

Cui prodest? The heterogeneous impact of green bonds on companies' environmental performance

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¹The opinions expressed are those of the authors and do not necessarily reflect the views of the Banca d'Italia.

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- When the yield spread is negative (greenium), there is a clear advantage in issuing green bonds when funding climate-friendly projects.
- The literature about the greenium and the pricing mechanism is abundant. Instead, the research concerning the effectiveness of green bonds in improving companies' environmental performance is scant... mainly focused on Chinese companies or small global samples.

Research questions

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- 1 Are green bond projects able to improve the environmental performance of the issuer via an increase in the ESG (and E) score?
- 2 Do results change depending on companies' past environmental attitude and bond use of proceeds?
- 3 What is the link between the existence of the greenium and the effectiveness of green bonds?

Related literature

- Greenium: Gianfrate and Peri (2019), Zerbib (2019), Tang and Zhang (2020), Flammer (2021), Fatica et al. (2021), Baker et al. (2022), Bolton et al. (2022), Pástor et al. (2022), Caramichael and Rapp (2024), Zaghini (2024), Moro and Zaghini (2025).

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- Effect of green bond issuance on Chinese companies' environmental performance: Wang and Wang (2022), Chen et al. (2023), Zheng et al. (2023).
- Effect of green bond issuance on companies' ESG score using small global samples: Fatica and Panzica (2021), Flammer (2021), Yeow and Ng (2021), Battaglia et al. (2024), ElBannan and Löffler (2024), Guesmi et al. (2025).

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- ① heterogeneous companies (different environmental attitudes: green reputation);
- ② technologies (green and brown);
- ③ investors endowed with non-pecuniary environmental preferences.

We solve the model and compare two equilibria: one with green bonds and the other without green bonds.

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Note that results 2 to 4 are amplified by a larger greenium.

Two data sets

We test the model implications, estimating the impact of green bond issuance on companies' ESG (and E) scores.

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We merge two data sets:

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 - From LSEG Data Analytics, we take ESG scores and sub components: Asset-4 data by Thomson Reuters.
 - From Standard&Poors Capital IQ, we take companies' balance sheet data: total assets, current liabilities, total debt, market capitalization, return on assets (RoA), return on equity (RoE).

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- Dealogic DCM Analytics: green label; maturity; amount issued; currency; use of proceeds, nationality and sector of the issuer, rating of the bond and that of the issuer, other bond characteristics.

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 - LSEG Data Analytics and Bloomberg: annualized yield to maturity at issuance.

Stylized facts

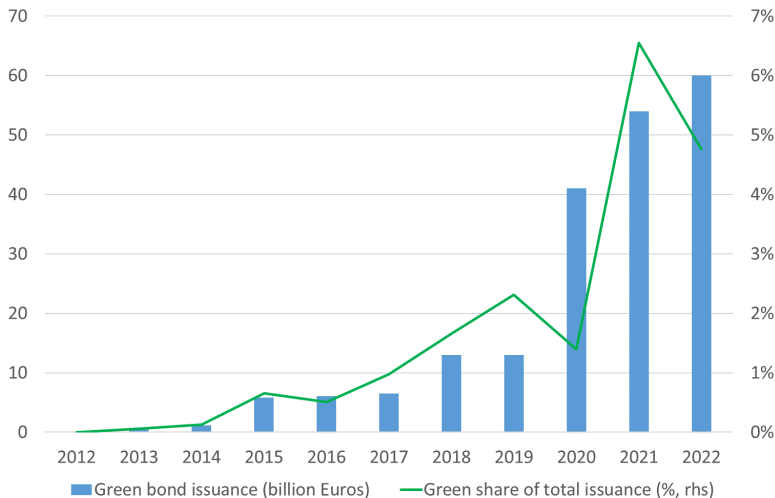


Figure 1: Green bond issuance and share of green bond issuance over time.

Stylized facts

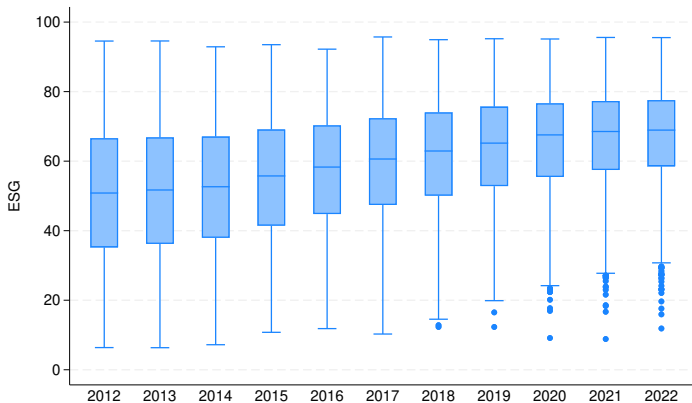


Figure 2: ESG distribution over time.

Identification strategy

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The identification strategy based on a staggered DID (difference-in-differences) scheme:

- 1 treatment group: companies that issued at least one green bond;
- 2 control group: companies that never issued green bonds;
- 3 pre- and post-treatment periods: years before and after the issuance of a green bond.

DID on ESG scores

Analytically:

$$ESG_{i,t} = \mu_i + \lambda_t + \gamma GB_i \times Post_{i,t} + \phi X_{i,t-1} + \varepsilon_{i,t}, \quad (1)$$

where:

- $ESG_{i,t}$ is the ESG score of company i in year t ;
- GB_i takes value one if company i issues at least one green bond, and zero, otherwise;
- $Post_{i,t}$ identifies, for each company, the year of a green bond issuance and the subsequent two years;
- μ_i are company fixed effects;
- λ_t are time fixed effect;
- $X_{i,t}$ includes: size, RoA, RoE, leverage ratio, current asset-liability ratio, liquidity ratio, Tobin's Q.

Heterogeneous impact of GB issuance on ESG

Table 1: Effects of green bond issuance on the ESG score. Brown (green) companies are those with an E score below (above) the median in 2012.

	(1) All ESG	(2) Brown companies ESG	(3) Green companies ESG	(4) Green - top 10% ESG
GB * Post	-0.732 (0.558)	2.542** (1.050)	0.320 (0.528)	1.547** (0.644)
Observations	20,240	10,120	10,120	8,096
Adjusted R-squared	0.834	0.788	0.775	0.746
Company Controls	YES	YES	YES	YES
Company FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES

Notes: Cluster-robust standard errors at issuer level in parentheses. Significance levels:

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Effects channeled through the E score

Table 2: Effects of green bond issuance on the ESG sub-components. Only brown companies.

	(1) E score	(2) S score	(3) G score
GB * Post	4.545** (1.791)	1.702 (1.211)	1.054 (1.424)
Observations	10,120	10,120	10,120
Adjusted R-squared	0.704	0.774	0.642
Company Controls	YES	YES	YES
Company FE	YES	YES	YES
Year FE	YES	YES	YES

Notes: Cluster-robust standard errors at issuer level in parentheses. Significance levels:

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The role of the use of proceeds

Table 3: Effects of green bond issuance by use of proceeds. Only brown companies.

	(1) ESG	(2) ESG	(3) E score	(4) E score
Adaptation * Post	0.507 (2.521)	0.569 (2.099)	1.884 (5.715)	2.447 (5.818)
Mitigation * Post	2.354** (1.160)		4.602** (2.015)	
(Energy + Pollution Control) * Post		1.267 (1.472)		1.717 (2.504)
(Transport + Construction) * Post		2.409* (1.450)		8.364*** (2.897)
General Purpose * Post	2.577* (1.556)	1.613 (1.338)	4.772* (2.579)	4.471* (2.440)
Observations	10,120	10,120	10,120	10,120
Adjusted R-squared	0.788	0.786	0.704	0.704
Company Controls	YES	YES	YES	YES
Company FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES

Notes: Cluster-robust standard errors at issuer level in parentheses. Significance levels:

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Green premia

Restricting our bond sample to corporate bonds only, we estimate:

$$Yield_{b,c,n,t} = \alpha - \delta Green_b + \sigma Z_b + \xi_n + \psi_{c,t} + \nu_{b,c,n,t}, \quad (2)$$

where:

- $Yield_{b,c,n,t}$ is the annualized yield to maturity at issuance on bond b , denominated in currency c , issued by an issuer resident in country n in month t ;
- $Green_b$ takes value one for green bonds, and zero otherwise;
- Z_b contains bond and issuer characteristics;
- ξ_n are nationality fixed effects;
- $\psi_{c,t}$ are time varying fixed effects taking into account the currency of denomination.

Estimates of green premia

Table 4: Estimates of green premia. All corporate bonds and only matched bonds.

	(1)	(2)	(3)	(4)	(5)	(6)
	Yield	All bonds Yield	Yield	Yield	Only matched bonds Yield	Yield
Green	-0.107** (0.042)			-0.0712* (0.043)		
Green * Adaptation		-0.105 (0.085)	-0.105 (0.085)		-0.0834 (0.086)	-0.0841 (0.086)
Green * Mitigation		-0.159*** (0.048)			-0.110** (0.049)	
Green * (Ener. + Poll. Contr.)			-0.0839 (0.073)			-0.0302 (0.073)
Green * (Tran. + Constr.)			-0.225*** (0.055)			-0.180*** (0.059)
Green * General Purpose		-0.00687 (0.084)	-0.00622 (0.084)		0.00467 (0.082)	0.00540 (0.082)
Observations	325,000	325,000	325,000	54,341	54,341	54,341
Adjusted R-squared	0.507	0.507	0.507	0.490	0.490	0.490
Bond controls	YES	YES	YES	YES	YES	YES
Nationality FE	YES	YES	YES	YES	YES	YES
Currency x Month FE	YES	YES	YES	YES	YES	YES

Notes: Cluster-robust standard errors at issuer level in parentheses. Significance levels:

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Conclusions

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Conclusions

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- The improvement in the overall ESG score is entirely due to an increase in the E score.
- Green bonds issued to finance clean transportation and construction have the largest impact on companies' ESG score.
- In line with the predictions of the model, these bonds are the ones with the largest greenium.

Policy implications

- ① Shifting the portfolio composition away from high emitters and towards low emitters may not lead to a fully-fledged decarbonization (Hartzmark and Shue, 2023; Angelini, 2024; Bartocci et al., 2024).

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- ② In their portfolio management strategies, central banks should primarily target green bonds issued by polluting companies.

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- ➋ In their portfolio management strategies, central banks should primarily target green bonds issued by polluting companies.
- ➌ Widening investors' attention to other scopes, beyond the clean transportation and construction, could increase the effectiveness of other types of green bonds.

THANK YOU

Parallel trend hypothesis

- We test for a parallel trend in ESG before the issuance of green bonds:

$$ESG_{i,t} = \mu_i + \lambda_t + \sum_{s=-6}^5 \gamma_s GB_i \times D_{i,t,t_0+s} + \phi X_{i,t-1} + \varepsilon_{i,t},$$

where D_{i,t,t_0+s} is a dummy equal to one if t is the s -th year after the issuance of the first green bond in year t_0 .

- We choose a window of 6 years before the issuance of the first green bond and 5 years after that period.
- The year before the issuance of the first green bond is considered the reference period ($\gamma_{-1} = 0$).
- The parallel trend hypothesis is confirmed if $\gamma_s = 0$ for $s < 0$.

Parallel trend test

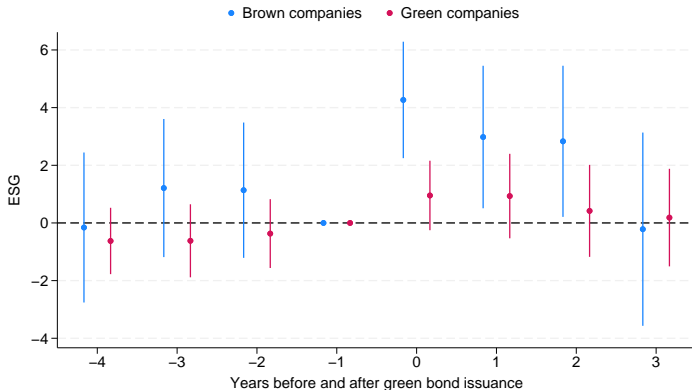


Figure 3: Estimates of the impact of the first green bond placement on the ESG score before and after the issuance and 90 per cent confidence interval.

Robustness: definition of green/brown companies (1)

Table 5: Effects of green bond issuance on the ESG by tertile of E score in 2012.

	(1) 1st tertile ESG	(2) 2nd tertile ESG	(3) 3rd tertile ESG
GB * Post	4.457*** (1.519)	1.818** (0.806)	0.252 (0.557)
Observations	6,754	6,743	6,743
Adjusted R-squared	0.777	0.765	0.756
Company Controls	YES	YES	YES
Company FE	YES	YES	YES
Year FE	YES	YES	YES

Notes: Cluster-robust standard errors at issuer level in parentheses. Significance levels:

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Robustness: definition of green/brown companies (2)

Table 6: Effects of green bond issuance on the ESG. Brown (green) companies are those with an E score below (above) the sector-specific median in 2012.

	(1) Brown companies ESG	(2) Green companies ESG
GB * Post	2.818** (1.096)	0.150 (0.520)
Observations	10,142	10,098
Adjusted R-squared	0.799	0.779
Firm Controls	YES	YES
Firm FE	YES	YES
Year FE	YES	YES

Notes: Cluster-robust standard errors at issuer level in parentheses. Significance levels:

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Robustness: impact of first GB issuance on ESG

Table 7: Effects of the first green bond issuance on the ESG.

	(1) All ESG	(2) Brown companies ESG	(3) Green companies ESG
GB * Post	-0.0675 (0.516)	2.848*** (0.994)	0.437 (0.480)
Observations	20,240	10,120	10,120
Adjusted R-squared	0.834	0.788	0.775
Company Controls	YES	YES	YES
Company FE	YES	YES	YES
Year FE	YES	YES	YES

Notes: Cluster-robust standard errors at issuer level in parentheses. Significance levels:

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Robustness: high vs low GB emission levels

Table 8: Effects of high and low GB issuance on the ESG. High and low GB issuance is defined considering the median of the distribution of green issuance and overall companies' debt ratio.

	(1) All ESG	(2) Brown companies ESG	(3) Green companies ESG
GB * Post * low GB issuance	-0.723 (0.570)	2.380** (1.035)	0.492 (0.560)
GB * Post * high GB issuance	-0.754 (0.728)	2.883** (1.431)	-0.130 (0.681)
Observations	20,240	10,120	10,120
Adjusted R-squared	0.834	0.788	0.775
Company Controls	YES	YES	YES
Company FE	YES	YES	YES
Year FE	YES	YES	YES

Notes: Cluster-robust standard errors at issuer level in parentheses. Significance levels:

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Robustness: impact of GB issuance on GHG emissions

Table 9: Effects of green bond issuance on GHG emissions (expressed in CO2 equivalent terms and relative to companies' total assets). Brown (green) companies are those with an E score below (above) the median in 2012.

	(1) All GHG emissions	(2) Brown companies GHG emissions	(3) Green companies GHG emissions
GB * Post	-61.54 (43.572)	-85.56** (38.381)	-69.85 (57.070)
Observations	16,313	6,677	9,636
Adjusted R-squared	0.846	0.875	0.832
Company Controls	YES	YES	YES
Company FE	YES	YES	YES
Year FE	YES	YES	YES

Notes: Cluster-robust standard errors at issuer level in parentheses. Significance levels:
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Robustness: alternative specifications (1)

Table 10: Effects of green bond issuance on the ESG and its sub-components. Specification with the interaction between treatment effect and brown companies dummy.

VARIABLES	(1) ESG	(2) E score	(3) S score	(4) G score
GB * Post	-3.278*** (0.561)	-6.385*** (0.715)	-2.132*** (0.734)	-2.082** (0.972)
GB * Post * Brown company	9.116*** (1.180)	16.36*** (1.950)	6.637*** (1.387)	4.531*** (1.692)
Observations	20,240	20,240	20,240	20,240
Adjusted R-squared	0.835	0.806	0.816	0.660
Company Controls	YES	YES	YES	YES
Company FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES

Notes: Cluster-robust standard errors at issuer level in parentheses. Significance levels:
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Robustness: alternative specifications (2)

Table 11: Effects of green bond issuance on the ESG. Brown (green) companies are those with an E score below (above) the median in 2012. Sun and Abraham (2021) estimator.

	(1) All ESG	(2) Brown companies ESG	(3) Green companies ESG
GB * Post * cohort 2013-16	1.803** (0.871)	0.884 (1.379)	1.265 (1.020)
GB * Post * cohort 2017-19	-0.245 (0.771)	2.755** (1.269)	0.244 (0.787)
GB * Post * cohort 2020-22	-0.489 (0.856)	3.323** (1.608)	0.306 (0.773)
Observations	20,240	10,120	10,120
Adjusted R-squared	0.834	0.788	0.775
Company Controls	YES	YES	YES
Company FE	YES	YES	YES
Year FE	YES	YES	YES

Notes: Cluster-robust standard errors at issuer level in parentheses. Significance levels:

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Green bonds: use of their proceeds

Table 12: Green bond use of proceeds.

Use of proceeds	Frequency
Adaptation	165
Mitigation (of which):	812
Energy and pollution control	302
Clean transportation and construction	510
General purpose	214

Summary statistics

Table 13: Summary statistics of the company-level regressors.

	(1) N	(2) mean	(3) sd	(4) min	(5) max
ESG score	20,240	59.13	17.83	6.350	95.72
E score	20,240	57.50	24.62	1.741	95.77
S score	20,240	60.09	21.55	0.670	98.78
G score	20,240	59.58	20.64	0.470	99.43
Size	20,240	9.553	1.526	6.338	13.86
RoA	20,240	4.216	3.913	-4.314	19.74
Leverage ratio	20,240	29.00	17.07	0.925	87.64
Cur. A-L ratio	20,240	146.3	118.5	6.862	823.0
Liquidity ratio	20,240	33.41	20.70	1.825	94.32
Tobin's Q	20,240	88.18	97.18	2.258	556.4
GB * Post	20,240	0.0442	0.206	0	1

Distribution of companies by nationality

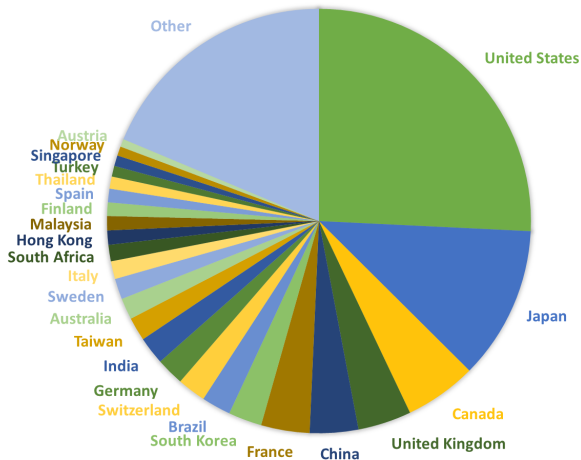


Figure 4: Distribution of companies by nationality of the issuer.

Distribution of companies by sector

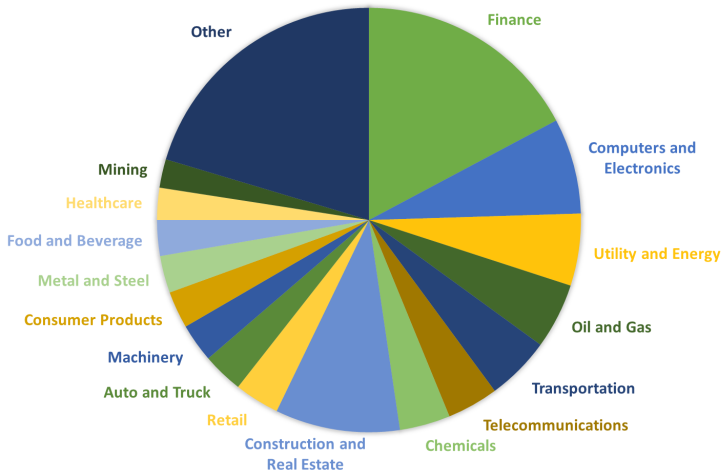


Figure 5: Distribution of companies by productive sector.

Green share by nationality

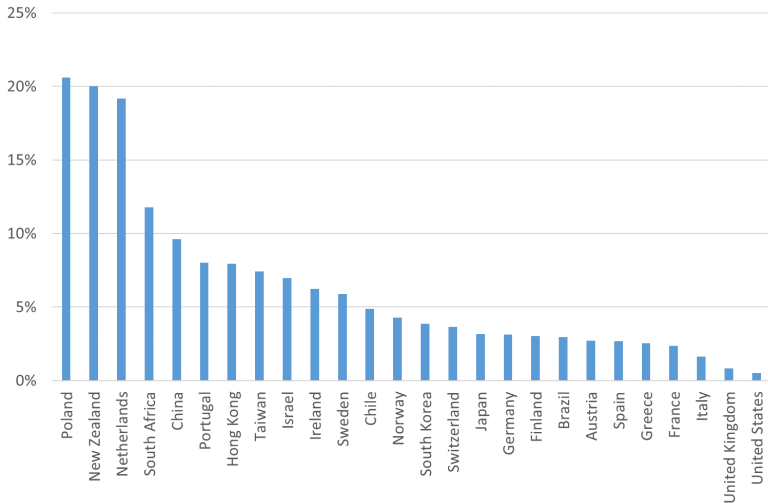


Figure 6: Share of green bond issuance by companies' nationality.

Green share by sector

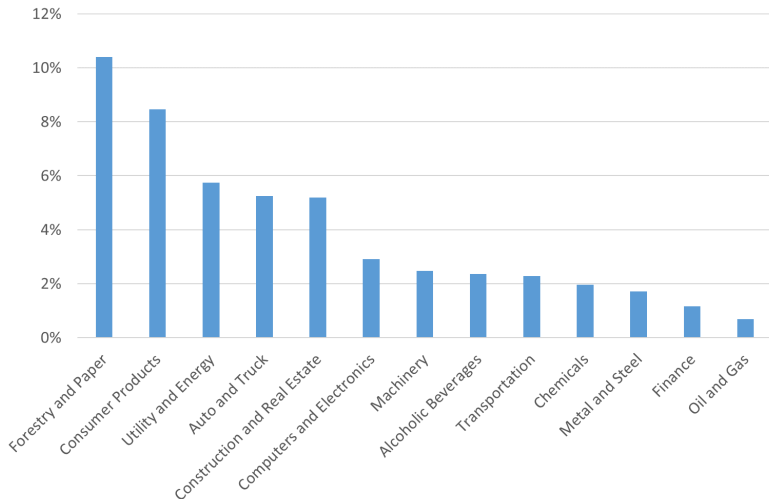


Figure 7: Share of green bond issuance by companies' sector.