Summer 7-29-2024

Comparative Performance Analysis of Green Bond Issuers to their Conventional Counterparts

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A Thesis submitted to the Department of Management In partial fulfillment of the degree of Master of Science in Finance Graduate Program's requirements.

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15th July 2024

Abstract

This thesis conducts a comparative performance analysis of green bond issuers versus their conventional counterparts. In the context of the 2015 Paris Climate Agreement, which underscores the financial sector's role in promoting environmental sustainability, green bonds have emerged as crucial instruments for financing eco-friendly projects. This research investigates the financial performance of firms issuing green bonds using metrics such as sales growth, return on assets (ROA), and total debts through Ordinary Least Squares (OLS) regression analysis. The analysis covers 54 publicly traded bonds issued in North America between 2018 and 2022.

Despite the growing popularity of green bonds, there are conflicting views regarding their financial benefits. While some studies suggest that green bonds lead to superior financial performance due to heightened investor demand and enhanced brand recognition, others argue that the high costs and stringent regulations associated with green bonds may negate these benefits. This thesis aims to contribute to this ongoing debate by providing a comprehensive comparative analysis of green bond issuers and traditional bond issuers.

The findings of this study are significant for investors, shareholders, and policymakers interested in sustainable finance and its potential to foster long-term economic growth and environmental stewardship. By examining the financial impacts of green bond issuance, this research seeks to provide deeper insights into the viability and benefits of green bonds as a tool for promoting sustainable development.

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1. Introduction

The 2015 Paris Climate Agreement marked a pivotal moment for investors, policymakers, governments, and all stakeholders concerned about the environment. This agreement underscored the critical role of the financial sector in combating global warming by promoting sustainable investments worldwide. In light of the Paris Climate Agreement, green bonds have emerged as one of the most effective tools for the financial sector to support environmental sustainability. Green bonds are fixed income instruments whose proceeds are dedicated to financing environmentally sustainable projects with positive climate impacts (ICMA 2021). The issuance of green bonds has grown exponentially, reflecting a broader trend towards incorporating Environmental, Social, and Governance (ESG) criteria into financial decision-making (Flammer 2020).

1.1 Definition of Green bonds:

Green bonds are debt instruments issued by private and public entities to finance projects with significant environmental and social benefits. Green bonds are defined by the International Capital Markets Association (ICMA) as any bond with proceeds directed to green finance projects (either new or existing). Any institution with bonding authority has the right to issue green bonds, whether it is a financial or non-financial organization, as long as the raised funds are directed to supporting climate, environment, or social-related investments (Ran, Yanaru & Liu 2021). There are several types of green bonds (World Bank 2019):

1. **Use of Proceeds Bonds:** Funds raised are designated for specific projects or purposes, such as renewable energy generation, energy efficiency, sustainable agriculture, and clean water projects.

2. Green Securitized Bonds: Backed by a pool of green assets such as energy-efficient mortgages or loans for electric vehicles, with revenue generated by the assets used to pay back bondholders.

3. Sustainability Bonds: Finance projects directed to provide affordable housing, education, and healthcare.

4. Transition Bonds: Used to finance projects that help companies transition to more sustainable practices, such as transitioning to renewable energy or reducing greenhouse gas emissions.

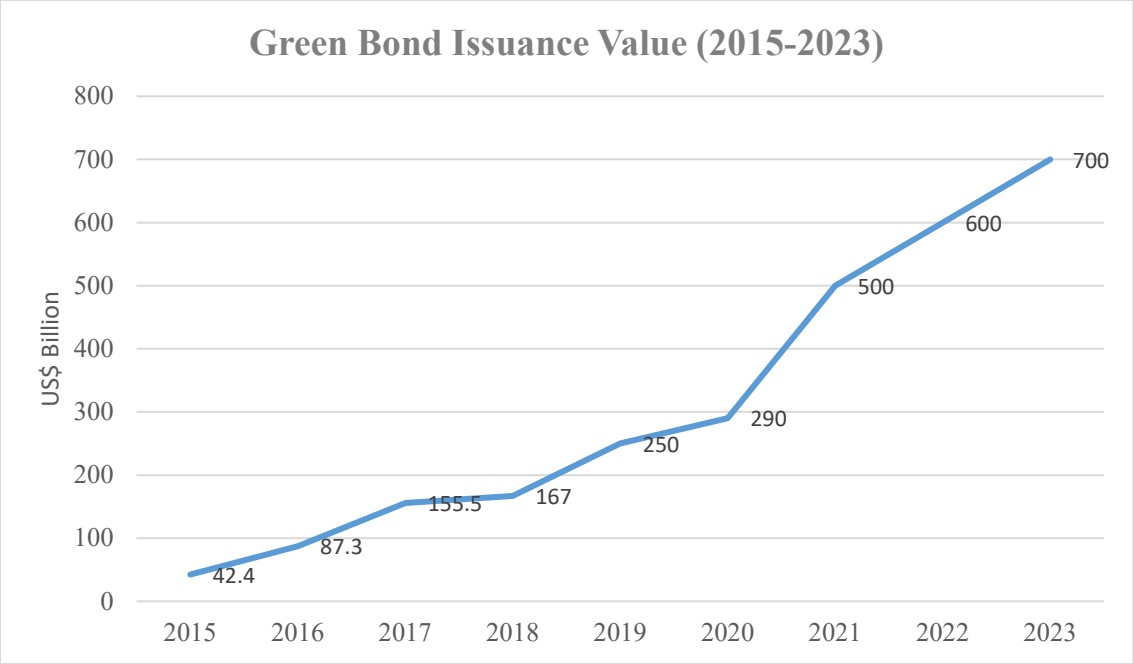
1.2 Evolution of green bonds:

Starting in 2007, green bonds were initially issued by the European Investment Bank (EIB) as structured bonds entitled to support energy either by financing projects related to renewable energy or by financing projects that increase energy efficiency (ICMA 2008). In 2008, the World Bank followed the EIB and issued its first green bond with proceeds dedicated to projects fighting global warming. Later, the World Bank issued the second green bond after receiving many requests from Swedish pension funds wanting to invest in projects supporting climate change (World Bank 2019). The announcement of the first constituted or regulated green bond issuance guidance, the so-called Green Bond Principles (GBP), was in 2014. GBP has a code of conduct that elaborates on the criteria for directing the green bond proceeds to qualify a bond, ensuring proper management of the bond proceeds, and reporting guidance. GBP proposed major components: use of proceeds, project evaluation, project selection, management of proceeds, and reporting (ICMA 2021).

In 2014, the issuance of green bonds increased by more than three times, achieving USD 36.6 billion. The rising volume of green bonds has demonstrated an increase in market demand for green bonds

due to investors' heightened awareness of environmental issues and the value added from sustainable investments. The Paris Climate Agreement served as a significant catalyst for the development of sustainable finance, including the green bond market. As illustrated below, the green bond market has experienced substantial growth since 2015. In 2015, the issuance of green bonds continued to grow, reaching a volume of USD 42.4 billion, further highlighting the evolving importance of sustainable finance.

Graph 1: Green bond issuance value from 2015 to 2023

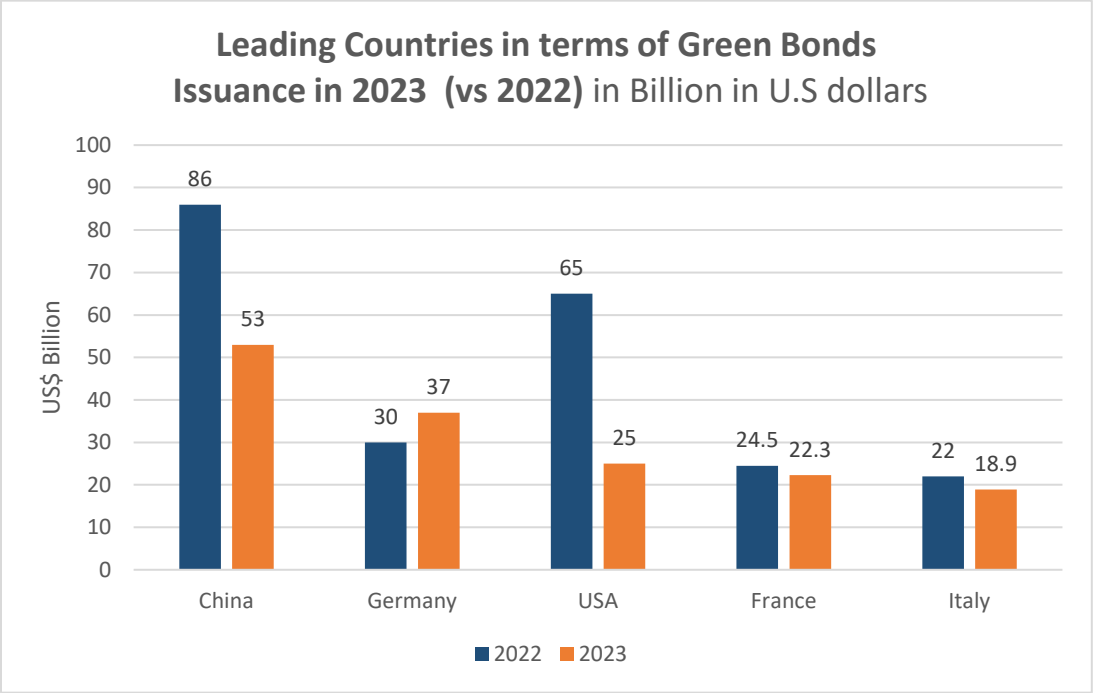


Source: Climate Bonds Initiative (CBI, 2023)

In recent years, the green bond market has expanded significantly. The Climate Bonds Initiative's research shows that the demand for green bonds has increased from less than $1 billion in 2007 to US$ 290 billion in 2020 and $700 billion in 2023. The United States, China, France, and Germany were the top green bond issuers in 2020 (World Bank 2019). The development of green finance policies and regulations, the increase in investor demand for environmentally sustainable investment options, and the growing understanding of the need to address climate change and other environmental

issues are all contributing factors to the growth of the green bond market (Al-Mheiri and Nobanee 2020).

Graph 2: Leading countries in Green Bond Issuance in 2022 and 2023 in Billion USD



Source: Statistica (2023)

As of 2023, the following were some of the countries with the highest statistics for green bonds (Statista, 2023):

1. **China:** According to the Climate Bonds Initiative, China was the largest issuer of green bonds in 2023, with a total of US$ 53 billion compared to US$ 86 billion in 2022.
2. **Germany:** Another major issuer of green bonds with a total issuance of US$ 37 billion in 2023 compared to US$ 30 billion in 2022.
3. **United States:** A significant issuer of green bonds with a total issuance of US$ 25 billion in 2023 compared to US$ 65 billion in 2022. The United States witnessed a decline in issuance compared to previous years due to macroeconomic uncertainty, mainly the rising interest rates, and companies delaying their green projects.

4. **France:** A relatively smaller issuer of green bonds compared to the previous countries but still has a significant market presence with a total issuance of US$ 22.3 billion in 2023 compared to US$ 24.5 billion in 2022.
5. **Italy:** One of the top green bonds issuers in 2023 with a total of US$ 22 billion compared to US$ 18.9 billion in 2022.

1.3 Thesis question and objectives

This thesis is designed to examine the relationship between sustainable finance, specifically green bonds, and the performance of the firm using financial performance metrics such as sales growth, return on assets (ROA), and total debts. The core objective is to evaluate whether companies that issue green bonds experience enhanced financial performance compared to those that issue conventional bonds by employing Ordinary Least Squares (OLS) regression analysis.

Notwithstanding the countless potential benefits of green bonds, including but not limited to strengthened investor outlook and lowered financing costs, there are conflicting empirical findings regarding their actual financial impact. Some studies, such as Sebastiani (2019) and Tang and Zhang (2020), suggest that green bond issuers outperform their conventional counterparts because of higher investor demand and improved brand recognition. On the other hand, other studies like those by Flammer (2019) and Smith (2020) suggest that these benefits might be outweighed by the high expenses and complicated regulations related to green bonds, which would result in underperformance.

1.4 Importance of the Thesis:

The study contributes to the ongoing discourse by providing a comprehensive comparative analysis of green bond issuers and traditional bond issuers. The findings have significant implications for

investors, shareholders, and policymakers who are concerned with sustainable finance and its role in promoting long-term economic growth and environmental stewardship. In this study, we will try to be part of the continuous attempts to examine the impact of issuing green bonds on the firm through performing a comprehensive comparative analysis of green bond issuers and traditional bond issuers.

1.5 Thesis outline

The thesis will comprise three parts with an introduction and a conclusion. The first part is an extensive literature review followed by the methodology, and then an analysis of the results of the thesis.

2. Literature review

2.1 Comparison between green bonds and conventional bonds

Green bonds do not differ from traditional bonds in terms of their origin and mechanism (Aaron & Bajoran 2020). The main key difference between green bonds and traditional bonds is the purpose of the bonds' proceeds, where green bonds' proceeds target sustainable projects only. Both traditional bonds and green bonds are fixed-income securities issued by corporations, governments, or other organizations to raise funds for various projects or operations. Both types of bonds promise to repay the principal amount to the investors at maturity and provide periodic interest payments.

Greenium Effect: Many researchers, including Zerbib (2019) and Baker et al. (2018), have investigated and proven the greenium effect, which implies that green bonds have a reduced yield spread in comparison to conventional bonds. Investors who are concerned about the environment are willing to accept lower yields for sustainable investments. Moreover, there is an increase in market demand for green bonds in alignment with the increase in investors who prioritize green investments, which accordingly drives green bond prices up and brings down their yields.

Dependability in returns: Green bonds prove to have lower volatility compared to traditional bonds; this could be justified by green bonds being directed to green projects, which are often characterized by being long-term (Banga, 2019).

Risk-Adjusted Returns: Gianfrate and Peri (2019) found that green bonds can potentially offer competitive yields, especially when adjusted for their lower risk profile and stable returns compared to conventional bonds. This study also complements the findings of Baker et al. (2018), which suggest that as the green bond market matures, yield spreads and liquidity are expected to significantly improve.

Market share: The liquidity of green bonds is directly proportional to the issuance of green bonds. The Climate Bonds Initiative report (2020) and Hachenberg and Schiereck (2018) highlight that green bonds have lower liquidity compared to conventional bonds, which is a result of the low issuance volume of green bonds compared to the volume of traditional bond issuance. However, it is expected that green bonds will have better liquidity in alignment with the growth of the green bond market.

The role of Regulations: Regulatory support has an impressive role in the performance and appeal of green bonds. Tang and Zhang (2020) examine how regulatory frameworks that are supportive of green bonds empower the green bond market. The development of the green bond market is excessively supported by the Green Bond Standard of the European Union and other comparable regulatory frameworks through different green initiatives. To guarantee that the funds raised from green bonds are fairly directed toward their purpose, green bonds frequently have strict reporting guidelines. Thus, transparency is a unique edge for green bonds, which helps in reinforcing investor confidence and setting them apart from other bonds (Flammer, 2020).

2.2 The impact of green bond issuance on the firm's performance

Many research and empirical studies investigate the relationship between green bonds and financial performance. They prove that green bond issuance leads to enhanced profitability for issuers, evidenced by sales growth, decreased cost of capital, or improved net profit margins. In 2019, Sebastiani conducted research using case studies and empirical analysis to examine the impact of green bond issuance on firm efficiency. The results show that the firms under examination achieve financial enhancement post-green bond issuance, using financial performance metrics such as total sales, profitability, and the cost of debt. Sebastiani conducted an empirical analysis using panel data regression, difference-in-differences analysis, and event study techniques to evaluate the long-term effects and market reactions to green bond issuance announcements. Sebastiani's results highlight the strong positive impact of green bond issuance on firm performance in terms of sales growth, higher profitability margins, and better debt profiles, endorsing the financial robustness and appeal for investors, shareholders, and policymakers.

Tang and Zhang examined stock market responses around the announcement dates of a large dataset of green bond issuances. Additionally, they used cross-sectional regressions to further examine the long-term effects on company financial measures like profitability and sales growth. After adjusting for various market factors and firm-specific factors, their approach provided solid evidence of the financial advantages related to green bond issuance, which in turn enhances investor confidence and market perception of green bonds. It is worth highlighting that Tang and Zhang conducted their research using the same methodology that Louis William used in 2017, and the results were almost identical in terms of the outperformance of green bond issuers over traditional bond issuers, driven by market demand leading to lower interest yields. In sum, most researchers indicated that investor

awareness and regulatory support are the main drivers for the further development of the green bond market.

On the other hand, other studies contradict these results. For instance, the study by Flammer (2021) emphasizes that green bond issuance does not contribute to the enhancement of a firm's financial performance. This study used the difference-in-differences approach to examine the relationship between green bond issuance and the improvement of stock returns. The results indicate that the market does not necessarily provide any reward to green bond issuers, as the research could not prove any significant improvement in stock returns following the announcement of green bonds (Flammer, 2021). This finding is consistent with the research of Scholtens and Kang (2019), who also used empirical analysis to show that green bond issuance does not consistently lead to superior financial performance for firms. Their study suggests that while green bonds may attract investors interested in sustainability, the financial benefits in terms of stock returns are not always evident.

2.3 The green bonds issuance and the cost of capital

A company's commitment to sustainability and environmental responsibility is demonstrated by its issuance of green bonds. By publicly promoting green initiatives and describing their environmental performance, organizations can improve their reputations and brand value. This favorable image attracts investors and stakeholders who are concerned with the environment, which could enhance the performance of the organization. Socially and environmentally conscious investors represent a significant investment base when it comes to green bonds (Smith & Green, 2022). Businesses are more likely to develop and succeed if investors prioritize sustainable investments by issuing green bonds. This wider population of investors boosts demand for the company's securities, improving liquidity, lowering borrowing costs, and facilitating access to finance.

Green bond issuance can strengthen a company's risk management structure by investing in climate and green initiatives, as the company can lower the risks associated with the environment, regulations, and adverse publicity. More dependable and robust operations can be the outcome of enhanced risk management, which could improve organizational efficiency. Companies that invest in sustainable infrastructure can lower their costs by using less energy, emitting less waste, and functioning more efficiently through energy efficiency and resource optimization (Smith & Brown, 2023).

Recent research highlighted the importance of the risk profile of green bonds compared to that of conventional bonds, especially since green bond issuers are typically large, reliable organizations such as governments, development banks, and well-known corporations (Zerbib, 2019). It is still challenging to determine if green bonds are riskier than traditional bonds, particularly due to the novelty and shifting standards of green bonds, which may lead to some uncertainties. The main drivers of these uncertainties are the lack of standardization and the limited data on green bonds (Baker & Bergstresser, 2021).

2.4 Challenges and concerns associated with green bonds

There is no clear definition of green investments, which makes measuring their impact challenging. Additionally, the relationship between a firm's performance and the issuance of green bonds cannot be easily measured. Most research uses the pairing method, where firms that do not issue green bonds are used as controls for firms that do issue green bonds. This method could be the most convenient way to understand the effectiveness of green bond issuance on a firm's performance (Sebastiani, 2019).

A further challenge is that the green bond market is still not completely mature, creating a need for third-party certification to classify green bonds into high and low-quality categories. There might be high demand for green bonds, yet confidence in them is relatively low due to the novelty of the green bond market, unstable regulations, and the risk of greenwashing (Kim Fe Yeow and Sin Huei Ng, 2021). Greenwashing involves using green marketing to encourage investments that may not be environmentally sustainable, leading to increasing concerns. Even though green bonds have the potential to play an essential role in funding environmentally responsible initiatives, many investors hesitate to invest in them. These investors would not choose the lower yield of return over the sustainable impact while there is a lack of confidence in the actual sustainable value added by these bonds.

Greenwashing can occur in various forms, such as false labeling or advertising. False labeling is a type of marketing that takes advantage of consumers' increased interest in sustainability and environmentalism without attempting to lower the environmental impact of a product or service. The use of ambiguous or intangible terms when promoting, such as "all-natural" or "eco-friendly," without featuring any supporting data, is an example of greenwashing. Another instance is advertising the utilization of recycled raw materials in a product without disclosing the product's overall effect on the environment. Greenwashing can seriously jeopardize the environment and mislead consumers who may make purchasing decisions that differ from their values. To limit greenwashing, consumers should inform themselves about the environmental impact of products and services and search for reliable third-party certifications and labeling that validate environmental claims (Smith, 2021).

There are other challenges and concerns associated with green bonds, such as a lack of standardization, pricing, limited availability of information, and regulatory risk. These points are explained as follows:

- **Lack of Standardization:** As explained previously, the lack of standardization is a challenge for investors to evaluate the real impact on the environment (Baker & Bergstresser, 2021).
- **Pricing:** Green bonds are likely to be valued differently than traditional bonds, which could be a matter of concern for investors when comparing the two bonds and assessing the cost of funds for both. However, as the green bond market matures and gains recognition, pricing discrepancies may diminish (Zerbib, 2019).
- **Regulatory Risk:** The regulatory framework is still evolving for green bonds, which may lead to increased risk and uncertainty for investors. Adequate and consistent regulatory structures should be established to ensure that green bonds are satisfactorily labeled and appropriately regulated (Flammer, 2021).
- **Limited Availability:** The green bond market is considered limited when compared to the overall bond market, which might restrict financing for green initiatives and projects. To fill this financing gap for sustainable investments, the green bond market must keep expanding (OECD, 2022).

It is important to mention that these challenges can be overcome by promoting the growth of the green bond market and completing the regulatory frameworks and standards. Businesses should be transparent about their environmental practices and make real attempts to lessen their environmental impact (ICMA, 2018).

2.5 Limited data on green bonds

Despite the recent expansion of the green bond market, there remains a lack of comprehensive information on the environmental impact of green bond issuances. Evaluating the specific environmental effects of these investments is challenging due to the market's lack of standardization.

Efforts have been made to address this issue by establishing standardized reporting frameworks. For example, the Green Bond Principles, developed by international organizations, provide guidelines for disclosing how proceeds from green bond sales are used (World Bank, 2020).

Several programs and initiatives, such as the Climate Bonds Initiative and the CBI Certification Scheme, aim to enhance transparency and accountability in the green bond market through independent verification and certification. Although more work is needed to improve the availability and reliability of data on green bond impacts, ongoing market expansion and standardization initiatives suggest that such data will become more accessible over time (International Capital Market Association, 2022).

Furthermore, generalizing whether issuers of green bonds outperform those of conventional bonds is challenging. Bond performance depends on various factors including issuer creditworthiness, interest rates, and market conditions at issuance. There is no evidence to suggest that green bond issuers receive specific advantages leading to improved performance. However, issuing green bonds can help businesses improve their environmental and social performance, potentially enhancing their long-term financial outcomes.

Increased investor interest in sustainable investments, including green bonds, may lead to higher demand and lower financing costs for issuers. Given the relative novelty of the green bond market, conclusive data on their performance compared to traditional bonds is lacking. Therefore, thorough evaluation of both the issuer and the bond is essential before making investment decisions, as with any other investment (Flammer, 2020).

3. Methodology

3.1 Data

The analysis was conducted using a sample of 54 publicly listed firms in the US from 2018 to 2022. Selection criteria required firms to be listed on major U.S. stock exchanges and to have issued bonds during this period. Data was sourced from Compustat North America, via Wharton Research Data Services, with issuance details gathered from Refinitiv. The list of companies is detailed in Annex 1. The sample comprises 54 firms selected for analysis, consisting of those that issued Green Bonds (GB) and non-GB issuers between 2018 and 2022. Of these, 19 firms issued Green Bonds, while the remaining 35 issued conventional bonds. The sample encompasses firms from diverse industries such as Automotive, Energy, Mining, Financial, Healthcare, Petrochemicals, Real Estate, Technology, and Semiconductor Equipment. Selected firms have total assets ranging from USD 1 billion to USD 300 billion, detailed in Appendix 1. Companies that issued both green bonds and non-green bonds during the study period were excluded from the sample. Summary statistics comparing Green Bond issuers to non-GB issuers indicate statistically significant differences in sales, total debt, and total assets. This suggests that, on average, GB issuers are larger firms compared to their non-GB counterparts.

3.2 Model:

The model was employed using Ordinary Least Squares (OLS) regression to assess the impact of being a green bond issuer on firm performance. All numerical values in the sample are log-transformed, except for Return on Assets (ROA), which measures how effectively a company utilizes its assets to generate earnings. For firm performance, two models were specified: one using Sales as a proxy (following Sebastiani's 2019 research on the effect of green bond issuance on firm efficiency using case studies and empirical data), and another using ROA as a robustness test. The main model is detailed below:

$$Y_{i,t} = \theta + \beta + \gamma_i + \delta_t$$

Where Y is the dependent variable (log Sales or log ROA)

θ is a constant that represents the average of the omitted variable (non-green bond issuers)

"Green bond" is a dummy variable that reads 1 for green bond issuers starting the year the firm issued its first green bond.

γ is a vector of firm controls

δ is time fixed effect.

Note: The analysis was augmented by including controls for firm size, specifically total assets and total debt. Additionally, we incorporate sector fixed effects and time-fixed effects to mitigate the impact of the COVID-19 shock in 2020. Time-fixed effects, as established in previous literature (Louis William Wagner, 2017), are utilized to adjust for macroeconomic shocks affecting all subjects in the sample at specific points in time. This approach helps mitigate any performance declines attributable to the pandemic. To address homoskedasticity, standard errors were adjusted accordingly. The primary findings are presented in the "Results" section, followed by a detailed discussion of the methodology.

Table1: Summary Statistics for Green Bond Issuers:

Summary Statistics Green Issuers

	(1)				
	mean	sd	p25	p50	p75
RevenueTotal	33058.93	69928.47	1874.50	6317.04	13224.50
AssetsTotal	288408.54	742304.14	10690.19	26731.42	121035.50
LongTermDe~l	36104.21	68553.13	3978.54	7210.50	18928.00
ROA	0.63	0.08	0.59	0.64	0.68

Table 2: Summary statistics for non-GB issuers:

Summary Statistics Non-Green Issuers

	(1)				
	mean	sd	p25	p50	p75
RevenueTotal	16069.57	45227.97	444.91	2922.28	10583.00
AssetsTotal	42066.20	110970.24	615.03	5183.42	24621.00
LongTermDe~l	9496.43	23587.31	105.42	1305.82	6675.60
ROA	0.65	0.91	0.54	0.64	0.73

Table 3: T-tests for mean differences between GB and non-GB issuers:

a) Sales

Two-sample t test with equal variances

Group	Obs	Mean	Std. err.	Std. dev.	[95% conf.	interval]
0	117	6.330042	.1195868	1.293529	6.093185	6.566899
1	56	8.845066	.2354434	1.761897	8.373227	9.316905
Combined	173	7.144154	.1425182	1.874534	6.862844	7.425464
diff		-2.515024	.2373463		-2.98353	-2.046518

diff = mean(0) - mean(1) t = -10.5964
H0: diff = 0 Degrees of freedom = 171

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.0000 Pr(|T| > |t|) = 0.0000 Pr(T > t) = 1.0000

b) Total Assets

Two-sample t test with equal variances

Group	Obs	Mean	Std. err.	Std. dev.	[95% conf.	interval]
0	117	7.174925	.1545828	1.672068	6.868754	7.481095
1	56	10.58796	.2428346	1.817208	10.10131	11.07461
Combined	173	8.279722	.1784075	2.346585	7.927572	8.631872
diff		-3.413036	.2795031		-3.964756	-2.861315

diff = mean(0) - mean(1) t = -12.2111
H0: diff = 0 Degrees of freedom = 171

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.0000 Pr(|T| > |t|) = 0.0000 Pr(T > t) = 1.0000

c) Total Debt

Two-sample t test with equal variances

Group	Obs	Mean	Std. err.	Std. dev.	[95% conf.	interval]
0	109	5.279718	.2138085	2.232226	4.855912	5.703524
1	56	9.31064	.1925651	1.441025	8.924731	9.696549
Combined	165	6.647788	.2152231	2.764591	6.222823	7.072754
diff		-4.030922	.3289148		-4.680405	-3.381438

diff = mean(0) - mean(1) t = -12.2552
H0: diff = 0 Degrees of freedom = 163

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.0000 Pr(|T| > |t|) = 0.0000 Pr(T > t) = 1.0000

3.3 Results:

The results from the main analysis in the table below:

	Resluts using Sales as Proxy for firm performance		
	OLS1	**OLS2**	**OLS3**
GB Dummy	0.5564**	0.1847	0.1299
	(0.2308)	(0.1304)	(0.1121)
Assets		0.5580***	0.3884**
		(0.1158)	(0.1637)
Long Term Debt		0.0571*	0.0201
		(0.0331)	(0.0317)
_cons	7.0279***	2.1039**	3.7775**
	(0.2204)	(0.8358)	(1.3419)
Firm FE	N	Y	Y
Time FE	N	N	Y
Robust SE	N	Y	Y

***Indicates significant at 10% confidence level, ** significant at 5% confidence level *** significant at 1% confidence level.**

4. Analysis of results

Although the results show a statistically significant effect in some of the specifications, the methodology may suffer from potential endogeneity problems. Specifically, there may be an unobserved variable that affects both firm performance and the firm's willingness and ability to issue green bonds. If such a variable exists, it will be reflected in the error term of the model and is likely to bias the coefficients. Attempts were made to control for such unobserved factors through sector and time-fixed effects, using fixed effects to account for common shocks across all firms, including economic conditions, monetary interventions, and other factors.

The results indicate that green bond issuers tend to perform better than conventional bond issuers in terms of sales. Specifically, in the first specification, OLS 1, green bond issuers show 0.57% more in sales compared to non-green bond issuers, at a 5% significance level. However, once additional controls are added, the results become insignificant, and the magnitude of the coefficients decreases to almost zero. This suggests that the effect of green bond issuance on sales is unlikely to be

economically meaningful.

	Resluts using ROA as Proxy for firm performance		
	OLS1	OLS2	OLS3
GB Dummy	0.2644	-0.0215	-0.0206
	(0.7870)	(0.0148)	(0.0138)
Assets		-0.015	0.1482
		(0.1055)	(0.1064)
Long Term Debt		-0.0082	-0.0777**
		(0.0223)	(0.0261)
_cons	0.6365***	0.8169	0.0898
	(0.0685)	(0.8502)	(0.8257)
Firm FE	N	Y	Y
Time FE	N	N	Y
Robust SE	N	Y	Y

***Indicates significant at 10% confidence level, **significant at 5% confidence level and *** significant at 1% confidence level.**

When using ROA as a measure of firm performance, there find no statistically significant impact of green bond issuance on firm performance, across different specifications. This may be in line with related literature that investigates the impact of green innovation on firm performance, assuming that green bond issuers may also be active in green innovation. For example, Aguilera-Caracuel & Mandojana (2013) finds that there is no significant difference in financial performance (using ROA as a proxy) between green innovative firms and non-green innovative firms. In 2019, Sebastiani has performed his research using case studies and empirical research to examine the of the green bonds' issuance on the firm's efficiency. The results were to prove that the firms under examinations have accomplished financial enhancement prior to the green bonds issuance using financial performance metrics such as total sales, profitability, and the cost of debt.

Green Bond Issuance (GB Dummy): Across all models, the issuance of green bonds does not show a significant impact on ROA. This suggests that, within this sample, issuing green bonds neither positively nor negatively affects firm performance as measured by ROA.

4.1 Recommended further research:

The ideal scenario involves identifying an exogenous shock that compels firms to switch to green bond issuances. In this context, the decision to issue green bonds would be exogenous to the model and independent of firm characteristics. Such a scenario might result from the introduction of specific regulations at the country or sector level, which push previously non-issuing firms to issue green bonds. A difference-in-difference identification methodology can then be employed to compare the outcome of interest, such as net income, before and after the regulation, and between treatment firms (issuing firms) and control firms (non-issuing firms), thereby achieving the difference-in-difference estimation. This approach would enable the establishment of causality between green bond issuance and firm performance. However, in the absence of such an exogenous shock, the effect of green bond issuance was isolated by using fixed effects and controlling for observable firm characteristics.

5. Conclusion

Since the initiation of green bonds in 2007, issuers have consistently experienced a comparative advantage compared to conventional bonds. To date, there have been numerous debates regarding green bonds, focusing on their definitions, applications, challenges, and potential impacts on the economy and environment. While green bonds are not yet fully mature, they are expected to continue expanding and developing in the coming years, particularly with the support of governments, policymakers, and other stakeholders.

Several studies have attempted to measure the real impact of green bond issuance on the issuing firms, aiming to highlight the importance of green bonds for the environment over profits. In this study, the relationship between green bond issuance and firm performance was examined by comparing the financial performance of firms in North America that issued green bonds from 2018-2022 with those that issued conventional bonds during the same period. Financial metrics such as sales and return on assets (ROA) were used for this comparison.

Sales growth was a primary measurement in the examination; it is a main driver for consumer behavior towards companies that issue green bonds and thus are identified as environmental supporters. The upsurge in a firm's operating performance, as indicated by sales growth, leads to greater efficiency, better asset utilization, and higher opportunities to achieve economies of scale, subsequently enhancing profit margins. This improvement can be measured by observing the Return on Assets. Moreover, green investments are characteristically more consistent due to their long-term tenor and lower risk profile, as discussed earlier in the literature review (Flammer, 2020). Therefore, issuing green bonds directly affects profitability and efficiency through sales growth and cost efficiencies.

In this study results showed that green bond issuers outperformed non-green bond issuers by 0.57% in sales, at a 5% significance level. However, further research is needed to establish firm causality. It is possible that other unobserved characteristics of green bond issuers influence their decision to issue green bonds and their performance relative to their peers. For instance, the quality of the management team could be a factor. Ideally, an external shock resulting in a quasi-experimental design that simulates the random assignment of treatment (green bond issuance) would be necessary to establish such a causal effect. Additionally, further studies could use a matching approach, equating the number of green bond issuers and non-green bond issuers and matching the size of the companies and the size of the issued bonds.

Moreover, policymakers should establish clear guidelines and harmonize global standards for green bonds, provide tax incentives and subsidies, mandate transparent reporting, and support market development through regulatory frameworks and education. Investors should conduct thorough due diligence, diversify their portfolios with green bonds, engage with issuers to promote better practices, advocate for supportive policies, and adopt a long-term perspective focused on sustainable returns. Together, these actions will enhance the credibility, growth, and impact of the green bond market.

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7. Appendix 1

No.	Issue Date	Issuer/Borrower Name Full Name	Proceeds Amount (USD, Mn)	Total Assets (USD,Mn)	Security Type	Industry
1	06/22/2021	Acme united corp	193.96	1,264.3	Senior Secured Notes	Technology
2	12/07/2020	Adams resources & energy inc	2,025.2	3,174.7	Bonds	Energy
3	09/03/2021	Agnico eagle mines ltd	2,494.8	34,603	Guaranteed Senior Unsecured Notes	Mining
4	07/31/2018	Alexander's inc	226.35	8,789.8	Senior Notes	Real estate
5	11/19/2020	American biltrite inc	204.81	1,265.5	Senior Unsecured Notes	Petrochemicals
6	01/23/2018	American express credit corp	1,615	1,032.5	Senior Notes	Financial
7	09/03/2021	American realty investors	7,500	37,357	Guaranteed Senior Unsecured Notes	Real estate
8	09/29/2021	American shared hsptl serv	20,605	1,865.7	Medium Term Senior Notes	Healthcare
9	06/29/2020	American vanguard corp	609.61	1,153.7	Senior Notes	Petrochemicals
10	06/11/2018	Ampco-pittsburgh corp	397.90	7,126.3	Senior Notes	Mining
11	01/10/2022	Asm international nv	2,576.66	5,106.5	Senior Unsecured Notes	Semiconductor Equipment
12	07/14/2019	Astronics corp	772.70	5,865	Senior Unsecured Notes	Aerospace and Defense
13	09/23/2020	Balchem corp -clb	942.36	19,924	Senior Notes	Petrochemicals
14	09/13/2021	Bank of hawaii corp	770.73	4,008.62	Senior Notes	Financial
15	09/23/2020	Barnes group inc	1,491.1	1,782.7	Senior Notes	Aerospace and Defense
16	02/11/2019	Bel fuse inc	654.23	1,624.5	General And Refunding Mortgage Bonds	Technology
17	02/26/2021	Bio-rad laboratories inc	2,513.6	281,962	Senior Secured Notes	Healthcare
18	06/23/2020	Black hills corp	2,551.8	18,095.4	Senior Unsecured Notes	Energy
19	02/26/2021	Brt apartments corp	136.95	2,738.3	Senior Secured Notes	Real estate
20	06/01/2022	Ceco environmental corp	422.62	5,160.4	Senior Secured Notes	Technology

21	03/15/2019	Entergy arkansas	2,673.19	12,972.6	Guaranteed Medium Term Notes	Energy
22	05/19/2020	Federal realty investment tr	935.04	9,618.2	Senior Unsecured Notes	Real estate
23	09/16/2020	Hexion inc	2,510	7,132.1	Senior Unsecured Notes	Petrochemicals
24	04/04/2023	Kilroy realty corp	842.09	5,104.7	Guaranteed Senior Unsecured Notes	Real estate
25	02/01/2021	Materion corp	1,757.11	7,449	Medium-Term Notes	Petrochemicals
26	03/24/2021	Matson inc	2,383.3	41,882	Senior Unsecured Notes	Technology
27	03/22/2021	Nabors industries ltd	2,653.7	13,006.5	General And Refunding Mortgage Bonds	Mining
28	04/08/2019	Popular inc	2,603.8	27,006	Senior Unsecured Notes	Financial
29	07/12/2021	Primerica inc	2,720.13	6,794.9	Senior Secured Notes	Financial
30	11/07/2019	Prog holdings inc	2,677.92	7,607.6	Senior Notes	Financial
31	05/06/2021	Protective insurance corp	493.95	4,148.3	Senior Secured Notes	Financial
32	05/29/2018	Trecora resources	272.69	4,002	Senior Notes	Petrochemicals
33	02/26/2021	Us ecology inc	988.01	12,352	Senior Secured Notes	Petrochemicals
34	04/26/2022	Valaris ltd	2,053.2	8,900	Asset Backed Certificates	Mining
35	11/18/2021	Arizona public service co	3,586.9	1,691.9	Senior Unsecured Notes	Energy
36	07/20/2022	Dana inc	10,156	2,900.6	Senior Unsecured Notes	Technology
37	03/18/2021	Dte energy co	12,669	257,607	Senior Medium-Term Notes	Energy
38	11/18/2019	Federal realty investment tr	842.02	4,729.8	Senior Notes	Real estate
39	06/28/2021	Host hotels & resorts inc	2,923	26,456	Senior Unsecured Notes	Real estate
40	02/09/2019	Bank of america corp	93,753	65,926	Senior Medium-Term Notes	Financial
41	11/12/2018	Pacificorp	5,296	15,348.8	Senior Notes	Energy
42	03/03/2022	Public service elec & gas co	7,122	2,621.7	Senior Medium-Term Notes	Energy
43	03/23/2022	Toyota motor credit corp	12,836	1,634.3	Secured Medium-Term Notes	Automotive

44	10/03/2022	Hannon armstrong sust infr	339.58	37,198	Guaranteed Senior Unsecured Notes	Energy
45	11/07/2018	Toyota motor corp	272,776	2,558.9	Medium Term Notes	Automotive
46	03/01/2022	Metropolitan life insurance	34,905	14,300	Medium Term Senior Notes	Financial
47	04/08/2019	Terraform power inc	941.24	5,504.2	Senior Unsecured Notes	Energy
48	09/29/2022	Aes corp (the)	9,660	16,483.2	Senior Unsecured Notes	Energy
49	10/29/2019	Sunrun inc	1,609.9	10,058.6	Senior Notes	Energy
50	03/07/2020	Sunnova enrgy intl inc	241.75	268,714	Senior Medium-Term Notes	Energy
51	03/09/2022	Ardagh metal packaging sa	4,689	116,516	Secured Medium-Term Notes	Packaging
52	06/07/2022	Equinix inc	5,998.5	2,193.54	Senior Unsecured Notes	Technology
53	11/12/2018	Southern power co	1,938	1,805.3	Senior Notes	Energy
54	11/13/2019	Renewable energy group inc	3,244.05	16,931.2	Fixed Or Straight Bond	Energy

Source: Wharton Research Data, 2022