The Inflation Reduction Act With a Side of Greenium

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Abstract

I examine corporate green bond yields before and after The Inflation Reduction Act to determine the existence of a greenium. Since 2014, the green bond market has experienced steady growth fueled by environmentally conscious investor demand, partly in response to government inaction. Nevertheless, the passage of The Inflation Reduction Act of 2022 marks the single largest investment in energy and climate in American history. Comparing green bonds to conventional bonds, I demonstrate that following the enactment of the Reduction Act, corporations gain access to cheaper capital for climate risk mitigation through green bonds.

Contents

1. Introduction

A greenium represents an investor's willingness to pay for "green" assets. The increase in adverse conditions stemming from climate change has prompted investors to categorize investment securities, particularly stocks and bonds, into two colors: green or brown. Green assets, representing environmentally responsible investments, incur higher costs and typically yield lower returns compared to brown assets. The green investor is motivated by non-pecuniary factors when considering these underperforming assets. In other words, the green investor is willing to receive a lesser return from an asset so long as the investment made contributes to the abatement or mitigation of some climate risk. A company transitioning from brown to green incurs costs to address these externalities, resulting in lower profits compared to a brown company that does not invest in abatement or mitigation. Issuing bonds is a primary method corporations use to finance such projects. Green companies and brown companies that undertake 'green' projects benefit from a lower cost of capital because their investors are willing to accept a lower interest rate. Given that corporations are primarily driven by financial motives, access to cheaper capital may incentivize them to prioritize environmental responsibility. The discrepancy between the returns for green and brown investors or the costs of capital for companies is referred to as the greenium.

In the absence of a global carbon pricing scheme, bond markets will be central to financing the necessary investments [@Baker et al.]. My research contributes, albeit in a small but meaningful way, to the very important research literature already existing at the intersection of finance and climate science. Zerbib [@ZERBIB201939] compared municipal bonds, sovereign, and a small subset of corporate bonds with data ranging from 2013 to 2017 and found a small greenium of 2 basis points. Baker et al. also compared 2083 green municipal bonds with data ranging from 2010 to 2016 and found a 6 basis point greenium [@Baker et al]. Larcker and Watts, who matched 640 municipal bonds with data ranging from 2010 to 2016 and found no greenium. Flammer matched 152 corporate green bonds with data ranging from 2010 to 2018 and also found no yield differenceas well. These studies were all conducted prior to the Inflation Reduction Act and investigating the impact of the Act on bond yields can help determine its effectiveness in providing corporations access to cheaper 'green' capital will contribute to the conversation.

The Inflation Reduction Act (IRA), enacted on August 16, 2022, represents the single largest investment in energy and climate in American history. The act aims to incentivize both companies and consumers to transition to 'green' practices by lowering the cost of cleaner energy and creating a market for green

technologies through tax incentives. These tax credits have the potential to stimulate the 'green' securities market by incentivizing companies to undertake more green projects in response to increased demand for green products. The IRA provides a way for companies in industries such as oil and gas, which do not qualify to issue green bonds, to eventually become eligible by investing in renewable technologies for those industries.

In the real estate industry, the Act provides tax deductions for green building developments and efficiency to a maximum of $250,000. According to Statista and my data, Boston Properties Inc., a company that prides itself on developing properties with the best green technologies and smallest carbon footprint, has issued 1.5 billion dollars worth of green bonds between 2022 and May 2023 [@statista].

Green bonds and conventional bonds share similar characteristics such as maturity dates, coupon rate, quality ratings, etc. However, one defining feature of green bond lies in how the proceeds from the sale are expectd to be utilized by the issuing firm. Typically, these funds must be allocated to projects aimed at climate risk mitigation or abatement. Typically, the proceeds must be used for a project that addresses climate risk mitigation or abatement.

Since the allocation of funds is based on self-reporting, concerns regarding transparency, disclosure, and market integrity are valid. To address these concerns, the International Capital Market Association has introduced a set of 'Best Practices' known as the Green Bond Principles (GBPs), providing a guiding framework for issuing green bonds. Despite the existence of these principles, many issuers choose not to adhere to them for various reasons. Consequently, their bonds do not benefit from the 'certified green' label [@Green].".

The Green Bond Principles (GBPs) outline three key principles guiding the issuance of green bonds.

Firstly, the principle of 'Use of Proceeds' directs funds to specific types of projects, including renewable energy, energy efficiency (building), and environmentally sustainable management of natural resources and land use. This encompasses a range of activities such as environmentally sustainable agriculture, climate-smart farming practices, sustainable forestry, and biodiversity conservation [@Green]. This principle ensures that responsible investors can allocate their investment dollars to finance green projects that contribute to environmental sustainability.

Secondly, the principle of 'Process for Project Evaluation and Selection' requires issuers to clearly communicate to investors the project's objectives, trade-off analysis, or any relevant research. This transparency

ensures that investors are informed about the environmental impact and sustainability of the projects funded by the green bonds.

Thirdly, the principle of 'Management of Proceeds' stipulates that the net proceeds of the Green Bond, or an equivalent amount, should be segregated and tracked by the issuer in a dedicated sub-account or sub-portfolio. This tracking should be part of a formal internal process linked to the issuer's lending and investment operations for eligible Green Projects. By managing proceeds in this manner, issuers demonstrate accountability and ensure that funds are allocated as intended for green initiatives.

While green and conventional bonds are priced similarly and share the same characteristics, there are additional transaction costs associated with the tracking, monitoring, and reporting of proceeds for green bonds. These costs could pose a potential barrier for small issuers and warrant further investigation. However, issuers can offset these initial costs with the benefits that a green label offers, such as highlighting their green assets and diversifying their investor base.

The first green bond was issued in 2007 by multilateral institutions European Investment Bank (EIB) and World Bank [@Climate]. However, the market began to experience rapid growth beginning in 2014. By 2020, the global green bond market had grown to a value of over one trillion dollars. In the United States, the largest issuers of green bonds in 2022 were Fannie Mae, issuing 10.5 billion dollars, Prologis (a real estate developer of green buildings), issuing 3.4 billion dollars, and General Motors, issuing 2.25 billion dollars. The primary banks that underwrite these green bond issues include Bank of America, JPMorgan Chase, and Wells Fargo. In 2021, the United States issued its largest amount of green bonds yet, valued at over 90 billion dollars.

2. Data and Methodology

In terms of my methodological approach, I followed Flammer's matching method and data processing to compare the yields between green and brown bonds before and after the Reduction Act. [@flammer21;@larcker_watts20]. I search Bloomberg's fixed income database for all bonds3 with the green leaf indicator, excluding all government and agency bonds, to create my database. Additionally, all entries with missing information for any of my search parameters are excluded. I set the parameters for country to U.S.A, ratings to investment grade, coupon type to fixed coupon, ratings to Bloomberg's credit composite,

and seniority level to senior bullet. I limit the date range search to begin on January 1, 2014 until March 15, 2024.This search yielded 938 green bonds. Further, I restricted the date to 578 days before and after Aug. 16, 2022 (IRA Inception), from January 15, 2021 to March 16, 2024. This filter results in 258 green corporate bonds issued by 35 unique issuers. Next, I return to the Bloomberg database and searched for all conventional bonds from the 35 unique issuers using the same parameters and date range as the initial green bond search. After some data processing and cleaning, both green and brown data sets were split into Pre-Reduction Act and post-Reduction Act resulting in four data sets. Now, I merged the green pre-Reduction act with brown pre-Reduction act and the same for post-Reduction act data sets. The matching was performed in two steps. First, I match all bonds by ratings. Then, I employed the n nearest neighbor algorithm using Mahalanobis distance based on maturity, coupon, log issue amount, and the number of days in between the green and brown bond issuance. This matching technique provides for each green bond a matched brown bond by the same issuer that is as similar as possible except for the "greenness" [@flammer21].

	Ticker	Issue.yield	Issue.Date	log.Issued	Cpn	Maturity	BBG	type
1	AMGN	4.43	2022-02-22	20.95	4.40	2062-02-22	BBB	Brown
2	AEE	1.76	2021-03-05	19.92	1.75	2028-03-15	BBB	Brown
3	AEE	1.95	2021-11-18	20.03	1.95	2027-03-15	BBB	Brown
4	LNT	3.62	2022-02-28	19.67	3.60	2032-03-01	BBB	Brown
5	ARE	3.57	2022-02-16	20.72	3.55	2052-03-15	BBB+	Brown
6	ARE	3.02	2021-02-18	20.56	3.00	2051-05-18	BBB+	Brown

Table 1: Sample of the brown data set pre-IRA

Ticker	Issue.yield	Issue.Date	log.Issued	Cpn	Maturity	BBG	type
XINAOG	4.72	2022-05-17	20.13	4.62	2027-05-17	BBB+	Green
XIAOMI	4.16	2021-07-14	19.81	4.10	2051-07-14	BBB-	Green
XEL	5.19	2022-05-31	19.11	5.15	2052-06-01	A-	Green
XEL	4.54	2022-05-09	20.03	4.50	2052-06-01	A+	Green
XEL	3.22	2021-03-30	19.87	3.20	2052-04-01	A+	Green
XEL	2.30	2021-03-30	19.87	2.25	2031-04-01	A+	Green

Table 2: Sample of the green data set

The matching technique results found in Table 3, show that all 258 green bonds were matched to a brown bond while 164 brown bonds were left unmatched.

	Category	Control	Treated
1	All	422.00	258.00
2	Matched	258.00	258.00
3	Unmatched	164.00	0.00
4	Discarded	0.00	0.00

Table 3: Sample of matched Pairs

From Table 4, the summary of balance helps evaluate the effectiveness of the matching procedure in creating comparable treated and control groups, which is crucial for reducing bias and making valid causal inferences in observational studies.The standardized mean differences (SMDs) represent the effect size or the standardized measure of the difference in means between the treated and control groups after matching. A smaller SMD indicates better balance between the groups on the variables (coupon, maturity, days between issue, log amount) being compared. The difference in means for the maturity between the treated and control groups is only 0.0243 standard deviations. This indicates a very small difference in maturity between the two groups after matching, suggesting good balance on this variable. The mean SMD for the coupon rate is -0.2547. A negative value indicates that the mean of the treated group is lower than the mean of the control group after matching. There is a moderate difference in coupon rates between the two groups after matching, with the control group having a slightly higher coupon rate on average. The variance ratio compares the variability of the treated group to that of the control group after matching. Values closer to 1 indicate similar variability, while values further from 1 suggest differences in variability between the groups after matching. The variability in maturity is relatively similar between the treated and control groups after matching but the variability of the coupon rate is slightly higher in the treated group after matching. Nevertheless, It appears that the Pre-IRA matched set achieved generally good balance, as indicated by small standardized mean differences and variance ratios close to 1.

	Variables	Means.Treated	Means.Control	Std..Mean.Diff.	Var..Ratio	eCDF.Mean	eCDF.Max
1	log.Issued	20.08	18.39	2.06	0.17	0.17	0.49
2	Maturity	22785.94	22706.35	0.02	0.86	0.09	0.17
3	Cpn	2.26	2.62	-0.25	1.34	0.08	0.15

Table 4: Summary balance of Pre-IRA matched Pairs

The post-IRA dataset has 98 more green bonds than the pre-IRA set which resulted in all 356 green bonds matched to brown bonds. There were 404 brown bonds left unmatched as shown in table 5.

	Category	Control	Treated
1	All	760.00	356.00
2	Matched	356.00	356.00
3	Unmatched	404.00	0.00
4	Discarded	0.00	0.00

Table 5: Sample of Post-IRA matched Pairs

Table 6 shows the summary balance for the Post_IRA matching. The Std. Mean Diff. of 0.1299 for Maturity indicates a small difference, while a negative value of -0.6016 for the Coupon rate suggests that the

control group has a higher mean for than the treated group. As for the variance ratio, The summary suggests that the variability of the coupon rate for the green bond set is much higher than for brown bonds.While it may not be a problem in this case, it does raise some concerns and warrants further examination. Having a higher variance in the treated group compared to the control group could potentially introduce bias in the estimation of treatment effects.

	Variables	Means.Treated	Means.Control	Std..Mean.Diff.	Var..Ratio	eCDF.Mean	eCDF.Max
1	log.Issued	20.05	18.37	1.71	0.24	0.16	0.50
2	Maturity	22932.59	22523.97	0.13	1.05	0.12	0.24
3	Cpn	4.48	5.21	-0.60	3.68	0.19	0.46

Table 6: Summary balance of Post-IRA matched Pairs

Overall, based on these indicators, it appears that the matching for pre and post-IRA achieved some degree of balance between treated and control groups.Figure 1 and 2 provide a visual of the difference in density as described above. In figure 1, the plot for pre-IRA shows a smaller positive difference in density associated with green bonds when compared to the post-IRA plot. So pre-IRA, it was less likely that green bonds would exceed brown bonds at low issue yield. This preliminary density analysis suggests that the Act improved outcomes for green bonds.

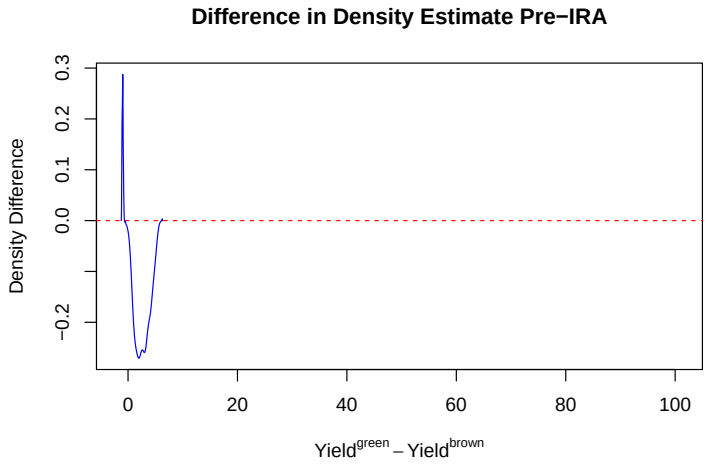

Figure 1: In this plot, there is a smaller positive difference in density associated with green bonds.

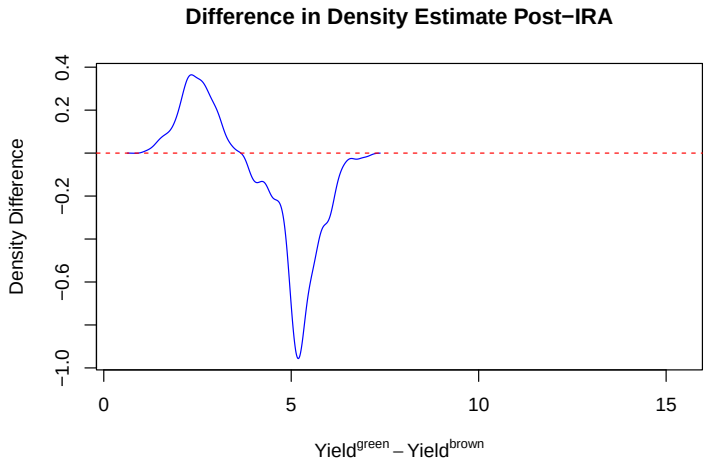

Figure 2: A brown bond typically demonstrates a higher issue yield than a green bond since the graph is negative

3. Results and Analysis

The results from the Welch Two Sample t-test (table.7) on the pre-IRA dataset shows a difference in issue yield of just two basis points between green and brown bonds. However with a p-value of 0.9067, it is statistically insignificant which is in line with Flammer's and Larcker & Watts' findings of no greenium. This suggests that before the Reduction Act, companies had little incentive to issue green bonds other than for the perks of promoting themselves as environmentally responsible. The bonds can serve as a way for a company to diversify it's investor pool and not really as a source of cheap capital to mitigate emissions.

Table 7: Pre-IRA T-test (continued below)

Test statistic	df	P value	Alternative hypothesis	mean in group 0
-0.1173	276.7	0.9067	two.sided	2.622

mean in group 1
2.668

After the Reduction Act, companies have access to cheaper capital.The post-IRA t-test (Table.8) shows a statistically significant difference of 68 basis points. The 68 basis points is the greenium. An indication of

demand for environmentally responsible projects, with investors willing to accept lower returns in favor of supporting such initiatives.

Table 9: Pre-IRA T-test (continued below)

Test statistic	df	P value	Alternative hypothesis
9.393	538	1.65e-19 * * *	two.sided

mean in group 0	mean in group 1
5.214	4.525

Plotting the yield at issue over time for green and brown bonds (Figure 3.) helps visualizes the results from the density analysis and the t-test in one graph. The yields at issue were practically the same leading up to the enactment (red line) with brown and green dots overlapping and resemble inkblot. Afterwards, brown bonds were more likely to have a higher yield than green bonds like both density and t-test suggested.

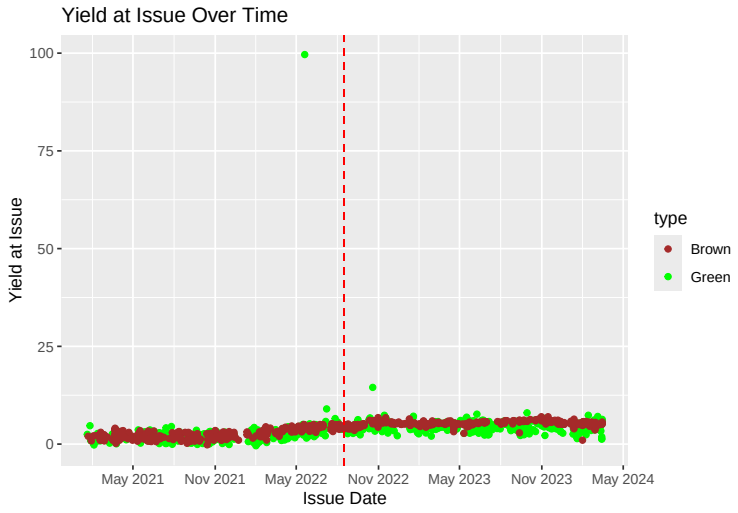

Figure 3: A brown bond typically demonstrates a higher issue yield than a green bond since the graph is negative

4. Robustness Check (sort of)

To validate my results, I run a difference-in-differences regression using the matched dataset. Since the matching technique applied to the dataset controlled for confounding variables, I do not control for any

additional variables in this regression. My regression model specification is

$$Issue.yield = treated + after\_act + treated \cdot after\_act$$

The regression model includes interaction terms between the treatment indicator, $brown = 0$ and $green = 1$, and the post-intervention indicator, $after\_act$. The model's results (Table 11) validates my prior results that while there was no significant difference in yields between green and brown bonds before the act, the IRA led to a significant reduction in yields for green bonds. The coefficient (-0.73) for treated:after_act is negative and statistically significant at the five percent level. On average, green bond yields were 73 basis points lower than brown bond yields which aligns with my prior t-test results of a reduction of 68 basis points after the enactment. The coefficient (0.04) for treated represents the average difference in yield between green and brown bonds before the act. However, it is not statistically significant.

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	2.6219	0.1867	14.05	0.0000
treated	0.0463	0.2640	0.18	0.8608
after_act	2.5919	0.2452	10.57	0.0000
treated:after_act	-0.7353	0.3467	-2.12	0.0341

Table 11: Difference-in-Differences Regression

5. Conclusion

In this study, I delve into the impact of the Inflation Reduction Act (IRA) on bond yields, specifically examining the emergence of a premium between green and brown bonds. Through comprehensive analysis, I discovered a significant trend: following the implementation of the IRA, green bonds exhibited a discernible reduction in yields, averaging a decrease of 68 basis points. This finding underscores the tangible effect of the IRA in lowering the cost of capital, a pivotal aspect of its efficacy in assisting corporations in their endeavors to mitigate their carbon footprint.

Moreover, the robust growth witnessed in the green bond market serves as a testament to the burgeoning demand for environmentally-conscious investment opportunities. This surge in interest from investors motivated by non-pecuniary factors underscores the evolving landscape of sustainable finance and the pivotal role it plays in shaping the future of corporate environmental responsibility.

By shedding light on these key findings, this study contributes to a deeper understanding of the intricate interplay between policy interventions, financial markets, and environmental sustainability.

6. References

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