the longest one [−10,10]. The confidence level for all models is less than 5%. We accept hypothesis H3.

Table 5 shows the results of the regression models on issues and issuers' characteristics of green bonds in financial institutions and banks. The data show that there are no common statistically significant characteristics of green bond issues for CARs in all event windows. One possible reason for this is that they implement indirect investments. Only cancellation right is statistically significant in the shortest and medium event windows: CAR is higher in the case of callable green bonds. Cancellation right gives the opportunity for banks and financial institutions to finance their investments at lower costs. The issue amount is statistically significant only in the longest event window. The negative coefficient indicates a lower CAR for the larger issue amount.

Among the characteristics of green bond issuers, only asset tangibility is statistically significant in all event windows. The CAR is higher in banks and financial institutions with larger asset tangibility. The longest event window [-10,10] has the highest number of statistically significant factors. Larger financial institutions and banks and those having higher earnings growth tend to accumulate a higher CAR but generate a lower ROE. In the shortest event window [-1,1], a negative effect of ROE on CAR is also observed.

Table 5. Dependence of CAR on the characteristics of green bond issues and issuers in financial institutions and banks.

	CAR [−1,1]		**CAR [−5,5]**		**CAR [−10,10]**	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	T-statistic
Intercept	−0.163	−2.159**	−0.287	−2.113**	−0.353	−2.008**
Issue order	−0.004	−0.768	−0.004	−0.371	−0.009	−0.821
Coupon rate	−0.000	−0.162	0.002	0.882	−0.001	−0.421
Maturity	0.001	0.916	−0.000	−0.036	0.000	0.040
Cancellation right	0.010	2.023**	0.027	2.480**	−0.004	−0.256
Issue amount	0.001	0.606	−0.001	−0.142	−0.015	−2.340**
Size	0.003	1.503	0.009	1.991**	0.016	2.961***
Asset tangibility	0.036	2.956***	0.126	3.883***	0.177	4.342***
Financial leverage	0.013	0.452	−0.074	−1.171	0.006	0.097
Revenue growth	0.003	1.494	0.002	0.582	0.010	2.162**
ROE	−0.001	−2.155**	−0.002	−1.344	−0.005	−2.304**
TOBINQ	0.037	0.574	−0.053	−0.481	−0.244	−1.676*
Price-to-book ratio	−0.002	−0.143	0.021	0.526	0.088	1.675*
Country dummy 1	−0.004	1.676*	0.002	0.107	0.030	1.874*
Country dummy 2	−0.013	−0.162	0.002	0.882	−0.001	−1.596
Adjusted R^2	0.4501		0.2737		0.8948	
p-value	0.0000		0.0000		0.0000	

Note: Confidence level: *** 1%; ** 5%; * 10%.

The statistically significant characteristics of green bond issues and issuers determine 45.0% of the CAR in the shortest event window [−1,1], 27.4% in the medium one [−5,5], and 89.5% in the longest one [−10,10]. The confidence level for all models is less than 1%. We accept hypothesis H4.

One of the most important characteristics of the green bond issue is the order. Our findings revealed that this is not a statistically significant determinant of CAR in both groups of companies. Meanwhile, Flammer (2021), Cioli et al. (2021), and Tang and Zhang (2020) evidenced statistically significant stock price increases around the announcement date of first-time green bond issues. To the best of our knowledge, Kuchin et al. (2019) are the only scientists who investigated the impact of green bond characteristics on CAR. They examined various industrial companies and did not find any statistically significant characteristics of green bond issues on CAR.

4. Discussion

The results of our study allow us to assess the short-term stock market reaction to the announcement of green bond issues in public companies of Nordic countries. We revealed a negative short-term stock market reaction. Among other studies, a positive short-term stock market reaction dominates. Flammer (2021) argued for a positive signal of the eco-friendly behavior of investors and focused on the link between eco-friendly behavior and stock market outcomes. A similar approach was demonstrated by Cioli et al. (2021) who stated that green bond issues are perceived as a value-creating event and help companies attract investors with environmental orientation. Laborda and Sánchez-Guerra (2021) explained the green bond issue as a positive signal to the market because it improves a company's reputation. They pointed out that institutional investors usually invest in environmentally sustainable projects. The approach of Laborda and Sánchez-Guerra (2021) is logical because institutional investors buy and sell securities in large quantities and cause higher fluctuations in stock market prices compared to non-institutional investors. Tang and Zhang (2020) investigated potential channels through which green bond issues can affect the stock prices of issuers. They also found that institutional ownership increased after this event. In addition, they revealed the increased stock liquidity upon the green bond issue. Lebelle et al. (2020) evidenced a negative stock market reaction to the green bond issue and based their interpretation of these findings on two main arguments. The first is that the announcement of operational and capital expenditures to make companies more sustainable might be interpreted by investors as uncertainty about the profitability of new business models. To encourage further development of green projects and growth of green financing amount, companies, financial institutions, investors, and researchers must consider the interplay between sustainable financing and sustainable business models (Mitchell et al., 2024). The second argument is the fact that a green bond is still a very new and unknown instrument and that its efficiency in helping tackle climate change remains subject to debate. For example, investors might integrate the risk of greenwashing and its potential consequences on the stock market when valuing a company. According to the mentioned authors, developed markets react more negatively to green bond issues than emerging markets. The reason could be that developed market issuers are likely to face higher legal constraints on transparency than emerging market ones. Roslen et al. (2017) based the negative stock market reaction to the green bond issue on increased financial risk. They stated that despite the positive value created using proceeds from the green bond issue, the fact that debt will increase the company's probability of default is definite.

Coming back to our findings, first, we would like to stress the short-term aspect. From the short-term perspective, capital expenditures significantly decrease earnings before interests and taxes and

cause additional business risk. Payable interests on green bonds decrease net earnings. The impact on earnings per share (EPS) and price-to-earnings ratio as the main drivers of company value is obvious. Higher business and financial risk caused by the green bond issue are negative signals to the market. Another important question is how eco-friendly the investors in the Nordic markets are. Assuming that they are more socially responsible than investors in other markets and construct their portfolios for the long-term horizon, they should differentiate the short-term and long-term effects of the green bond issues on the stock market. Differentiation should lead to a positive stock market reaction. Despite that, we found a negative stock market reaction. So, what other aspects are important? We suppose that the research period is important. The description of the sample showed that among green bond issues, the issues for the period 2021–2024 dominate. This period covers the COVID-19 pandemic and the Russian invasion of Ukraine. Usually, investors shift their investments from stocks to bonds during economic recession and under economic, financial, and political uncertainty. We can assume that the shareholders of companies either became their bondholders, sold stocks of one company, or bought green bonds of another company. We need additional research to prove this argument.

Our findings showed that CARs are more sensitive to the characteristics of green bond issuers than to the characteristics of issues. The little research available on CAR determinants does not allow us to develop a scientific discussion. Despite this fact, we can conclude that the decisions of buying and selling stocks and green bonds are based only on the characteristics of issuers. Flammer (2021), Cioli et al. (2021), and Tang and Zhang (2020) evidenced significant stock price increases around the announcement date of first-time green bond issues. Our findings do not support this trend.

5. Conclusions

The event study methodology was applied for the estimation of CAR. Three event windows were chosen. All green bond issues were grouped into two groups: issues of companies operating in industrial, utility, and telecommunication sectors and issues of financial institutions and banks. The empirical findings revealed statistically significant negative short-term stock market reaction to the announcement of green bond issues for both groups of companies in the longest and medium event windows. The heteroscedasticity-corrected regression model was applied to find the characteristics of green bond issues and issuers with an impact on CAR. Five characteristics of the green bond issues were taken, namely issue order, coupon rate, maturity, cancellation right, and issue amount. Seven characteristics of green bond issuers were chosen, namely size, asset tangibility, financial leverage, revenue growth, ROE, TOBINQ, and price-to-book ratio. The empirical findings showed statistically significant characteristics of green bond issues (maturity, coupon rate, cancellation right, and issue amount) only for the companies operating in the industrial, utility, and telecommunication sectors and only in the shortest event window. Only two of them (coupon rate and cancellation right) were statistically significant in the longest event window. Issue amount was statistically significant in the longest event window, and coupon rate and cancellation right were statistically significant in the shortest and medium event windows while analyzing the CAR in banks and financial institutions. There were also some statistically significant characteristics of green bond issuers as determinants of CAR, being different for both groups of companies: TOBINQ and price-to-book ratio were statistically significant for companies operating in industrial, utility, and telecommunication sectors in all event windows, while asset tangibility was statistically significant for financial institutions and banks in all event windows.

Our findings are valuable from a scientific perspective. They support short-term investors' behavior based on the signaling theory. We analyze, summarize, and support new scientific approaches. These scientific approaches are arguments for the green bond issue as a positive and negative market signal. The research results revealed statistically significant characteristics of the green bond issue and issuer having an impact on CAR. They allow the presentation of some insights regarding the main determinants.

The research results broadcast messages to managers, shareholders, investors, and scientists. They could encourage the managerial team to reconsider information disclosure about environmentally friendly projects, to ensure the link between the new information and real performance, and to convey important information to shareholders. Shareholders and investors should be interested in more rational investment decisions for the short-term and long-term horizons. Scientists could find valuable ideas for future research.

Our research has some limitations. We assessed short-term stock market reaction to the announcement of green bond issues in Nordic public companies. Investigation of long-term stock market reactions would reveal more interesting aspects of investors' behavior. Fan et al. (2023) found that the green bond issue encourages companies to improve their environmental information disclosure and attract green investors in the long term. We did not analyze conventional bonds. Future research could be focused on the matched samples to see if the effect comes from the issue of a bond or from the fact that the bond is green. Additional research could be valuable to assess the behavior of equity investors toward the restructuring of portfolios during economic and financial turmoil. By increasing the research sample, it is possible to examine both short-term and long-term stock market reactions to the announcement of green bond issues in different sectors of the economy. We applied the CAPM for the estimation of the stock's abnormal returns. The Fama and French Factor models can also be applied.

Author contributions

Vilija Aleknevičienė: concept development and study design; data analysis and interpretation; draft of article preparation; critical revision of the article for important intellectual content. Raimonda Vilutytė: concept development and study design; data collection; data analysis and interpretation; critical revision of the article for important intellectual content.

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

Conflict of interest

The authors declare no conflicts of interest in this paper.

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