## **Corporate Green Bonds**

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### New Phenomenon in Corporate Landscape

- Issuance of corporate green bonds
  - Bonds whose proceeds are committed to finance environmental and climate-friendly projects
    - E.g., renewable energy, green buildings, resource conservation, etc.

### Anecdotal Evidence

- Several companies issued green bonds in recent years.
  - For example:



In March 2014, **Unilever** issued a **£250M green bond** to *"cut in half the amount of waste, water usage and greenhouse gas emissions of existing factories"*. (Financial Times, 2014)



In February 2016, **Apple** issued a **\$1.25B green bond** to finance the *"installation of more energy efficient heating and cooling systems, and an increase in the company's use of biodegradable materials"*. (The Guardian, 2016)

### **Corporate Green Bond Issuance over Time**

• The "green bond boom"



### **Corporate Green Bond Issuance across Industries**

Industry	Amount (\$B)
Financials	46.0
Banking	40.2
Real estate	5.9
Industrials	67.3
Utilities	21.8
Power generation	18.7
Transportation and logistics	8.0
Renewable energy	4.0
Forest and paper products manufacturing	3.3
Communications equipment	2.5
Waste and environment services and equipment	t 2.5
Automobiles manufacturing	2.2
Food and beverage	1.2
Travel and lodging	0.8
Consumer products	0.7
Managed care	0.6
Electrical equipment manufacturing	0.5
Others	0.5
Total	113.4

### **Corporate Green Bond Issuance across Countries**

Country	Amount (\$B)
France	25.1
China	14.7
Netherlands	14.3
United States	14.1
Mexico	8.0
Germany	6.5
India	4.3
Spain	3.4
Australia	3.3
Austria	2.4
Brazil	1.9
Sweden	1.9
Italy	1.8
Canada	1.7
Denmark	1.7
Britain	1.3
Japan	1.2
Singapore	1.1
Chile	1.0
Costa Rica	1.0
South Korea	1.0
Others	1.6
Total	113.4

## This Paper

- Corporate Green Bonds are on the rise
- Yet, very little is known about this new financial innovation
  - > Its effectiveness in terms of financial and environmental performance
  - Its implications for firm-level outcomes
- Key questions
  - Do corporate green bonds deliver on their promise and yield improvements in companies' environmental footprint? Or are they merely a greenwashing tool?
    - Greenwashing is of particular concern given lack of legal enforceability
  - Do companies benefit from issuing green bonds? What are the implications for shareholder wealth?
- If both financial and environmental performance improve, corporate green bonds could serve as a powerful tool against climate change

## This Paper

- This paper: First to study corporate green bonds
  - 1) Characterize this new phenomenon
  - 2) Examine **effectiveness** and **implications** of corporate green bonds w.r.t.
    - Financial performance (CAR, Tobin's Q, ROA)
    - Environmental performance (environmental rating, emissions)
    - Innovation (green patenting)
    - Temporal orientation (LT- index)
    - Ownership structure (institutional ownership, LT investors, green investors)

### Agenda

- 1. Introduction
- 2. Data
- 3. Event Study
  - Methodology
  - Results
- 4. Firm-level Analysis
  - Methodology
  - Results
- 5. Cross-Sectional Heterogeneity
- 6. Robustness
- 7. Conclusion

### **Corporate Green Bonds**

- To compile a database of corporate green bonds
  - Source: Bloomberg's fixed income database
  - Extract all corporate bonds labeled as green bonds (i.e. "use of proceeds" is "green Bond/Loan")
    - For each bond, information on:
      - Date of announcement
      - Date of issuance
      - Amount
      - − Currency → to facilitate comparison convert in USD
      - Maturity
      - Coupon
      - Credit rating
    - Exclude green bonds issued by "government-like" entities (e.g., development banks, supranational entities)

## Sample

### Database of corporate green bonds

#### > Coverage:

- All public and private firms
- Across the world
- 5 years (January 1, 2013—December 31, 2017)

#### > Final sample:

– 368 corporate green bonds

### Summary Statistics at Green Bond Level

		All	Private	Public
	# Green bonds	368	151	217
	Amount (in \$M)	308.1	294.1	317.8
		(655.6)	(751.0)	(581.8)
	Certified (1/0)	0.686	0.695	0.680
		(0.464)	(0.462)	(0.466)
	Maturity (years)	7.4	6.2	8.3
		(26.5)	(5.0)	(34.3)
	Fixed-rate bonds (1/0)	0.747	0.656	0.810
		(0.418)	(0.452)	(0.382)
	Coupon (for fixed-rate bonds)	3.4	2.9	3.6
		(2.3)	(2.1)	(2.3)
	Credit rating			
	S&P rating (median)	A–	А-	А-
	Moody's rating (median)	A3	A3	A3
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### **Summary Statistics at Issuer Level**

	N	Green bond issuers	(Non-green) bond issuers in same country and industry	(Non-green) bond issuers in same country but differen industry	<i>p</i> -value (diff. in means) t
Log(assets)	106	11.085	9.377	-	0.000***
Return on assets	106	(2.451) 0.056 (0.048)	(1.819) 0.056 (0.033)	-	0.874
Tobin's Q	106	1.172	1.211	-	0.429
Leverage	106	(0.393) 0.286 (0.161)	(0.332) 0.309 (0.140)	-	0.366
Environment rating (ASSET4)	76	83.374	66.467	-	0.000***
Social rating (ASSET4)	76	(16.012) 79.814 (21.158)	(21.108) 64.324 (21.473)	-	0.000***
Governance rating (ASSET4)	76	66.401	57.906	_	0.008***
Composite rating (ASSET4)	76	(23.690) 80.936 (18.263)	(18.627) 65.661 (20.049)	-	0.001***
Environment materiality (SASB, industry level)	106	2.473 (1.588)	_	1.539 (0.280)	0.000***

### **Summary Statistics at Issuer Level**

	Ν	Green bond issuers	(Non-green) bond issuers in same country and industry	(Non-green) bond issuers in same country but different industry	<i>p</i> -value (diff. in means)
Log(assets)	106	11.085	9.377	_	0.000***
		(2.451)	(1.819)		
Return on assets	106	0.056	0.056	_	0.874
		(0.048)	(0.033)		
Tobin's Q	106	1.172	1.211	_	0.429
		(0.393)	(0.332)		
Leverage	106	0.286	0.309	_	0.366
		(0.161)	(0.140)		
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		(18.263)	(20.049)		
Environment materiality (SASB, industry level)	106	2.473	-	1.539	0.000***
		(1.588)		(0.280)	

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### Event Study Methodology

#### • Event study

Analyze stock market reaction to corporate news

• Announcement of corporate green bond issuance



For each firm, compute cumulative abnormal returns (CAR) using market model

### **Stock Market Reaction to Announcement**

	Event time	CAR	Std. Err.
	[-20, -11]	0.120	0.975
	[-10, -6]	0.257	0.509
	[-5, -2]	-0.013	0.487
Announcement	[-1, 0]	0.673**	0.278
	[1, 5]	-0.106	0.625
	[6, 10]	0.328	0.659
	[11, 20]	-0.281	1.140

Stock return in excess of "normal" market return is **0.67%** 

Stock market expects green bonds to contribute to value creation

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# Methodology

- Empirical Challenge: Endogeneity
  - Issuance of corporate green bonds likely endogenous with respect to dependent variable y (e.g., firm value)

Companies that aim to improve their environmental rating may take actions to reduce their emissions, and at the same time, issue green bonds.

Better governed firms may be more sustainable. At the same time, they may more likely issue green bonds.

- Ideally: need an insurment for issuance of green bonds
- 2<sup>nd</sup> best: build a plausible counterfactual of how firm-level outcomes would evolve absent the issuance of green bonds

### Methodology

- Matching
  - Each firm that issues a green bond ("treated" firm) is matched to a similar "control" firm ex ante
  - Selection criteria:
    - All public firms that issue bonds (but not green bonds)
    - Same country
    - Same 2-digit SIC industry group
    - Select nearest neighbor i.e. firm with lowest Mahalanobis distance to treated firm – on basis of 14 characteristics prior to issuance:
      - Size 0 0
      - Tobin's O 0  $\cap$
      - ROA  $\bigcirc$
      - Leverage 0
      - Firm's environmental rating 0
      - Firm's social rating  $\bigcirc$
      - Firm's governance rating Ο

- Δ Size
- $\Delta$  Tobin's Q
- $\Delta ROA$  $\bigcirc$
- $\Delta$  Leverage 0
- $\circ$   $\Delta$  Firm's environmental rating
- $\circ$   $\Delta$  Firm's social rating
- $\Delta$  Firm's governance rating 0

### Summary Statistics Treated and Matched Control Firms

		Obs.	Mean	Median	Std. Dev.	<i>p</i> -value (diff. in means)	<i>p</i> -value (diff. in medians)
Panel A. Matching characteristics	8						
Log(assets)	Green bond	106	11.085	10.813	2.451	0.280	0.461
	Matched control	106	10.993	10.7 <mark>7</mark> 3	2.276		
Return on assets	Green bond	106	0.056	0.053	0.048	0.243	0.680
	Matched control	106	0.058	0.051	0.0 <mark>4</mark> 7		
Tobin's Q	Green bond	106	1.172	1.023	0.393	0.202	0.527
	Matched control	106	1.140	1.012	0.286		
Leverage	Green bond	106	0.286	0.242	0.161	0.189	0.131
	Matched control	106	0.309	0.286	0.162		
Environment rating (ASSET4)	Green bond	76	83.37	91.36	16.01	0.311	0.783
	Matched control	76	82.39	91.18	16.29		
Social rating (ASSET4)	Green bond	76	79.81	90.36	21.16	0.364	0.921
	Matched control	76	79.05	90.41	22.09		
Governance rating (ASSET4)	Green bond	76	66.40	73.73	23.69	0.705	0.424
	Matched control	76	66.15	70.93	22.64		

### Summary Statistics Treated and Matched Control Firms

		Obs.	Mean	Median	Std. Dev.	<i>p</i> -value (diff. in means)	<i>p</i> -value (diff. in medians)
Panel A. Matching characteristics		-2					
$\Delta$ Log(assets)	Green bond	106	0.022	0.030	0.158	0.632	0.668
	Matched control	106	0.020	0.027	0.116		
$\Delta$ Return on assets	Green bond	106	0.001	-0.001	0.019	0.296	0.810
	Matched control	106	0.000	-0.001	0.016		
Δ Tobin's Q	Green bond	106	-0.002	-0.002	0.159	0.316	0.753
	Matched control	106	0.001	-0.003	0.121		
$\Delta$ Leverage	Green bond	106	0.003	0.000	0.033	0.596	0.811
	Matched control	106	0.002	0.001	0.046		
$\Delta$ Environment rating (ASSET4)	Green bond	76	3.897	0.955	9.958	0.916	0.870
	Matched control	76	3.899	0.960	9.972		
$\Delta$ Social rating (ASSET4)	Green bond	76	4.051	1.415	9.675	0.302	0.338
	Matched control	76	3.775	1.460	9.283		
$\Delta$ Governance rating (ASSET4)	Green bond	76	3.901	3.065	10.719	0.772	0.474
	Matched control	76	3.773	3.100	10.499		

### Summary Statistics Treated and Matched Control Firms

			Obs.	Mean	Median	Std. Dev.	<i>p</i> -value (diff. in means)	<i>p</i> -value (diff. in medians)
Panel B. Other characteristics								
CO <sub>2</sub> emissions / assets		Green bond	69	77.87	17.91	168.12	0.245	0.503
		Matched control	69	75.10	17.26	181.06		
Green patents / total patents		Green bond	43	0.140	0.000	0.254	0.776	0.982
		Matched control	43	0.128	0.000	0.152		
LT-index (U.S. only)		Green bond	32	0.793	0.747	0.148	0.481	0.510
		Matched control	32	0.755	0.745	0.156		
Institutional ownership (U.S. c	only)	Green bond	32	0.416	0.402	0.372	0.409	0.717
		Matched control	32	0.428	0.411	0.348		
Ownership by long-term inves	tors (U.S. only)	Green bond	32	0.071	0.049	0.089	0.106	0.220
		Matched control	32	0.057	0.035	0.084		
Ownership by green investors	(U.S. only)	Green bond	32	0.040	0.016	0.037	0.632	0.554
		Matched control	32	0.038	0.014	0.052		
$\Delta$ CO <sub>2</sub> emissions / assets		Green bond	<mark>6</mark> 9	-0.773	-0.024	19.947	0.757	0.971
		Matched control	<mark>6</mark> 9	<b>-</b> 0.708	-0.019	20.703		
$\Delta$ Green patents / total patents		Green bond	43	0.004	0.000	0.162	0.878	0.980
		Matched control	43	0.001	0.000	0.193		
$\Delta$ LT-index (U.S. only)		Green bond	32	0.009	0.005	0.118	0.749	0.597
		Matched control	32	0.004	0.005	0.106		
			2010/2010	100 100 100 100	CONTRACT PROVIDENT			

Control firms are very similar to treated firms, and hence, likely provide reliable counterfactual of how treated firms would have behaved absent issuance of green bond

# Difference-in-Differences Approach

- "Treatment":
  - Issuance of green bond
- Difference-in-differences methodology:
  - Before versus after issuance of green bond
  - Treatment versus control group
- Treatment group:
  - > Public firms issuing green bond
- Control group:
  - Matched public firms issuing bond (but not green bond)

# Difference-in-Differences Approach

**BEFORE 2016** 

**AFTER 2016** 









Difference after versus before (treated firm):  $\Delta y_T = y_{After, T} - y_{Before, T}$ 

Difference after versus before (control firm):  $\Delta y_{\rm C} = y_{\rm After, C} - y_{\rm Before, C}$ 

Difference-in-differences:  $\Delta(\Delta y) = \Delta y_{T} - \Delta y_{C}$ 

## **Difference-in-Differences** Approach

$$y_{it} = \alpha_i + \alpha_c \times \alpha_t + \alpha_s \times \alpha_t + \beta \times \text{Green bond}_{it} + \varepsilon_{it}$$

- $y_{it}$  : outcome variable of interest of firm *i* in year *t*.
- $\alpha_i$  : firm fixed effects
- $\alpha_c \times \alpha_t$  : country-year fixed effects
- $\alpha_s \times \alpha_t$  : 2-digit industry-year fixed effects
- Green bond: dummy variable equal to one for treated firms
- *E* : error term (standard errors clustered at 2-digit SIC industry level)

# **Financial Performance**

Firm value increases by		Financial performance						
0.028/1.172 = <b>2.4%</b>	Tobi	n's Q	RO	DA	]			
Green bond	0.028**		0.005**					
	(0.012)		(0.002)					
Green bond (pre-issue year)		0.003		0.001	]			
		(0.013)		(0.003)				
Green bond (short-term, 1 yea	ar)	0.026**		0.002	1			
		(0.013)		(0.003)				
Green bond (long-term, 2+ ye	ears)	0.029**		0.006**	1			
		(0.014)		(0.003)				
Firm fixed effects	Yes	Yes	Yes	Yes				
Country-year fixed effects	Yes	Yes	Yes	Yes				
Industry-year fixed effects	Yes	Yes	Yes	Yes				
Obcomutions	071	071	1 005	1.005				
Observations	9/1	9/1	1,005	1,005				
R-squared	0.89	0.89	0.86	0.86				
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### **Environmental Performance**

	Environ	ment rating	CO <sub>2</sub> emiss	ions / assets		
Green bond	6.132**		<b>-</b> 16.977**			
	(2.619)		(7.130)			
Green bond (pre-issue year)		0.448		1.228	٦	
7.52 53		(2.722)		(7.986)		
Green bond (short-term, 1 ye	ear)	4.407		-9.168		
		(2.885)		(7.411)		
Green bond (long-term, 2+ y	rears)	7.283**		-21.585***	ķ	
		(2.988)		(8.071)		
Firm fixed effects Country-year fixed effects Industry-year fixed effects	Environmental rating improves by 8.8% in long-term		Emission: by 2 in lon	s decrease 7.7% g-term		
Observations	795	795	600	600		
R-squared	0.88	0.88	0.92	0.92		
2/07/2018 Caroline Flammer (Boston U) Corporate Green Bonds 28						

Environmental performance

### **Green Innovation**

#### Green innovation

	Green patents	/ total patents	
Green bond	0.021 (0.016)		
Green bond (pre-issue year)		0.002 (0.016)	
Green bond (short-term, 1 year)		0.012 (0.016)	
Green bond (long-term, 2+ years	)	0.034* (0.019)	
Firm fixed effects	Yes	Ratio of gree	n patents
Country-year fixed effects	Yes	increases k	oy <b>3.4%</b>
Industry-year fixed effects	Yes	in long-	term
Observations	416	416	
R-squared	0.66	0.66	
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### Long-term Orientation (U.S. only)

12/07/2018

	Long-term orientation				
Adoption of a longer-term orientation	LT-index				
Green bond	0.039** (0.016)				
Green bond (pre-issue year)		0.014 (0.017)			
Green bond (short-term, 1 year)		0.032*			
Green bond (long-term, 2+ years)	)	0.044** (0.019)			
Firm fixed effects	Yes	Yes			
Industry-year fixed effects	Yes	Yes			
Observations	382	382			
R-squared	0.84	0.84			
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### Ownership Structure (U.S. only)

	Institutional ownership		Ownership by LT investors		Ownership by green investors	
Green bond	0.010 (0.010)		0.015* (0.008)		0.030** (0.012)	
Green bond (pre-issue year)	0.003 (0.009)		0.001 (0.007)		0.005 (0.013)	
Green bond (short-term, 1 year	0.010 (0.009)		0.007 (0.008)		0.017 (0.013)	
Green bond (long-term, 2+ yea	0.012 (0.010)		0.023** (0.011)		0.041** (0.015)	
Firm fixed effects Industry-year fixed effects Observations R-squared in institution Observations		<b>o</b> t change utional rship	Long-term ownership increases by <b>2.3%</b> in long-term		Green ownership increases by <b>4.1%</b> in long-term	

#### Ownership

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### **Cross-Sectional Heterogeneity**

	CAR[-1, 0]	Std. Err.
Panel A. Certified vs. non-certified		
Certified green bonds ( $N = 147$ )	0.803**	0.354
Non-certified green bonds ( $N = 70$ )	0.401	0.427

Panel B. Financial materiality of the environment above vs. below median

SASB score above median ( $N = 109$ )	0.908***	0.212
SASB score below median ( $N = 108$ )	0.437	0.516

Panel C. First-time issue vs. seasoned issue		
First-time green bond issue $(N = 85)$	0.862***	0.252
Seasoned green bond issue ( $N = 132$ )	0.552	0.427

### **Cross-Sectional Heterogeneity**

	Tobin's Q	ROA	Environment	CO <sub>2</sub> emissions	Green patents	LT-index	Institutional	Ownership by	Ownership by
			rating	/ assets	/ total patents		ownership	LT investors	green investors
Panel A. Certified vs. non-certified	l green bond	s							5
Green bond × certified	0.032**	0.006**	7.165**	-19.354**	0.025	0.043**	0.011	0.022**	0.040**
	(0.014)	(0.003)	(2.893)	(7.714)	(0.018)	(0.020)	(0.015)	(0.010)	(0.018)
Green bond × non-certified	0.021	0.004	4.201	-11.849	0.016	0.029	0.008	0.006	0.014
l	(0.013)	(0.003)	(2.701)	(7.330)	(0.017)	(0.019)	(0.014)	(0.009)	(0.017)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-year fixed effects	Yes	Yes	Yes	Yes	Yes	-	(50)	2 <del></del>	5 <del>0</del> 5
Industry-year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	971	1,005	795	600	416	382	316	316	316
R-squared	0.89	0.86	0.88	0.92	0.66	0.84	0.90	0.57	0.72
Panel B. Financial materiality of t	he environm	ent above	vs. below medi	ian					
Green bond × high SASB score	0.041***	0.008***	7.210**	-19. <mark>1</mark> 97**	0.023	0.041**	0.011	0.018**	0.032**
	(0.013)	(0.003)	(2.931)	(7.510)	(0.018)	(0.019)	(0.013)	(0.009)	(0.015)
Green bond × low SASB score	0.017	0.003	5.414**	-14.883**	0.020	0.036**	0.010	0.014*	0.027*
	(0.013)	(0.002)	(2.698)	(7.429)	(0.018)	(0.018)	(0.014)	(0.009)	(0.015)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-year fixed effects	Yes	Yes	Yes	Yes	Yes		-	4 <del>17</del> .17	( <b>1</b> 72)
Industry-year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	971	1,005	795	600	416	382	316	316	316
R-squared	0.89	0.86	0.88	0.92	0.66	0.84	0.90	0.57	0.72

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### Robustness Checks

		CAR[-1,0]	SIG. EII.				
1.	Global market model based on MSCI world index	0.681**	0.272				
2.	Global three-factor model of Fama and French	0.735**	0.359				
3.	Industry-adjusted CARs	0.633**	0.259				
<u>4</u> .	Cross-sectional correlation	0.673**	0.296				
5.	Precision-weighted CARs	0.797**	0.360				
6.	Excluding banking	0.848**	0.339				
7.	Excluding confounding events	0.629**	0.301				
8.	Median CARs	0.479***	0.141				
	Robustness tests vield verv similar results						

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# **Key Findings**

- Do corporate green bonds deliver on their promise?
   Or are they merely a greenwashing tool?
  - Green bonds have real impact, and are not merely a tool of greenwashing
    - i) Increase financial performance (CAR, Tobin's Q, ROA)
    - ii) Improve environmental performance (environmental rating, emissions)
    - iii) Boost green innovation (green patenting)
    - iv) Adoption of a longer-time horizon (LT- index)
    - v) Attract long-term and green investors (LT investors, green investors)
  - Results suggest corporate green bonds serve as
    - effective financing tool to create long-term value and improve environmental footprint
    - → could serve as a **powerful tool against climate change**

### Conclusion

# Thank You!

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