Outsourcing Climate Change

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1

Climate Change

2015 Paris climate change agreement
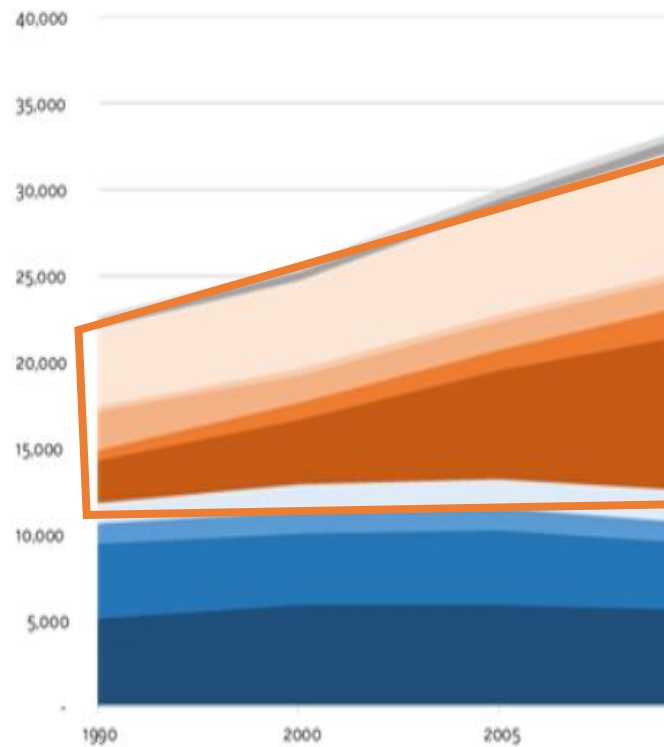
"*...the increase in the global ... temperature to well below 2 ... pre-industrial levels*". drafted ... countries (Brazil, South Africa, ... China) and the U.S.

... ied at G20 Hangzhou
... n "Green finance"

40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000

1990   2000   2005

Figure 1: Total Co2 emissions per region/country

https://www.unpri.org/pri-blog/can-soe
engagement/5467.article

Biden returns US to Paris climate accord hours after becoming president

Biden administration rolls out a flurry of executive orders aimed at tackling climate crisis

▲ Joe Biden kicks off his new administration with orders to restore the United States to the Paris climate accord. Photograph: Jim Watson/AFP/Getty Images

Joe Biden has moved to reinstate the US to the Paris climate agreement just hours after being sworn in as president, as his administration rolls out a cavalcade of executive orders aimed at tackling the climate crisis.

Biden's executive action, signed in the White House on Wednesday, will see the US rejoin the international effort curb the dangerous heating of the ...
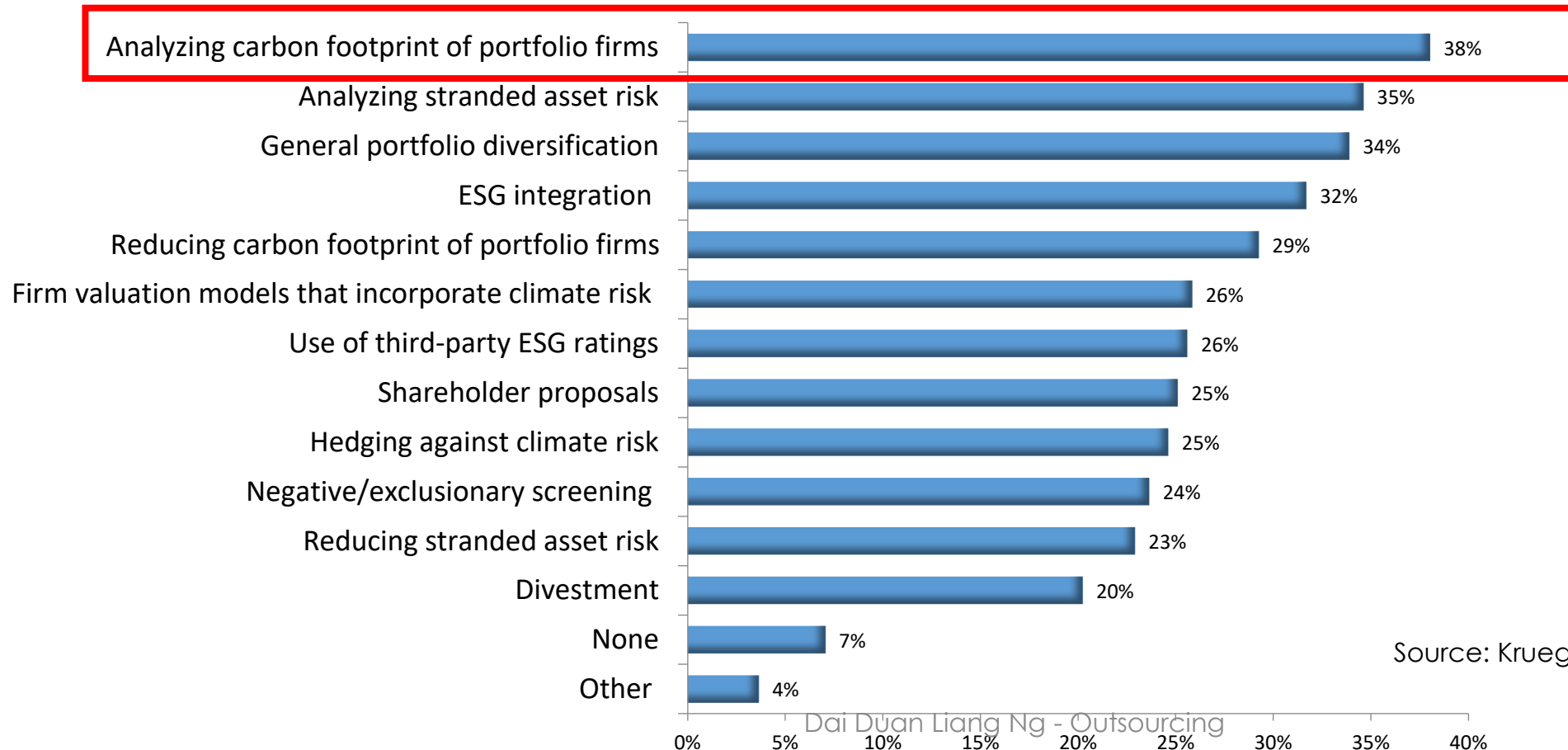

-Moon   Xi Jinping   Barack Obama
            (China)   (US)

2

Investors increasingly analyze carbon footprints of portfolio firms

Question: Which approach have you taken in the past five years to incorporate climate-risk management in your investment process?

Approach	Percentage
Analyzing carbon footprint of portfolio firms	38%
Analyzing stranded asset risk	35%
General portfolio diversification	34%
ESG integration	32%
Reducing carbon footprint of portfolio firms	29%
Firm valuation models that incorporate climate risk	26%
Use of third-party ESG ratings	26%
Shareholder proposals	25%
Hedging against climate risk	25%
Negative/exclusionary screening	24%
Reducing stranded asset risk	23%
Divestment	20%
None	7%
Other	4%

Source: Krueger, Sautner, and Starks (2020, RFS)

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3

Corporate Efforts in Reducing GHG Emission

- Besides governmental efforts (laws, regulations, taxation), corporations play an important and proactive role in reducing GHG emission
  - For example, Microsoft has been carbon neutral since 2012; Amazon is targeting a net-zero carbon footprint by 2040; 100% renewable electricity commitment (RE100)
  - In many countries/states, regulations are strong in curbing corporate emission (e.g., California cap-and-trade program)
  - Some financially constrained firms may shift their emissions and plants to less regulated countries/states to evade regulatory costs (e.g., Bartram, Hou, Kim, 2021)
- Much of the attention is paid to a firm's direct emission ("Scope 1" emission) and energy consumption ("Scope 2" emission)
- However, indirect emission from a firm's supply chain ("Scope 3" emission) is often ignored, despite it being a substantial part of total emission

The GHG protocol categorizes a company's GHG footprint into three different scopes: Scopes 1, 2, and 3.
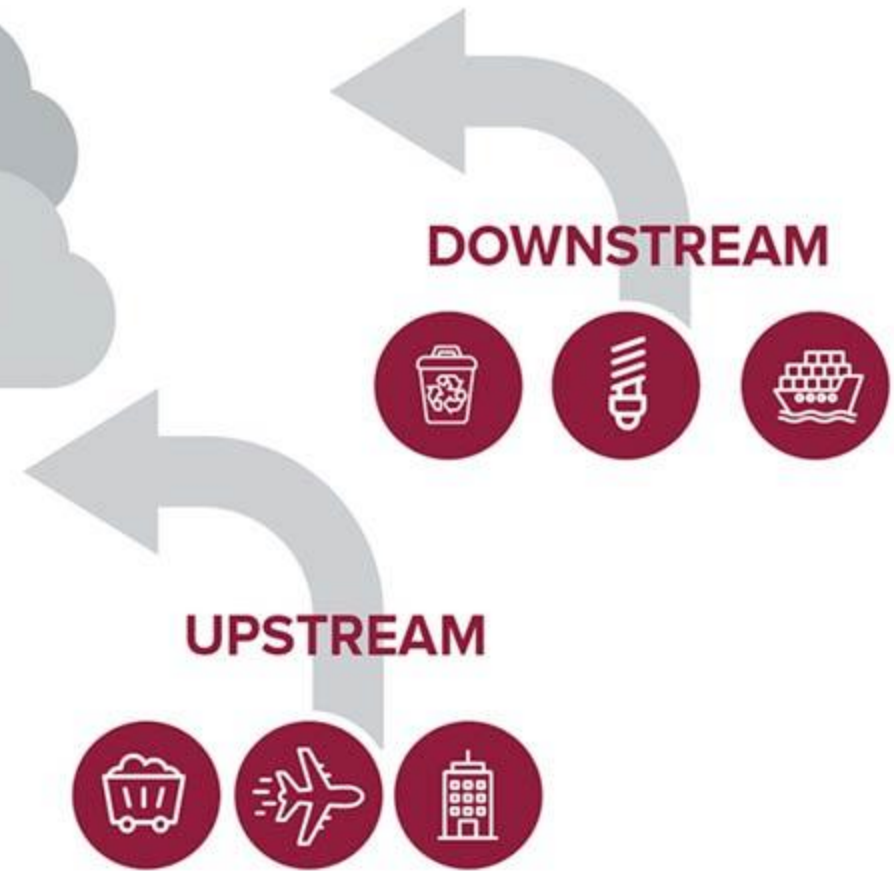
DOWNSTREAM

UPSTREAM

SCOPE 1
emissions are direct emissions from owned or controlled sources.

SCOPE 2
emissions are indirect emissions from the generation of purchased energy.

SCOPE 3
emissions are all indirect emissions (not included in scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions.
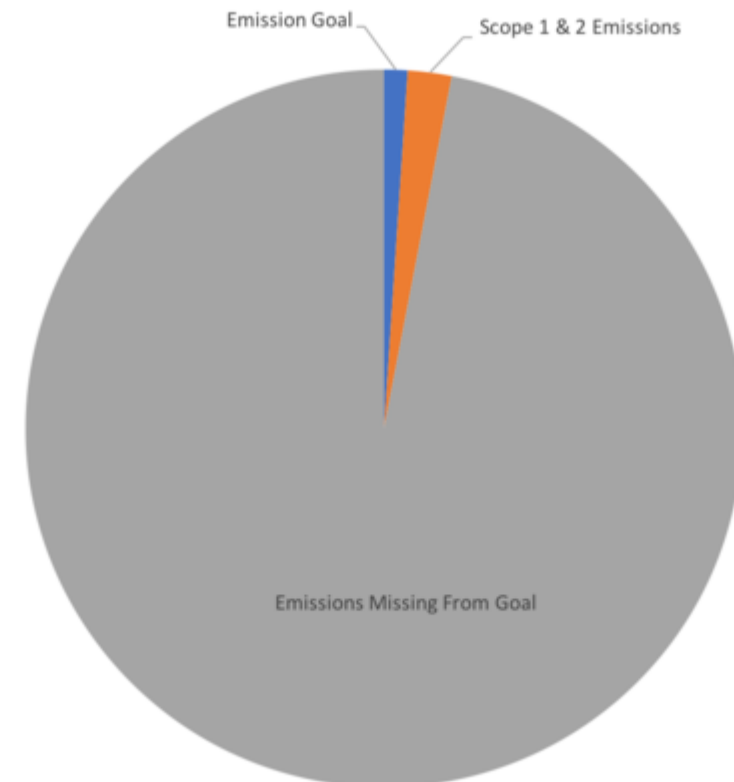
The Case of P&G

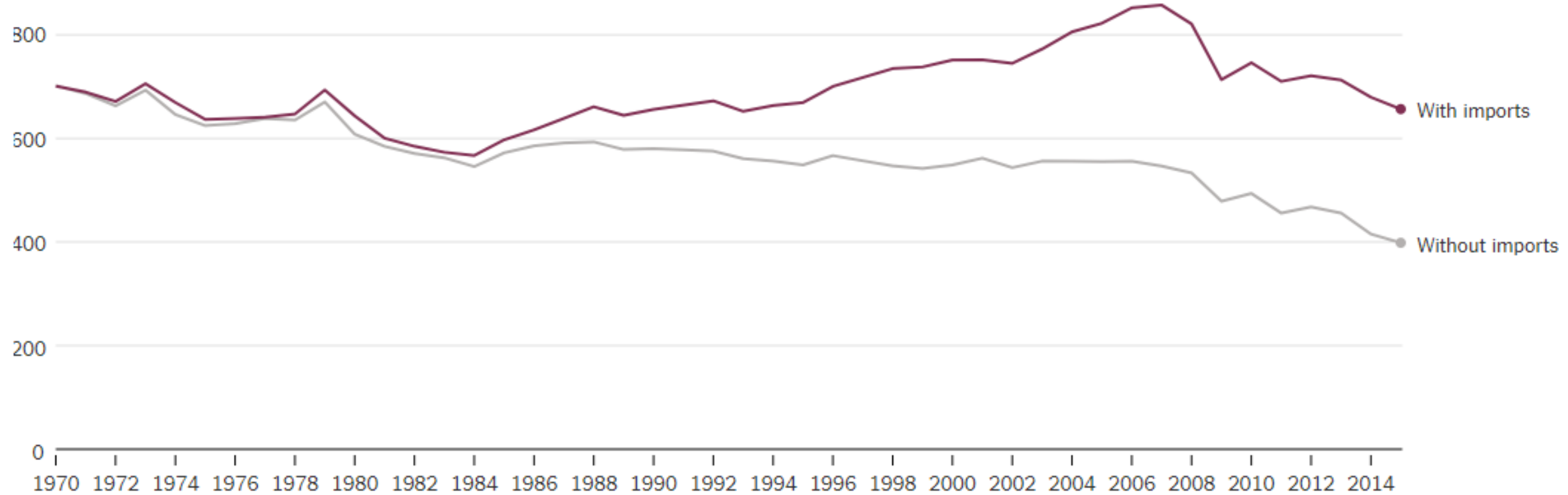P&G's climate commitment: reduce annual emissions by 50% by 2030

See "Corporate Honesty and Climate Change: Time to Own Up and Act," by Joshua Axelrod at the Natural Resources Defense Council (NRDC).

British emissions are higher when imports are included

Million metric tons of carbon dioxide

The top line shows emissions from all British consumption, including imports and excluding exports. The bottom line only shows domestic emissions.

https://www.nytimes.com/2018/09/04/climate/outsourcing-carbon-emissions.html

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7

Research Questions

- Do firms curb their own domestic emissions (in the U.S.) by outsourcing their carbon pollution to suppliers overseas, resulting in "carbon leakage"?

- What are the mechanisms that drive such emission outsourcing?

- Are investors aware of such emission outsourcing and its potential risks, and properly pricing it?

Data

- **S&P Global – Trucost**
  - Collects company environmental data, including performance data and disclosure metrics on greenhouse gas (GHG) emissions, water use, pollution impacts, and waste disposal.
  - Uses a variety of publicly disclosed sources, such as company financial reports (annual reports, financial statements, 10-K/20-F reports, SEC/regulatory filings), environmental data sources (CSR, sustainability, or environmental reports, the CDP, EPA filings), and data published on company websites or other public sources.

- **S&P Global – Panjiva**
  - Import and export details on commercial shipments worldwide; ocean freight shipment data for imports and exports from the U.S. including container specifications, TEU, weight in kilograms and metric tons.

- **Refinitiv ESG: Firm-level ESG ratings**

- **RepRisk: firm-level ESG reputational risk data**

- **Other data sources:** League of Conservation Voters, Enforcement and Compliance History Online, Energy Information Administration, EM-DAT, World Bank, IMF, OECD, WEF, BoardEx, Factset Revere, Factset Ownership, Compustat, CRSP, etc.

Arrival Date	Consignee Ultimate Parent	Shipper	Shipment Origin	Volume (TEU) ☐	Weight (t)	Value of Goods (USD)	CONTAINER INFO HS Code
				7,435			
Feb 23, 2021	Tesla, Inc. ☐ www.tesla.com 3500 Deer Creek Road, Palo Alto California 94304, United States ☐ company profile Stock Tickers: NasdaqGS:TSLA, BOVESPA:TSLA34	Shenzhen Qiyuanda Technology C Bei Liu Lu Shenzhen Shi Guangdong Sheng China Bei Liu Lu, Baoan Qu, Shenzhen Shi, Guangdong Sheng, China ☐ company profile Trade Roles: Manufacturer	China	2.0	11	$40,500.00	6004.10 ☐ 5603.12 ☐
Feb 23, 2021	Tesla, Inc. ☐ www.tesla.com 3500 Deer Creek Road, Palo Alto California 94304, United States ☐ company profile Stock Tickers: NasdaqGS:TSLA, BOVESPA:TSLA34	Autis Ingenieros S.L. 125 Avinguda d'Alacant Gandia Comunidad Valenciana 46702 Spain Av. d'Alacant, 125, 46702 Gandia, Valencia, Spain ☐ emvelopez@autis.es ☐ Phone 1: +34 962 96 58 00 ☐ company profile Industry: Professional Services Employees: 50 Incorporation Year: 1999	Spain	4.0	9		8428.90 ☐ 8428.90 ☐
Feb 23, 2021	Tesla, Inc. ☐ www.tesla.com 3500 Deer Creek Road, Palo Alto California 94304, United States ☐ company profile Stock Tickers: NasdaqGS:TSLA, BOVESPA:TSLA34	Varroc Lighting Systems S. De R.L. De C.V. 608 México Ciudad Apodaca Nuevo León Mexico México 608, Nuevo Apodaca, Ciudad Apodaca, N.L., Mexico ☐ Phone 1: +52 81 8369 2200 ☐ Fax: +52 81 8369 2388 ☐ company profile D-U-N-S®: 816518617 Revenue: $115,781,600 Employees: 2,200 Incorporation Year: 2012 Trade Roles: Manufacturer SIC Codes: 3714	Mexico	2.0	0		8512.20 ☐

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Method

$$Scope\ 3_{i,t} = \alpha + \beta_{SI} \boxed{Scope\ 1_{i,t} \times Import_{i,c,t}} + \beta_S Scope\ 1_{i,t} + \beta_I Import_{i,c,t}$$

$$+ \beta_{CS}{}' Controls_{i,t} + \gamma_i + \theta_c + \phi_t + \epsilon_{i,t},$$

- Scope 1 = ln(1 + Scope 1 emission/total assets), same for Scope 2 & Scope 3 (upstream)

- Imports = ln(# of shipments)

- Control variables: Assets (Ln(total assets)), Tobin's Q, Leverage, ROA, Sales Growth, Tangibility (PP&E/(total assets)), R&D (R&D expenditure/(total assets))

- Fixed effects: firm + country + year, or firm + country x year

- Following Dai, Liang, Ng (2020), we expect β_S to be positive – customer's and supplier's CSR activities (including GHG emission/reduction) are positively correlated

- We then expect β_{SI} to be negative – more imports from suppliers attenuate the positive Scope 1-Scope 3 link

A one-SD increase in Imports from its mean attenuates the Scope 1-Scope 3 association by 2.4%, and the Scope 1-Scope 2+3 association by 1.7%.

A one-SD increase in Scope 1 leads to 4.9% increase in Scope 3, and 6.1% increase in Scopes 2+3.

	Dependent Variable			
	Scope 3		Scopes 2 + 3	
Variable	(1)	(2)	(3)	(4)
Scope 1 × Import	-0.104**	-0.097**	-0.098**	-0.088**
	(-2.68)	(-2.45)	(-2.64)	(-2.34)
Scope 1	0.112***	0.112***	0.138***	0.138***
	(6.35)	(6.51)	(7.73)	(7.88)
Import	0.355**	0.329**	0.325**	0.285**
	(2.65)	(2.39)	(2.57)	(2.20)
Assets	-0.156***	-0.157***	-0.151***	-0.152***
	(-4.41)	(-4.45)	(-4.73)	(-4.77)
Tobin's Q	-0.026**	-0.027**	-0.028**	-0.028**
	(-2.35)	(-2.38)	(-2.46)	(-2.49)
Leverage	-0.061	-0.061	-0.057	-0.057
	(-0.75)	(-0.75)	(-0.82)	(-0.83)
ROA	2.084***	2.068***	1.943***	1.926***
	(7.99)	(8.09)	(8.27)	(8.38)
SalesGrowth	0.073*	0.072*	0.049	0.047
	(1.81)	(1.80)	(1.29)	(1.28)
Tangibility	0.374**	0.375**	0.366***	0.366***
	(2.94)	(2.99)	(3.20)	(3.26)
R&D	0.157	0.149	0.261	0.256
	(0.74)	(0.71)	(1.18)	(1.18)
Firm, Country, Year FE	Yes	No	Yes	No
Firm, Country×Year FE	No	Yes	No	Yes
Observations	73,966	73,659	73,966	73,659
Adj. R^2	0.968	0.969	0.969	0.969

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12

Identification

- Endogeneity concern: e.g., US firms may choose countries of imports for other production cost considerations than carbon emissions

- Explore demand shocks on the incentives for U.S. firms to outsource carbon emissions: (1) domestic legislative pressure and (2) regulatory stringency
  - Calculate average voting scores across Congress members on environmental legislation separately across the Senate and House of Representatives in each state
  - Identify state-years that experience score increases by more than three times the average increase during our sample period
  - Identify facility-level inspection intensity by EPA (one-year lagged) increases by more than three times the average increase during the sample period

- Estimate in a triple-interaction fashion

| Variable | Legislative Pressure | | State-Level Regulatory Stringency |
| | Treat=House | Treat=Senate | Treat=Onsite |
	(1)	(2)	(3)
Scope 1 × Import × Treat	-0.309***	-0.482**	-0.341**
	(-4.50)	(-2.44)	(-2.58)
Scope 1 × Import	-0.077	-0.071**	-0.081*
	(-1.74)	(-2.36)	(-2.12)
Scope 1 × Treat	0.021**	0.001	-0.005
	(2.63)	(0.08)	(-0.55)
Import × Treat	0.926***	1.413*	0.935**
	(3.58)	(2.15)	(2.97)
Scope 1	0.105***	0.106***	0.107***
	(6.26)	(6.40)	(6.41)
Import	0.294*	0.267**	0.290*
	(1.98)	(2.53)	(2.11)
Treat	-0.035	0.001	0.036
	(-1.28)	(0.02)	(1.26)
Controls	Yes	Yes	Yes
Firm, Country×Year FE	Yes	Yes	Yes
Observations	66,333	66,333	66,333
Adj. R^2	0.969	0.969	0.969

Other tests

- The outsourcing effects are stronger:
  - For suppliers from emerging/non-OECD economies
  - For suppliers from countries with less stringent environmental regulations
  - For suppliers from common law countries
  - For suppliers from countries with greater emission intensity

  - For firms with higher Environmental rating from Refinitiv ESG ("Green firms")
  - For firms with CEOs having more past employment experience in high ESG companies ("Green CEOs")
  - For with average directors having more past employment experience in high ESG companies ("Green Directors")

  - For firms without government customers
  - For firms with fewer green corporate customers
  - For firms with fewer ownership by green institutional investors

Economic Consequences

- Do firms that emit less/more will have lower/higher systematic reputational risks (RepRisk)?

- Do investors price in such climate risk by suppliers (i.e., hidden in imports)?

- Do outsourcing firms have more green innovations as substitutes?

- Measures: Scope 1 CO_2, Scope 2 CO_2, Scope 3 CO_2, Imported CO_2

Variable	(1)	(2)	(3)	(4)	(5)
Imported CO_2	0.058**				0.059**
	(2.53)				(2.85)
Scope 1 CO_2		-0.014			-0.045
		(-0.46)			(-1.01)
Scope 2 CO_2			0.032		-0.003
			(0.69)		(-0.06)
Scope 3 CO_2				0.184	0.201
				(1.42)	(1.40)
Assets	0.091	0.108	0.078	-0.032	-0.020
	(0.83)	(0.94)	(0.70)	(-0.34)	(-0.22)
Tobin's Q	0.165**	0.172***	0.169***	0.162**	0.164**
	(2.97)	(3.16)	(3.15)	(2.99)	(3.00)

$$RepRisk\ \beta_{,i,t} = \alpha + \beta_1 \text{Imported CO}_{2i,t} + \beta_2 Scope\ 1\ CO_{2i,t} + \beta_3 Scope\ 2\ CO_{2i,t}$$
$$+\beta_4 Scope\ 3\ CO_{2i,t} + \beta'_{CS} Controls_{i,t-1} + \mathbf{FE} + \epsilon_{i,t},$$

Variable	(1)	(2)	(3)	(4)	(5)
Leverage	-0.302	-0.280	-0.274	-0.258	-0.267
	(-1.35)	(-1.26)	(-1.24)	(-1.18)	(-1.20)
CapEx	0.396	0.598	0.620	0.713	0.659
	(0.47)	(0.72)	(0.74)	(0.86)	(0.80)
Cash	0.148	0.151	0.164	0.191	0.179
	(1.03)	(1.08)	(1.14)	(1.26)	(1.22)
Income Volatility	-0.008*	-0.009*	-0.009*	-0.008	-0.008*
	(-2.08)	(-2.05)	(-1.98)	(-1.80)	(-1.86)
ROA	0.910	0.822	0.783	0.525	0.512
	(1.07)	(0.91)	(0.89)	(0.70)	(0.69)
Firm, Year FE	Yes	Yes	Yes	Yes	Yes
Observations	5,904	5,615	5,615	5,615	5,615
Adj. R^2	0.314	0.316	0.316	0.318	0.319

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17

Economic Consequences

Investors do not seem to fully price in the outsourced carbon risk

$$Stock\ Return_{i,m,t} = \alpha + \beta_1 \text{Imported CO}_2{}_{i,t-1} + \beta_2 Scope\ 1\ CO_2{}_{i,t-1} + \beta_3 Scope\ 2\ CO_2{}_{i,t-1}$$
$$+ \beta_4 Scope\ 3\ CO_2{}_{i,t-1} + \beta'_{CS} Controls_{i,t-1} + \mathbf{FE} + \epsilon_{i,t},$$

Variable	(1)	(2)	(3)	(4)	(5)
Imported CO_2	0.002***				0.002***
	(3.12)				(3.16)
Scope 1 CO_2		0.001*			0.000
		(1.86)			(0.78)
Scope 2 CO_2			0.002*		0.001
			(2.10)		(0.75)
Scope 3 CO_2				0.006**	0.005*
				(2.37)	(1.94)
Controls	Yes	Yes	Yes	Yes	Yes
Firm, Month FE	Yes	Yes	Yes	Yes	Yes
Observations	62,978	62,978	62,978	62,978	62,978
Adj. R^2	0.303	0.302	0.303	0.303	0.303

Economic Consequences

$$Green\ Innovation_{i,t+1} = \alpha + \beta_1 \text{Imported CO}_{2i,t} + \beta_2 Scope\ 1\ CO_{2i,t} + \beta_3 Scope\ 2\ CO_{2i,t}$$
$$+ \beta_4 Scope\ 3\ CO_{2i,t} + \beta'_{CS} Controls_{i,t} + \mathbf{FE} + \epsilon_{i,t},$$

Variable	(1)	(2)	(3)	(4)
Imported CO_2	-0.024**	-0.025**	-0.025**	-0.027**
	(-2.37)	(-2.26)	(-2.26)	(-2.42)
Scope 1 CO_2		-0.006	-0.007	-0.010
		(-0.65)	(-0.82)	(-1.05)
Scope 2 CO_2			0.006	-0.001
			(0.40)	(-0.09)
Scope 3 CO_2				0.031
				(1.77)
Controls	Yes	Yes	Yes	Yes
Firm, Year FE	Yes	Yes	Yes	Yes
Observations	5,203	4,845	4,845	4,845
Adj. R^2	0.579	0.585	0.584	0.585

Conclusion

- Despite significant efforts in reducing GHG emission, corporations have strong incentives to evade their responsibility – 'Whack-a-Mole' Game

- We find strong evidence that US firms reduce their carbon footprints through outsourcing pollution overseas
  - Such emission outsourcing is not fully priced in by investors
  - Firms that outsource emissions to their suppliers are those with less green innovation

- It is important to count carbon footprints along the whole supply chain

- Divesting polluting business is not the right policy prescription – it may induce more pollution elsewhere

- Climate change is a global issue – a quest for international cooperation to achieve global carbon neutrality