

Climate-triggered institutional price pressure: Does it affect firms' cost of equity?

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Motivation

- ▶ Institutional investors consider firms' climate change exposures
 1. Does climate-triggered portfolio rebalancing affect firms' cost of equity?
 2. If so, does it also affect firms' future environmental profile?
 3. Is it physical or transition exposures that matter?
 4. Which types of institutional investors contribute to any effects?

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- ▶ This paper: Address (1) - (4) via **climate change price pressure (CCPP)**
 - **CCPP**: Institutional stock price pressure triggered by portfolio rebalancing stemming from firm-level climate change exposures
 - First to address these questions via the CCPP lens
 - CCPP offers a direct approach to examine the above in a unified setting

Research approach

1. Derive a **closed-form** expression for stock-specific CCPP
 - Kojien and Yogo (2019) demand-based asset pricing setting
 - Include firm-specific climate change exposures as a stock characteristic
 - CCPP: Percentage change in stock price per one-SD change in firms' climate change exposures

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 2. CCPP effects to firms' cost of equity & future environmental profile
- ✓ Granular topics-based firm-specific climate change exposures
 - Sautner et al. (2023) total, opportunity, regulatory & physical
 - ✓ **Option-implied** cost of equity (CoE) measures
 - Real-time, market-based, forward-looking measures
 - Term structure effects

Previous literature & Our contributions

- ▶ **Mixed** evidence on whether sustainable investing affects firms' CoE & its future environmental profile
 - Non-unified setting; Implicit measures of CCPP; “Hard” ESG information

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- ▶ **This paper:** Examines the impact of climate-triggered institutional portfolio rebalancing in a *direct* way
 - Closed-form, theoretically-based, stock-level CCPP measure
 - Takes into account investors' **heterogeneity**
 - Theoretically-based CoE measure
 - **Soft** information: May capture insights beyond “hard” information

Portfolio weights and climate change exposures: The model

- ▶ Investor i 's portfolio weight on stock n (relative to the outside asset) at t :

$$\frac{w_{i,t}(n)}{w_{i,t}(0)} = \exp[\beta_{0,i,t}me_t(n) + \beta_{1,i,t}cc_t(n) + \beta'_{2,i,t}\mathbf{x}_t(n) + \beta_{3,i,t}]\epsilon_{i,t}(n) \quad (1)$$

- ▶ Stock characteristics (predict expected returns & risks)
 - $me_t(n)$: log market equity
 - $cc_t(n)$: firm-level climate change exposures
 - $\mathbf{x}_t(n)$: log book equity, beta, profitability, investment, dividends to book equity

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- ▶ Non-linear GMM: applied to each investor's cross-section of portfolio weights at every t

$$\forall i, t : \mathbb{E}[\epsilon_{i,t}(n) \mid \widehat{me}_{i,t}(n), cc_t(n), \mathbf{x}_t(n)] = 1 \quad (2)$$

Model-based CCPP

- ▶ In equilibrium, CCPP for stock n at t

$$CCPP_t(n) \equiv \frac{\partial p_t(n)}{\partial cc_t(n)} = \frac{\sum_i s_{i,t}(n) \beta_{1,i,t} (1 - w_{i,t}(n))}{1 - \sum_i s_{i,t}(n) \beta_{0,i,t} (1 - w_{i,t}(n))} \quad (3)$$

where $s_{i,t}(n) = A_{i,t} w_{i,t}(n) / \sum_i^I A_{i,t} w_{i,t}(n)$ (investor i 's ownership in stock n)

- ▶ Considers investors' heterogeneity
 1. Climate triggered portfolio rebalancing ($\beta_{1,i,t}$)
 2. Investor's demand elasticity (inversely related to $\beta_{0,i,t}$)
 3. Investor's stock ownership ($s_{i,t}(n)$)

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- ▶ CCPP properties

1. Can be either positive or negative, depending on the sign of $\beta_{1,i,t}$
2. Greater magnitude for stocks owned by investors with lower demand elasticity
3. More negative as most investors underweight more & demand elasticities decrease

Dataset (2005Q1 - 2021Q4)

▶ **Institutional U.S. stock holdings**

- Thomson Reuters Institutional (13F) quarterly U.S. stock holdings
- U.S. investors and foreign investors
- Banks, Insurance companies, Investment advisors, Mutual funds, Pensions

▶ **Firm-specific climate change exposures & carbon emissions**

- Sautner et al. (2023 JF) quarterly textual climate change exposures
- Share of climate change related bigrams in earnings conference call
- Trucost carbon emission intensities (Scope 1 & 2)

▶ **Option-implied firm-level cost of equity (S&P 500 stocks)**

- Martin and Wagner (2019) & Chabi-Yo et al. (2023)
- OptionMetrics - Standardized implied volatilities
- Alternative horizons (1-month, 1, 2, 3-quarters and 1-year)

▶ **Stock characteristics**

- CRSP: Prices and shares outstanding
- Compustat: Accounting data

Stock-level CCPP (S&P 500 stocks)

Variable	Mean	SD	Min	Median	Max	Obs.
CCPP_total	-0.079	0.082	-0.392	-0.072	0.158	39967
CCPP_opp	-0.070	0.063	-0.320	-0.070	0.158	32651
CCPP_reg	-0.060	0.062	-0.364	-0.057	0.094	32651
CCPP_phy	-0.027	0.041	-0.180	-0.027	0.091	32651

- On average, CCPP is **negative**
- One SD \uparrow total (physical) exposures \Rightarrow \downarrow 7.9% (2.7%) stock prices
- **Variation** across different climate change exposures

CCPP: Time series evolution

Total climate change CCPP



Total climate change exposure portfolio weight beta



- Negative for most of sample period
- Downward trend for 2008-2015, then reverses post-2015
- Explained by investors' portfolio rebalancing

CCPP effects to firms' cost of equity: Total exposures

$$CoE_{t,h}(n) = \alpha + \beta_1 \cdot CCPP_t(n) + \gamma' \mathbf{X}_t(n) + \delta_t + \phi_j + \epsilon_{t,h}(n),$$

	One-month	One-quarter	Two-quarter	Three-quarter	One-year
Panel A: Effects to MW cost of equity					
CCPP_total	-0.220*** (-3.49)	-0.258*** (-4.53)	-0.248*** (-4.54)	-0.189*** (-2.74)	-0.153** (-2.30)
N	39743	39739	39730	27506	26787
Adj. R ²	0.644	0.630	0.610	0.621	0.629
Economic effect	3%	4%	4%	3%	2%
Panel B: Effects to GLB cost of equity					
CCPP_total	-0.106** (-2.32)	-0.184*** (-5.70)	-0.184*** (-6.36)	-0.179*** (-5.07)	-0.151*** (-4.41)
N	39743	39739	39730	27506	26787
Adj. R ²	0.812	0.850	0.858	0.859	0.863
Economic effect	1%	2%	2%	2%	2%

- One SD ↓ CCPP (intensification) ⇒ **0.22%** ↑ CoE (MW annualized **1-month** horizon)
- Percentage increase relative to the average CoE: **3%** (= 0.220%/0.073)
- Stronger effects for the mid-term (**4%**); robust for alternative CoE measure

CCPP effects to firms' cost of equity: Topics exposures

	One-month	One-quarter	Two-quarter	Three-quarter	One-year
Panel A: Effects to MW cost of equity					
CCPP_opp	-0.325*** (-3.64)	-0.372*** (-4.55)	-0.352*** (-4.50)	-0.258** (-2.54)	-0.208** (-2.13)
Economic effect	4%	6%	6%	4%	3%
CCPP_reg	0.016 (0.18)	-0.095 (-1.19)	-0.107 (-1.39)	0.045 (0.47)	0.064 (0.69)
Economic effect	0.2%	1%	2%	0.7%	1%
CCPP_phy	-0.311*** (-5.26)	-0.313*** (-5.86)	-0.298*** (-5.86)	-0.294*** (-4.79)	-0.256*** (-4.37)
Economic effect	4%	5%	5%	4%	4%
Panel B: Effects to GLB cost of equity					
CCPP_opp	-0.132** (-2.05)	-0.231*** (-4.97)	-0.224*** (-5.36)	-0.229*** (-4.33)	-0.191*** (-3.70)
Economic effect	1%	3%	3%	3%	2%
CCPP_reg	0.069 (1.10)	-0.075* (-1.67)	-0.094** (-2.32)	-0.090* (-1.81)	-0.076 (-1.57)
Economic effect	0.7%	1%	1%	1%	1%
CCPP_phy	-0.194*** (-4.81)	-0.203*** (-6.66)	-0.194*** (-7.01)	-0.213*** (-6.23)	-0.186*** (-5.56)
Economic effect	2%	2%	2%	3%	2%

- Opportunity CCPP has the strongest impact, reaching up to **6%** of the average cost of equity

Which investors contribute to CCPP?

- Estimated demand sensitivity to climate change exposures for each type of investors

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	Banks	Insurances	Investment advisors	Mutual	Pension	Households
Panel A: Total climate change exposures						
Total	-0.168*** (-6.49)	-0.129*** (-5.78)	-0.039 (-1.63)	-0.056* (-1.78)	-0.121*** (-7.01)	-0.060*** (-5.07)
N	2,874,813	882,213	21,647,525	3,864,705	1,247,698	39,913
Panel B: Opportunity climate change exposures						
Opp	-0.149*** (-6.61)	-0.097*** (-4.23)	-0.029 (-1.33)	-0.054* (-1.91)	-0.100*** (-5.89)	-0.009 (-0.68)
N	2,403,826	713,163	1,9624,585	3,148,908	1,063,173	32,597
Panel C: Regulatory climate change exposures						
Reg	-0.133*** (-5.37)	-0.106*** (-5.29)	-0.032 (-1.45)	-0.056* (-1.94)	-0.115*** (-5.32)	-0.097*** (-4.36)
N	2,403,826	713,163	1,9624,585	3,148,908	1,063,173	32,597
Panel D: Physical climate change exposures						
Phy	-0.029* (-1.67)	-0.043*** (-5.03)	0.012 (0.90)	-0.025** (-2.30)	-0.032*** (-3.42)	-0.035** (-2.16)
N	2,403,826	713,163	19,624,585	3,148,908	1,063,173	32,597

- **Banks (insurance companies)** contribute the most to CCPP from total, opportunity and regulatory (physical) climate change exposures
- Mutual funds contribute the least; Investment advisors' holdings are not affected

CCPP: Does it affect future climate change exposures?

$$\Delta CCE_{t+h}(n) = \alpha + \beta_1 \cdot CCPP_t(n) + \gamma' \mathbf{X}_t(n) + \delta_t + \phi_j + \epsilon_{t+h}(n)$$

	1-quarter	2-quarter	3-quarter	1-year	2-year	3-year	4-year	5-year
Panel A: Effects to future total climate change exposures								
CCPP_total	0.070 (1.46)	0.101 (1.12)	0.147 (1.10)	0.164 (0.93)	0.163 (0.65)	0.314 (0.94)	0.645 (0.91)	0.419 (0.96)
N	38840	38617	38396	38173	35250	32464	29779	27113
Panel B: Effects to future opportunity climate change exposures								
CCPP_opp	0.051 (0.96)	0.103 (1.02)	0.182 (1.26)	0.220 (1.22)	0.112 (0.71)	0.145 (0.66)	0.199 (0.76)	0.293 (0.99)
N	31717	31536	31357	31180	28436	25809	23264	20734
Panel C: Effects to future regulatory climate change exposures								
CCPP_reg	-0.001 (-0.09)	-0.013 (-0.63)	-0.020 (-0.65)	-0.029 (-0.76)	-0.081 (-0.94)	-0.114 (-1.00)	-0.105 (-0.84)	-0.141 (-1.15)
N	31717	31536	31357	31180	28436	25809	23264	20734
Panel D: Effects to future physical climate change exposures								
CCPP_phy	-0.002 (-1.24)	-0.004 (-1.25)	-0.003 (-0.65)	0.001 (0.15)	0.007 (0.59)	0.020 (1.37)	0.023 (1.55)	0.007 (0.48)
N	31717	31536	31357	31180	28436	25809	23264	20734

- Firms **do not** reduce their future climate change exposures
- This insignificance prevails even over longer horizons

CCPP: Does it affect future carbon emission intensities?

$$\Delta Emissions_{t+h}(n) = \alpha + \beta_1 \cdot CCPP_t(n) + \gamma' \mathbf{X}_t(n) + \delta_t + \phi_j + \epsilon_{t+1}(n)$$

	One-year	Two-year	Three-year	Four-year	Five-year
Effects to Trucost total carbon emission intensities					
CCPP_total	-3.666 (-0.68)	-6.603 (-0.90)	-11.041 (-1.40)	-13.373 (-1.47)	-13.794 (-1.46)
<i>N</i>	7108	6582	6062	5536	5030
Adj. <i>R</i> ²	0.052	0.110	0.175	0.237	0.280
CCPP_opp	2.730 (0.91)	-0.464 (-0.10)	-3.417 (-0.53)	-6.054 (-0.73)	-7.481 (-0.79)
<i>N</i>	5939	5424	4911	4391	3888
Adj. <i>R</i> ²	0.069	0.134	0.201	0.250	0.293
CCPP_reg	1.054 (0.26)	-3.690 (-0.59)	-7.305 (-0.96)	-10.471 (-1.00)	-12.909 (-1.14)
<i>N</i>	5939	5424	4911	4391	3888
Adj. <i>R</i> ²	0.069	0.134	0.201	0.251	0.294
CCPP_phy	-0.639 (-0.25)	0.423 (0.09)	-1.549 (-0.29)	-4.364 (-0.76)	0.820 (0.14)
<i>N</i>	5939	5424	4911	4391	3888
Adj. <i>R</i> ²	0.069	0.134	0.201	0.250	0.293

- Firms **do not** become greener as a response to CCPP
- This insignificance prevails even over longer horizons

Further analysis

Reverse causality: Portfolio holdings and CCE

- ▶ Portfolio weights may affect a firm's climate change exposures
 - Instrument: Industry average of climate change exposures, excluding focal firm
 - Use it to re-estimate CCPP by re-estimating β_1

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- ▶ Portfolio weights may affect a firm's climate change exposures
 - Instrument: Industry average of climate change exposures, excluding focal firm
 - Use it to re-estimate CCPP by re-estimating β_1

	One-month	One-quarter	Two-quarter	Three-quarter	One-year
Panel A: Effects to MW cost of equity					
InstrumentCCPP_total	-0.291*** (-4.64)	-0.330*** (-5.82)	-0.323*** (-5.97)	-0.309*** (-4.66)	-0.288*** (-4.54)
N	39739	39735	39726	27506	26787
Adj. R^2	0.644	0.630	0.611	0.622	0.630
Panel B: Effects to GLB cost of equity					
InstrumentCCPP_total	-0.156*** (-3.49)	-0.217*** (-6.87)	-0.220*** (-7.78)	-0.224*** (-6.46)	-0.206*** (-6.24)
N	39739	39735	39726	27506	26787
Adj. R^2	0.812	0.850	0.858	0.859	0.863

- Instrumentalized CCPP is **significantly negatively** correlated with CoE

CCPP and firms' future CCE: Does greenness matter?

- ▶ The previous insignificant effect may be due to conflating effects from green & brown firms
 - Sort firms into quintiles by emission intensities
 - Green (quintile 1), Brown (quintile 5), Neutral (quintiles 2, 3, 4)

$$\Delta CCE_{t+h}(n) = \alpha + \beta_1 \cdot CCPP_t(n) \times Type_t(n) + \beta_2 \cdot Type_t(n) + \gamma' \mathbf{X}_t(n) + \delta_t + \phi_j + \epsilon_{t,h}(n),$$

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$$\Delta CCE_{t+h}(n) = \alpha + \beta_1 \cdot CCPP_t(n) \times Type_t(n) + \beta_2 \cdot Type_t(n) + \gamma' \mathbf{X}_t(n) + \delta_t + \phi_j + \epsilon_{t,h}(n),$$

	One-quarter	Two-quarter	Three-quarter	One-year	Five year
Effects to future total climate change exposures					
CCPP_total × Brown	0.287 (1.33)	0.543 (1.26)	0.720 (1.07)	0.894 (0.97)	0.334 (1.47)
CCPP_total × Neutral	0.052 (0.80)	0.091 (0.72)	0.176 (0.95)	0.209 (0.85)	-0.009 (-0.15)
CCPP_total × Green	0.044 (0.48)	0.036 (0.21)	0.010 (0.04)	-0.042 (-0.14)	-0.084 (-0.95)
<i>N</i>	29452	29435	29419	29400	21158
Adj. R^2	0.096	0.110	0.131	0.151	0.246

- Brown, Green and Neutral firms **do not** reduce future climate change exposures

Do firms act against CCPP?

Investment, innovation, and financing activities

$$\Delta Y_{t+h}(n) = \alpha + \beta_1 \cdot CCPP_t(n) + \gamma' \mathbf{X}_t(n) + \delta_t + \phi_j + \epsilon_{t+h}(n),$$

	One-quarter	Two-quarter	Three-quarter	One-year
Panel A: Effects to future capital expenditures				
CCPP_total	-0.047* (-1.86)	-0.002 (-0.06)	-0.008 (-0.24)	0.047* (1.78)
N	38800	38562	38337	38113
Adj.R ²	0.375	0.365	0.358	0.152
Panel B: Effects to future PPE ratio				
CCPP_total	-0.005 (-0.60)	-0.001 (-0.07)	0.008 (0.42)	0.020 (0.79)
N	38725	38489	38263	38120
Adj.R ²	0.060	0.090	0.113	0.124
Panel C: Effects to future R&D				
CCPP_total	-0.001 (-0.48)	-0.001 (-0.21)	-0.002 (-0.46)	-0.002 (-0.36)
N	38820	38592	38373	38152
Adj.R ²	0.065	0.055	0.058	0.039
Panel D: Effects to future leverage ratio				
CCPP_total	0.028* (1.85)	0.026 (0.87)	0.027 (0.63)	0.046 (0.84)
N	38820	38592	38373	38152
Adj.R ²	0.051	0.069	0.083	0.097

- Firms **do not** take actions against CCPP → Costs of reform may outweigh benefits

CCPP and media climate change attention

$$\Delta CCE_{t+h}(n) = \alpha + \beta_1 \cdot CCPP_t(n) \times Attention_t + \beta_2 \cdot CCPP_t(n) + \beta_3 \cdot Attention_t + \gamma' \mathbf{X}_t(n) + \delta_t + \phi_j + \epsilon_{t+h}(n)$$

	One-quarter	Two-quarter	Three-quarter	One-year
Panel A: Ardia et al. (2023) MCCC measure				
CCPP_total × MCCC	1.704*** (4.90)	2.691*** (4.73)	3.282*** (4.64)	3.720*** (4.33)
CCPP_total	-0.993*** (-4.92)	-1.576*** (-4.90)	-1.898*** (-4.79)	-2.154*** (-4.52)
<i>N</i>	38840	38617	38396	38173
Adj. <i>R</i> ²	0.086	0.099	0.118	0.136
Panel B: Faccini et al. (2023) Policy measure				
CCPP_total × Policy	0.629*** (4.91)	0.990*** (4.64)	1.110*** (4.11)	1.109*** (3.48)
CCPP_total	-0.483*** (-4.80)	-0.769*** (-4.68)	-0.828*** (-4.00)	-0.810*** (-3.32)
<i>N</i>	38840	38617	38396	38173
Adj. <i>R</i> ²	0.087	0.100	0.118	0.136

- As media climate change attention increases, firms with more negative CCPP tend to decrease future climate change exposures

Conclusions

- ▶ We explore the effects of institutional portfolio rebalancing via the incurred climate change price pressure (CCPP) channel

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- ▶ Sustainable investing **affects** S&P 500 firms' cost of equity (CoE)
 - The pooled average CCPP is sizable up to -8%
 - A one-SD CCPP intensification **raises** firms' CoE by up to **6%** of the average CoE
 - Banks and insurance companies mostly contribute to CCPP

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- ▶ We explore the effects of institutional portfolio rebalancing via the incurred climate change price pressure (CCPP) channel
- ▶ Sustainable investing **affects** S&P 500 firms' cost of equity (CoE)
 - The pooled average CCPP is sizable up to -8%
 - A one-SD CCPP intensification **raises** firms' CoE by up to **6%** of the average CoE
 - Banks and insurance companies mostly contribute to CCPP
- ▶ Despite higher CoE from more negative CCPP, firms do not reduce their future climate change exposures and carbon emissions
 - Except over periods of heightened media climate change attention

Implications

- ▶ For investors, firms, media & policy makers:
 1. **Institutional** underweighting increases **firms'** CoE, yet it does not affect their future environmental profile
 2. **Firms'** cost of reforms exceeds 6% increase of the average CoE
 3. Engagement may be more effective - Importance of **climate coalitions**
 4. **Media** can play a role in incentivising managers to act
 5. **Policy** makers could use CCPP metrics to foster firms' investments & detect greenwashing by institutional investors

Thank You!

https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4803113