



# The pricing of green bonds: are financial institutions special?

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*13th NBR-IMF Seminar on Financial Stability Issues*

*Bucharest, September 13, 2019*

# Motivation

- Paris Agreement, art.2 "aims to strengthen the global response to the threat of climate change... by **making finance flows** consistent with a pathway **towards low greenhouse gas emissions and climate-resilient development.**"

*How to channel funds to environmentally beneficial projects?*

- Policy initiatives:
  - **EU High-Level Group on Sustainable Finance** → **Technical Expert Group on Sustainable Finance**, working on:
    - EU taxonomy
    - **EU Green Bond standards**
    - Investment Benchmarks
  - **Network of Central Banks and Supervisors for Greening the Financial System**

# Green bonds

→ Fixed income securities issued to finance environmental or climate-related projects.

The market started in 2007 with EIB's 5y bond of EUR 600m.

→ new practice in finance, still lacking a commonly accepted full characterization/definition (compliance to the Green Bond Principles by the International Capital Market Association (ICMA) is voluntary).



## European Investment Bank - EIB

Supranational - EUR600,000,000 (US\$816,937,845)

Priced Tuesday, July 3, 2007

Deal Summary	
Deal Type	Supranational
Deal Sector Type	SSA
Rule 144a	No
SEC Registered	No
Reg S Y/N	No
Market Type	Euro market public issue
Currency	EUR
Deal Nationality	Luxembourg
MTN Y/N	Yes
Issued from	Debt Issuance Programme
Debut Product	

Deal Snapshot	Local Currency (EUR)	US Dollars	Euro
Deal Value Face	600,000,000	816,937,845	600,000,000
Deal Value Proceeds	600,000,000	816,937,845	600,000,000
Deal Total Value Face	600,000,000	816,937,845	600,000,000
Deal Total Value Proceeds	600,000,000	816,937,845	600,000,000

Tranche	Curr	Tranche Value Local	Tranche Value \$	Tranche Value Eur	Coupon	Offer Price	Maturity Date	Years to Maturity	Effective Rating	Rank Eligible
Tranche 1	EUR	600,000,000	816,937,845	600,000,000	0	100	28 Jun 2012	4.98	AAA	Y

Dealogic Information	
Rank Eligible	Yes
Use of Proceeds	General Corporate Purposes
Dealogic Note	Selling group: Banca Comerciala HVB Tiriac, Bank Austria Creditanstalt Ljubljana, HVB Bank Czech Republic, Rasbank and Unicredit Bank Slovakia. Debut Product: Green bond. Redemption linked to performance of FTSE4Good Environmental leaders Europe 40 Index according to undisclosed formula. Minimum redemption 105%.

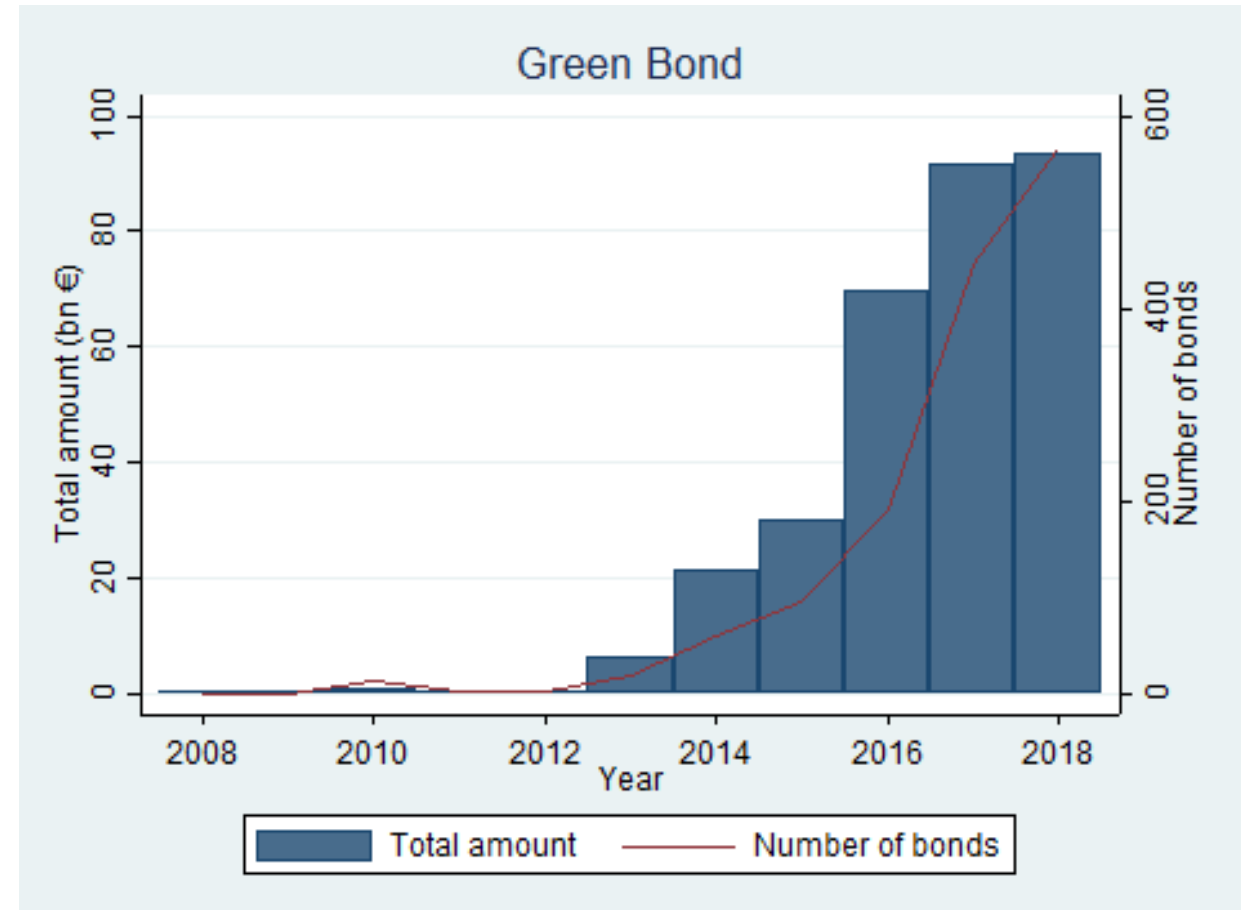
Deal Dates	
Pricing Date	03 Jul 2007
Settlement Date	05 Jul 2007

Deal Fees	
Modeled Gross fee \$	7,442,304
Modeled Gross fee €	5,466,000
Estimated Expenses \$	744,230
Net Fee/Revenue \$	6,698,073
Net Fee/Revenue €	4,919,400

# Green bond market: evolution over time

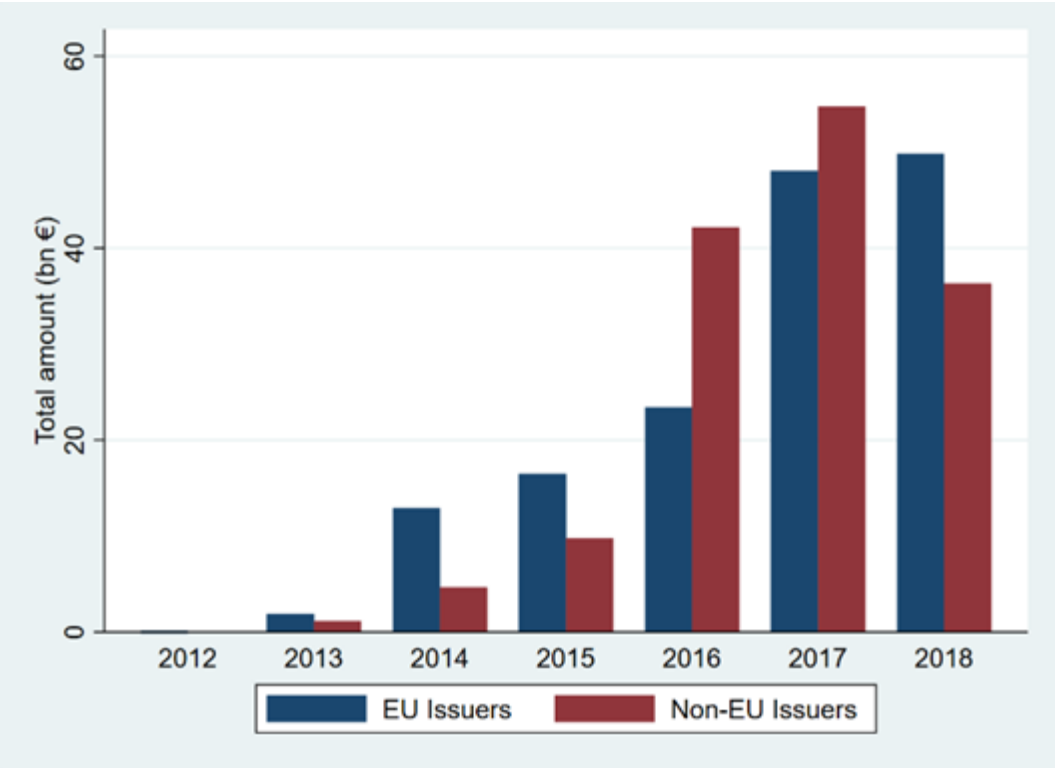
- Rapidly growing market, reaching EUR 93 bn (565 green bonds issued) in 2018.
- Despite the growing trend, green bonds account for a small fraction of the overall bond market, 2.42% in 2018.

Total amount and number of green bonds

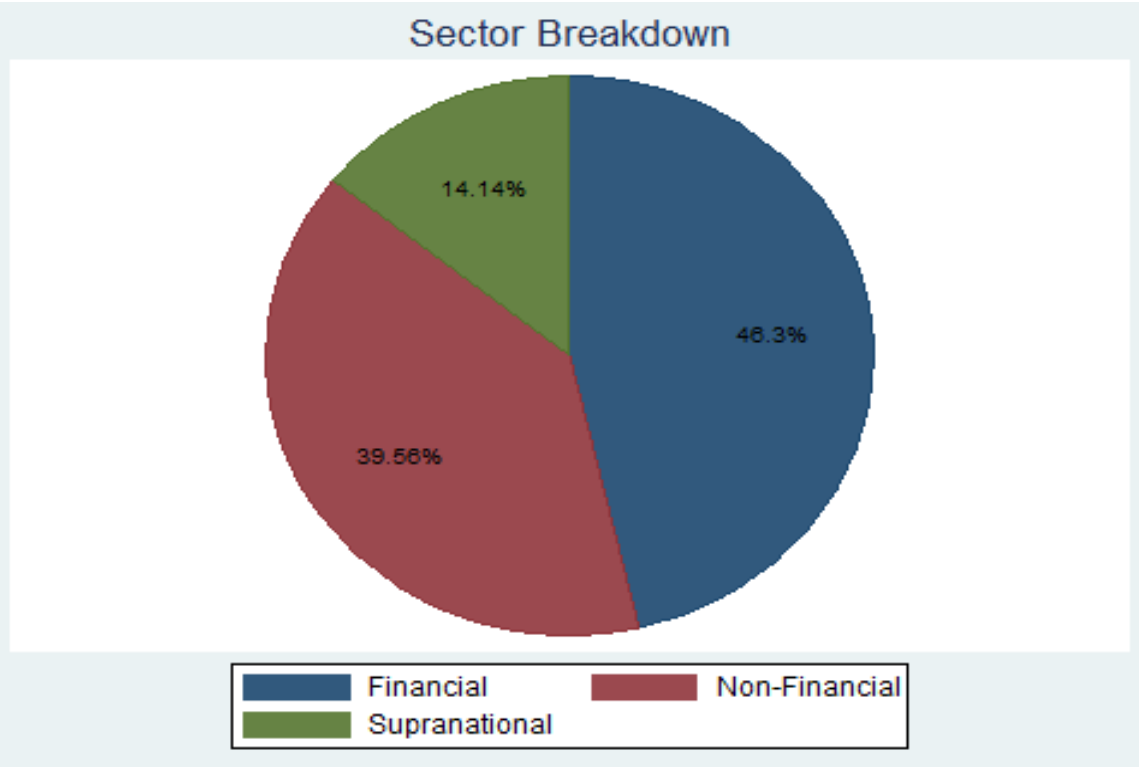


# Green bond market: breakdown of total amounts

by nationality of issuer



by issuer type



# Research questions & Preview of the results

- Are green bonds priced differently than ordinary bonds at issuance?
  - ✓ We find a premium for supranational institutions and corporates
  - ✓ We do not find a premium for financial institutions
- Why do we find this heterogenous effect?
  - ✓ Signaling/reputation matters:
    - ✓ Certification
    - ✓ Repeat issuance
    - ✓ Subscription to the United Nations Environment Programme Finance initiative
- Do banks change their lending decisions after issuing a green bond?
  - ✓ Yes, to some extent, banks re-direct syndicated lending to less polluting activities, but only when considering the *lead* bank

# Literature

- Environmental issues and firm financing
  - ✓ Lower cost of capital is associated to improvement in environmental risk management (Sharfman and Fernando, 2008) and higher environmental performance Ghoul et al. (2011), while environmental concerns are related to higher cost of capital, also for loans (Chava, 2014).
  - ✓ **Investors' preferences modify equilibrium prices** (Fama and French, 2007)
- Pricing of green bonds
  - ✓ Standard bonds = Green bonds (Hachenberg and Schiereck, 2018)
  - ✓ Standard bonds > Green bonds (Baker et al., 2018; Zerbib, 2018)
- Green bonds and corporate performance
  - ✓ issuance is followed by a positive market reaction (Tang and Zhang, 2018) and higher operating performance (Flammer, 2018)
- Environmental risks may lead to large environmental liabilities and high risk of bankruptcy:
  - ✓ Firms with larger environmental liabilities need more capital (Chang et al., 2018)
  - ✓ Banks charge higher loan rates to fossil fuel firms after the Paris Agreement in December 2015 (Delis et al., 2018)
  - ✓ Natural disasters increase the likelihood of banks' default (Klomp, 2014)
  - ✓ Contagion effects for the overall financial system (Battiston et al., 2017)

# Green bond pricing - econometric strategy

- Specification:

$$Yield_{b,i,t} = \beta_0 + \beta_1 \mathbf{Green}_{b,i,t} + \beta_2 \mathbf{X}_{b,i,t} + \delta_i + \epsilon_{b,i,t}$$

- Dependent variable: Yield at issuance of bond  $b$  issued by issuer  $i$  at time  $t$
- Independent variables:
  - ✓ Green: dummy variable equal 1 if a bond is classified as green
  - ✓  $\mathbf{X}_{b,i,t}$  vector of bond characteristics:
    - ✓ Callable
    - ✓ Puttable
    - ✓ Collateralized
    - ✓ Currency
    - ✓ Use of proceeds (General corporate purpose, Securitization, Refinancing)
    - ✓ Bond size categories
  - ✓  $\delta_i$  Issuer fixed effects (captures time-invariant unobservable issuer characteristics)
  - ✓ Additional fixed effects: Maturity  $\times$  Rating  $\times$  Time and Issuer size categories in that day
  - ✓ Standard errors clustered at issuer level



# Results – green bond pricing

	(1) All	(2) Supranational	(3) Financial	(4) Non-financial
<b>Green</b>	-0.2866 (0.178)	-0.8046*** (0.149)	0.1001 (0.312)	-0.2156** (0.108)
Callable	0.2518*** (0.083)	-0.4640*** (0.106)	0.2741*** (0.100)	0.2253*** (0.034)
Puttable	0.1207*** (0.044)	0.0861 (0.219)	-0.0548 (0.158)	0.0542* (0.030)
Collateralized	0.3298*** (0.065)		0.2949*** (0.074)	0.0766 (0.075)
Use of proceeds General Corporate Purposes	0.0294 (0.051)	0.2241 (0.288)	0.0353 (0.085)	0.1233*** (0.044)
Securitisation	-0.3633*** (0.140)		-0.0801 (0.147)	-0.6990*** (0.142)
Refinancing	-0.0435 (0.048)	0.0386 (0.664)	0.1770* (0.099)	-0.0892** (0.044)
Constant	3.5876*** (0.057)	5.0464*** (0.282)	2.9697*** (0.092)	4.5865*** (0.044)
Observations	266,724	7,391	168,594	89,902
R-squared	0.7296	0.4767	0.7176	0.8056
Adjusted R-squared	0.714	0.436	0.707	0.775
Bond size cat FE	Yes	Yes	Yes	Yes
Issue size cat FE	Yes	Yes	Yes	Yes
Currency FE	Yes	Yes	Yes	Yes
Maturity×Rating×Time FE	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes

Main results:

- Green bonds have a lower yield to maturity than conventional bonds if issued by **supranational institutions** (-80 bps) or **non-financial corporations** (-22 bps)
- No significant yield differences for green bonds issued by **financial institutions**

Additional results:

- Green **certification** reduces the yield at issuance for non-financial issuers (signaling effect)
- Repeat issuers** benefit from additional premium (reputational effect)
- Environmentally-committed** financial institutions issue green bonds at a lower yield than other NFCs

# Financial issuers and lending decisions

- Why don't we find a premium for financial institutions?

Bank <i>b</i>	
Assets	Liabilities
Cash	Bond issued
Bonds, Equities	Other debt
Loans	
	Capital

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Assets	Liabilities
Cash	Bond issued
Bonds, Equities	Other debt
Loans	
	Capital

- We test if banks change their lending (i.e. away from more polluting activities) after issuing a green bond:
  - ✓ Merge bond data (from Dealogic-DCM) with syndicated loan data (from Dealscan)
  - ✓ Exploit Eurostat data on GHG emissions at sector-country level (we do not have data at firm level!)
  - ✓ Apply a diff-in-diff setting

# Green bonds and lending: econometric strategy

- Specification:

$$Y_{bjct} = \alpha + \beta Green\_issuer_{bt} + \lambda Emission\_intensities_{jct} + \gamma Green\_issuer_{bt} * Emission\_intensities_{jct} + u_{bjct}$$

- $Y_{bjct}$ : log(tot. loan volume) industry  $j$  in country  $c$  attains from bank  $b$  in period  $t$
- $Green\_issuer_{bt}$ : dummy variable equal 1 from bond issuance (at time  $t$ ) onwards, zero otherwise
- $Emission\_intensities_{jct}$ : ratio between greenhouse gasses and output (VA)
- $\gamma$ : parameter of interest
- Set of fixed effects:
  - ✓ Supply side: Bank×Industry, Bank×Country, Bank×Year
  - ✓ Demand side: Industry×Country, Country×Year, Industry×Year
  - ✓ Standard errors clustered at bank level

# Results – green bonds and lending

Panel A: Amount	All		Excluding domestic	
	(1)	(2)	(3)	(4)
Green issuer	0.2958 (0.186)		0.3793* (0.205)	
Emission intensities	-0.0714** (0.028)	-0.1105* (0.061)	-0.0842*** (0.029)	-0.0189 (0.056)
<b>Green issuer* Emission intensities</b>	<b>-0.1254*** (0.030)</b>	<b>-0.0686** (0.034)</b>	<b>-0.1383*** (0.038)</b>	<b>-0.1846*** (0.032)</b>
Observations	65,021	64,715	49,875	49,470
R-squared	0.1118	0.3367	0.1093	0.2693
Adjusted R-squared	0.108	0.266	0.105	0.196
Bank FE	Yes	No	Yes	No
Country FE	Yes	No	Yes	No
NACE FE	Yes	No	Yes	No
Year FE	Yes	No	Yes	No
Bank-NACE FE	No	Yes	No	Yes
Bank-Country FE	No	Yes	No	Yes
Bank-Year FE	No	Yes	No	Yes
Country-Year FE	No	Yes	No	Yes
Country-NACE FE	No	Yes	No	Yes
NACE-Year FE	No	Yes	No	Yes

- Results: after having issued a green bond banks decrease their lending to more polluting activities

→ A one standard-deviation increase in the emission intensities yields a 10% reduction of lending volumes by banks active on the green bond market

# Results – green bonds and lending (cont'd)

## Panel B: Average

	(1)	(2)	(3)	(4)
Green issuer	0.2575 (0.165)		0.3385* (0.184)	
Emission intensities	-0.0691*** (0.025)	-0.1112* (0.056)	-0.0797*** (0.028)	-0.1778*** (0.063)
<b>Green issuer* Emission intensities</b>	<b>-0.1083*** (0.027)</b>	<b>-0.0647** (0.031)</b>	<b>-0.1227*** (0.034)</b>	<b>-0.0892** (0.036)</b>
Observations	65,021	64,715	49,875	49,457
R-squared	0.1020	0.3100	0.1019	0.2979
Adjusted R-squared	0.0985	0.237	0.0976	0.216

## Panel C: Any loan

	(1)	(2)	(3)	(4)
Green issuer	0.0292 (0.019)		0.0398* (0.021)	
Emission intensities	-0.0055** (0.003)	-0.0102 (0.007)	-0.0066** (0.003)	-0.0179** (0.007)
<b>Green issuer* Emission intensities</b>	<b>-0.0128*** (0.003)</b>	<b>-0.0077** (0.004)</b>	<b>-0.0144*** (0.004)</b>	<b>-0.0103** (0.004)</b>
Observations	65,021	64,715	49,875	49,457
R-squared	0.0982	0.3059	0.0966	0.2898
Adjusted R-squared	0.0946	0.232	0.0923	0.207

- Panel B: average amount to industry  $j$ , instead of total loan volumes, to exclude that effect in the baseline specification be driven by a limited number of large deals.
  - Panel C: indicator variable for lending at the extensive margin.
- results are in line with baseline

# Conclusions

- Green bond pricing
  - ✓ 'Greenium' only for some type of issuers (suprnational inst. and corporates)
  - ✓ Signaling & reputation seem to matter
- Lending decisions of green issuers
  - ✓ Evidence of lower lending towards more polluting activities
- How to finance the green economy?
  - ✓ Green bond market is growing and a price advantage will foster the market in the next years (market based solution)
  - ✓ But its development may depend on the credibility of the «green» label
  - ✓ Is there a future for «green» label for loans? Certification/verification?
  - ✓ Is a regulatory intervention advisable to promote bank support to green projects? i.e. Lower Capital Requirements for green loans
  - ✓ Paris Agreement, art. 9 (4) "*The provision of scaled-up financial resources should aim to achieve a balance between adaptation and mitigation...*"



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# Additional slides



# Green Bond pricing - Data

- Source: Dealogic-DCM details on bond tranches (primary market)
- Sample:
  - ✓ Period 2007-2018
  - ✓ Supranational institutions, financial institutions, corporates
  - ✓ Worldwide
- Including bond characteristics
  - ✓ Amount, Maturity, Rating, Fee, Collateralized...
  - ✓ Yield
  - ✓ Note details (green bond, second party opinion)
- and (a few) issuer variables
  - ✓ Type, Country, Industry

# Summary statistics – Green Bonds sample

Variable	N	Mean	Median	St. Dev.	P. 1	P. 99
Yield	271312	3.7702	3.3700	2.5090	0.0500	12.0900
Green	271312	0.0051	0.0000	0.0716	0.0000	0.0000
Certified	271312	0.0007	0.0000	0.0266	0.0000	0.0000
Callable	271312	0.3715	0.0000	0.4832	0.0000	1.0000
Puttable	271312	0.0687	0.0000	0.2529	0.0000	1.0000
Collateralized	271312	0.1656	0.0000	0.3718	0.0000	1.0000
Amount (Ml€)	271312	166.94	45.2580	353.42	0.6861	1630.21
Years to Maturity	271312	7.5556	5.0000	7.6287	0.5000	39.8300
Rating	271312	5.8809	5.0000	4.2202	1.0000	11.0000

# Green Bond pricing – The value of certification

	(1) All	(2) Supranational	(3) Financial	(4) Non-financial
<b>Green</b>	-0.3037 (0.232)	-1.0255*** (0.102)	0.0456 (0.198)	-0.0049 (0.143)
<b>External certification</b>	0.0380 (0.278)	0.5740 (0.496)	0.1137 (0.339)	-0.4374** (0.179)
Callable	0.2518*** (0.083)	-0.4643*** (0.106)	0.2741*** (0.100)	0.2252*** (0.034)
Puttable	0.1207*** (0.044)	0.0892 (0.219)	-0.0548 (0.158)	0.0539* (0.030)
Collateralized	0.3298*** (0.065)		0.2949*** (0.074)	0.0761 (0.075)
Use of proceeds:				
General Corporate Purposes	0.0294 (0.051)	0.2124 (0.278)	0.0356 (0.085)	0.1237*** (0.044)
Securitisation	-0.3633*** (0.140)		-0.0797 (0.147)	-0.6997*** (0.142)
Refinancing	-0.0435 (0.048)	0.0081 (0.665)	0.1773* (0.099)	-0.0884** (0.044)
Constant	3.5876*** (0.057)	5.0582*** (0.270)	2.9694*** (0.093)	4.5862*** (0.044)
Observations	266,724	7,391	168,594	89,902
R-squared	0.7296	0.4769	0.7176	0.8056
Adjusted R-squared	0.714	0.436	0.707	0.775
Bond size cat FE	Yes	Yes	Yes	Yes
Issue size cat FE	Yes	Yes	Yes	Yes
Currency FE	Yes	Yes	Yes	Yes
Maturity×Rating×Time FE	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes

- **External certification:** variable equal to 1 for green bonds that are certified by a third party (i.e. Cicero, Vigeo Eiris, ...)
- Results: green certification reduces the yield at issuance for non-financial issuers (signaling effect)

# Green Bond pricing – Repeat green issuances

	(1) All	(2) Supranational	(3) Financial	(4) Non-financial
<b>Green</b>	-0.0285 (0.108)	-1.3087* (0.722)	-0.1062 (0.122)	-0.0808 (0.126)
<b>Experienced green</b>	-0.4415* (0.240)	0.5180 (0.765)	0.3679 (0.410)	-0.3501** (0.147)
Callable	0.2518*** (0.083)	-0.4639*** (0.106)	0.2741*** (0.100)	0.2260*** (0.034)
Puttable	0.1205*** (0.044)	0.0867 (0.218)	-0.0544 (0.158)	0.0542* (0.030)
Collateralized	0.3293*** (0.065)		0.2955*** (0.073)	0.0770 (0.075)
Use of proceeds:				
General Corporate Purposes	0.0290 (0.051)	0.2265 (0.288)	0.0359 (0.085)	0.1235*** (0.044)
Securitisation	-0.3634*** (0.140)		-0.0797 (0.147)	-0.6985*** (0.142)
Refinancing	-0.0433 (0.048)	0.0362 (0.665)	0.1780* (0.099)	-0.0887** (0.044)
Constant	3.5878*** (0.057)	5.0442*** (0.282)	2.9690*** (0.093)	4.5858*** (0.044)
Observations	266,724	7,391	168,594	89,902
R-squared	0.7296	0.4767	0.7176	0.8056
Adjusted R-squared	0.714	0.435	0.707	0.775
Bond size cat FE	Yes	Yes	Yes	Yes
Issue size cat FE	Yes	Yes	Yes	Yes
Currency FE	Yes	Yes	Yes	Yes
Maturity×Rating×Time FE	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes

- **Experienced green:** dummy variable equal to 1 if the issuer is not issuing a green bond for the first time
- Results: having already issued a green bond matters (reputational effect)

# Green Bond pricing – Financial institutions: UNEP FI membership

	(1) Financial
<b>Green</b>	0.3977 (0.386)
<b>Environmentally committed</b>	0.1696 (0.217)
<b>Green × Environmentally committed</b>	-1.0020** (0.450)
Callable	0.2741*** (0.100)
Puttable	-0.0563 (0.158)
Collateralized	0.2944*** (0.074)
Use of proceeds: General Corporate Purposes	0.0317 (0.083)
Securitisation	-0.0827 (0.146)
Refinancing	0.1731* (0.097)
Constant	2.9447*** (0.105)
Observations	168,594
R-squared	0.7177
Adjusted R-squared	0.707
Bond size cat FE	Yes
Issue size cat FE	Yes
Currency FE	Yes
Maturity×Rating×Time FE	Yes
Issuer FE	Yes

- **Environmentally committed:** dummy variable equal to 1 if the issuer is a member of the United Nations Environment Programme Finance Initiative (UNEP FI)
- Environmentally-committed financial institutions issue green bond at a lower yield

# Green Bonds and lending - Data

- Dealogic-DCM: green bond information
- Dealscan: syndicated data at loan level indicating the lender(s) and the borrowers (industry and country)
- Eurostat (Air emissions accounts and intensities): data by NACE Rev. 2 activity (64) and country (EU member states, EFTA countries, and candidate countries)
- Procedure:
  - ✓ Extract syndicated loans for the period 2007-2018 extended to borrowers located in the relevant countries
  - ✓ Identify the syndicated structure (lead and participant banks)
  - ✓ Merge bond issuers with lenders by bank names
  - ✓ Merge borrowers with Emission intensities by industry (from NAICS to NACE Rev. 2) and country
  - ✓ Aggregate the lending amount of each *lead* bank by industry, country, and time
  - ✓ Sample limited to bank-industry-country with non-zero loans in at least two years
- Summary statistics of the final sample

	N	Mean	Median	St. Dev.	P. 1	P. 99
Amount	69180	3.3092	0.0000	4.4904	0.0000	11.8679
Average amount	69180	3.0225	0.0000	4.1017	0.0000	10.9739
Any loan	69180	0.3589	0.0000	0.4797	0.0000	1.0000
Green issuer	69180	0.1504	0.0000	0.3575	0.0000	1.0000
Emission intensities	65455	0.6381	0.0498	1.5643	0.0000	7.6062
Emission intensities 2	65380	0.2074	0.0231	0.4905	0.0000	2.6389