Do investors care about carbon risk?

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Outline

- Introduction
- Data and sample
- Empirical results
- Conclusion

1. Introduction-- Background

- The **Paris COP 21 climate agreement** of December 2015, with 195 signatories committing to limit global warming to well below 2 °C above preindustrial levels.

- The rising engagement of the **finance industry** with climate change, largely as a result of the call to non-governmental actors to join the fight against climate change at the COP 21.

1. Introduction-- Motivation

- Considerable skepticism remains, not least in the US where the Trump administration had worked to upend regulations that limit CO2 emissions.
- The lack of consensus among institutional investors around climate change naturally raises the possibility that carbon risk may not yet be reflected in asset prices.

➢ Whether carbon emissions represent a material risk for investors that is reflected in the cross-section of stock returns and portfolio holdings.

1. Introduction– Research assumptions

- The carbon risk premium hypothesis:
  - positive relation in the cross-section between a firm's own CO2 emissions and its stock returns.
  - CO_2 → fossil-fuel energy prices and commodity price risk

    →carbon pricing risk and other regulatory interventions.

    →lower-cost renewable energy
- Market inefficiency, or carbon alpha, hypothesis:
  - Financial markets are pricing carbon risk inefficiently and the risk associated with carbon emissions is underpriced.
- A third hypothesis is that the stocks of firms with high emissions are like other "sin stocks"

1. Introduction– main results

- Carbon emissions significantly and positively affect stock returns.
- Investors are discerning these cross-sectional differences and are pricing in carbon risk.
- The carbon premium cannot be explained through a sin stock divestment effect.

1. Introduction-- Contribution

- Carbon emissions significantly affect stock returns.
- Our study is related to a rapidly growing literature on climate change and financial markets.

2. Data and sample

- Database :2005–2017, Trucost and FactSet in the US
  - Trucost provides information on corporate carbon and other greenhouse gas emissions.
  - FactSet provides data on stock returns, corporate fundamentals, and institutional ownership

- Seven main carbon emissions providers: CDP, Trucost, MSCI, Sustainalytics, Thomson Reuters, Bloomberg, and ISS.

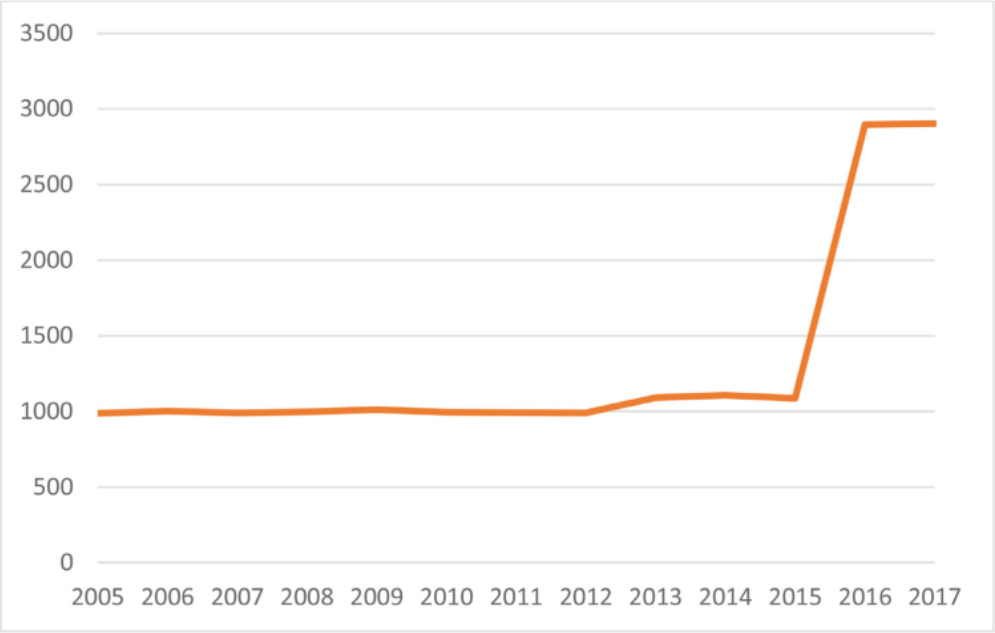

Fig. 2. Carbon emissions: sample selection.
The data source is Trucost. The figure presents the number of firms with valid emission data over the 2005–2017 period.

2. Data and sample

- Three different sources of emissions:
  - Scope 1 emissions: **direct emissions** and **fossil fuel** used in production.
  - Scope 2 emissions : **purchased heat, steam, and electricity.**
  - Scope 3 emissions : **sources not owned or controlled** by the company.

- Three categories of measurements:
  - Log (Carbon Emissions Scope (tons CO2e))
  - Growth Rate in Carbon Emissions Scope
  - Carbon Intensity Scope (tons CO2e/USD m.)/100

2. Data and sample

- Other variables
  - Cross-sectional return variables
    - RET、LOGSIZE 、B/M 、LEVERAGE 、MOM 、INVEST/A 、ROE、HHI 、LOGPPE、BETA、VOLAT、SALESGR、EPSGR
  - Time-series variables
    - MKTRF、HML 、SMB 、MOM 、CMA 、BAB 、LIQ 、NET ISSUANCE 、IDIO VOL
  - Ownership variables
    - IO 、IO_BANKS 、IO_INSURANCE 、IO_INVESTCOS、IO_ADVISERS 、IO_PENSIONS 、IO_HFS 、PRINV 、VOLAT 、VOLUME 、NASDAQ 、SP500

3. Results-- **Determinants of carbon emissions**

Variables	(1) LOG (SCOPE 1)	(2) LOG (SCOPE 2)	(3) LOG (SCOPE 3)
LOGSIZE	0.438***	0.571***	0.572***
	(0.036)	(0.032)	(0.022)
B/M	0.464***	0.555***	0.562***
	(0.060)	(0.059)	(0.054)
ROE	0.006***	0.006***	0.007***
	(0.001)	(0.001)	(0.001)
LEVERAGE	0.531**	0.625***	0.574***
	(0.196)	(0.188)	(0.162)
INVEST/A	−2.026***	−1.950***	−2.457***
	(0.489)	(0.460)	(0.432)
HHI	−1.044***	−0.569***	−0.499***
	(0.119)	(0.081)	(0.063)
LOGPPE	0.376***	0.372***	0.317***
	(0.036)	(0.037)	(0.023)
SALESGR	0.237***	0.190**	0.231**
	(0.059)	(0.062)	(0.077)
EPSGR	0.137**	0.146**	0.144**
	(0.049)	(0.049)	(0.050)
Year/month F.E.	Yes	Yes	Yes
Industry F.E.	Yes	Yes	Yes
Observations	189,187	189,115	189,283
R-squared	0.899	0.849	0.905

- All three categories of emission levels,and changes in emissions, are significantly positively related to LOGSIZE.

3. Results--**Evidence on cross-sectional returns**

Panel A: Total emissions

Variables	(1)	(2)	(3)	(4)	(5)	(6)
LOG (SCOPE 1 TOT)	0.043**			0.164***		
	(0.023)			(0.036)		
LOG (SCOPE 2 TOT)		0.098**			0.167***	
		(0.042)			(0.048)	
LOG (SCOPE 3 TOT)			0.135**			0.312***
			(0.046)			(0.071)

Panel B: Growth rate in total emissions

Variables	(1)	(2)	(3)	(4)	(5)	(6)
ΔSCOPE 1	0.641***			0.627***		
	(0.153)			(0.144)		
ΔSCOPE 2		0.345**			0.321**	
		(0.125)			(0.120)	
ΔSCOPE 3			1.203***			1.186***
			(0.318)			(0.314)

Panel C: Emission intensity

Variables	(1)	(2)	(3)	(4)	(5)	(6)
SCOPE 1 INT	−0.010			0.005		
	(0.012)			(0.006)		
SCOPE 2 INT		0.145			0.081	
		(0.121)			(0.074)	
SCOPE 3 INT			0.055			0.048
			(0.033)			(0.075)

$$RET_{i,t} = a_0 + a_1 LOG\ (TOT\ Emissions)_{i,t} + a_2 Controls_{i,t-1} + \mu_t + \varepsilon_{i,t},$$

3. Results--**Carbon premium and risk factors**

Panel A: Total emissions						
	LOG (SCOPE 1 TOT)		LOG (SCOPE 2 TOT)		LOG (SCOPE 3 TOT)	
Variables	(1)	(2)	(3)	(4)	(5)	(6)
MKTRF		−1.176		3.298***		3.429**
		(0.714)		(1.084)		(1.357)
HML		−6.020***		−4.284**		−6.444**
		(1.598)		(1.759)		(2.537)
SMB		−0.331		1.184		1.539
		(0.887)		(2.858)		(1.840)
Constant	0.058**	0.053**	0.085**	0.070***	0.103***	0.065**
	(0.026)	(0.023)	(0.037)	(0.027)	(0.035)	(0.027)

Panel B: Growth rate in total emissions						
	ΔSCOPE 1		ΔSCOPE 2		ΔSCOPE 3	
Variables	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.640***	0.643***	0.435***	0.463***	1.559***	1.424***
	(0.089)	(0.120)	(0.065)	(0.063)	(0.237)	(0.250)

Panel C: Emission intensity						
	SCOPE 1 INT		SCOPE 2 INT		SCOPE 3 INT	
Variables	(1)	(2)	(3)	(4)	(5)	(6)
Constant	−0.006	−0.004	0.121	0.181*	0.018	0.012
	(0.008)	(0.007)	(0.102)	(0.097)	(0.027)	(0.028)

$$a_{1,t} = c_0 + \boldsymbol{cF_t} + \varepsilon_t,$$

3. Results-- **The divestment hypothesis**

Panel A: Aggregate ownership (Emission intensity)

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	(0.085)	(0.083)				
SCOPE 2 INT			−0.383	−0.381		
			(1.621)	(1.610)		
SCOPE 3 INT					0.094	−0.130
					(0.550)	(0.581)

Panel B: Disaggregate ownership

Variables	(1) Banks	(2) Insurance	(3) Invest. Cos.	(4) Advisers	(5) Pensions	(6) Hedge Funds
SCOPE 1 INT	0.001**	−0.011*	0.026	−0.258***	−0.009*	0.033
	(0.000)	(0.005)	(0.022)	(0.056)	(0.004)	(0.028)
SCOPE 2 INT	0.009	−0.253	−0.139	−0.156	0.049	0.108
	(0.006)	(0.144)	(0.406)	(0.992)	(0.097)	(0.441)
SCOPE 3 INT	0.004*	−0.021	0.038	0.052	0.028	−0.230
	(0.002)	(0.071)	(0.115)	(0.409)	(0.030)	(0.151)

$$IO_{i,t} = d_0 + d_1 Emission_{j,t} + d_2 Controls_{j,t} + \varepsilon_{i,t}$$

3. Results-- **Coarse categorization**

Panel A: Total emissions						
Variables	(1)	(2)	(3)	(4)	(5)	(6)
LOG (SCOPE 1 TOT)	0.072**			0.177***		
	(0.025)			(0.044)		
LOG (SCOPE 2 TOT)		0.097**			0.227***	
		(0.039)			(0.057)	
LOG (SCOPE 3 TOT)			0.117**			0.324***
			(0.048)			(0.074)
Panel B: Growth rate in total emissions						
Variables	(1)	(2)	(3)	(4)	(5)	(6)
ΔSCOPE 1	0.657***			0.630***		
	(0.151)			(0.142)		
ΔSCOPE 2		0.463***			0.438***	
		(0.117)			(0.112)	
ΔSCOPE 3			1.480***			1.456***
			(0.321)			(0.322)
Panel C: Emission intensity						
Variables	(1)	(2)	(3)	(4)	(5)	(6)
SCOPE 1 INT	0.004			−0.012		
	(0.016)			(0.016)		
SCOPE 2 INT		0.154			0.150	
		(0.102)			(0.112)	
SCOPE 3 INT			0.054			0.160*
			(0.035)			(0.078)

Excludes companies in the oil and gas (gic=2), utilities (gic=65–69), and transportation (gic=18, 19, 23) industries

3. Results-- **Investor awareness(sub-periods)**

Panel A: Total emissions						
	2005–2015			2016–2017		
Variables	(1)	(2)	(3)	(4)	(5)	(6)
LOG (SCOPE 1 TOT)	0.127***			0.205**		
	(0.037)			(0.075)		
LOG (SCOPE 2 TOT)		0.127***			0.233**	
		(0.042)			(0.087)	
LOG (SCOPE 3 TOT)			0.265***			0.340***
			(0.086)			(0.107)
Panel B: Growth rate in total emissions						
	2005–2015			2016–2017		
Variables	(1)	(2)	(3)	(4)	(5)	(6)
ΔSCOPE 1	0.610***			0.629**		
	(0.161)			(0.249)		
ΔSCOPE 2		0.265***			0.459**	
		(0.097)			(0.193)	
ΔSCOPE 3			1.259***			1.032**
			(0.355)			(0.436)
Panel C: Emission intensity						
	2005–2015			2016–2017		
Variables	(1)	(2)	(3)	(4)	(5)	(6)
SCOPE 1 INT	0.005			0.010		
	(0.007)			(0.019)		
SCOPE 2 INT		0.091			0.117	
		(0.094)			(0.125)	
SCOPE 3 INT			0.030			0.040
			(0.091)			(0.087)

3. Results-- **Investor awareness(Paris Agreement)**

Panel A: Total emissions

Variables	(1)	(2)	(3)	(4)	(5)	(6)
TREAT1*AFTER	10.615***			10.705***		
	(1.175)			(1.200)		
TREAT2*AFTER		−1.783			−1.681	
		(5.861)			(5.821)	
TREAT3*AFTER			−8.917			−8.782
			(6.081)			(6.127)

Panel B: Growth rate in total emissions

Variables	(1)	(2)	(3)	(4)	(5)	(6)
TREAT1*AFTER	0.438			4.425		
	(4.426)			(3.373)		
TREAT2*AFTER		−3.712			0.361	
		(3.541)			(2.592)	
TREAT3*AFTER			0.396			3.671
			(4.338)			(3.927)

Panel C: Emission intensity

Variables	(1)	(2)	(3)	(4)	(5)	(6)
TREAT1*AFTER	2.825			2.855		
	(5.876)			(5.994)		
TREAT2*AFTER		−0.016			0.021	
		(5.344)			(5.417)	
TREAT3*AFTER			−7.614***			−7.749***
			(2.070)			(2.128)

$$RET_{i,t} = e_0 + e_1 TREAT * AFTER_{j,t} + e_2 Controls_{i,t} + e_3 \mu_i + e_4 \mu_t + \varepsilon_{i,t},$$

3. Results-- **Investor awareness(imputed emissions)**

Panel A: (2005–2017)						
Variables	(1)	(2)	(3)	(4)	(5)	(6)
LOG (SCOPE 1 TOT)	0.097***			0.291***		
	(0.024)			(0.046)		
LOG (SCOPE 2 TOT)		0.186***			0.336***	
		(0.043)			(0.065)	
LOG (SCOPE 3 TOT)			0.245***			0.585***
			(0.043)			(0.127)
Panel B: (1990–1999)						
Variables	(1)	(2)	(3)	(4)	(5)	(6)
LOG (SCOPE 1 TOT)	−0.037			0.082		
	(0.034)			(0.078)		
LOG (SCOPE 2 TOT)		0.033			0.236	
		(0.045)			(0.134)	
LOG (SCOPE 3 TOT)			0.005			0.318*
			(0.059)			(0.162)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year/month F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Industry F.E.	No	No	No	Yes	Yes	Yes

- Investors did not yet internalize carbon risk over the 1990s , but began to do so in the last two decades, as reporting on climate change.

Conclusion

- Carbon emissions significantly and positively affect stock returns.
- Investors are discerning these cross-sectional differences and are pricing in carbon risk.
- The carbon premium cannot be explained through a sin stock divestment effect.

Idea

- 碳排放交易市场对碳溢价的影响。

- Wen, Fenghua, Nan Wu and Xu Gong. China’s Carbon Emissions Trading and Stock Returns. Energy Economics,2020.