

# Carbon Transition Risk

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Mayo Center Seminar

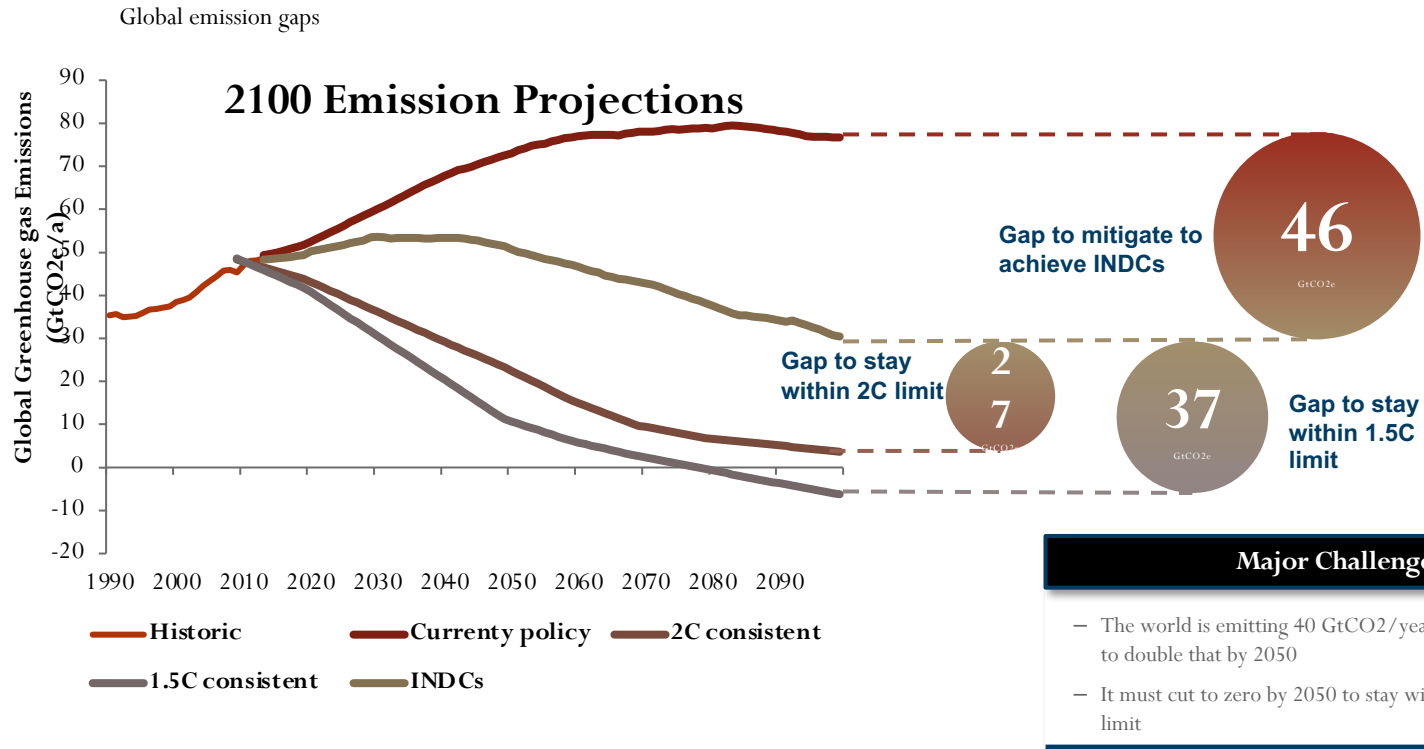
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# Motivation

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- Global warming is at the forefront of policy and social debates for some time now
  - COP21 and “Net Neutral” commitments
  - The stated objective is to reduce carbon emissions sufficiently to avoid an average temperature rise of more than 1.5 degrees Celsius by 2050
  - These commitments to reduce carbon emissions generate **transition risk** for corporations
  - **Two dimensions of transition risk:**
    1. At what **cost** will carbon emissions decline; will they decline fast enough?
    2. How do investors’ perceptions and **expectations** about carbon risk evolve?

# The Global Net Neutrality Target



Source: Climate Action Tracker Database, Global emissions time series, updated November 2017. Time series data for INDCs, 2C consistent, 1.5C consistent time series are computed as medians of highest and lowest potential global emission level results.

# Background on Transition Risk

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- **Level** of firms' emissions determines their distance from net neutrality (size of transition) → **Long-term risk**
- Short-term **changes** in emissions determine firms' progress towards net neutrality
  - An increase in emissions means more risk as firms move away from Net Zero
  - **Short-term risk**
- Investors require compensation for holding assets with greater transition risk
- The absence of an asset pricing model with transition risk makes the discussion of “fair pricing” difficult (carbon “alpha” vs. carbon “beta”)

# Background on Transition Risk (2)

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- 1) The rate of decline depends on:
  - technological progress
  - policy tightness
- Uncertainty about each element increases transition risk  
(the cash-flow effect)
- 2) Investors' perceptions about carbon risk depend on:
  - socio-economic environment
- Stronger preferences for greening the economy amplify transition risk  
(the discount rate effect)

# Research Questions

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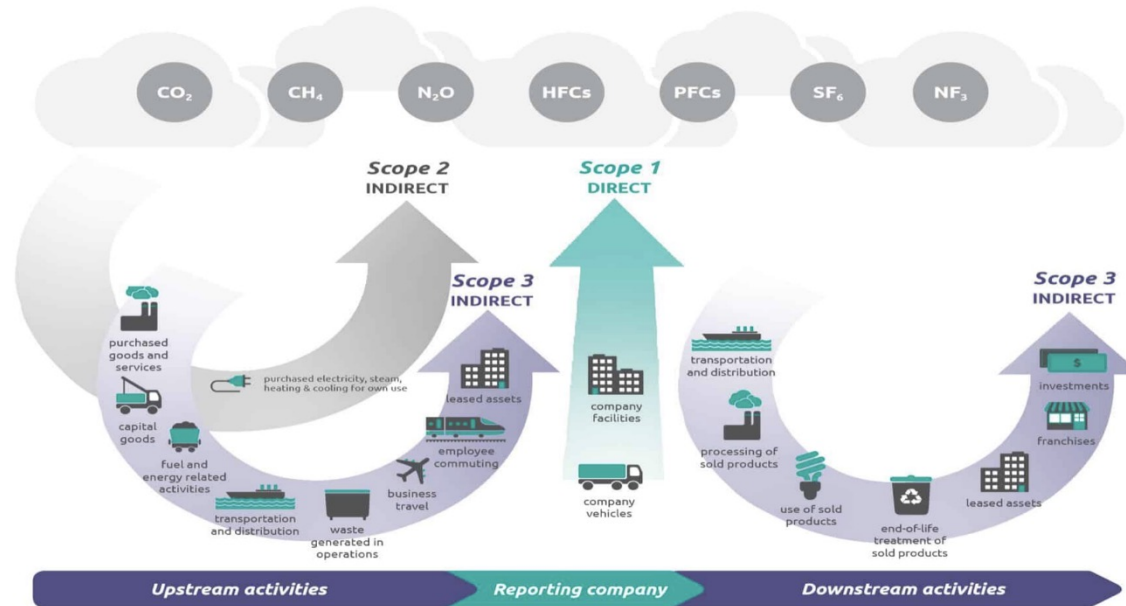
- Our research is based on a large panel of over 14,400 firms from 77 countries over the **2005-2018** time period

## Main Questions:

- Do we observe systematic differences in returns between firms with different exposures to carbon-transition risk?
- How is carbon-transition risk priced across countries?
- What are the key drivers of carbon-transition risk?

# Primer on Carbon Emissions

- Three different basic sources of carbon emissions from a company's operations and economic activity



Source: GHG Protocol

- Data on scope 1 and scope 2 emissions have been more systematically reported
- Although scope 3 emissions are the most important component of companies' emissions in a number of industries (e.g., automobile manufacturing) they are the hardest to measure and assemble

# Carbon Premia Measurement

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- Estimate a pooled data regression model á la Daniel & Titman (1997) with:
  - monthly stock returns as a dependent variable
  - carbon emissions as a main explanatory variable (observed on an annual basis)
  - various firm-level characteristics as controls
- Include year-month and country fixed effects
- Coefficient of carbon emission measure identifies average carbon premium



# Estimating Carbon Premia (Levels)

DEP. VARIABLE: RET	(1)	(2)	(3)	(4)	(5)	(6)
LOGS1TOT	0.040* (0.021)			0.102*** (0.014)		
LOGS2TOT		0.136*** (0.026)			0.178*** (0.024)	
LOGS3TOT			0.173*** (0.024)			0.272*** (0.027)
LOGSIZE	-0.244*** (0.043)	-0.291*** (0.043)	-0.294*** (0.044)	-0.292*** (0.046)	-0.351*** (0.047)	-0.397*** (0.049)
B/M	0.706*** (0.222)	0.700*** (0.221)	0.713*** (0.220)	0.830*** (0.216)	0.796*** (0.213)	0.769*** (0.214)
LEVERAGE	-0.536** (0.205)	-0.522** (0.196)	-0.420* (0.193)	-0.417* (0.192)	-0.446** (0.180)	-0.433** (0.185)
MOM	0.977** (0.423)	0.980** (0.422)	0.979** (0.419)	0.968** (0.424)	0.979** (0.424)	0.979** (0.420)
INVEST/A	-2.255** (1.000)	-2.206* (1.041)	-1.784 (1.092)	-1.813* (0.950)	-1.593 (0.972)	-1.162 (0.992)
HHI	-0.008 (0.118)	0.019 (0.114)	0.141 (0.099)	0.050 (0.113)	0.047 (0.110)	0.134 (0.109)
LOGPPE	0.051** (0.022)	0.020 (0.027)	-0.004 (0.028)	0.052** (0.023)	0.038 (0.023)	0.010 (0.023)
ROE	0.019*** (0.004)	0.018*** (0.004)	0.017*** (0.004)	0.019*** (0.004)	0.018*** (0.004)	0.017*** (0.004)
VOLAT	0.641 (3.907)	0.314 (3.834)	0.386 (3.882)	0.942 (3.500)	0.814 (3.471)	0.836 (3.493)
SALESGR <sub>t+12</sub>	3.147*** (0.172)	3.212*** (0.175)	3.245*** (0.178)	3.176*** (0.168)	3.222*** (0.172)	3.281*** (0.174)
Yr/mo fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	Yes	Yes	Yes
Firm fixed effects	No	No	No	No	No	No
Observations	589,734	589,781	590,262	582,551	582,598	583,079
R-squared	0.165	0.166	0.166	0.167	0.167	0.167

# Estimating Carbon Premia (Changes)

DEP. VARIABLE: RET	(1)	(2)	(3)	(4)	(5)	(6)
S1CHG	0.440*** (0.061)			0.463*** (0.064)		
S2CHG		0.244*** (0.047)			0.257*** (0.052)	
S3CHG			1.278*** (0.173)			1.324*** (0.179)
LOGSIZE	-0.256*** (0.044)	-0.253*** (0.044)	-0.270*** (0.044)	-0.263*** (0.045)	-0.259*** (0.046)	-0.277*** (0.046)
B/M	0.717*** (0.221)	0.712*** (0.220)	0.753*** (0.222)	0.889*** (0.216)	0.881*** (0.216)	0.926*** (0.217)
LEVERAGE	-0.557** (0.208)	-0.538** (0.204)	-0.590** (0.201)	-0.385* (0.198)	-0.365* (0.196)	-0.413* (0.192)
MOM	0.948** (0.421)	0.964** (0.421)	0.856* (0.416)	0.938** (0.425)	0.955** (0.425)	0.844* (0.419)
INVEST/A	-2.240* (1.063)	-2.100* (1.079)	-2.420** (1.088)	-2.028* (0.951)	-1.926* (0.951)	-2.222** (0.946)
HHI	-0.097 (0.126)	-0.088 (0.126)	-0.114 (0.122)	-0.083 (0.115)	-0.074 (0.116)	-0.102 (0.113)
LOGPPE	0.092*** (0.026)	0.088*** (0.026)	0.107*** (0.026)	0.104*** (0.021)	0.100*** (0.021)	0.120*** (0.022)
ROE	0.020*** (0.004)	0.019*** (0.004)	0.020*** (0.004)	0.020*** (0.004)	0.019*** (0.004)	0.020*** (0.004)
VOLAT	0.546 (3.898)	0.635 (3.922)	0.550 (3.993)	0.833 (3.496)	0.904 (3.519)	0.856 (3.565)
SALESGR <sub>t+12</sub>	3.075*** (0.174)	3.102*** (0.177)	3.035*** (0.193)	3.079*** (0.169)	3.106*** (0.173)	3.046*** (0.190)
Yr/mo fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	Yes	Yes	Yes
Firm fixed effects	No	No	No	No	No	No
Observations	589,830	589,745	590,262	582,647	582,562	583,079
R-squared	0.165	0.165	0.166	0.167	0.167	0.167

# Book-to-Market Ratios (Levels)

DEP. VARIABLE: LNBM	(1)	(2)	(3)	(4)	(5)	(6)
LOGS1TOT	0.025*** (0.004)			0.053*** (0.004)		
LOGS2TOT		0.032*** (0.005)			0.057*** (0.004)	
LOGS3TOT			0.044*** (0.006)			0.072*** (0.005)
MSCI	-0.101*** (0.018)	-0.111*** (0.018)	-0.128*** (0.018)	-0.163*** (0.017)	-0.174*** (0.018)	-0.190*** (0.018)
ROE	-0.009*** (0.001)	-0.010*** (0.001)	-0.010*** (0.001)	-0.008*** (0.001)	-0.008*** (0.001)	-0.009*** (0.001)
ROE <sub>t+12</sub>	-0.016*** (0.001)	-0.016*** (0.001)	-0.016*** (0.001)	-0.015*** (0.000)	-0.015*** (0.000)	-0.015*** (0.001)
ROE <sub>t+24</sub>	-0.007*** (0.001)	-0.007*** (0.001)	-0.007*** (0.001)	-0.007*** (0.001)	-0.007*** (0.001)	-0.007*** (0.001)
ROE <sub>t+36</sub>	-0.005*** (0.001)	-0.005*** (0.001)	-0.005*** (0.001)	-0.004*** (0.000)	-0.004*** (0.000)	-0.004*** (0.000)
MOM	-0.467*** (0.043)	-0.467*** (0.042)	-0.465*** (0.041)	-0.464*** (0.038)	-0.463*** (0.038)	-0.461*** (0.038)
VOLAT	-0.537 (0.357)	-0.582 (0.352)	-0.508 (0.352)	-0.080 (0.256)	-0.103 (0.257)	-0.030 (0.254)
Yr/mo fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	Yes	Yes	Yes
Firm fixed effects	No	No	No	No	No	No
Observations	448,036	447,961	448,407	442,842	442,767	443,213
R-squared	0.496	0.495	0.498	0.577	0.575	0.578

# Book-to-Market Ratios (Changes)

DEP. VAR.: LNBMCHG	(1)	(2)	(3)	(4)	(5)	(6)
S1CHG	0.004*** (0.001)			0.004*** (0.001)		
S2CHG		0.004*** (0.001)			0.003*** (0.001)	
S3CHG			0.016*** (0.003)			0.015*** (0.003)
MSCI	0.000 (0.001)	0.000 (0.001)	0.000 (0.001)	0.000 (0.001)	0.000 (0.001)	0.001 (0.001)
ROE	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)
ROE <sub>t+12</sub>	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)
ROE <sub>t+24</sub>	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)
ROE <sub>t+36</sub>	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)
MOM	-0.061*** (0.005)	-0.061*** (0.005)	-0.062*** (0.005)	-0.061*** (0.005)	-0.061*** (0.005)	-0.062*** (0.005)
VOLAT	0.043 (0.108)	0.044 (0.107)	0.041 (0.106)	0.034 (0.108)	0.035 (0.108)	0.033 (0.107)
Yr/mo fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	Yes	Yes	Yes
Firm fixed effects	No	No	No	No	No	No
Observations	447,967	447,856	448,301	442,776	442,665	443,110
R-squared	0.149	0.149	0.149	0.150	0.150	0.150

# Regional Evidence

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- Does the geographic location matter for transition risk? Are markets for carbon risk segmented?
  - The short-term and long-term premium is **present in most geographic locations** globally. Some cross-sectional variation in magnitudes
  - Weaker results for countries from Africa and the Southern Hemisphere (Argentina, Australia, Brazil, Chile, Nigeria, South Africa)

# Decomposing Transition Risk

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- Which aspects of transition risk matter for asset prices?
  - technological (energy mix) changes
  - political environment
  - climate-related policy tightness
  - investor awareness
- What is the role of emissions disclosure?
- Do firm commitments matter?

# Decomposing Transition Risk

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- Which aspects of transition risk matter for asset prices?
  - technological (energy mix) changes: **production mix matters for ST Risk**
  - political environment : **matters for ST Risk**
  - climate-related policy tightness : **domestic policy matters for LT Risk**
  - investor awareness: **matters for LT Risk (based on COP 21 shock)**

# The Role of Disclosure

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- Transition risk is diluted by limited observation of firm-level carbon emissions
- Carbon disclosure is a way of reducing uncertainty about emissions
  - *Voluntary disclosure*: a way of signaling firm type/impact on society
  - *Mandatory disclosure*: a way of reducing uncertainty
- A significant policy push towards more disclosure (TCFD, NDC)
- SEC Chair Gary Gensler speech 28 July 2021



# The Value of Disclosure

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- Informational:
- Carbon emission disclosure tells us something about the level of emissions and the response of companies to the emissions
- Levels of emissions are persistent (easier to predict); surprises are more likely with the changes in emissions (changes more important)
- Disclosure can be connected to decarbonization plans
  - Disclosure events predict subsequent commitments by firms
- Legitimacy:
- Any engagement activity is easier if information is obtained from the source
- Divestment requires a strong proof of wrong-doing

# Disclosure and Carbon Premia

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- We estimate the pooled (panel) data return regressions with:
  - monthly stock returns as a dependent variable
  - **interaction** between **disclosure** and **emissions** as the main variable
  - various firm-level characteristics as controls
- We include year-month, country, industry, and firm fixed effects

# Estimating Carbon Premia (Changes)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Scope1chg	0.618***		0.633***		0.717***	
	(0.132)		(0.130)		(0.120)	
Scope2chg		0.445***		0.451***		0.512***
		(0.100)		(0.102)		(0.101)
Disclosure	0.196***	0.212***	0.182***	0.197***	0.181**	0.203**
	(0.055)	(0.058)	(0.050)	(0.053)	(0.076)	(0.080)
Disclosure*Scope1chg	-0.563***		-0.545***		-0.552***	
	(0.132)		(0.122)		(0.101)	
Disclosure*Scope2chg		-0.490***		-0.481***		-0.487***
		(0.111)		(0.104)		(0.092)
Industry Fixed Effects	N	N	Y	Y	Y	Y
Firm*Discl. Fixed Effects	N	N	N	N	Y	Y

# Voluntary vs. Mandatory Disclosure

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- What is the mechanism guiding voluntary disclosure results?
  - Uncertainty reduction
  - Adverse selection/Signaling
- In October 2013, Britain imposed **mandatory disclosure** for publicly listed companies
- Use a one-year window around the rule to assess the difference between voluntary and mandatory disclosure
- **Triple-difference regression** with:  $GBshock = 1$  for period 2013/11-2014/10 and  $GBshock = 0$  for 2012/11-2013/10
- Treatment = 0 (1) are firms that did (not) disclose prior to the shock
- Controls are set at the pre-period levels (robust for time-varying ones)

# 2<sup>nd</sup> Stage

VARIABLES	(1) ret_agg	(2) ret_agg	(3) ret_agg	(4) ret_agg
Ln(scope1)	0.104 (0.120)	-0.007 (0.425)		
Scope1chg			0.062 (0.185)	0.069 (0.130)
Treatment	0.846 (0.787)		-0.101 (0.359)	
Treatment*Ln(scope1)	-0.106 (0.086)	0.333 (0.404)		
Treatment*Scope1chg			-0.384 (0.591)	-0.688 (0.492)
GBshock*Ln(scope1)	-0.087 (0.116)	-0.109 (0.121)		
GBshock*Scope1chg			-0.642 (0.452)	-0.861* (0.420)
Treatment*GBshock	-2.952** (1.322)	-2.935** (1.386)	-0.800 (0.568)	-0.770 (0.509)
Treatment*GBshock*Ln(scope1)	0.234* (0.140)	0.245* (0.138)		
Treatment*GBshock*Scope1chg			1.288* (0.757)	1.313 (0.888)

# 2<sup>nd</sup> Stage: Spillover Effects (Europe)

Panel B12: Carbon Premium Effects (Europe cross-section)

Variable (Return)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	EU (ex. UK)				Non-EU			
Log(scope1)	0.067 (0.101)	0.658* (0.376)			0.259 (0.273)	0.021 (0.455)		
Scope1chg			0.384 (0.301)	0.410 (0.464)			1.278* (0.681)	1.897** (0.703)
Treatment	1.013 (0.668)	0.000 (0.000)	0.078 (0.277)	0.000 (0.000)	0.875 (0.740)	0.000 (0.000)	0.500 (0.420)	0.000 (0.000)
Treatment*Log(scope1)	-0.103 (0.064)	1.496 (1.261)			-0.030 (0.065)	2.275 (2.685)		
Treatment*Scope1chg			0.357 (0.808)	0.644 (1.171)			-1.383 (1.256)	-3.583 (2.483)
GBshock*Log(scope1)	0.096 (0.153)	0.046 (0.152)			-0.628* (0.336)	-0.564* (0.329)		
GBshock*Scope1chg			-0.042 (0.498)	-0.224 (0.650)			-1.926 (1.658)	-3.065** (1.392)
Treatment*GBshock	-2.898* (1.477)	-3.135** (1.473)	-0.610 (0.509)	-0.615 (0.512)	-2.480 (1.883)	-4.075** (1.916)	-0.530 (0.849)	-0.359 (0.845)
Treatment*GBshock*Log(scope1)	0.247* (0.134)	0.265* (0.136)			0.186 (0.196)	0.368* (0.202)		
Treatment*GBshock*Scope1chg			0.459 (1.251)	0.032 (1.424)			3.265 (3.040)	5.913 (3.768)
Controls	Y	Y	Y	Y	Y	Y	Y	Y
Firm Fixed Effects	N	Y	N	Y	N	Y	N	Y
Observations	9,378	9,378	9,368	9,368	1,262	1,262	1,262	1,262
R-squared	0.494	0.513	0.494	0.512	0.592	0.604	0.590	0.602

# 2<sup>nd</sup> Stage: Spillover Effects (North America)

Panel B2: Carbon Premium Effects (North America)

Variable (Return)	(1)	(2)	(3)	(4)
Log(scope1)	0.032 (0.076)	-0.383 (0.237)		
Scope1chg			-0.130 (0.349)	-0.272 (0.468)
Treatment	-0.393 (0.788)		0.109 (0.150)	
Treatment*Log(scope1)	0.046 (0.066)	0.604 (0.650)		
Treatment*Scope1chg			0.250 (0.752)	0.680 (0.601)
<u>GBshock</u> *Log(scope1)	-0.005 (0.112)	0.045 (0.133)		
<u>GBshock</u> *Scope1chg			-0.042 (0.480)	-0.090 (0.538)
Treatment* <u>GBshock</u>	0.233 (1.039)	0.747 (1.075)	-0.369 (0.282)	-0.391 (0.303)
Treatment* <u>GBshock</u> *Log(scope1)	-0.053 (0.087)	-0.102 (0.089)		
Treatment* <u>GBshock</u> *Scope1chg			0.431 (1.018)	0.199 (0.882)
Controls	Y	Y	Y	Y
Firm Fixed Effects	N	Y	N	Y
Observations	20,992	20,992	20,982	20,982
R-squared	0.433	0.454	0.433	0.454

# Firm Commitments

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## Net Zero (NZ) commitments:

- **Objective:** reduce carbon emissions sufficiently to avoid an average temperature rise of more than 1.5 degrees Celsius by 2050 with sufficiently high probability.
  - By now, **113 countries** (50% of the world's GDP) have made NZ commitments
  - IPCC Report 2021 → additional carbon emissions as of 2020 should not exceed 300Gt of CO<sub>2</sub>
  - IEA Report 2021 → global emissions last year were 31.5 Gt of CO<sub>2</sub>
- ⇒ At this rate the global **carbon budget** will be exhausted in **8.5 years**.

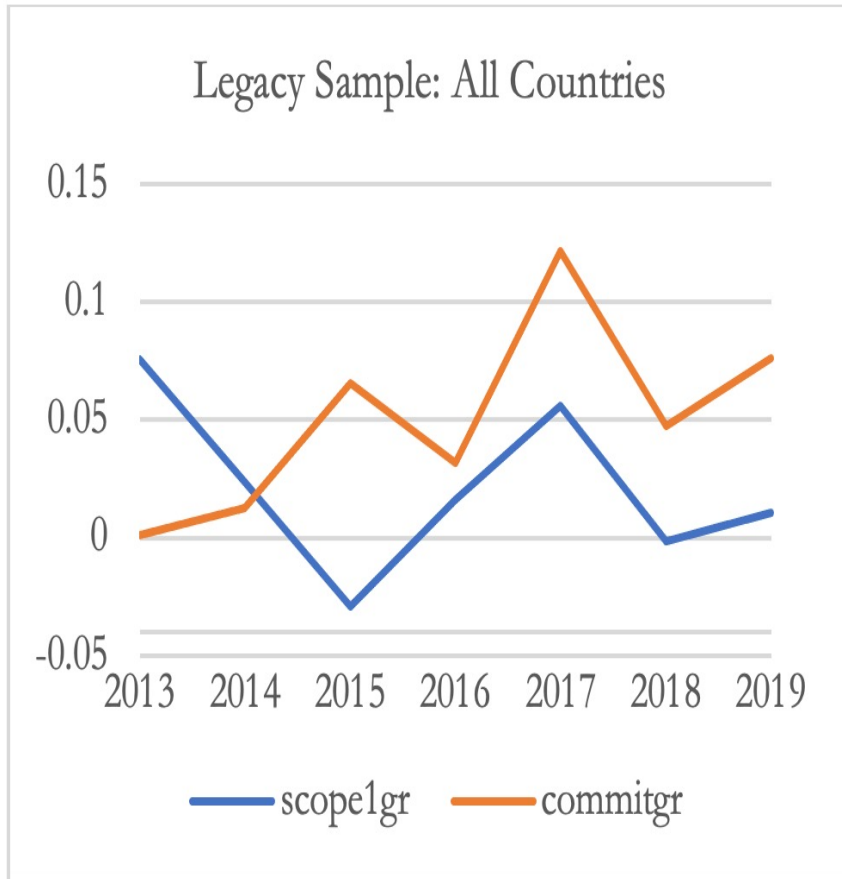


# Research Questions

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- What motivates companies to join a commitment movement?
- What are the real effects of commitment drives?
- Commitment activity is centered around two broad initiatives:
  - **CDP & SBTi**

# Aggregate Emissions and Commitments



	Coef.	Std. Err.	t	P>t
scope1gr				
<u>commitgr</u>	-0.1155	0.3764	-0.31	0.771
Constant	0.0276	0.0240	1.15	0.3

# What Predicts CDP Commitments?

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
LOGS1TOT	0.034*** (0.001)	0.057*** (0.001)	-0.006*** (0.002)	0.008*** (0.001)	-0.003** (0.001)	-0.009*** (0.002)
LOGSIZE				0.052*** (0.001)	0.060*** (0.002)	0.009*** (0.002)
LOGPPE				0.015*** (0.001)	0.017*** (0.001)	0.004** (0.002)
LEVERAGE				-0.000 (0.000)	0.000*** (0.000)	0.000 (0.000)
ROE				-0.000*** (0.000)	-0.000*** (0.000)	0.000*** (0.000)
M/B				-0.001 (0.001)	-0.005*** (0.001)	-0.000 (0.001)
INVEST/A				-0.003*** (0.000)	-0.003*** (0.000)	0.000 (0.000)
BETA				0.012*** (0.004)	0.016*** (0.005)	0.011* (0.006)
VOLAT				0.105*** (0.022)	0.102*** (0.022)	0.019 (0.018)
MOM				-0.367*** (0.040)	-0.352*** (0.040)	-0.033 (0.029)
RET				0.010 (0.009)	-0.003 (0.009)	-0.006 (0.006)
MSCI				0.195*** (0.005)	0.191*** (0.004)	0.055*** (0.006)
Constant	-0.026*** (0.003)	-0.152*** (0.005)	0.199*** (0.009)	-0.439*** (0.009)	-0.455*** (0.009)	0.088*** (0.021)
Country FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Industry FE	N	Y	N	N	Y	N
Firm FE	N	N	Y	N	N	Y
Observations	63,049	63,046	61,578	63,049	63,046	61,578
R-squared	0.155	0.238	0.820	0.309	0.352	0.821

# Commitments and Future Emissions

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- Do firm commitments lead to a reduction in corporate emissions?
- What is the relationship between firm and national commitments?
- Do commitments affect the level or the intensity of emissions?

# Results: Conditioning on Current Emissions

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		One Year Ahead				Three Years Ahead		
CDPCOM	-0.084*** (0.018)	-0.023 (0.058)			-0.132*** (0.042)	0.062 (0.073)		
SBTCOM			-0.120** (0.059)	-0.046 (0.105)			-0.234* (0.142)	0.044 (0.124)
LOGS1TOT	0.921*** (0.004)	0.459*** (0.014)	0.924*** (0.004)	0.292*** (0.016)	0.815*** (0.008)	-0.013 (0.016)	0.823*** (0.010)	-0.053*** (0.020)
CDPCOM*LOGS1TOT	0.012*** (0.002)	0.008 (0.008)			0.022*** (0.005)	-0.005 (0.010)		
SBTCOM*LOGS1TOT			0.015** (0.007)	0.004 (0.013)			0.022 (0.017)	-0.012 (0.015)

# Conclusions

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- Transition risk is already a material risk for investors & corporations
  - Transition risk is difficult to measure: focus on carbon emissions
  - It is reflected both as a long-term and short-term risk
  - The long-term premium is unrelated to economic development, energy mix, or social environment; more related to **domestic** policy implementation
  - The short-term premium is related to technology risk and social environment, less so to policy implementation
  - Importance of changing investor awareness (especially post Paris)
- Disclosure is important for scaling the size of transition risk
- Firm commitments can inform the path of future decarbonization
- Carbon premium acts like a carbon tax on capital