The Pricing of Green and Sustainability-Linked Corporate Bonds

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Goals and Definitions

- The goal of this project is to estimate the market pricing for Green and Sustainability-linked corporate bonds

- Green bonds are typically defined as those whose proceeds are designed to go towards pre-determined environmentally related projects

- Sustainability-linked bonds (SLBs) include covenants which make the cost of debt contingent on the achievement of sustainability performance targets at predetermined dates

Prior Literature

- Larcker and Watts (2020) find no significant difference between the pricing of Green and regular bonds for US municipal government bond issues.
  - Flammer (2021) finds that green and non-green corporate bonds had similar spreads using a matching technique and data up to 2018.
- Cheong and Choi (2020) provide an early survey on the literature, much of which uses propensity score matching to compare Green and regular bonds.
  - A number of studies document additional value from Green bonds, often of relatively small (2-17 bp) magnitude.
  - Some studies document that Green bonds trade at higher values (e.g., Karpf and Mandel, 2017).
  - Deng, Tang, and Zhang (2020) show that Chinese green corporate bonds trade at 79 basis point tighter spreads for all-green issuances, and that bonds with international third-party certification have tighter spreads.
- Pastor, Stambaugh, and Taylor (2022) document that the premium paid for German sovereign Green bonds has increased over the past two years.

Estimation Methods

- A firm's decision to issue Green Bonds or SLBs is potentially endogenous with the bond's pricing.

- When facing higher issuance costs, companies may be more likely to issue green or SLB so as to reduce those costs. This would cause observable spreads between green and regular bonds to appear smaller – even for the same issuer.
  - Instead of "Reaching for Yield" maybe issuers "Reach for Features" to keep costs down

- We therefore consider estimation methods to address this endogeneity.

First Stage Estimation

- The first stage process considers a trivariate choice model, where the issuer chooses between regular, green, or sustainability-linked debt.

- The primary method is a Multinomial Probit (although a nested multinomial logit would be a possible alternative)

  - A simpler multinomial logit estimation would be easier to estimate, but would suffer from the Independence of Irrelevant Alternatives (IIA) problem (see, e.g., the red bus/blue bus example described by McFadden, 1974).

  - Multinomial Probit allows for more general correlation structures and therefore is not subject to the IIA problem; although, multinomial probit – even with only 3 alternatives – can take a long time and have convergence issues.

Second Stage Estimation – Method I

- The results of the trivariate choice model are interesting, and we use them to correct for the second stage estimation

- One procedure is to use an instrumental variables (IV) regression, where the instruments are the fitted values from the first-stage regression (see, Woolridge, 2002, p. 621-625). Thus, the second stage pricing equation would be:

- $spread_i = XB + \theta_1 Green_i + \theta_2 SLB_i + \epsilon_i$

- We instrument for Green and SLB using the fitted values from the trivariate choice model.

Second Stage Estimation – Method II

- An alternative to the IV estimation would be to use a regime-switching model (see, e.g., Maddala, 1983, p. 223-228)

  - The regime-switching model allows for different specifications in the second stage. However, as the sample size for the Green and SLB bonds is more limited, the parameters for the different types of bonds are estimated imprecisely.

  - This suggests, for the moment, the restricted IV procedure should be used.

Data

- We gather data from Bloomberg and SDC
- Data on 8,812 issues from 36 countries.
- 8,002 regular bonds
- 438 green bonds
- 372 SLBs

More Empirical Specification

- Typically, the first-stage specification requires additional variables that do not appear in the second-stage specification
  - See the discussion in Reisel (2013), Bradley and Roberts (2015)
  - Barbalau and Zeni (2021) suggest several additional variables for these choices including:
    - Pollution emission prior to issue
    - ESG score prior to issue
  - Changes in disclosure laws as documented by Kreuger, Sautner, Tang, and Zhong (2021) also help explain the first-stage choice.

Summary Statistics

Variable	Full Sample	Traditional	Green	SLBs	Emerging Economies	Developed Economies
Observations	8,812	8,002	438	372	1,162	7,650
Spread to Benchmark						
Mean	1.86	1.90	1.39	1.32	2.91	1.85
Std. deviation	1.25	1.26	.94	1.22	1.69	1.23
CO2 Emissions/Sales (Company)						
Mean	196.28	158.17	272.89	926.08	471.05	190.69
Std. deviation	439.94	246.61	684.31	1,470.15	956.83	421.16
ESG Environmental (Company)						
Mean	52.77	52.32	55.92	58.80	54.28	52.74
Std. deviation	13.85	14.12	9.90	9.80	2.96	13.99

First Stage Results - CMMProbit

VARIABLES	Industry-Level		Company-Level	
	Green	SLB	Green	SLB
ESG Score (Industry)	.0275***	.0237***		
	(.0027)	(.0029)		
	[.0329]	[.0011]		
CO2 Emissions (Industry)/100	.0975*	.8611***		
	(.0740)	(.0548)		
	[.0052]	[.0003]		
ESG Score (Company)			.0130**	.0118***
			(.0058)	(.0037)
			[.0067]	[.0001]
CO2 Emissions (Company)/100			.1643***	1.071***
			(.0068)	(.0523)
			[.0193]	[.0099]
Mandatory ESG Disclosure	1.6311***	2.5085***	1.7398***	2.1138***
	(.1544)	(.1439)	(.1946)	(.1740)
	[.0655]	[.0231]	[.0322]	[.0095]
Comply-or-Explain	.0377	.6845***	-.3572*	-1.0808***
	(.1711)	(.1674)	(.2121)	(.1945)
	[.0483]	[.0168]	[-.1462]	[-.0017]
Quality Spread	.0034***	.0045***	.0026***	.0033***
	(.0004)	(.0004)	(.0004)	(.00041)
	[.0041]	[.0002]	[.0013]	[.0001]
Treasury Yield	.0271***	.1304***	-.0036	-.2445***
	(.0527)	(.0482)	(.0806)	(.0679)
	[.0331]	[.0065]	[-.0018]	[-.0001]
Industry Fixed Effects	Yes	Yes	Yes	Yes
Country Fixed Effects	No	No	No	No
Year Fixed Effects	Yes	Yes	No	No

Choice Model Implications

- Companies with higher ESG scores are more likely to issue green bonds
  - A one standard deviation increase in company ESG implies a 9.3% increase in probability of green issuance
  - A one standard deviation increase in industry ESG implies an 8.3% increase in probability of green issuance

- Companies which issue more CO_2 are more likely to issue green and SLB bonds
  - A one standard deviation increase in company emissions implies an 8.5% increase in probability of green/ a 4.4% increase in SLB

- Countries switching to mandatory ESG reporting imply a 6.6% increase in probability of green/2.3% increase in probability of SLB (depending on specification)

- A one standard deviation increase in quality spreads implies a 7% or 21% increase in the probability of green bond issuance (depending on specification)
  - Companies reach for features when spreads are high!

Second Stage Results

VARIABLES	OLS	Fitted IV
SLB	-.6300***	-.8278***
	(.1216)	(.1306)
Green	-.4711**	-.6879
	(.1854)	(.4842)
SLB x TPO	.0705	-.5617***
	(.2742)	(.1566)
Green x TPO	.1333	-.8065*
	(.2844)	(.4319)
Quality Spread	.0039***	.0038***
	(.0004)	(.0004)
Treasury Yield	.7673***	.2462***
	(.0889)	(.0354)
Rating	-.2473***	-.2884***
	(.0153)	(.0029)
Maturity	.0118***	.0029*
	(.0026)	(.0015)
Callable	.0485**	.1407***
	(.0178)	(.0297)
Industry Fixed Effects	Yes	Yes
Country Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Observations	8,812	8,812
Adjusted R-squared	.6275	.6089

Spread Model Implications

- Spreads for SLB and green bonds are 63 bp and 47 bp lower using OLS
  - Consistent with the results from China in Deng et al. (2020)

- Correcting for self-selection increases the estimated spreads to 83 bp and 69 bp.
  - However, the estimate on green is not significant

- Third party opinions further reduce spreads in the Fitted IV specification (and these are significant).

Key Takeaways

- Companies are more likely to issue green and SLB securities when spreads are high.

- This causes methods which do not account for self-selection to understate the difference in spreads associated with green and SLB securities.

- Mandatory disclosure also significantly increases the issuance of green and SLB securities.

- Correcting for self-selection, green issues are priced an average of 69 bp lower than regular issues, and SLBs are priced 83 bp lower.

- Using a third-party opinion is associated with an additional discount in spreads.