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How do the Green Energy Stocks React to Green Bond Issuances?

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Abstract

Achieving sustainable development is one of the main issues at the global level and both public and private sector enterprises need to make large – scale investments to fight against climate change. In this respect, green bonds gain importance to raise money for environmentally – friendly projects, especially clean energy. Proceeds from green bonds are earmarked towards financing of investments that have positive environmental impacts. This paper explores the relationship among green bond issuances and stock market reaction with special focus on renewable energy firms. Herein, through a dataset of green bond issuance announcements worldwide by 46 unique firms over the period from 2014 to 2023, we investigate how the share prices respond to such announcements using event – study methodology. From the empirical evidence of the downward stock price movements, we suggest that investors react negatively to the announcement of green bond issuances. In other words, we find significant and negative cumulative average abnormal returns (CAAR) across all the event windows except in the window of [0, 10], meaning that our findings are robust to several alternative event windows. Further, we determine that the share price response, in general, does not differ depending on the use of green bond proceeds and the years.

Keywords: Green Bonds, Event Study, Stock Market Reaction, Renewable Energy Firms.

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1. INTRODUCTION

Green finance and green financial products have gained popularity in recent years along with the sustainable development goals put forward by the United Nations. Although the history of green financial products dates back to the early 2000s, green issuances have become widespread after the 2015 Paris Agreement adopted by 195 countries. Nowadays, green financial instruments are vital due to the increasing environmental awareness of firms, governments, institutional investors, managers and regulators. Furthermore, environmental, social and governance (ESG) standards are being integrated into corporate policies around the world.

The main purpose of green instrument issuances is to raise money for projects aimed to tackle environmental problems such as CO2 emissions and water and air pollution. Firms can issue green products in order to finance their green investments, which consider a set of ESG standards. Although there are many green financial products, green bonds are the most commonly issued among them. Green bond is a sort of fixed-income instrument that provides funding for environmentally friendly projects such as renewable energy production (wind, solar, etc.), sustainable water and waste management, energy efficiency and climate change adaptation (Campiglio, 2016; OECD, 2017; Tang & Zhang, 2020; Suyadal & Yavuz, 2021).

Since the European Investment Bank (EIB) launched the first green bond in 2007, known as a climate awareness bond, the green bond market has grown very fast. Thenceforth, by raising awareness on climate-related risks, many public and private sector organizations have started to issue green bonds. According to the reports conducted by Statista Research Department (SRD), green bond issuances totaled $633.9 billion in 2021. In 2022 and 2023, issuances decreased slightly, reaching $554.9 billion and $619.9 billion. Green bonds were mainly issued in developed countries. USA ($454.4 billion), China ($371.9 billion), Germany ($287.1 billion), France ($228.7 billion) and international organizations ($204 billion) are the world’s largest issuers of green bonds on a global scale (Climate Bonds Initiative, 2024).

Despite the rising popularity and rapid growth of green bonds, the size of the relevant markets remains small compared to a conventional bond market. Even the same issuer issues the bond, there exists yield differences, so – called greenium, between green and conventional bonds (Löffler et al., 2021; Hyun et al., 2021; Teti et al., 2022) and this can be considered as one of the obstacles to green bond market development. In addition, the absence of global standards, greenwashing and high issuance costs seem to be other possible future threats for those markets (Deschryver & De Mariz, 2020). On the other side, green bonds have portfolio diversification benefits with a low – risk exposure for investors. Green bonds can be a reliable investment option, particularly during extreme market conditions, due to their low correlation with traditional asset classes (Nguyen et al., 2021). Moreover, it is known that issuing green bonds by firms enhances shareholder value (Baulkaran, 2019).

In the common literature, many researchers stated the positive effects of green bond issuances on firm value (Baulkaran, 2019; Tang & Zhang, 2020; Flammer, 2021). The question is, however, whether issuing green bond create value for the green companies generating energy using renewable resources. From that point of view, the objective of the current paper is to investigate the impact of green bond issuance announcements on the stock returns of renewable energy companies by applying an event study approach. With this as motivation, we obtain 156 announcement dates regarding green bond issuances and stock market data of 46 green energy companies. Our findings shed light on the link between green bond issuances and the stock price reaction of renewable energy firms.

The contribution of our paper is threefold. First and foremost, it contributes to the existing literature that examines green bond issuances and their impacts on firm stocks (Baulkaran, 2019; Zhou & Cui, 2019; Lebelle et al., 2020; Tang & Zhang, 2020; Flammer, 2021; Dumlu & Keleş, 2023). Second, it discusses the impact of green bond issuance announcements on share prices, particularly for green energy companies. Lastly, the current study helps generate awareness and enable stakeholders to understand better the dynamics of green bonds.

The remainder of this study is organized as follows. Section 2 presents the relevant literature on green bonds. Section 3 describes the data and details the methodology while section 4 discusses the empirical findings. Section 5 offers concluding remarks. This section also gives suggestions for future researches.

2. INSPIRING LITERATURE

Numerous studies focus on the dynamics of the green bonds in the extant literature. Most of these papers have examined the relationship between green bonds and other financial instruments. For instance, Nur & Ege (2022) reported no volatility spillover between the S&P Green Bond Index and the S&P500 but they observed a unidirectional causality from the S&P500 to the S&P Green Bond Index. Chatziantoniou et al. (2022) investigated the return linkages among the S&P Green Bond Index, the MSCI Global Environmental Index, Dow – Jones Sustainability World Index and the S&P Global Green Energy Index. They confirmed that total connectedness between these indices depends upon economic activities. Besides, the S&P Green Bond Index and the S&P Global Green Energy Index are receivers of shocks while the MSCI and DJ Index transmit shocks for both the short and long run. In a related research, Tiwari et al. (2023) analyze the link between green and green stocks and found a weak connectedness between the two variables during normal times while this relation strengthens during periods of market downturns. Yan et al. (2022) investigated the impact of energy prices, gold prices and green energy stocks on green bond markets using the QARDL methodology. Results showed that strong long – run relationship exists between all variables and green bond markets at a global level. Naeem et al. (2021a) reveal a strong connectedness between green bonds and gold and silver using Diebold – Yılmaz (2014) and Barunik – Krehlik (2018) spillover indices. Su et al. (2023) studied the influence of oil prices on green bonds employing the quantile-on-quantile (QQ) method and concluded that oil prices positively affect the green bonds in the short – run. Reboredo (2018) claimed that the green bonds are excellent tools in terms of portfolio diversification when combined with stocks and energy market instruments. Likewise, Nguyen et al. (2021) documented that green bonds can be used for portfolio diversification due to their weak correlation with stocks and commodities. Also, Naeem et al. (2021b), Ferrer et al. (2021), Naeem et al. (2022) and Ozkan et al. (2024) emphasize the risk reduction benefits of green bonds. Reboredo & Ugolini (2020) revealed that green bond market is closely related to the conventional bond market and currency market. Similarly, Pham & Nguyen (2021) explored a link between green bonds and conventional asset classes in the US and EU markets. In another research, authors examined the effects of stock volatility (VIX), oil price volatility (OVX) and economic policy uncertainty (EPU) on green bond returns. They found a time –varying connectedness between uncertainty indicators and green bonds (Pham & Nguyen, 2022). Broadstock & Cheng (2019) provide evidence for time-varying relationship between green and conventional bonds. Authors also argue that this relation depends on financial market volatility, economic uncertainty, oil prices and daily news, while Baysan (2019) reported a bi-directional causality between green and conventional bonds. Lastly, Lee et al. (2021) detected a bi-directional causality among oil prices and green bonds. Unlike the aforementioned studies, Hammoudeh et al. (2020) found no causal association between green bonds and other assets, such as conventional bonds and the clean energy index.

Many academic papers examine the yield differences between conventional and green bonds, also known as greenium. For instance, Nanayakkara & Colombage (2019) uncover that green bonds are traded at a premium of approximately 63 bps. Another salient research is Zerbib (2019). Employing a two-step regression approach, the study reported that there is an average negative green premium of 2 bps. A study conducted with a large dataset found a green premium (Löffler, et al., 2021) while Hyun et al. (2021) noted that green bonds have a price premium compared to non-green bonds with the same characteristics. In a similar vein, Hachenberg & Schiereck (2018), Gianfrate & Peri (2019), Kapraun et al. (2021) and Sheng et al. (2021) achieved the same results. Contrary to these findings, Fatica et al. (2021) found no empirical evidence of greenium. They also suggested that investors might not be able to establish an association between the green bond issued by a financial institution and a green project. On the other hand, Dorfleitner et al. (2022) revealed interesting findings about the premium puzzle. Authors found a positive and significant green bond premia. Furthermore, the premium increases with third-party external assessments and investor attention.

Another strand of the literature analyzes the volatility behavior and spillover effects of the green bond markets. Pham (2016) measured the volatility of green bond market using the daily data from the S&P Green Bond Index. Empirical results indicated a high level of volatility clustering in the “labelled” green bonds. Additionally, a shock in the conventional bond markets tends to spill over into the green bond market. Park et al. (2020) confirmed that both green bond and stock markets show volatility spillover effects while Liu (2022) assessed the factors causing volatility in the green bond market and determined that volatility dynamics of the relevant market are mainly driven by conventional bond, FX and stock markets.

Some of the studies in the extant literature discussed green bonds from the perspective of behavioral finance. In particular, Pham & Huynh (2020) investigated the relationship among investor sentiment and green bond market. Using the Google Search Volume Index and five green bond indices, they discovered that search statistics, as an investor attention indicator, are useful for understanding green bond performance. Similarly, Piñeiro-Chousa et al. (2021) tested the influence of investor sentiment on the green bond market using Twitter data and GMM method to detect a significant positive connection between sentiment and green market. Maltais & Nykvist (2020) conducted interviews to figure out what attracts issuers and investors to engage in green bond market and emphasized that the low cost of capital and low risk of capital are the main factors affecting the green bond market expansion. Sangiorgi & Schopohl (2023) analyzed the survey data to explain the main motivations behind the green bonds issuances. Authors argue that slowing down climate change, sending positive signals to the market and building reputation are important to issuing green bonds. In another study, from the viewpoint of institutional investors, Sangiorgi & Schopohl (2021) stated that aggressive pricing and green credentials seem to be the major determinants of investment decisions in green bonds.

The association between the environmental effects of green bond financing, green bond issuances and firms’ environmental performance is also widely probed in the literature. In this sense, Yeow & Ng (2021) investigated the time-dependent changes in the green bond issuers’ environmental and financial performance and verified that the certified green bonds are useful financial tools to enhance environmental performance. Fatica & Panzica (2021) provided evidence that the reduction in emissions is consistent with the rise in the number of eco-friendly projects financed by green bonds. In addition, green bonds with external review as well as those issued after the Paris Agreement have a large impact on emissions. The study by Chang et al. (2022) focused on the relationship between green bond issuances and carbon footprint in view of environmental performance across economies. According to the authors, green financing improves environmental quality in selected countries. More recently, Tu & Rasoulinezhad (2022) employed quarterly data from 37 countries over the period 2007Q1-2020Q4 to analyze the role of green bond financing on energy efficiency projects and affirmed that green bonds positively influence energy efficiency.

Most researchers assessed the stock market reaction to green bond issuance announcements. Tang & Zhang (2020) carried out one of the pioneering studies. Using comprehensive firm-level data from 28 countries from 2007-2017, they pointed out that stock prices reacted positively to green bond issuances. Similarly, Baulkaran (2019) highlighted that issuing green bond produces positive cumulative abnormal returns except for bonds with higher coupon. Flammer (2021) concentrated on the effect of green bond issuance announcements on firm value using an event study approach. Results proved that stock market responded positively to such announcements and certified bonds have a stronger impact on stock returns. Zhou & Cui (2019), Flammer (2020) and Dumlu & Keleş (2023) also confirm a positive stock price reaction to the issuance announcement. However, Lebelle et al. (2020) investigated corporate green bond issuances and argued that the market reacts negatively to the announcement. Depending on the different asset pricing models (CAPM, FF3FM and C4FM), authors found cumulative abnormal returns between -0.5 percent and -0.2 percent in corporate stocks, especially on the announcement day and the following day. Using the data of Turkish Banks traded in the stock market, Yağcılar & Yılmaz (2022) document that abnormal returns cannot be directly associated with the green bond issuances.

Finally, few studies evaluate the influence of the global pandemic on the green bond markets. Using the data from the S&P Green Bond Index, Keliuotytė-Staniulėnienė & Daunaravičiūtė (2021) employed correlation and regression analyzes to demonstrate the negative impact of the COVID-19 on the green bond market. In a similar research, Taghizadeh-Hesary et al. (2021) suggested that global green financing activities have reduced due to the COVID-19 outbreak.

Our literature review sheds some light on a large body of the academic literature on green bonds. However, to our best knowledge, there are no studies exploring the interactions among green bond issuances and stock market reactions with particular attention to renewable energy companies. We, therefore, expect that the current paper will fill the gap in the common literature in terms of bond issuance dynamics of renewable energy firms and hence will be guidance to assist institutional investors and regulators.

3. DATA AND METHODOLOGY

In this part of the research, we introduce a large and comprehensive dataset that covers the announcement dates for green bond issuances, which is obtained from Refinitiv, from publicly-traded green energy firms. Considering an estimation window of 100 trading days, we also gather data on firm-level stock price around the announcements from Yahoo Finance and Investing.

Given the use of green bond proceeds and the availability of data, we narrowed down the scope of our study and examined the issuances of energy firms that mainly generate energy from renewable sources (hydro, solar, wind, thermal, biomass etc.). Companies that indirectly engage in green energy production by supplying renewable energy components, constructing energy generation facilities or using a mix of fossil fuel and renewable resources were excluded. Further, we remove firms that have no trading data or are non-publicly traded from the data set. Consequently, our sample contains 185 green bonds from 46 unique issuers and spans 2014 to 2023. Table 1 presents the number of green bond issuances by use of proceeds, and years.

Table 1. Number of Issuances (by use of proceeds and years)

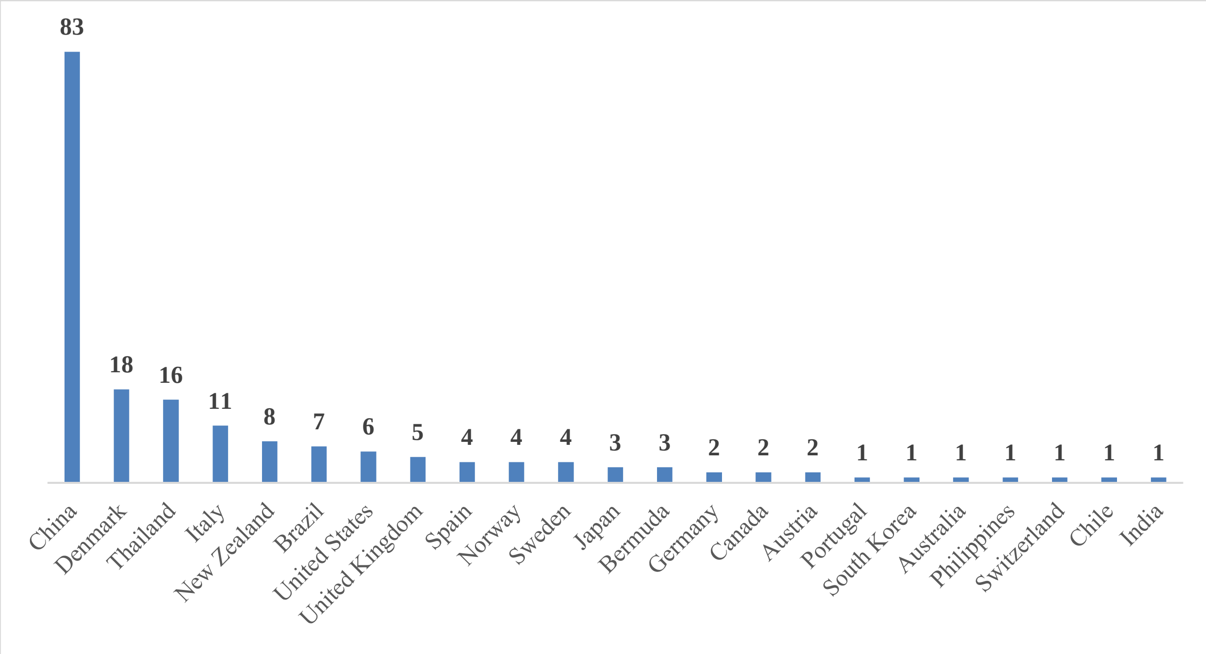
Use of Proceeds	Number	Years	Number
Energy Efficiency	82	2014	3
Renewable Energy Projects	31	2015	1
Climate Change Adaptation	23	2016	5
Eligible Green Projects	18	2017	10
Alternative Energy	11	2018	9
Clean Transport	8	2019	25
General Purpose	4	2020	16
Equipment Upgrade/Construction	2	2021	39
Green Construction/Buildings	2	2022	51
China Urban Construction	1	2023	26
Environmental Protection Projects	1		
Pollution Prevention & Control	1		
Redeem Existing Bonds or Securities	1		
Total	**185**		**185**

Source: (Refinitiv Eikon, 2023)

As shown in Table 1, one can argue that the funds raised through green bond issuances are largely used to finance energy efficiency, renewable energy and climate change adaptation projects. In accordance with their purpose, green bonds generally play a significant role in funding environmentally-friendly projects. Green bond issuances have gained momentum particularly after 2019 and 2022 was the year with the highest number of issuance by green energy firms. Figure 1 demonstrates the green bond issuances by country.

According to Figure 1, green energy enterprises operating in China are responsible for about half of total issuances between 2014 and 2023. In our sample, Danish, Thai and Italian firms are the other leading firms in terms of number of issuances, respectively.

Figure 1. Number of Issuances (by country)



Source: (Refinitiv Eikon, 2023)

Table 2 provides some information about the highest value of green bonds.

Table 2. Largest Green Bond Issuances

Issuer	Announcement Date	Issue Date	Maturity	Amount Issued (USD)
Ørsted A/S	6.09.2022	13.09.2022	13.09.2031	975.694.369
Ørsted A/S	16.11.2017	24.11.2017	26.11.2029	813.078.640
Ørsted A/S	7.06.2022	14.06.2022	14.06.2033	813.078.640
SSE PLC	29.08.2023	5.09.2023	5.09.2031	813.078.640
Ørsted A/S	22.02.2023	1.03.2023	1.03.2026	758.873.398
Ørsted A/S	22.02.2023	1.03.2023	1.03.2035	758.873.398
Adani Green Energy Ltd	1.09.2021	8.09.2021	8.09.2024	750.000.000
Adani Green Energy Ltd	1.09.2021	8.09.2021	8.09.2024	750.000.000
Avangrid Inc	14.05.2019	16.05.2019	1.06.2029	750.000.000
Avangrid Inc	7.04.2020	9.04.2020	15.04.2025	750.000.000

Source: (Refinitiv Eikon, 2023)

The Danish company Ørsted A/S issued the green bond with the highest nominal value of $975 million (Table 2). SSE PLC, Adani Green Energy and Avangrid are the other firms in the top ten in terms of amount issued.

To determine the effects of green bond issuances on the stock market reactions, we use the announcement dates as event time. Table 3 shows the summary statistics of green bonds.

Table 3. Descriptives of Green Bonds

	N	Mean	Median	Max.	Min.	Std. dev
Maturity (year)	185	33,36	5,00	1000,66	0,11	162,82
Coupon (%)	185	3,55	2,88	15,20	0,38	2,30
Amount (mln $)	185	228,93	126,75	975,69	1,37	229,66

Although our initial sample includes 185 green bonds, we realized that some firms made multiple issuances on the same date, which may lead to erroneous results. Therefore, we dropped the issuances made by the same firms on the same date to overcome such limitations. Or, to put it more clearly, we assumed that there was a single event day or single issuance, hence our final sample includes 156 green bond issuances by 46 renewable energy firms.

We apply the event study methodology Brown & Warner (1985) introduced to test green energy firms' stock market reaction**.** Event study, which is based on the Efficient Markets Hypothesis by Fama (1970), determines whether the information released on a certain date leads to anomalous stock returns. We utilize a 100-day estimation window starting 110 trading days prior to the announcement and ending 11 trading days prior to announcement (where day 0 is the announcement date). Then, we adopt two different event windows from 10 days prior-10 days after [-10, 10] and from 5 days prior-5 days after [-5, 5] the announcement. In order to perform a robustness check and to investigate stock reactions, we also considered time intervals of [-10, 0], [-5, 0], [0, 5] and [0, 10].

First, we calculated the daily stock returns of firms as follows:

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

where $R_{i,t}$ represents the return of the firm *i* on day *t*, $P_{i,t}$ represents the stock price of the firm *i* on day *t* and $P_{i,t-1}$ represents the stock price of the firm *i* on day *t* – 1. We then use mean – adjusted returns model (MAR) to obtain abnormal daily returns of renewable energy companies as:

$$AR_{i,t} = R_{i,t} - \bar{R} \tag{2}$$

where $AR_{i,t}$ is the abnormal return of firm i, on day t and $R_{i,t}$ is the return of firm i, on day t. $\bar{R}$ denotes the average return of firm over the estimation window (-110, -11) and can be written by

$$\bar{R} = \frac{1}{100}\sum_{t=-110}^{-11} R_{i,t} \tag{3}$$

We used standardized abnormal returns methodology by Brown & Warner (1985) to test the statistical significance of abnormal returns:

$$SAR_{i,t} = \frac{AR_{i,t}}{SD(AR_{i,t})} \tag{4}$$

$$SD\left(AR_{i,t}\right) = \sqrt{\frac{1}{T_0-1}\sum_{t=1}^{T_0} AR_{i,t}^2} \tag{5}$$

where $SAR_{i,t}$ shows the standardized abnormal returns and $SD\left(AR_{i,t}\right)$ shows the standard deviation of abnormal returns.

Afterwards, we compute cumulative abnormal returns (CAR) by summing up the abnormal returns:

$$CAR_{i,t} = \sum_{t=t_1}^{t_2} AR_{i,t} \tag{6}$$

Equation (7) and Equation (8) estimates the t – statistics of average abnormal returns (AAR) and cumulative average abnormal returns (CAAR), respectively (Zhou & Cui, 2019):

$$T - test_{AAR_t} = \frac{AAR_t}{SD\ (AR_{i,t})/\sqrt{N}} \tag{7}$$

$$T - test_{CAAR_t} = \frac{CAAR_t}{SD\ (CAR_{i,t})/\sqrt{N}} \tag{8}$$

where $T - test_{AAR_t}$ is the t – statistics for the daily average abnormal returns of all renewable energy firms on day t, $T - test_{CAAR_t}$ is the t – statistics for the cumulative average abnormal returns of all renewable energy firms during the event period. AAR_t is the average abnormal return of all firms on day t, $CAAR_t$ is the cumulative average abnormal return of all firms on day t, while $SD\ (AR_{i,t})$ and $SD\ (CAR_{i,t})$ represent the standard deviation of abnormal returns and cumulative abnormal returns, respectively.

4. EMPIRICAL FINDINGS

In the first step, we focused on the stock price reaction to green bond issuance announcements for the final sample, which contains all 156 announcement dates from 46 renewable energy firms, regardless of the use of proceeds or year. We calculate the daily abnormal returns of each firm using mean-adjusted returns model (Eq. 2) and the average abnormal returns (AAR) and cumulative average abnormal returns (CAAR) using the mean values of abnormal and cumulative abnormal returns of firms. In the second and third parts, we shed light on the stock behaviors by use of proceeds and years, respectively.

4.1. Stock Market Response to Green Bond Issuances

Table 4 reports the average abnormal returns (AAR), t-scores, summary statistics and cumulative average abnormal returns (CAAR) across different event windows.

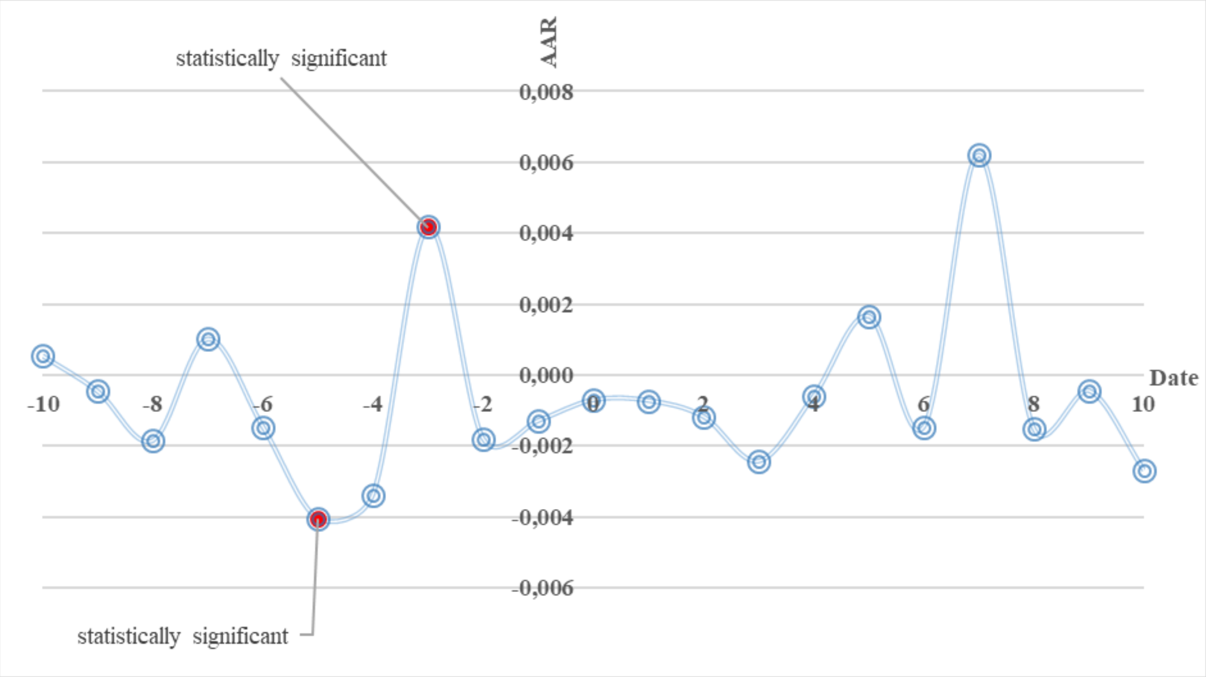
Table 4. Daily AAR's and CAAR's

	Date (t)	AAR	T-test	Median	Min	Max
Event Date	-10	0.0005	0.2280	-0.14%	-10.34%	15.13%
	-9	-0.0005	-0.1943	0.03%	-19.42%	10.35%
	-8	-0.0019	-1.0573	-0.05%	-12.84%	8.44%
	-7	0.0010	0.5565	-0.18%	-5.72%	16.03%
	-6	-0.0015	-0.8509	-0.22%	-10.21%	6.87%
	-5	-0.0041	-2.3418**	-0.14%	-8.10%	5.47%
	-4	-0.0034	-1.8274	-0.14%	-8.82%	7.98%
	-3	0.0042	2.3015**	0.13%	-3.93%	9.44%
	-2	-0.0018	-0.9937	-0.02%	-5.72%	13.03%
	-1	-0.0013	-0.7052	-0.06%	-6.07%	9.94%
	0	-0.0007	-0.3592	-0.02%	-7.40%	8.28%
	1	-0.0007	-0.4590	-0.09%	-5.53%	9.97%
	2	-0.0012	-0.5905	-0.09%	-6.51%	14.29%
	3	-0.0024	-1.2668	-0.18%	-7.50%	8.81%
	4	-0.0006	-0.3363	-0.01%	-8.30%	8.14%
	5	0.0017	0.8533	0.02%	-6.14%	15.53%
	6	-0.0015	-0.8998	-0.04%	-7.97%	5.44%
	7	0.0062	1.2722	-0.04%	-7.19%	71.24%
	8	-0.0015	-0.6650	-0.18%	-9.20%	13.54%
	9	-0.0004	-0.1878	-0.02%	-10.39%	13.74%
	10	-0.0027	-1.0481	-0.25%	-14.97%	15.52%
Event Window	**[-10, 10]**	**[-5, 5]**	**[-10, 0]**	**[-5, 0]**	**[0, 5]**	**[0, 10]**
CAAR	-0.01245	-0.01033	-0.00928	-0.00706	-0.00397	-0.00387
SD (CAAR)	0.002364	0.002277	0.002233	0.002908	0.001328	0.002462
t-statistic	-5.2653***	-4.5351***	-4.1555***	-2.4290**	-2.9859***	-1.5729

Note: ***, ** denote statistical significance at the 1% and 5% level, respectively.

According to Table 4, event day average abnormal returns of renewable energy firms are not statistically significant, signifying that there may have been information leakage to the market before the announcements. As a result of this, it would be crucial to examine the average abnormal returns before and after the green bond issuance announcement. Figure 2 depicts the average abnormal returns in an event window.

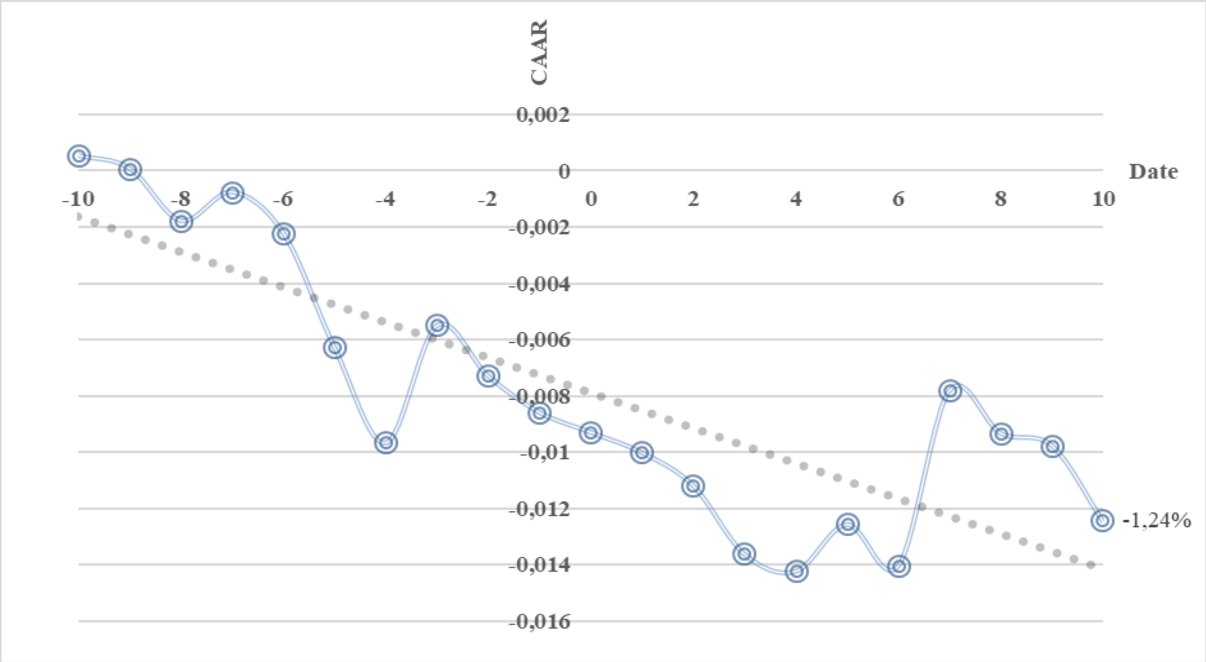
Figure 2. Illustration of Daily AAR's of Green Energy Firms



AAR's are negative on 16 days and positive on 5 days but, in general, there exists no significant return fluctuation before and after the issuance announcement. Interestingly, we observed a statistically significant and positive AAR on the third day prior to the event. Hence one can claim that insider trading through leakage might be playing an important role. Another finding in our analysis suggests that significant negative AAR occurred on the fifth day before the event. In addition, there are no statistically significant AAR coefficients after the event day. Conversely, we detected negative and statistically significant cumulative average abnormal returns (CAAR) in all the event windows except for [0, 10] event windows. These results indicate that green bond issues have a small but negative influence on the shares of green energy companies.

Figure 3 shows green energy companies' cumulative average abnormal returns (CAAR) before and after the event. The average abnormal returns (AAR) changed the sign on the ninth day prior to the event's occurrence and the negative persistence in average abnormal returns continued until the event day. Statistically significant CAAR's point out that green bond issuances have a negative impact on the stock prices of renewable energy firms.

Figure 3. Daily CAAR's of Green Energy Firms over [-10, 10] Event Window



4.2. Stock Market Response to Green Bond Issuances by Use of Proceeds

In this section, we examine the market response to green bond issuance announcements by use of issue proceeds. Table 5 presents the average abnormal returns before and after the event by use of proceeds.

Table 5. Daily AAR's during the event period

Date (t)	AARs by Use of Proceeds							
	General Purpose	**Other**	**Clean Transport**	**Alternative Energy**	**Eligible Green Projects**	**Climate Change Adaptation**	**Renewable Energy Projects**	**Energy Efficiency**
-10	0.0032	0.0091	0.0088	-0.0048	-0.0041	0.0053	-0.0013	0.0012
-9	-0.0199	0.0032	-0.0040	0.0061	-0.0010	-0.007	0.0017	0.0020
-8	-0.0049***	0.0136	-0.0094***	-0.0083	-0.0016	-0.007	0.0031	-0.0026
-7	-0.0048***	0.0056	-0.0030	0.0044	0.0063	0.0088	0.0017	-0.0028
-6	-0.0189	-0.0159**	0.0011	0.0000	-0.0003	-0.0014	-0.0082	0.00434
-5	0.0053	0.0088	0.0006	-0.0020	0.0026	-0.0057	-0.0115	-0.0051
-4	0.0015	-0.0008	0.0032	-0.0017	-0.0020	-0.0066	-0.0007	-0.0057**
-3	-0.0240***	-0.0047	0.0000	0.0121**	0.0027	-0.0007	0.0080	0.0072**
-2	-0.0009	-0.0084**	-0.0038	-0.0032	-0.0086	-0.0097**	0.0067	-0.0022
-1	-0.0121***	0.0032	-0.0051	-0.0068	-0.0055	0.0047	0.0017	-0.0022
0	-0.0063	-0.0159	-0.0034	0.0093**	-0.0026	-0.0047	0.0060	-0.0009
1	-0.0023	0.0089	-0.0073	0.0032	-0.0078	-0.0017	0.0034	-0.0016
2	-0.0026	0.0108	-0.0090	0.0009	-0.0094	-0.0015	-0.0025	0.0004

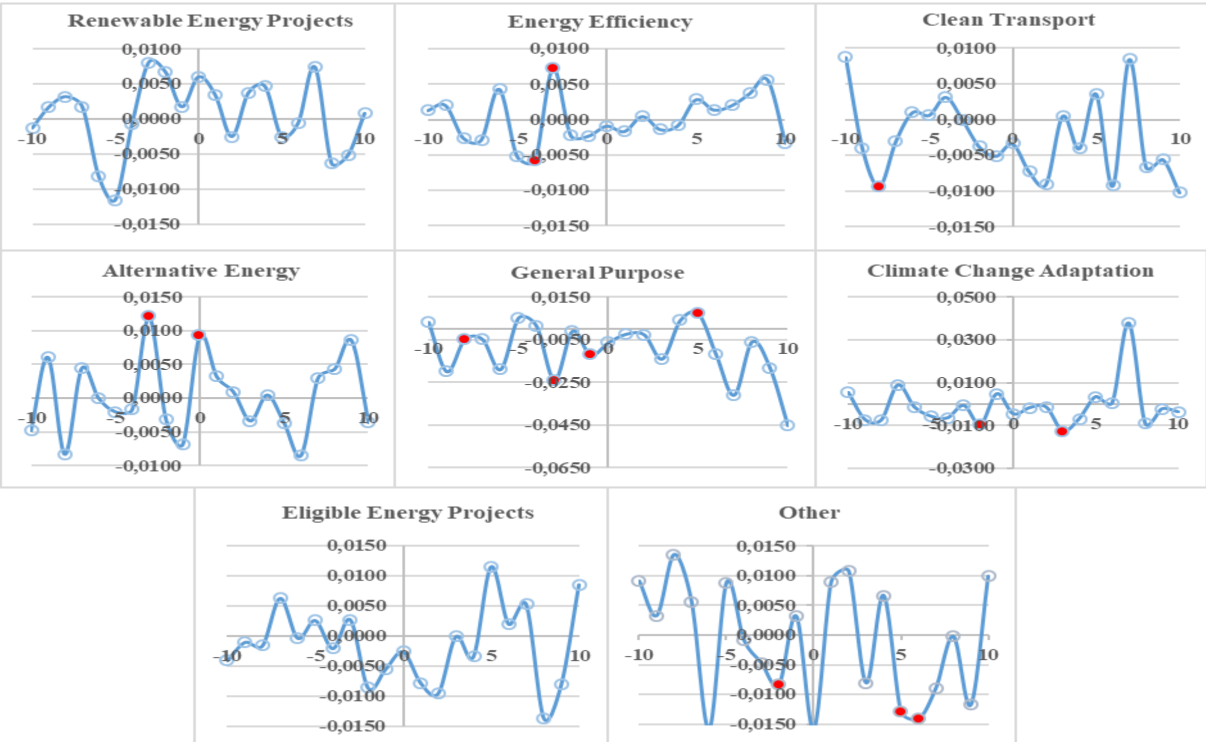
Table 5 (cont.)

Date (t)	AARs by Use of Proceeds							
	General Purpose	Other	Clean Transport	Alternative Energy	Eligible Green Projects	Climate Change Adaptation	Renewable Energy Projects	Energy Efficiency
3	-0.0140	-0.0080	0.0005	-0.0034	-0.0001	-0.0127**	0.0037	-0.0013
4	0.0042	0.0067	-0.0040	0.0005	-0.0034	-0.0068	0.0046	-0.0007
5	0.0075***	-0.0129***	0.0036	-0.0037	0.0115	0.0034	-0.0025	0.0028
6	-0.0119	-0.0142***	-0.0093	-0.0085	0.0020	0.0005	-0.0005	0.0013
7	-0.0310	-0.0089	0.0085	0.0029	0.0053	0.0380	0.0074	0.0020
8	-0.0059	-0.0002	-0.0066	0.0044	-0.0136	-0.0091	-0.0063	0.0037
9	-0.0182	-0.0117	-0.0055	0.0086	-0.0080	-0.0023	-0.0051	0.0056
10	-0.0454	0.0099	-0.0102	-0.0036	0.0086	-0.0037	0.0008	-0.0033

Note: ***, ** denote statistical significance at the 1% and 5% level, respectively.

According to Table 5, we infer that significant AAR's generally appear before the announcement day. As in our initial analysis, we determine a predominantly negative market response to green bond issuances. Only four daily average abnormal returns are positively significant and these belong to "the general purpose", "alternative energy" and "energy efficiency" categories. Overall, our findings underline that the announcement of green bond issuances leads to negative and significant average abnormal returns in renewable energy firms. Figure 4 demonstrates the stock market reactions due to green bond issuance announcements.

Figure 4. Daily AAR's by use of green bond proceeds



Note: ● denote statistical significance at the 1% or 5% level.

We compute cumulative average abnormal returns across all event windows (Table 6). Results emphasize that cumulative average abnormal returns are positive yet insignificant for [-10, 10] window while all statistically significant cumulative average abnormal returns are negative. We observe statistically significantly negative cumulative average abnormal returns within [-10, 10] and [-5, 5] intervals except for “alternative energy” and “renewable energy projects” categories. Share prices react positively to green bonds issued to finance “renewable energy projects” mainly in the intervals [-5, 5] and [0, 5].

Table 6. CAAR’s by use of proceeds

	Use of Proceeds							
Event Window	**General Purpose**	**Other**	**Clean Transport**	**Alternative Energy**	**Eligible Green Projects**	**Climate Change Adaptation**	**Renewable Energy Projects**	**Energy Efficiency**
[-10, 10]	-20.13% (-18.96)***	-2.19% (-2.22)**	-5.44% (-10.08)***	0.65% (1.10)	-2.88% (-4.77)***	-2.11% (-1.96)*	1.03% (1.91)	0.19% (0.56)
[-5, 5]	-4.36% (-4.59)***	-1.24% (-1.31)	-2.46% (-5.94)***	0.53% (0.92)	-2.24% (-3.65)***	-4.23% (-7.96)***	1.70% (3.01)***	-0.97% (-2.69)***
[-10, 0]	-8.18% (-8.18)***	-0.22% (-0.21)	-1.51% (-3.12)***	0.51% (0.76)	-1.40% (-3.38)***	-2.49% (-4.03)***	0.74% (1.21)	-0.69% (-1.73)
[-5, 0]	-3.65% (3.41)***	-1.78% (-2.04)**	-0.84% (-2.66)***	0.77% (1.01)	-1.33% (-2.99)***	-2.28% (-4.46)***	1.03% (1.40)	-0.91% (-1.94)
[0, 5]	-1.34% (-1.76)	-1.04% (-0.87)	-1.95% (-4.12)***	0.69% (1.44)	-1.17% (-1.56)	-2.42% (-4.38)***	1.28% (3.43)***	-0.14% (-0.86)
[0, 10]	-12.58% (-8.10)***	-3.56% (3.35)**	-4.27% (-7.24)***	1.07% (1.95)	-1.74% (-2.20)**	-0.08% (-0.06)	0.89% (1.93)	0.80% (2.98)***

Note: ***, **, * denote statistical significance at the 1%, 5% and 10% level, respectively. t-statistics are in the parentheses.

4.3. Stock Market Response to Green Bond Issuances by Years

Lastly, we offer valuable findings on the relationship between announcements of green bond issuances and stock market reactions over the years. Since the number of green bonds issued increased dramatically in the last few years, we combine green bond issuances until 2020. We calculate cumulative average abnormal returns for each year from 2020 to 2023 (Table 7).

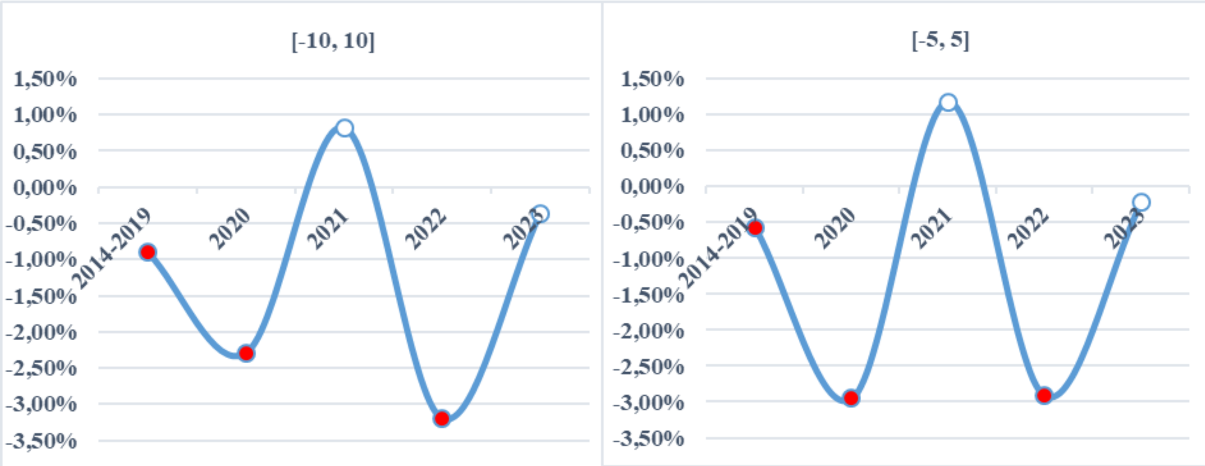
Table 7. CAAR’s by years

	Years				
Event Window	**2014 – 2019**	**2020**	**2021**	**2022**	**2023**
[-10, 10]	-0.90% (-2.70)***	-2.30% (-3.34)***	0.83% (1.31)	-3.20% (-8.26)***	-0.36% (-1.06)
[-5, 5]	-0.57% (-2.43)**	-2.95% (-3.66)***	1.18% (1.70)	-2.91% (-13.35)***	-0.21% (-0.70)
[-10, 0]	0.29% (0.88)	-3.18% (-4.84)***	-0.80% (-1.08)	-1.99% (-7.56)***	-0.03% (-0.07)
[-5, 0]	-0.27% (-0.92)	-3.28% (-4.44)***	0.07% (0.07)	-1.34% (-5.44)***	0.10% (0.27)
[0, 5]	-0.34% (2.18)***	-0.59% (-0.69)	2.05% (4.18)	-2.09% (-10.91)	-0.49% (-2.37)
[0, 10]	-1.23% (-3.84)***	-0.02% (-0.03)	2.57% (4.97)***	-1.73% (-3.50)***	-0.50% (-1.83)

Note: ***, ** denote statistical significance at the 1% and 5% level, respectively. t-statistics are in the parentheses.

Table 7 indicates a significant negative investor reaction to green bond issuances until 2020. In the same vein, stock responses remain negative both in 2020 and 2022 but we detect a positive and insignificant reaction in 2021. Figure 5 presents cumulative average abnormal returns in the [-10, 10] and [-5, 5] intervals.

Figure 5. Illustration of CAAR's by years



Note: ● denote statistical significance at the 1% or 5% level.

In Figure 5, we observe similar CAAR patterns over main time intervals. A possible reason for positive reaction in 2021 may be that the expansive monetary and fiscal policies worldwide during the Covid-19 pandemic. In the following years, many countries have taken steps, especially increasing interest rates, to slow soaring inflation and this has led to negative extremes in financial markets.

5. CONCLUDING REMARKS

As a result of the rising worldwide environmental awareness, practices such as renewable energy generation, waste management, and clean transportation have come to the fore in order to ensure sustainability and achieve sustainable development goals. Fighting climate change, however, requires considerable amounts of financial resources. Green bonds have emerged as alternative financial instruments to fund environmentally-friendly projects and to accelerate the transition to a low-carbon economy. Green bonds are of great importance not only for regulatory bodies and policy makers, but also for investors and issuers, as stakeholders take into account the environmental performance of firms as well as their financial performance (Reboredo et al., 2020). Following the first issuance of a green bond by the European Investment Bank in 2007, the green bond market has seen rapid growth (Gianfrate & Peri, 2019).

In addition to the environmental impacts and sustainability profiles of projects, their social impacts are also considered by institutional investors in portfolio management decisions. Therefore, examining green bonds which focus on environmental sustainability is warranted (Baulkaran, 2019). In light of this, we attempted to explore the response of the share prices to the announcements of green bond issuances. No study so far, as per our knowledge, has investigated the impact of green bond issuance announcements on stock returns with the focus on renewable energy firms. Using the event study methodology, we analyze 185 green bonds by 46 unique public issuers from 2014 to 2023. Our results indicate that green bond issuance announcements generate statistically significant negative (except for [0, 10] event window) impacts on stock returns. This finding is consistent with the study by Lebelle et al. (2020). Since renewable energy firms invest in green projects due to the nature of their activities, one can claim that bond issuance may burden a firm more. Another possible reason may be that it is unclear whether new investments will positively influence financial performance and profitability. We next concentrate on the issuance announcements according to the use of the proceeds and find out that share price reaction does not depend on the use of the proceeds and remains negative. This implies that investors do not pay much attention to what kind of projects will be financed. Further, significant negative AAR’s generally appear in the days prior to the announcement, which can be a symptom of insider trading. Finally, we investigate the announcements by years to document a statistically significantly negative stock market response in both 2020 and 2022, unlike positive but insignificant reactions in 2021. We argue that Covid-19 pandemic which started in 2020 and the rising global interest rates in 2022 to control inflation led to a bad atmosphere in financial markets and affected investor reactions. Our results suggest that share prices react negatively to green bond issuance announcements.

Private sector participation, the prominent role of capital markets, and financial regulatory policies are critical for financing green investments (Baker et al., 2022). States, international agencies and the private sector should take appropriate steps to support the growth of green bond markets, improve liquidity and increase the visibility of green bonds. Raising awareness of green bonds may influence investors' reactions to issuing these financial products. Moreover, post-issuance reporting will contribute to reducing information asymmetry. On the other hand, firms can expand their investor base by attracting environmentally conscious investors, thanks to green bonds.

Against this background, this study suffers from a major limitation but also calls for future research. Our data set only contains 156 green bond issuances from 46 firms that generate energy from renewable sources. Generalizing our results, therefore, may lead to incorrect judgments. In this vein, it would be fruitful to expand the data set by including firms in different sectors to make inter-sectoral comparisons. Another pathway could be to use different event window lengths. Future research might also assess the portfolio diversification benefits of green bonds by addressing correlations between green bonds and other assets —and a fortiori green stocks— and spillover behaviors. At last, investigating the factors that affect the issuance of green bonds would be another promising research avenue.

The study does not necessitate Ethics Committee permission.

The study has been crafted in adherence to the principles of research and publication ethics.

The authors declare that there exists no financial conflict of interest involving any institution, organization, or individual(s) associated with the article. Furthermore, there are no conflicts of interest among the authors themselves.

The authors contributed equally to the entire process of the research.

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