

# 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:



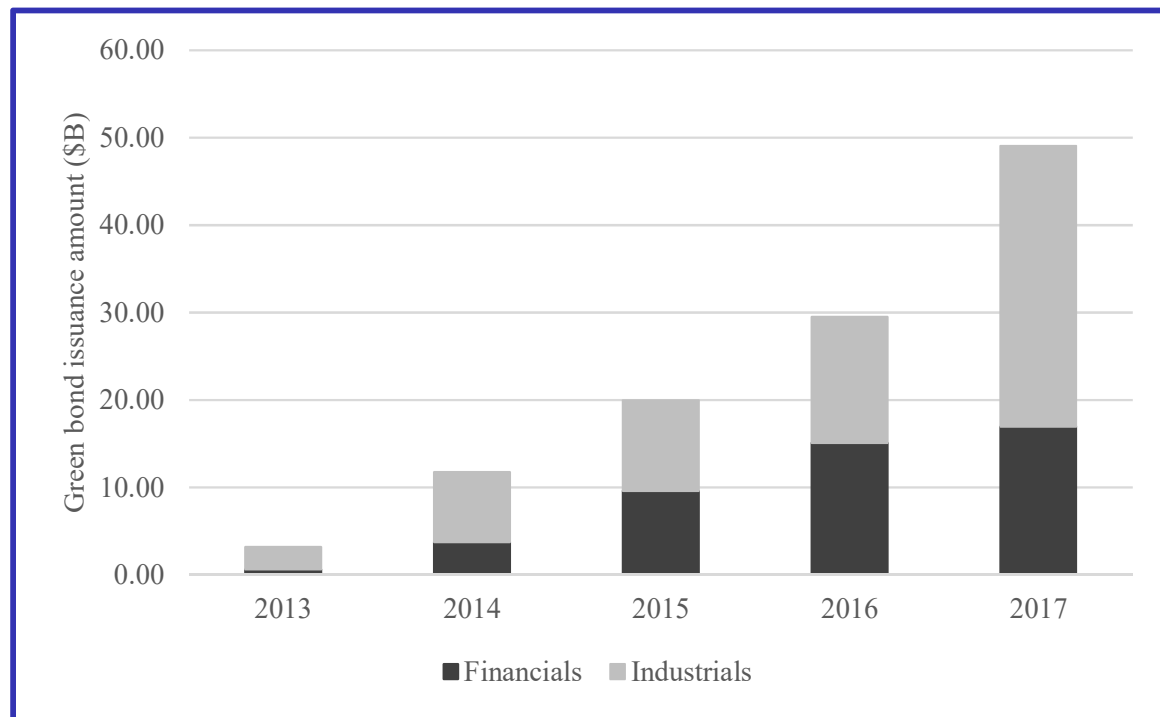
In March 2014, **Unilever** issued a **£250M green bond** to “*cut in half the amount of waste, water usage and greenhouse gas emissions of existing factories*”. (Financial Times, 2014)



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	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 (655.6)	294.1 (751.0)	317.8 (581.8)
Certified (1/0)	0.686 (0.464)	0.695 (0.462)	0.680 (0.466)
Maturity (years)	7.4 (26.5)	6.2 (5.0)	8.3 (34.3)
Fixed-rate bonds (1/0)	0.747 (0.418)	0.656 (0.452)	0.810 (0.382)
Coupon (for fixed-rate bonds)	3.4 (2.3)	2.9 (2.1)	3.6 (2.3)
Credit rating			
S&P rating (median)	A–	A–	A–
Moody's rating (median)	A3	A3	A3

# Summary Statistics at Issuer Level

	<i>N</i>	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 (2.451)	9.377 (1.819)	–	0.000***
Return on assets	106	0.056 (0.048)	0.056 (0.033)	–	0.874
Tobin's Q	106	1.172 (0.393)	1.211 (0.332)	–	0.429
Leverage	106	0.286 (0.161)	0.309 (0.140)	–	0.366
Environment rating (ASSET4)	76	83.374 (16.012)	66.467 (21.108)	–	0.000***
Social rating (ASSET4)	76	79.814 (21.158)	64.324 (21.473)	–	0.000***
Governance rating (ASSET4)	76	66.401 (23.690)	57.906 (18.627)	–	0.008***
Composite rating (ASSET4)	76	80.936 (18.263)	65.661 (20.049)	–	0.001***
Environment materiality (SASB, industry level)	106	2.473 (1.588)	–	1.539 (0.280)	0.000***

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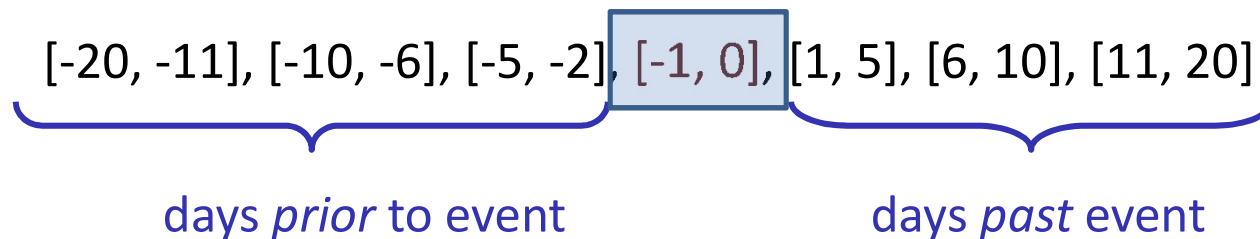
# Event Study Methodology

- Event study

- Analyze stock market reaction to corporate news

- Announcement of corporate green bond issuance

- Time intervals:



- 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
<b>Announcement</b>	[−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 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 ~~instrument~~ 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	○ $\Delta$ Size
○ Tobin’s Q	○ $\Delta$ Tobin’s Q
○ ROA	○ $\Delta$ ROA
○ Leverage	○ $\Delta$ Leverage
○ Firm’s environmental rating	○ $\Delta$ Firm’s environmental rating
○ Firm’s social rating	○ $\Delta$ Firm’s social rating
○ Firm’s governance rating	○ $\Delta$ Firm’s governance rating

# 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)
<i>Panel A. Matching characteristics</i>							
Log(assets)	Green bond	106	11.085	10.813	2.451	0.280	0.461
	Matched control	106	10.993	10.773	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	0.047		
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)
<i>Panel A. Matching characteristics</i>							
$\Delta$ 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		
$\Delta$ 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.	p-value (diff. in means)	p-value (diff. in medians)
<i>Panel B. Other characteristics</i>								
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. 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 investors (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			
Δ CO <sub>2</sub> emissions / assets	Green bond	69	-0.773	-0.024	19.947	0.757	0.971	
	Matched control	69	-0.708	-0.019	20.703			
Δ 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			
Δ 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			

- 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



Firm outcome **treated** firm T



Firm outcome **treated** firm T



Firm outcome **control** firm C



Firm outcome **control** firm C

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

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

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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
- $\varepsilon$  : error term (standard errors clustered at 2-digit SIC industry level)

# Financial Performance

	Financial performance			
	Tobin's Q		ROA	
Green bond	0.028** (0.012)		0.005** (0.002)	
Green bond (pre-issue year)		0.003 (0.013)		0.001 (0.003)
Green bond (short-term, 1 year)		0.026** (0.013)		0.002 (0.003)
Green bond (long-term, 2+ years)		0.029** (0.014)		0.006** (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
Observations	971	971	1,005	1,005
R-squared	0.89	0.89	0.86	0.86



# Environmental Performance

	Environmental performance			
	Environment rating		CO <sub>2</sub> emissions / assets	
Green bond	6.132**		-16.977**	
	(2.619)		(7.130)	
Green bond (pre-issue year)		0.448		1.228
		(2.722)		(7.986)
Green bond (short-term, 1 year)		4.407		-9.168
		(2.885)		(7.411)
Green bond (long-term, 2+ years)		7.283**		-21.585***
		(2.988)		(8.071)
Firm fixed effects	Yes	Yes	Yes	Yes
Country-year fixed effects	Yes	Yes	Yes	Yes
Industry-year fixed effects	Yes	Yes	Yes	Yes
Observations	795	795	600	600
R-squared	0.88	0.88	0.92	0.92



# 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	Yes
Country-year fixed effects	Yes	Yes
Industry-year fixed effects	Yes	Yes
Observations	416	416
R-squared	0.66	0.66



# Long-term Orientation (U.S. only)

Long-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* (0.017)
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





# Ownership Structure (U.S. only)

## Ownership

	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+ years)		0.012 (0.010)		0.023** (0.011)		0.041** (0.015)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry-year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	316	316	316	316	316	316
R-squared	0.90	0.90	0.57	0.57	0.72	0.72



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# Cross-Sectional Heterogeneity

	CAR[−1, 0]	Std. Err.
<hr/>		
<i>Panel A. Certified vs. non-certified</i>		
Certified green bonds ( $N = 147$ )	0.803**	0.354
Non-certified green bonds ( $N = 70$ )	0.401	0.427
<i>Panel B. Financial materiality of the environment above vs. below median</i>		
SASB score above median ( $N = 109$ )	0.908***	0.212
SASB score below median ( $N = 108$ )	0.437	0.516
<i>Panel C. First-time issue vs. seasoned issue</i>		
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 rating	CO <sub>2</sub> emissions / assets	Green patents / total patents	LT-index	Institutional ownership	Ownership by LT investors	Ownership by green investors
<i>Panel A. Certified vs. non-certified green bonds</i>									
Green bond × certified	0.032** (0.014)	0.006** (0.003)	7.165** (2.893)	-19.354** (7.714)	0.025 (0.018)	0.043** (0.020)	0.011 (0.015)	0.022** (0.010)	0.040** (0.018)
Green bond × non-certified	0.021 (0.013)	0.004 (0.003)	4.201 (2.701)	-11.849 (7.330)	0.016 (0.017)	0.029 (0.019)	0.008 (0.014)	0.006 (0.009)	0.014 (0.017)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-year fixed effects	Yes	Yes	Yes	Yes	Yes	-	-	-	-
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
<i>Panel B. Financial materiality of the environment above vs. below median</i>									
Green bond × high SASB score	0.041*** (0.013)	0.008*** (0.003)	7.210** (2.931)	-19.197** (7.510)	0.023 (0.018)	0.041** (0.019)	0.011 (0.013)	0.018** (0.009)	0.032** (0.015)
Green bond × low SASB score	0.017 (0.013)	0.003 (0.002)	5.414** (2.698)	-14.883** (7.429)	0.020 (0.018)	0.036** (0.018)	0.010 (0.014)	0.014* (0.009)	0.027* (0.015)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-year fixed effects	Yes	Yes	Yes	Yes	Yes	-	-	-	-
Industry-year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
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# Robustness Checks

	CAR[−1, 0]	Std. Err.
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
4. 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 yield very 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**

# Thank You!

Contact: [cflammer@bu.edu](mailto:cflammer@bu.edu)

Research papers: <http://sites.bu.edu/cflammer>