Greenium in the Primary Market for Brazilian Debentures

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Abstract This paper investigates whether the Brazilian corporate debenture market prices a greenium—a reduction in issuers' borrowing costs driven by ESG labeling—at the time of issuance. Using a BRL-denominated panel of corporate debentures issued between 2015 and 2025, we model issuance-day spreads relative to the contractual indexer (DI, IPCA, or PRE) to directly target primary-market pricing. The empirical strategy employs high-dimensional fixed-effects regressions with Issuer and Indexer×Month effects, two-way clustered standard errors, and comprehensive controls for maturity, size, bond type, sector, rating, convertibility, tax-incentivized status, and same-day issuance intensity, isolating within-issuer and within-regime-month variation in spreads. Results indicate a small but emerging greenium: the baseline specification yields a negative coefficient of approximately –18 basis points, robust in sign though sensitive to model granularity and more pronounced after 2019. No consistent differences arise across indexers. Overall, ESG labeling is associated with modest yet economically relevant issuance-day spread reductions.

Keywords: Asset pricing; Green bonds; Primary market; Issuance spreads; ESG label effects; Fixed effects; Brazil.

JEL codes: G12,G32 ,C23.

1. Introduction

International commitments such as the Paris Agreement and the UN Sustainable Development Goals (SDGs) underscore the need for a coordinated global effort, with the financial system playing a significant role in mobilizing and allocating capital to sustainable activities—from emissions reduction and climate-resilient infrastructure to social inclusion (United Nations, 2015). Meeting these ambitions requires sizeable resources: developing countries

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alone need about US 2.5 trillion in additional investment per year to achieve the SDGs by 2030 (Arora & Sarker, 2022). Against this backdrop, we examine whether Brazil's corporate bond market prices a financing advantage for labeled issues—i.e., a greenium—thereby providing a tangible, market-based incentive to fund the country's transition.

Brazil's transition agenda raises a central corporate-finance question: do green labels reduce issuers' borrowing costs at the time of issuance? We analyze the Brazilian corporate debenture market to test whether labeled issues price at a discount—a greenium—once issuer fundamentals, market conditions, and bond characteristics are held constant. The global green bond market has matured rapidly over the past decade; we focus on whether this demand translates into a pricing advantage in Brazil. An important milestone was ICMA's Green Bond Principles, which improved transparency and helped standardize external reviews, but methodological details are discussed in the Literature Review.

Brazil's market is relevant for testing the greenium: issuers span agribusiness, energy, and infrastructure, and projects are naturally aligned with environmental use-of-proceeds. This breadth allows us to examine whether labeled issues command distinct pricing at launch. We define the greenium as the issuance-day yield spread difference between a green bond and a comparable conventional bond. Because cash-flow rights are otherwise equivalent, any premium reflects investor preferences, market friction, or information effects rather than fundamentals.

We focus on the primary market because issuance-day yields determine the issuer's actual cost of debt. By modeling the spread at issuance, we directly test whether labeled debentures price at a discount relative to conventional peers, net of issuer heterogeneity and monthly market conditions. This issuer-centric lens complements secondary-market studies that speak more to investor returns than to firms' financing costs. Our final panel comprises three hundred labeled (green) and 3,308 conventional bonds (Feb-2015 to Jun-2025). Regressions retain 2,780 observations after fixed-effects and data cleaning. Using this extensive dataset, we employ a fixed-effects regression model, like that used by (Baker et al., 2022). This approach allows us to analyze the factors influencing variations in the yield spread at issuance across an unbalanced panel of corporate bonds.

We assess whether labeled corporate debentures in Brazil price at a discount at issuance—a greenium—after controlling for issuer fundamentals, indexer-specific market conditions (DI, IPCA, PRE), and bond characteristics. Our empirical design targets the firm's borrowing cost rather than

secondary-market dynamics and rests on five pillars: (i) an issuer-centric view of primary-market pricing; (ii) a BRL-only dataset with broad coverage of domestic debentures; (iii) high-dimensional fixed effects (issuer; indexer × month) with two-way clustered standard errors; (iv) explicit treatment of heterogeneity across indexers (DI, IPCA, PRE); and (v) policy relevance for segmented pricing (incentivized vs. conventional) and issuer strategy.

Across baseline fixed-effects specifications, the green indicator is negative, indicating a potential discount at issuance; however, the effect becomes statistically imprecise under stricter issuer × year controls. The discount is more pronounced post-2019, consistent with international evidence that the greenium emerges only in later years. Overall, we do not find full-sample, statistically robust evidence of a systematic greenium, but the pattern suggests an emerging primary-market discount in Brazil. The next chapter reviews the theoretical and empirical literature on green bond pricing and outlines the identification challenges specific to Brazil.

2. Literature Review

Green bonds are conventional fixed-income instruments whose cash-flow structures do not differ from traditional bonds; the only distinguishing feature is the labeling of environmental use-of-proceeds (Caramichael & Rapp, 2022). Because seniority, recourse, and credit fundamentals are identical, any pricing differential must stem from investor preferences, information frictions, or market segmentation, rather than from risk-based characteristics (Caramichael & Rapp, 2022). To mitigate information asymmetry and greenwashing risks, most issuances now adhere to the ICMA Green Bond Principles and third-party verification standards, which strengthen the informational content of the label (International Capital Market Association, 2021).

International studies have documented small and heterogeneous green premia, usually in the order of a few basis points. These premia tend to be more prevalent for sovereign and supranational issuers or for bonds carrying external certification (Kapraun et al., 2019). Meta-analyses suggest that effects are sensitive to identification strategy: matching approaches often produce precise but sample-restricted estimates; fixed-effects panels exploit within-issuer and within-time variation but require high-dimensional controls and robust clustering (Bour et al., 2019). Importantly, several recent global studies show that the greenium tends to emerge after 2019, when ESG-dedicated investor demand accelerated and green indices expanded (Caramichael & Rapp, 2024).

The literature highlights at least three identification approaches. First, matching constructs comparable bond pairs to isolate conditional yield dif-

ferences, but severely reduces sample size and biases toward frequent issuers (Flammer, 2021). Second, panel regressions with fixed effects absorb issuer heterogeneity and macro-rate variation—an approach particularly suited to unbalanced panels, with two-way clustering widely adopted (Zerbib, 2018). Third, hybrid robustness designs apply tail trimming, size-weighted regressions, and post-period subsampling to test stability (Dorfleitner et al., 2021).

For Brazil, empirical findings remain limited and mixed. Prior local studies find either no clear premium or small discounts, depending on sample composition, method, and the treatment of indexation regimes (Ferrari, 2022). Brazil's corporate debenture market is structurally segmented: incentivized debentures attract retail investors due to tax exemptions, whereas non-incentivized corporate paper is dominated by institutional investors benchmarked to CDI (Cardillo & Basso, 2025). Furthermore, heterogeneous indexation structures (DI, IPCA, PRE) and liquidity conditions introduce measurement noise, making unconditional spread comparisons highly unreliable (Yamahaki et al., 2022).

This combination of segmentation, indexation heterogeneity, and scarce primary-market evidence motivates issuer-centric estimation strategies. Recent work emphasizes that properly identifying a greenium in Brazil requires indexer-specific monthly controls, issuer fixed effects, and rich conditioning sets to isolate within-issuer, within-regime-month spread variation (Slimane et al., 2024). As highlighted in your own results, this identification approach aligns with the most rigorous international methodologies and addresses a clear gap in the Brazilian literature.

3. Methodology

3.1 Database Construction

We assemble a BRL-denominated primary-market dataset of Brazilian corporate debentures from Feb-2015 to Jun-2025, comprising three hundred labeled (green) and 3,308 conventional issues after cleaning. 2,780 observations remain in regressions once fixed-effects and data filters are applied. The sample focuses on BRL instruments placed in the domestic market, aligning this chapter with our identification strategy and results.

The core source is ANBIMA bond-level data, complemented by issuer disclosures, from which we extract only the fields used in construction and estimation. Specifically, we capture the issue and maturity dates, the coupon structure and payment frequency, the contractual indexer (DI, IPCA, or PRE), the issuance price and the yield at issuance, and the amount issued in BRL. We also record the bond's specie—Unsecured ("Quirografária"), Secured

("Real"), or subordinated)—together with the issuer's sector (ANBIMA classification) and a grouped credit rating, plus a convertibility indicator and an incentivized-debenture flag (Law 12,431/2011). These variables were extracted at the time of issuance and harmonized to a BRL-only primary-market setting, ensuring consistency with the empirical design.

The identification of these specific assets was based on data from ERM NINT. ERM NINT is an ESG consulting and assessment firm operating in Latin America, formerly part of SITAWI. The ERM NINT database includes green, social, sustainable and transition bonds (green/social/sustainable/transition bonds), including all sustainable credit operations in the country, covering various mechanisms and themes, such as loans and financing. Green bonds were identified by this characteristic in the databases used. In other words, if a bond is presented as green in some of these sources, it was added as part of the sample of the treatment group. In cases where there was any conflict or inconsistency in the information presented between the databases, institutional disclosure materials of the issuers were consulted to confirm their green character, in addition to other pertinent information about the bond.

This calculation incorporated essential financial variables, including the bond's issue price, coupon rate, coupon frequency, and day-count convention (Flammer, 2021). We focus on issuance-day yields because they determine the issuer's borrowing cost at time t; secondary-market quotes reflect liquidity and trading frictions that need not mirror primary pricing. Our dependent variable is the primary-market spread relative to the bond's local indexer on the issuance day (column spreadbps), as conventionally quoted for Brazilian debentures (DI, IPCA, or PRE). This indexer-relative convention maximizes coverage and matches the specification reported in the Results (Table 5), where month-by-indexer fixed effects absorb regime-specific market conditions.

The magnitude and even the presence of a greenium can be method dependent given noise from liquidity, yield-curve conditions at issuance, and issuer characteristics; we therefore rely on high-dimensional fixed effects and several robustness checks. (Larcker & Watts, 2020). (Zerbib, 2018). Many Brazilian debentures combine fixed and indexed components (e.g., DI or IPCA). Our indexer-relative spread accommodates these regimes directly, while controls and fixed effects handle residual heterogeneity.

3.2 Variable Definitions

We construct a variable set tailored to primary-market pricing in Brazilian debentures that mirrors the information investors observe at launch. The Green indicator is a binary flag equal to one for labeled issues that obtained third-party review (certification, verification, or second-party opinion) and zero otherwise;

it is our main regressor and is expected to load non-positively if a greenium exists. To capture contractual rate regimes, we include Indexer dummies for DI, IPCA, and PRE, which also underpin the formation of Indexer×Month fixed effects used later in estimation. Term-structure exposure is measured by log (Maturity in years) at issuance, for which credit spreads typically increase with tenor, while primary-market liquidity/placement conditions are proxied by log (Amount issued in BRL). We also represent seniority and collateral with Specie categories—Unsecured ("Quirografária"), Secured ("Real"), and Subordinated—and absorb cross-industry heterogeneity with Sector indicators based on ANBIMA classifications (e.g., Agribusiness, Energy, Financials).

Beyond these core characteristics, we add variables that are particularly salient in Brazil's segmented debenture market. A grouped credit-rating variable summarizes issuer credit quality, and a Convertibility indicator flags embedded optionality. A key market-structure control is the Incentivized-debenture dummy, equal to one for securities issued under Law 12,431/2011 (the tax-exempt retail segment) and zero otherwise; this helps separate tax-driven demand effects from any incremental green-label contribution to pricing. To capture same-day financing intensity at the issuer level, we form issuer-day total borrowing deciles, which proxy bookbuilding pressure and potential scale economies when multiple tranches are placed concurrently. Together, these variables are drawn at issuance and harmonized to a BRL-only primary-market setting to ensure measurement consistency across the sample.

In the regressions, this construction pairs with Issuer and Indexer × Month fixed effects to isolate within-issuer, within-regime-month variation, so that the green coefficient is identified net of time-invariant firm traits and regime-specific macro conditions. Exchange-rate controls are omitted by design because the panel is BRL-only and our dependent variable is the indexer-relative issuance-day spread, which conditions the analysis on the local rate environment. This specification allows us to separate label-specific pricing from fundamentals (maturity, specie), scale/liquidity (amount, issuer-day intensity), and structural segmentation (incentivized versus conventional), yielding an estimate of the greenium that is directly interpretable in basis points and aligned with the institutional realities of the Brazilian debenture market.

3.3 Identification and Estimation

To investigate the existence of a greenium in the Brazilian primary market, we employ a fixed-effects regression model using an unbalanced panel of corporate bonds, with the yield spread at issuance serving as the dependent variable. This approach allows our model to effectively control potential nonlinearities, as well as unobserved heterogeneity and time-varying effects

specific to each issuer and bond.

$$Spread_{i,t} = \alpha\, Green_{i,t} + \beta^1 \log(\text{Maturity}_{i,t}) + \beta^2 \log(\text{Amount}_{i,t}) + X'_{i,t}\,\beta + \gamma_{\text{Issuer}(i)} + \delta_{\text{Indexer}\times\text{Month}(t)} + \varepsilon_{i,t}. \quad (1)$$

Where $\text{Spread}_{i,t}$ is the issuance-day indexer-relative spread (bp); $\text{Green}_{i,t}$ equals 1 for labeled issues with third-party review; $\log(\text{Maturity}_{i,t})$ and $\log(\text{Amount}_{i,t})$ are the logs of years-to-maturity and BRL amount; $X_{i,t}$ includes Specie (Unsecured/"Quirografária", Secured/"Real", Subordinated), sector (ANBIMA), convertibility, an incentivized-debenture flag (Law 12,431/2011), and issuer-day borrowing deciles; Issuer(i) and Indexer×Month(t) are issuer and indexer×month fixed effects; $_{i,t}$ is the error term; and standard errors are two-way clustered by issuer and by issuance month-year.:

We prefer fixed effects to matching because matching sharply reduces the usable sample and selects issuers with multiple comparable bonds, biasing composition toward frequent issuers. Our FE design uses the full panel, allows conventional-only issuers, and then treats matching as a diagnostic in the Appendix. Robustness includes Issuer × Year fixed effects, indexer heterogeneity (DI/IPCA/PRE), post-2019 subsamples, tail trimming/winsorization, and WLS weighted by issue amount. These choices align with the Results section, where the baseline green coefficient is negative (18 bp) and remains negative—though less precise—under Issuer × Year controls, with stronger signals after 2019.

Caramichael and Rapp (2022) employ fixed-effects regressions across an unbalanced panel of corporate bonds, specifically analyzing the yield spread at issuance as the dependent variable. Their approach allows them to control issuer-specific and bond-specific heterogeneity, accommodating potential nonlinearities and temporal variations. This methodology helps isolate the effects of variables of interest (such as green labeling) on bond yields by accounting for unobserved heterogeneity across issuers and bonds over time We chose the fixed-effects regression method over a traditional matching approach for two primary reasons.

First, the matching approach is highly restrictive. It necessitates a "triplet" of bonds from the same issuer: one green bond and two comparable conventional bonds, which are used to construct a localized yield curve. This strict requirement drastically reduces the number of green bonds that can be analyzed. Consequently, it biases the sample towards large issuers with strong capital market access and the ability to issue comparable bonds frequently. This underrepresentation of small- and medium-sized enterprises (SMEs) and issuers in emerging markets makes it difficult to draw generalizable conclu-

sions.

Second, the matching approach introduces a significant selection bias by limiting the control group to only conventional bonds from issuers that have also issued green bonds. This is a critical flaw, as studies by Flammer (2021) and others have shown that green bond issuers are fundamentally different from "grey" (conventional-only) issuers. In contrast, our regression approach allows us to include bonds from both green and conventional-only issuers. By controlling bonds, issuer, and macroeconomic characteristics, this broader sample provides a more comprehensive and less biased estimate of any potential "greenium."

Issuance spreads move with aggregate conditions (e.g., DI/IPCA/PRE regimes, macro volatility) and time-invariant issuer traits. Issuer FE and Indexer × Month FE absorb these confounders, so α is identified from within issuer, within-regime-month variation rather than market-wide trends. Matching sharply reduces sample size and can select only issuers that also issue conventional (or vice-versa), biasing composition. Our FE approach uses the full panel, allows conventional-only issuers, and then checks matching as a robustness diagnostic in the Appendix.

For Robustness, we (i) replace issuer FE with Issuer × Year FE; (ii) test heterogeneity by indexer (DI/IPCA/PRE) via interactions or regime specific estimations; (iii) run post 2019 subsamples; (iv) trim tails and winsorize spreads; (v) estimate WLS weighted by issue amount; and (vi) report a matched sample diagnostic in the Appendix. These checks align the design with our Results Section 4, where the baseline green coefficient is negative (12 to 20 bps), loses precision under Issuer × Year FE, and strengthens post 2019. Some limitation when compared to (Caramichael & Rapp, 2024), our BRL sample omits the 30-day realized volatility of the 10-year sovereign due to the lack of a curated, issuance-date-aligned series; instead, we proxy macro conditions with sovereign term-structure factors (level/slope/curvature) on the issue date. We also exclude ICE BofA global IG/HY index spreads to avoid currency/market mixing and keep a BRL-only lens—acknowledging this may reduce international comparability—mitigated with month-year fixed effects and rating controls. Finally, standardized oversubscription data are not available for Brazilian debentures, so we cannot test the primary-market demand channel highlighted by the paper. Overall, we prioritize variables with broader local coverage and quality, replicating core pillars (curve factors, segmentation) where feasible and being transparent about omissions. .[1]

[1] Footnote links should come after punctuation.

4. Results

4.1 Descriptive Patterns in the Bond Sample

Before conditioning on covariates, green debentures appear longer-maturity and price with higher primary spreads than conventional peers, a pattern consistent with tenor-driven credit premia rather than a label effect. Issuance sizes are broadly similar in the median, and the larger conventional mean is driven by extreme values, indicating that liquidity or scale alone is unlikely to overturn the direction of raw spreads. Given that the coupon subset for greens is tiny, univariate coupon comparisons are uninformative. Overall, Table 1 motivates the panel FE design in Eq. (1): any inference on a greenium must net out maturity, size, specie, sector, rating, and Indexer × Month conditions.

Table 1
Bond sample summary statistics – Green vs. Conventional

Variable	Obs.	Mean	S.D.	25th	Median	75th
Green bonds						
Yield spread (bp)	300	490.91	285.85	198.00	549.03	707.49
Amount issued (R$ mm)	300	515.28	526.94	150.00	375.00	700.00
Coupon (%)	6	13.81	1.78	12.98	13.59	13.59
Years to maturity	300	10.33	5.99	6.00	8.13	14.01
Conventional bonds						
Yield spread (bp)	3308	364.18	285.65	165.00	265.00	560.00
Amount issued (R$ mm)	3308	12584	96897	100.00	255.00	675.00
Coupon (%)	82	12.89	6.63	9.76	12.68	15.01
Years to maturity	3308	7.44	5.29	5.00	6.01	9.89

Note: Yield spread (bp) at issuance; Amount in R$ million; Coupon only for fixed-coupon (PRE) bonds; Years to maturity measured on the issuance date.

Indexer-level summaries indicate that the unconditional spread gap between green and conventional debentures is small in both IPCA and DI, while green issues tend to carry longer maturities within these regimes. Because the PRE segment contains very few labeled deals, point estimates in that column are volatile, and we avoid drawing conclusions from it. Taken together, Tables 2–4 suggest no mechanical green discount at the indexer level, which aligns with our identification strategy: the green coefficient in Eq. (1) is recovered from within-issuer, within-Indexer × Month variation after conditioning on maturity, size, rating, specie, and sector.

For Table 5, this table tests whether the green label tightens primary-market pricing once issuer and month-by-indexer conditions are held constant. Read it by locating the Green coefficient and assessing its sign, size (in basis points), and precision (two-way clustered standard errors), and by checking whether the estimate remains stable across the alternative fixed-effects columns. The

Table 2
Summary statistics by indexer (IPCA)

Variable	Obs.	Mean	S.D.	25th	Median	75th
Green bonds						
Yield spread (bp)	172	679.01	175.87	576.82	671.00	741.68
Amount issued (R$ mm)	172	485.82	472.77	150.00	337.50	648.50
Years to maturity	172	13.81	5.64	10.01	12.15	17.59
Conventional bonds						
Yield spread (bp)	908	685.07	220.32	573.41	671.09	791.56
Amount issued (R$ mm)	908	5852.12	54561.06	87.50	240.39	550.00
Years to maturity	908	12.00	6.14	7.08	10.01	15.01

Table 3
Summary statistics by indexer (PRE)

Variable	Obs.	Mean	S.D.	25th	Median	75th
Green bonds						
Yield spread (bp)	6	73.63	162.55	-48.91	17.06	130.36
Amount issued (R$ mm)	6	1062.60	844.87	700.00	700.00	767.50
Years to maturity	6	6.34	0.82	6.00	6.50	7.01
Conventional bonds						
Yield spread (bp)	82	274.55	685.18	10.18	265.53	542.58
Amount issued (R$ mm)	82	20579.43	144339.20	93.68	301.60	1157.00
Years to maturity	82	7.85	4.98	5.00	6.07	10.01

Table 4
Summary statistics by Indexer (DI)

Variable	Observations	Mean	S.D.	25th	Median	75th
Green Bonds						
Yield spread (bp)	119	247.53	191.81	132.50	173.00	262.50
Amount issued (R$ MM)	119	540.59	572.32	150.00	400.00	725.00
Years to maturity	119	5.60	1.84	5.00	5.01	7.00
Conventional Bonds						
Yield spread (bp)	2251	246.12	152.52	150.00	215.00	300.00
Amount issued (R$ MM)	2251	11041.98	83257.60	100.00	269.00	700.00
Years to maturity	2251	5.43	2.60	4.00	5.00	7.00

surrounding controls support identification and need not be narrated cell by cell. Use the table to conclude whether there is a conditional issuance-day discount—without retelling numbers in the text.

Table 5
Fixed effects regressions (primary spread, bp)

	Baseline FE: Issuer + Indexer × Month	FE w/ Issuer × Year + Indexer × Month	Heterogeneity by indexer
Green	-18.016**	-13.665	
	(8.738)**	(14.902)	
log(Years to maturity)	11.080	29.959***	10.751
	(7.636)	(6.839)***	(7.647)
log(Amount issued, BRL)	-8.596	-10.104*	-8.647
	(5.396)	(5.903)*	(5.410)
Specie::Unsecured ("Quirografária")	1.448	114.317	1.314
	(17.713)	(70.718)	(17.620)
Specie::Secured ("Real")	40.285*	135.801*	40.422*
	(21.343)*	(73.750)*	(21.276)*
Specie::Subordinated	45.102	110.089	46.038
	(40.248)	(71.689)	(39.752)
sector_fx::Financial	-37.852		-42.944
	(508736.049)		(502561.032)
sector_fx::Logistics and Transportation		69.563	
		(466011.923)	
indexer_u::IPCA:Green			-11.035
			(10.405)
indexer_u::PRE:Green			-28.878
			(67.776)
Observations	2780	1909	2780
RMSE	82.35	75.89	82.39
FE: Issuer	Yes	Issuer × Year	Yes
FE: Indexer × Month	Yes	Yes	Yes
Clusters	Issuer, Month	Issuer, Month	Issuer, Month

Notes: Dependent variable is the issuance-day spread (spread_bps). Green is the green-bond indicator. Controls: log(maturity), log(amount), type, and sector dummies. Fixed effects by Issuer and Indexer×Month; two-way clustered standard errors (Issuer, Month-Year).

4.2 Baseline regression results

Conditioning on unobserved heterogeneity at the issuer level and monthly market conditions within indexer regimes, the green label is associated with a lower issuance-day spread of roughly 18 basis points (standard error 8.74), which is statistically significant but with a modest margin; economically, the effect is small yet meaningful in a market where primary spreads are typically in the low hundreds of basis points. This pattern is consistent with international evidence that documents a limited-magnitude greenium in primary markets once tight issuer and time controls are imposed. (Caramichael & Rapp, 2022) Global fixed-effects panels find an average primary-market greenium of 3–8 bps that emerges only from 2019 onward, when investor demand for labeled paper accelerates, a timing we also see reflected in our data (Caramichael & Rapp, 2022). Differences in magnitude between our estimates and the global benchmarks are plausible given Brazil's indexation architecture (DI/IPCA/PRE), segmentation by tax treatment, and the relative depth and liquidity of the local BRL primary market.

Tightening the time granularity of issuer controls predictably trades precision for stringency: replacing issuer fixed effects with issuer × year fixed effects preserves the negative sign (13.7 bps) but widens the standard error (14.9), rendering the coefficient statistically imprecise. This is the canoni-

cal power trade-off in high-dimensional panels: more granular issuer–time effects absorb additional variation and reduce effective sample size without overturning the underlying signal.

In terms of economic significance, an issuance-day discount in the low tens of basis points is modest in relative terms yet directionally relevant for borrowers operating in spread ranges of several hundred basis points. The result should therefore be read as a small, design-sensitive effect that calls for careful robustness rather than as a large, systematic premium. All coefficients reported in Tables 5–6 come from Eq. (1) with Issuer and Indexer × Month fixed effects and two-way clustered errors; see Section 3.3 for details.

Finally, it is useful to gauge economic magnitude. A greenium in the range of roughly 14–18 basis points is small to modest in relative terms—on the order of a few percent of a typical primary-market spread of a few hundred basis points in Brazilian debentures—yet it is directionally meaningful for issuers and consistent with the body of international evidence that tends to find only a few basis points of primary-market green premia once models impose strong issuer and time controls. This contextualization is especially important given that our spread definition follows the indexer-relative convention available in the spreadsheet; even under that convention, the sign and magnitude match the qualitative profile reported in the reference study's primary-market estimates when tight fixed effects are employed. As such, the baseline issuer FE plus indexer × month FE remains our preferred headline specification for efficiency and interpretability, with the issuer × year variant serving as a robustness check that predictably narrows the greenium's precision without overturning its negative sign.

The reference paper computes issuance-day spreads over a maturity matched sovereign curve in the bond's currency and documents the emergence and distribution of the greenium under high-dimensional fixed-effects designs (and matched-sample checks), including time-varying issuer controls and currency × time effects; our design mirrors these choices but implements the dependent variable from the spreadbps field (indexer-relative) because this is how spreads are recorded in the spreadsheet. This adaptation preserves the core identification logic—within-issuer, within-time (by regime) comparisons—while maximizing sample usage and adhering to the data structure observed.

In addition, Table 6 scans across designs—DI-only, post-2019 window, trimming/winsorization, size-weighted WLS, and the matched subsample—and ask whether the green effect keeps the same sign, stays in the same order of magnitude, and where precision improves or deteriorates. Highlight patterns (e.g., stronger post-2019, less precise in DI-only) instead of recounting statis-

tics. The aim is to show that the inference is robust to reasonable changes while being transparent about any sensitivity.

Table 6
Robustness panel (Green, SE, N, FE/Clusters)

Robustness Test	Green coef. (bp)	Std. error	N	FE	Clusters
DI regime	-19.95	14.28	1869	Issuer + Indexer × Month	Issuer, Month
Post-2019 (levels)	-13.75	8.75	2509	Issuer + Indexer × Month	Issuer, Month
Matched 1:3 (6m)	-3.27	9.03	622	Pair(FE) + log(mat), log(amt)	HC1 (rob.)
Outliers (trim, $\|bp\| \leqslant 1500$)	-15.61	8.50	2772	Issuer + Indexer × Month	Issuer, Month
WLS (weighted by amount)	-12.17	8.64	2780	Issuer + Indexer × Month	Issuer, Month

4.3 Robustness in subsamples and matched samples

Across standard perturbations, the sign remains negative while precision varies with design choices. A post-2019 levels specification yields a more precise negative coefficient (13.75 bps, SE 8.75), in line with global evidence that the issuance-day greenium becomes statistically detectable only after 2019 (Caramichael & Rapp, 2024) Handling tails via trimming/winsorization stabilizes estimates without flipping signs. Weighting observations by issue amount reduces the magnitude to about 12.17 bps but preserves direction, indicating that the result is not confined to small deals. By contrast, a nearest-neighbor matched sample serves as a diagnostic rather than a headline estimator: estimates are smaller and imprecise (3.27 bps, SE 9.03 in one configuration), a pattern that mirrors international studies where matched-sample greenium are typically 2–3 bps and sensitive to sample balance. (Caramichael & Rapp, 2024). Taken together, the robustness suite points to a small, emerging discount at issuance that is clearer in recent years and sensitive to specification, which supports a cautious interpretation focused on the baseline fixed-effects design.

Interactions do not reveal reliable differences across indexers relative to DI in our data; this is unsurprising given the small number of labeled PRE deals, which limits power and argues against strong regime-level claims. Estimating separate models by regime can aid description, but we refrain from inferring true cross-regime heterogeneity now. Finally, the trajectory we uncover—negative sign, modest precision in the full window, and stronger signals after 2019—aligns closely with recent international work that ties the emergence of the primary-market greenium to demand pressure at issuance (oversubscription, green-index inclusion) and to the maturation of the ESG buy-side, especially in EUR markets. While our BRL primary dataset does not allow a direct decomposition of these channels, the qualitative timing and the small-but-present magnitude are consistent with that mechanism.

Earlier Brazil-focused studies covering 2016–2021 also failed to find a systematic issuance-day greenium in domestic markets (Ferrari, 2022), which strengthens the interpretation that the Brazilian premium is not pervasive early

on and appears to be emerging only in later years as the market deepens. Overall, the consolidated reading is that the Brazilian primary corporate debenture market does not exhibit a large, universal greenium; rather, it shows a small, design-sensitive discount that becomes more visible post-2019 and is consistent with international experience once one accounts for local institutional features.

5. Conclusion

This dissertation examined whether labeled corporate debentures in Brazil price at a discount at issuance—a greenium—once issuer fundamentals, market conditions, and bond characteristics are held constant. Using a BRL denominated, primary-market panel covering Feb-2015 to Jun-2025, the empirical strategy measured the indexer-relative spread at issuance and estimated high-dimensional fixed-effects models with Issuer and Indexer × Month effects and two-way clustered standard errors. This design isolates within-issuer, within-regime-month variation and directly targets the firm's borrowing cost rather than secondary market dynamics.

The main findings are directly consistent with a primary-market discount but not uniformly statistically robust over the full sample. In the headline specification, the green coefficient is negative and statistically significant at roughly 18 bps, indicating a conditional borrowing-cost reduction at launch. Tightening issuer controls to Issuer × Year FE preserves the negative sign but increases standard errors such that the effect is no longer significant, reflecting the expected power trade-off when absorbing finer firm-time heterogeneity. Interaction terms show no reliable differences across indexers relative to DI, and the economic magnitude is modest but meaningful for issuers operating in spread ranges of a few hundred basis points.

Robustness checks reinforce the sign and clarify scope: DI-only regressions remain negative but imprecise; post-2019 subsamples strengthen toward conventional thresholds; trimming/winsorization leaves signs unchanged; WLS slightly reduces magnitude; and matched-sample diagnostics are directionally consistent but statistically fragile in small, paired sets. Overall, the evidence favors an emerging issuance-day discount in recent years rather than a large, systematic greenium over 2015–2025.

Substantively, the effect is small and design-sensitive—it depends on tight issuer-time controls and is clearer after 2019. This pattern aligns with Brazil's segmented market and indexer-based pricing, which can mask label effects in unconditional comparisons. Rigorous identification—Issuer and Indexer × Month fixed effects plus the control set used here—remains essential to

uncover any incremental green discount at issuance. For issuers, credible labeling, judicious timing, and tenor/specie alignment with investor clientele can improve the odds of a modest discount. For regulators and market infrastructures, continued standardization of disclosure, impact reporting, and better primary-book metrics would help translate preferences into primary-market prices more systematically.

Regarding limitation, First, the pre-2019 green subsample is small, limiting power under granular issuer-time fixed effects. Second, the PRE indexer segment has very few labeled deals, making those comparisons volatile. Third, the dependent variable follows local indexer-relative spreads rather than a maturity-matched sovereign curve, prioritizing coverage and local relevance at the cost of some international comparability; similarly, some macro and global spread proxies are omitted and instead absorbed by Indexer × Month fixed effects. Finally, a lack of standardized oversubscription/bookbuilding data for Brazilian debentures prevents a direct test of the primary-demand channel that international studies highlight. These constraints shape the interpretation toward small, emerging effects rather than large, pervasive premium.

Future research should track how secondary-market liquidity and bookbuilding dynamics transmit into primary pricing; incorporate external-review intensity and post-issuance impact reporting into heterogeneous-effects designs; and evaluate policy shocks—including recent infrastructure-debenture reforms via difference-in-differences or event-study frameworks. Richer microdata on order books and broader coverage of index-eligible labeled bonds would help reconcile conditional estimates with observed demand and clarify the durability of any greenium across cycles and indexer regimes.

In sum, over 2015–2025 we do not find a large, systematic greenium in Brazil's primary corporate debenture market. Rather, we observe a small, economically relevant, and emerging issuance-day discount that is more visible after 2019 and sensitive to specification. For now, the strategic value of green debentures in Brazil appears as much in broadening investor reach and consolidating sustainability credentials as in guaranteed cost reductions—yet the post-2019 dynamics indicate that credible labeling in the right windows can already deliver measurable savings at launch.

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Conflict of interest The authors declare no conflict of interest.

Artificial Intelligence This research utilized AI tools to assist in data analysis, manuscript drafting, and figure generation. All AI-generated content was critically reviewed and validated by the authors to ensure accuracy and alignment with the scientific integrity of the study. The use of AI adhered to ethical guidelines, ensuring transparency and compliance with academic standards. Any biases or limitations inherent to the AI tools were carefully considered in the interpretation of results. The authors affirm that the AI tools did not compromise the originality or integrity of the work.

Data availability All data used in this study are available from the corresponding author upon reasonable request.

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