Why do firms issue green bonds?

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Séminaire Energie-Environnement
December 9, 2021

Green finance/bonds

Green finance allows to link investment to firms' environmental commitments

"Green bonds are the stars of green finance" (*The Economist*)

- Their issuers commit to use the proceeds to certified climate-friendly projects

Eg, Unilever's famous March 19, 2014 green bond

- $>$ \$400m earmarked to new climate friendly production capacities
- Confirming success of years-long developments: CO2-reducing refrigerants, detergents, etc
- Investors' enthusiasm: announcement stock returns of $\simeq$ 5%!

2010 "Sustainable Living Plan"

Eg, 2016-19 Apple's \$4.7B green bonds

- "Reducing its impact on climate change by using renewable energy sources and driving energy efficiency"
- Certified by external reviewers

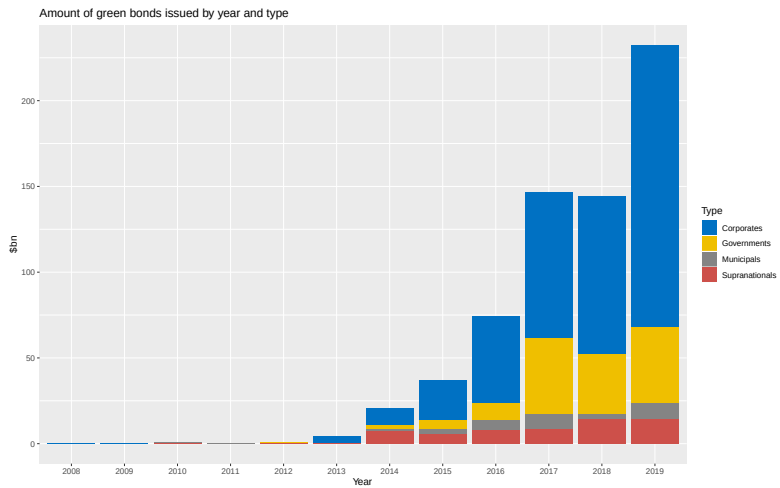
Apple 2017 (also E&Y and Sustainalitics)

Green bond boom

In the past few years, a rapidly increasing number of firms have made similar commitments

$\Rightarrow$ (Corporate) "Green bond boom:"

- Volume has $\simeq \times 2$ every year since 2013
- Expanding $\simeq 4\%$ of total corporate bond issuance (Central Banking 2021)



Source: Bloomberg green bond data

This paper

We attempt to understand why firms issue green bonds

- We build on prior empirical studies
- To present a theory for why firms commit to CO2 reducing projects through certified green bonds
- Our explanation relies on managerial incentives
- We will test this explanation
- Both our theory and its empirical validation will stress the role of public policies

Empirical analysis of the green bond boom

Stylized facts:

- F1 Green bonds work: Issuers reduce CO2 emissions wrt non issuers
  - Flammer 2020
- F2 Issuing firms' stock price increases: "abnormal returns"
  - Tang & Zang 2018 (1.5%), Baulkaran 2019, Flammer 2020
- F3 Certification is critical: F1 and F2 only if certified green bonds
  - Flammer 2020, Kapraun & Scheins 2020
- F4 Green bonds pay the same as conventional ones: yield spread ≈ 0
  - Tang & Zang 2018 (7 bps), Zerbib 2019, Kapraun & Scheins 2020

Interpretation?

- × Greenwashing? Not for certified green bonds by F1 and F3
- × Cost of capital? Concerned investors? Excluded by F4
- ✓ Signal? F2 shows that information is revealed by green bonds
  - × Signal of environmental performance? Inconsistent with F4
  - ✓ Signal related to profitability of financed project
    - ⋆ F2 mainly for first issuance of large certified bonds wrt firm's size

Our theory: Two ingredients

1. Firms' green bonds are a **signaling device**, conveying positive, although imperfect, information about the profitability of environmental investments
   - Investors find it difficult to assess green projects wrt business-as-usual
   - Only firms with most profitable green projects would commit to finance them
   - This explains abnormal stock returns

But why do managers care about signaling and resulting stock returns?

2. Managers are interested in their firms' current stock price
   - **Managerial incentives**, also inducing "short-termism"
   - Various origins:
     1. Executive pay: stock and options with short vesting periods (eg, Edmans, Gabaix & Landier 2009)
     2. Other factors: attention to short-term results, takeover risk, short-term investors (Stein 1988; Summers & Summers 1989; Bolton, Scheinkman, & Xiong 2006; Cremers, Pareek & Sautner 2020), reflected by stock share turnover

Why do we care about green bonds?

Economists' traditional recommendation: Tax carbon!

- But evident political resistance
- Large carbon pricing gaps (OECD 2018)

Popular alternative to finance publicly climate friendly initiatives

- But governments' information, expertise and indebtedness constraints

Green finance certification is a potentially efficient work-around

- But it lacks consistent theoretical and empirical foundations
- Someday, a yield spread may arise
- In the meantime, why do firms issue green bonds?

$\Rightarrow$ Our spirit is "all of the above:" Pay attention to everything that seems to be working

Literature: Corporate Social Responsibility

Green finance commitments, although certified, are voluntary
Perhaps surprisingly, it seems effective

However, the mechanism sharply contrasts with the conventional view of CSR:

- Bénabou & Tirole 2010: Correction of excessive short-termism
- Maxwell, Lyon & Hackett 2000: Deterrence of future regulation
- Heal 2005, Daubanes & Rochet 2019: Avoidance of future conflicts
- Magill, Quinzii & Rochet 2015, Hart & Zingales 2017, Edmans 2020: Firms should be more inclusive

$\Rightarrow$ By contrast, we suggest that the green bond boom, although effective environmentally, mainly has to do with financial interest and short-termism

More Related literature

Certification: Here, agents not interested in information certified

- Bonroy & Constantatos 2015; Bonneton 2020
- Farhi, Lerner, & Tirole 2005; and Lerner & Tirole 2006
- Lyon & Fisher 2014; Bouvard & Levy 2020

Climate policy instruments: new mechanism of voluntary actions

- Tietenberg 1998; Khanna & Damon 1999; Denicolò 2008

Managerial incentives and short-termism

- Georgen & Renneboog 2011
- Stein 1988; Summers & Summers 1989; Bolton, Scheinkman, & Xiong 2006, Thanassoulis 2013
- Edmans et al 2018; Ladika & Sautner 2020; Cremers, Pareek, & Sautner 2020

Green finance: other aspects

- Gollier & Pouget 2009; Kotchen & Costello 2017; Chava 2014; Gibson Brandon, Krüger, & Mitali 2020; Barrage & Furst 2019; van der Ploeg & Rezai 2019; Landier & Lovo 2021

Model

Firms' projects

Continuum of firms, with regular activities, implement a single, incremental project:

$$\begin{array}{c}\text{1 unit of capital}\\ \text{at date } t=0\end{array} \quad \mapsto \quad \begin{array}{c}\text{Revenue } Y\\ \text{at date } t=1\end{array}$$

- Date 0 choice between green and conventional technologies $k = G, B$

$$\text{CO2 emissions at date } t=1: \quad x_B > x_G \geq 0$$

- CO2 taxed at unit rate $\tau > 0$, penalizing conventional projects more heavily
- Project of type $i \in [0,1]$ has cost

$$c_k(i) = \begin{cases} c_B & \text{if } k = B; \\ c_B + \Delta c(i) & \text{if } k = G, \end{cases}$$

  - No asymmetric info when $k = B$: Business as usual
  - Additional cost $\Delta c(i)$ is private information

Model

Firms with green finance

- Projects financed by bonds that repay $R \equiv 1 + r$, exogenous
- Green projects ($k = G$) are financed by certified green bonds
- Profit generated at $t = 1$ by incremental project $i \in [0, 1]$ under technology $k = G, B$:

$$\pi_k(i) = Y - R - c_k(i) - \tau x_k + \varepsilon_k(i), \quad \text{with} \quad \mathbb{E}\left[\varepsilon_k(i)\right] = 0$$

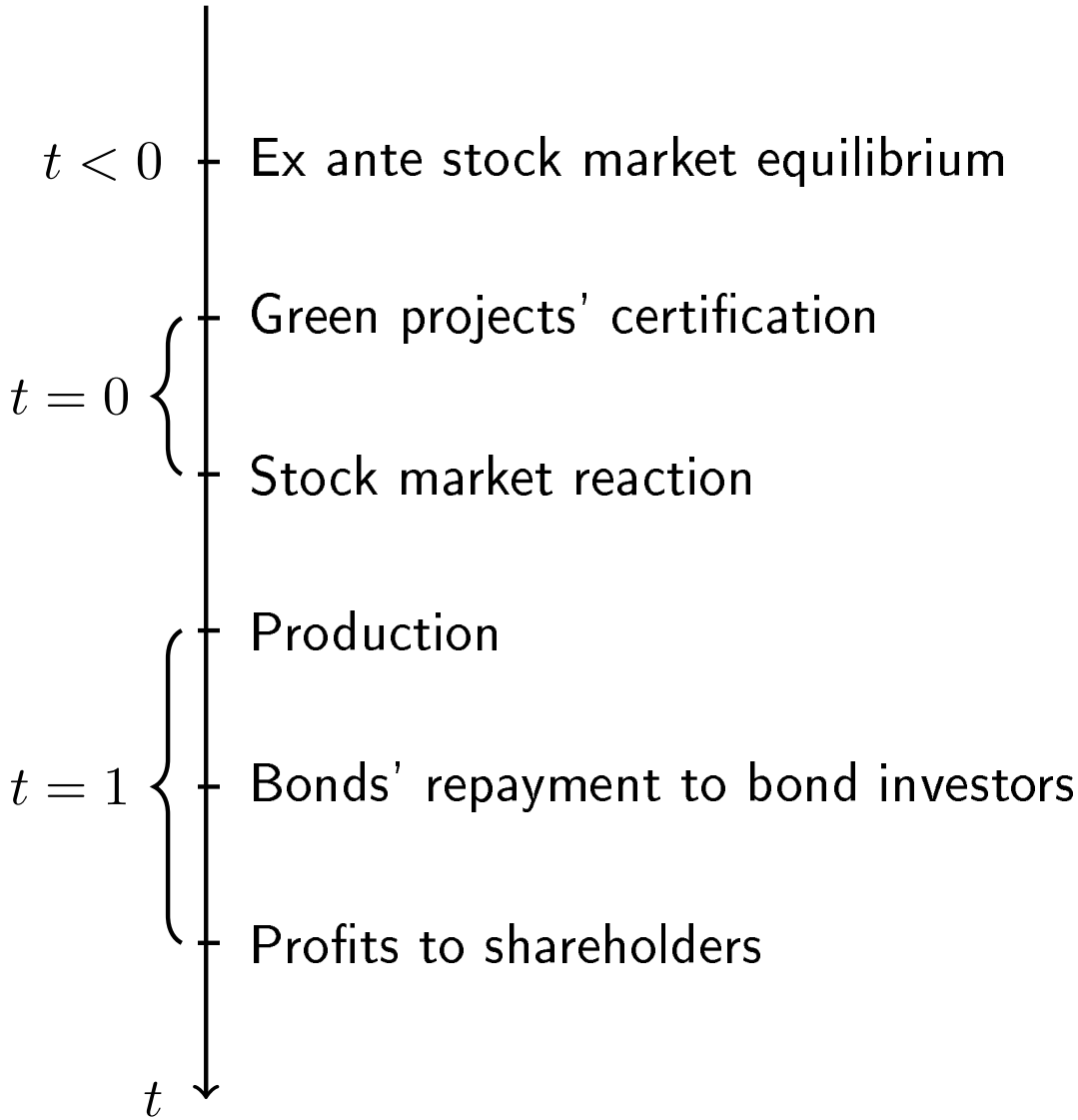
- At $t = 0$, managers observe i and choose $k = G, B$:

$$\max_k \ \mathcal{U}_k(i) = (1 - \alpha)\frac{V + \mathbb{E}\left[\pi_k(i)\right]}{1 + \rho} + \alpha \mathcal{S}_k$$

  - V is regular profit
  - Expected profit from new project is perfectly anticipated by manager but not by market
  - $\mathcal{S}_k$ is stock price, function of k
  - $\alpha \geq 0$ captures managers' sensitiveness to the stock price

Model

Timing



Model

Bond supply and stock market reaction

1. Bond supply: Managers choose $k = G$ (green bond) iff $i \leq i^e$ (most profitable projects):

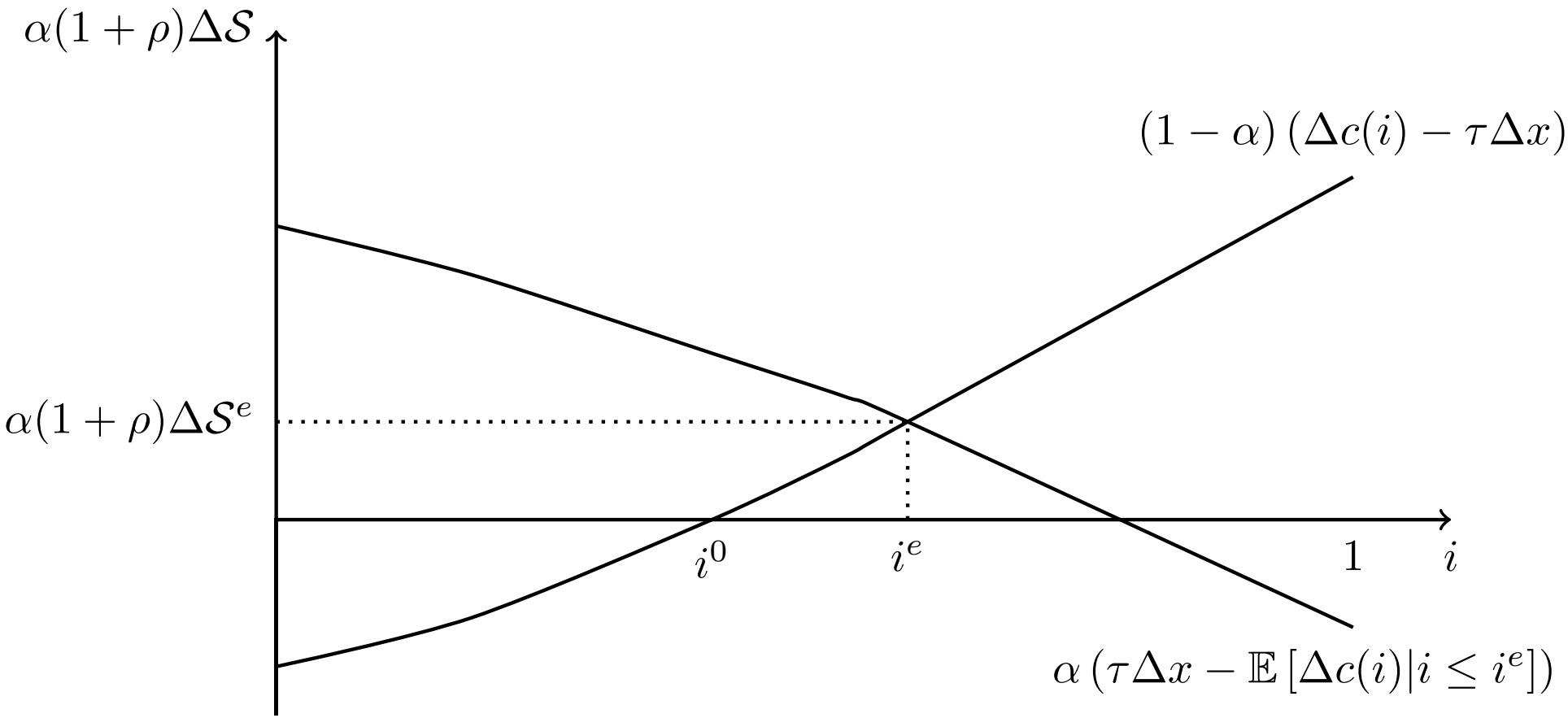
$$(1-\alpha)\underbrace{(\Delta c(i^e) - \tau\Delta x)}_{\text{net cost of green}} = \alpha\underbrace{(1+\rho)\Delta\mathcal{S}}_{\text{stock reaction}}, \quad \text{increasing} \tag{1}$$

2. Stock market reaction: Investors infer that firms issuing green bonds have projects with type $\mathbb{E}\left[\Delta c(i)|i \leq i^e\right]$:

$$\underbrace{(1+\rho)\Delta\mathcal{S}^e}_{\text{stock reaction}} = \underbrace{\tau\Delta x - \mathbb{E}\left[\Delta c(i)|i \leq i^e\right]}_{\text{signaled net cost}}, \quad \text{decreasing} \tag{2}$$

Model

Rational expectations equilibrium



Model

Equilibrium properties

Proposition 1 (Equilibrium with green bonds)

1. The rational expectations equilibrium exists and is unique
2. In this equilibrium:
   - The stock market reaction to green bonds is positive ($\Delta \mathcal{S}^e > 0$)
   - This proportion increases with both the industry's managerial stock-price sensitivity α and carbon pricing τ;

The positive effect of managerial incentives is the main prediction

Model

Testable prediction

Corollary 1 (Testable linear implication)

Assume that the green technology cost is affine: $\Delta c(i) \equiv a + bi$, with $b > 0$
The equilibrium proportion of green bonds in the industry takes the closed linear form:

$$i^e = \underbrace{-\frac{a}{b} + \frac{\tau \Delta x}{b}}_{i^0} + \underbrace{\frac{\Delta x}{b}\tilde{\alpha}\tau - \frac{a}{b}\tilde{\alpha}}_{\text{managerial incentives}} , \tag{3}$$

where $\tilde{\alpha} \equiv \alpha/(2-\alpha) \in (0,1)$

- i^0 only depends on τ
- Positive role of managerial incentives is driven by interaction between α and τ

$\Rightarrow$ Important implications!

1. Carbon price is essential to effectiveness of green bonds
2. The former is more powerful with the latter

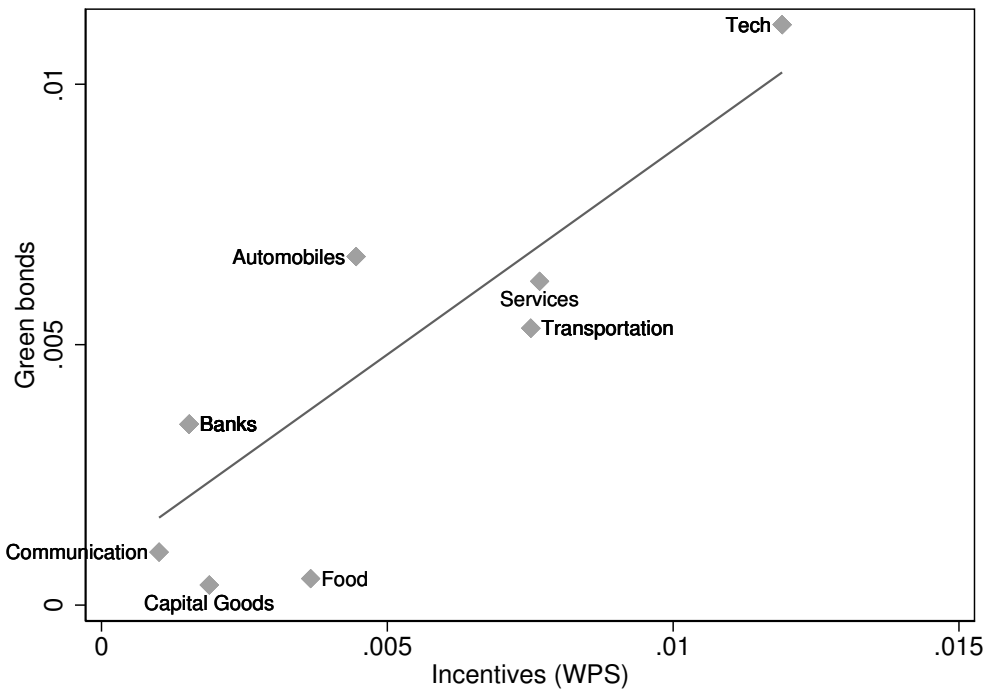
Empirics

Main data

- **Certified corporate green bonds**: Bloomberg/CBI 2013-19
- **Effective carbon price**: OECD
- **Managers' WPS (pay sensitivity to stock price)** measured in the US industries and extrapolated
- **Firm and industry characteristics** (size, book value, debt issuance, share stock turnover, stock market returns) from CRSP and Compustat Global
- **Environmental score** from Thomson Reuters ASSET4

$\rightarrow$ 455 firms and their 888 certified green bonds in 50 countries over 2013-19

Sectors with highest WPS are those issuing the most green bonds



Empirics: Main prediction

Firms' green bonds, carbon prices, and managerial incentives

$$\begin{aligned} \textit{Green bonds}_{i,t} &= \beta_0 + \beta_1 \textit{Carbon price}_{c(i),t-1} \times \textit{Incentives}_{j(i),t-1} \\ &+ \beta_2 \textit{Incentives}_{j(i),t-1} \\ &+ \beta_3 \textit{Controls}_{i,t-1} + \textit{Fixed effects} + \epsilon_{i,t} \end{aligned} \tag{4}$$

	Green bonds			
	(1)	(2)	(3)	(4)
Incentives (WPS)	-0.505***			
	(0.110)			
Carbon price × Incentives (WPS)	0.017***	0.024*		
	(0.006)	(0.014)		
Incentives (Turnover)			-0.158***	
			(0.053)	
Carbon price × Incentives (Turnover)			0.006**	0.005***
			(0.002)	(0.002)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Industry FE	Yes	No	Yes	No
Industry-year FE	No	Yes	No	Yes
Country-year FE	Yes	Yes	Yes	Yes
Observations	15011	15008	15148	15145
R^2	0.335	0.358	0.335	0.358

Empirics: Main prediction

Total effect of managerial incentives

- The total role of *Incentives* variables is positive on average, ie, at the average effective carbon price in our sample of \$32, but not statistically $\neq 0$
- At the EU average effective carbon price (most of the global current volume), total role of *Incentives* is positive and significantly $\neq 0$ at the 5-10% level when *Incentives=Turnover* and *Incentives=WPS*
- Eg, Automobiles industry in Germany has issued a few green bonds in the past few years
  - $WPS_{Automobiles} = 0.0002$, moderate
  - $\textit{Carbon price}_{Germany,2018} = \$74$, below EU average
  - Estimates predict: Firms in this industry issue around 4-5% more green bonds than the average firm

$\Rightarrow$ **Green bonds are effective where carbon prices are sufficiently high**

Empirics: Other aspects

Stock market reaction

Event-study estimation of stock returns generated by green bond announcements

- We estimate cumulative "abnormal"—not explained by other factors—returns (CAR) using the Fama-French Developed three-factor model
- Event window: $[-5, +5]$ days
- Different categories

	CAR	N
All	0.68%***	432
	(3.00)	
Financials	0.65%*	181
	(1.87)	
Corporate	0.68%**	238
	(2.19)	
First Issue	0.75%**	215
	(2.37)	
Certified	0.75%***	282
	(3.24)	
Non-certified	0.46%	189
	(1.08)	
Large	0.75%**	141
	(2.05)	

$\Rightarrow$ **Certified green bonds generate positive stock market reactions**
Effect concentrated on large, corporate, first issues

Empirics: Other aspects

Green bonds' environmental effectiveness

Instrumental variable analysis: Country-level two-stage regression
Instrument: Green bond policy support post 2017-18 in Japan, Singapore, Hong-Kong, & Malaysia

$$\textit{Green bonds}_{c,t} = \beta_0 + \beta_1 \textit{Policy}_{c,t-1} + \beta_2 \textit{Controls}_{c,t-1} + \textit{Fixed effects} + \epsilon_{c,t}$$

$$\textit{CO2}_{c,t+1} = \beta_0 + \beta_1 \widehat{\textit{Green bonds}}_{c,t} + \beta_2 \textit{Controls}_{c,t} + \textit{Fixed effects} + \epsilon_{c,t}$$

	1st stage *Green bonds*	2nd stage *CO2*	
	(1)	(2)	(3)
Policy (1 year), instrument	0.120**		
	(0.049)		
Instrumented *Green bonds*, (1 year)		-0.606**	-0.623**
		(0.272)	(0.260)
Controls	Yes	Yes	Yes
Year FE	Yes	No	Yes
Observations	211	211	211
R^2		0.703	0.701

⇒ **Green bonds contribute to reduce CO2 emissions**

Extension

Investors' concern for the environment

Investors' concern on bond market (projects' impact) and stock market (ESG)

- Investors' concern may play a role in the future (FT 2021)
- Extension features:
  - **Green bond yield spread**
  - **ESG-augmented** stock market reaction
- No qualitative change in testable prediction

Conclusion

Our theoretical analysis and empirical results suggest the following conclusions:

1. Although voluntary, **certified green bonds can induce firms to commit to effective CO2 reducing projects**
   - Firms' announcement of certified green projects convey positive information about the profitability of these projects as abnormal stock returns reflect.
2. Perhaps surprisingly, **firms' incentives to issue green bonds is likely a matter of financial interest and short-termism**
   - Very different from usual logic of CSR (Bénabou & Tirole 2010)
3. Green bonds are complementary to carbon pricing, with important practical implications
   - **Green bonds do not help governments avoid carbon penalties**
   - On the contrary, the latter are instrumental in the effectiveness of the latter
   - If carbon prices are sufficiently high, green bonds are likely to make them more effective

Extensions

Investors' concern for the environment

- Spread:

$$R_G = R_B - s$$

- Green bond demand:

$$s = \theta_B \Delta x \tag{5}$$

- ESG-augmented stock price:

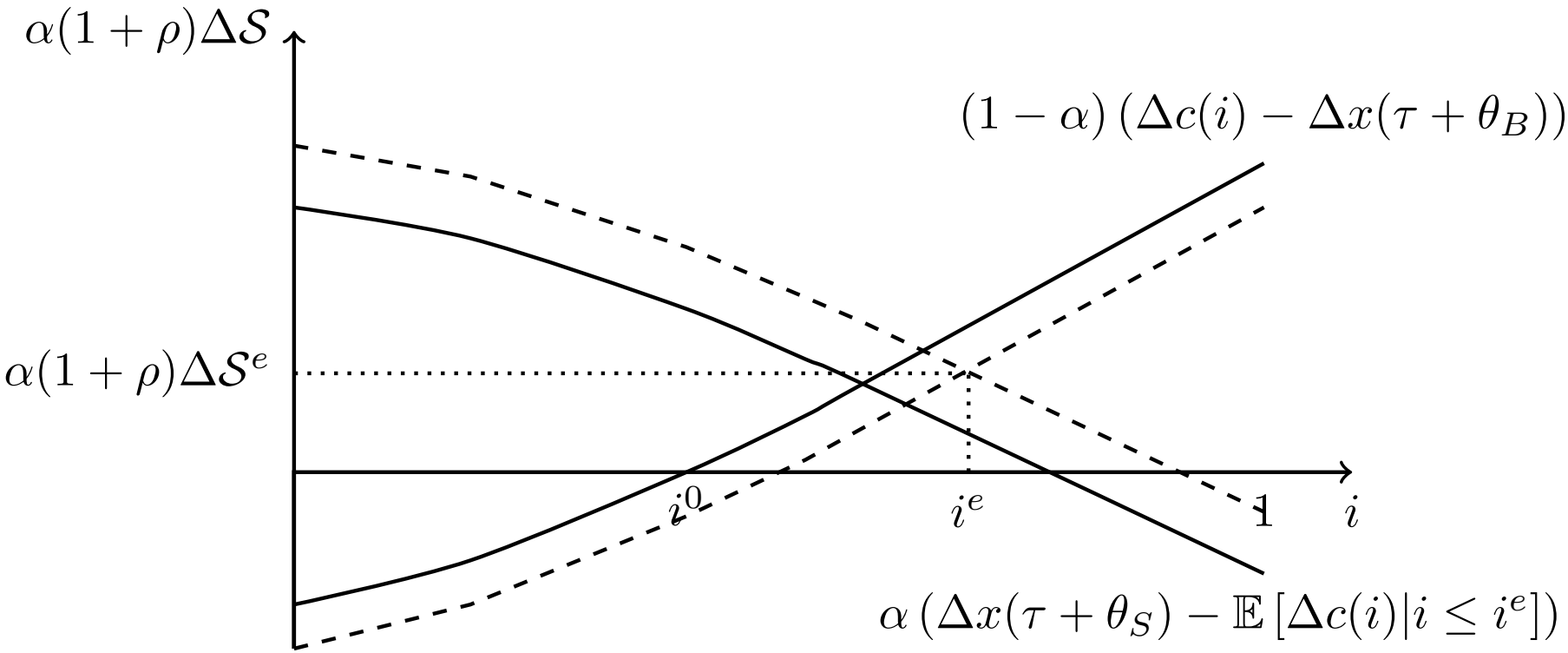
$$\mathcal{S}_k = \frac{V + \mathbb{E}\left[\pi_k(i)|k\right] + \theta_S \Delta x}{1+\rho},\ V \geq 0,\ i \in [0,1],\ k = G, B \tag{6}$$

- Stock price reaction to green bonds:

$$(1+\rho)\Delta\mathcal{S}^e = \tau\Delta x - \mathbb{E}\left[\Delta c(i)|i \leq i^e\right] + \theta_S \Delta x \tag{7}$$

Extensions

Investors' concern for the environment



Linear testable prediction for $i^e = i^e(\alpha, \tau, \theta_B, \theta_S)$:

$$i^e = \underbrace{-\frac{a}{b} + \frac{\tau\Delta x}{b}}_{i^0} + \underbrace{\frac{\Delta x}{b}\frac{\alpha\tau}{2-\alpha} - \frac{a}{b}\frac{\alpha}{2-\alpha}}_{\text{managerial incentives}} + \underbrace{\frac{2\Delta x}{b}\frac{[(1-\alpha)\theta_B + \alpha\theta_S]}{2-\alpha}}_{\text{investors' concern}} \tag{8}$$

Empirics

Distribution of green bonds

Distribution of green bonds by country

	N	Total (MM)
China	275	109,085
France	193	39,585
Italy	21	10,267
Japan	69	10,762
Mexico	9	12,186
Netherlands	81	53,496
Norway	34	8,188
Others	578	159,694
SNAT	445	85,766
Sweden	220	18,548
UK	22	8,005
US	248	53,147

Empirics

Summary statistics

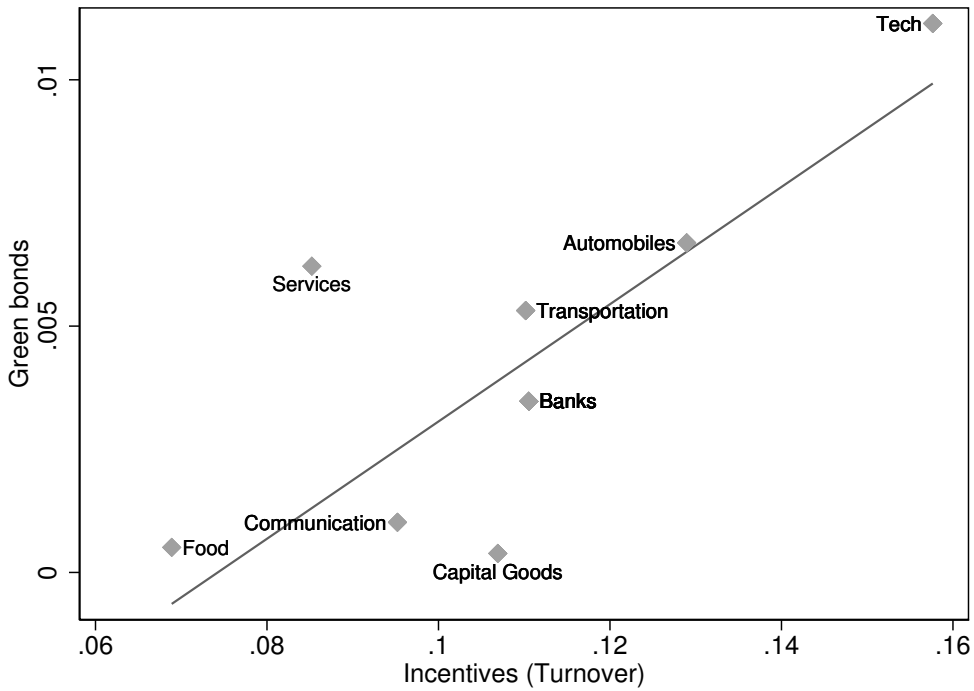
Summary statistics of key variables

	mean	sd	min	p25	p50	p75	max
Green bonds (%)	17.009	24.179	0.070	0.742	5.043	21.332	92.589
Carbon price ($)	32.480	37.202	0.882	8.042	11.364	55.519	163.147
Environmental score	48.998	23.079	0.000	29.480	47.340	67.560	99.310
Firm Size ($B)	239.843	5,422.056	0.000	0.102	0.641	3.981	4.48e+05
Scaled WPS	529.688	15771.873	0.992	7.096	13.615	40.943	8.69e+05
Share turnover	142.685	407.876	0.000	71.814	97.905	135.681	7,880.690
Firm CO2 emissions (Mt)	4.00	10.8	0.000	0.082	0.359	2.14	99

Empirics

Main data: Share turnover

Sectors with highest share turnover are those issuing the most green bonds



Empirics

Total effect of managerial incentives: Empirical model

Rewrite (4):

$$\begin{aligned} \textit{Green bonds}_{i,t} &= \beta_0 + \eta_1 \textit{Incentives}_{j(i),t-1} \\ &+ \eta_2 \left(\textit{Carbon price}_{c(i),t-1} - \overline{\textit{Carbon price}} \right) \times \textit{Incentives}_{j(i),t-1} \\ &+ \beta_3 \textit{Controls}_{i,t-1} + \textit{Fixed effects} + \epsilon_{i,t}, \end{aligned} \tag{9}$$

where $\eta_1 \equiv \beta_1 \times \overline{\textit{Carbon price}} + \beta_2$ becomes the coefficient of the total contribution of managerial incentives.

Consider, for example, the average effective carbon price in the EU, accounting for about 50% of the global volume of green bonds: $\overline{\textit{Carbon price}} = \$81.75$.

Empirics

Total effect of managerial incentives: Test

	Green bonds			
	(1)	(2)	(3)	(4)
Incentives (WPS)	0.908*			
	(0.454)			
$\overline{Carbon\ price}$ × *Incentives (WPS)*	0.017***	0.024*		
	(0.006)	(0.014)		
Incentives (Turnover)			0.340**	
			(0.144)	
$\overline{Carbon\ price}$ × *Incentives (Turnover)*			0.006**	0.005***
			(0.002)	(0.002)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Industry FE	Yes	No	Yes	No
Industry-year FE	No	Yes	No	Yes
Country-year FE	Yes	Yes	Yes	Yes
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R^2	0.335	0.358	0.335	0.358

Empirics

Some robustness analysis: Firm-level variations and foreign activity

	Green bonds			
	(1)	(2)	(3)	(4)
Carbon price × *Incentives (Firm-level Turnover)*	1.463**	1.588**	0.403*	0.441*
	(0.637)	(0.682)	(0.235)	(0.240)
Foreign sales		0.250		
		(0.230)		
Foreign assets			229.362*	
			(121.177)	
Foreign income				2.191
				(2.510)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes
Country-year FE	Yes	Yes	Yes	Yes
Observations	15145	14008	11912	11260
R^2	0.358	0.359	0.428	0.429