# A Quantity-Based Approach to Constructing Climate Risk Hedge Portfolios

Georgij Alekseev NYU Stern Stefano Giglio Yale & NBER

Quinn Maingi NYU Stern

Julia Selgrad NYU Stern

Johannes Stroebel NYU Stern & NBER

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# Introduction

- Climate change poses a risk to economic activity & asset values
- Important Question: Can you use financial markets to transfer exposures to various climate risks?
- Few dedicated financial instruments such as derivatives that offer a direct and targeted hedge against specific climate risks
- Alternative approach (Engle et al., 2020): Build a hedging portfolio against climate news using available instruments (e.g., stocks)
- Traditional methods for building hedge portfolios do not work well in the climate change context, because of limited time series data
- This paper: New approach based on *quantities* traded by subsets of investors with changes in climate beliefs

# **Existing Hedge Approaches**

- Approach I: "Narrative Approach"
  - · Uses beliefs on relationships, based on factors such as business models

"Solar companies should do well when there is news about stricter limits on carbon emissions [a realization of negative transition risk]."

- Direction hard to predict beyond a few obvious examples, but ideally use all assets for diversification
- Engle et al. (2020): Systematic approach forming long-short portfolios on E-Score (or data on carbon emissions, etc.)
  - Required data usually not available or low quality
  - Scores unreliable & barely correlated across providers (Billio et al., 2020)
  - Modest and unstable hedge performance

# **Existing Hedge Approaches**

- Approach II: "Mimicking Portfolio Approach"
  - Proposed by Lamont (2001) to hedge macro shocks such as inflation
  - Infer hedge portfolio based on past time-series relationships between news and prices
  - Project climate news series on a set of asset or portfolio returns

$$ClimateNews_t = \beta^Z \mathbf{Z}_t + e_t$$

- Use fitted  $\beta^Z$  to construct portfolios, then compare next period return with next period climate news realization
- **Challenge:** Curse of dimensionality; large asset space and short time series make stable out-of-sample results difficult
  - Special challenge for climate risk, which was likely not priced 10 years ago, and which does not feature very regular "news"

# This Paper: Quantity-Based Hedge Approaches

• Exploits cross-sectional variation in investor trading responses to climate news or climate attention shocks to subset of investors



- Suppose climate change awareness or concern increases in Oregon
- Observe: Oregon-based investors disproportionately buy solar stocks
  - No price changes because affected investor base is small
- Still informative about what would hedge a national news shock

### This Paper: Quantity-Based Hedge Approaches

• Exploits cross-sectional variation in investor trading responses to climate news or climate attention shocks to subset of investors



- Now, what if we had a similar *national* shift in climate change awareness or concern (e.g., the arrival of news we want to hedge)
  - All investors now buy solar stocks  $\rightarrow$  prices rise
  - Solar stocks thus hedge the national climate news series

# **Approach 1: Local Heat Shocks**

- **Objective:** Shocks that are localized, but shift climate attention / climate beliefs of local population
- Many studies show that local **heat** shocks shift climate change beliefs (Joireman et al., 2010; Li et al., 2011; Deryugina, 2013; etc.)
- Construct three local heat shocks using data from SHELDUS (Spatial Hazard Events and Losses Database) and PRISM temperature data:
  - 1 Injuries or fatalities
  - 2 High crop indemnity payments
  - **3** Extreme monthly temperature maximum (relative for county)
- The three classes of heat shocks are only weakly correlated
- Correlated with increased Google Search volume for "climate change"

# **Approach 2: Investor Report Measure**

- Mutual funds publish semi-annual N-CSR filings. Include copy of report to stockholders and disclosure of proxy voting policies
- Search filings for climate-change-related words

"Climate change remains a concern in the form of more severe weatherrelated events."

"We find that despite progress in some areas and several examples of individual best practice, the sector as a whole is failing to capture the risks and opportunities of climate change."

 Capture changes in climate beliefs / attention by measuring differences over time

# Determining the Quantity Response and Portfolio Weights

- Which **industries** are disproportionately bought/sold by mutual fund managers with chaning climate change beliefs ?
- Active holdings change of fund f in industry I, scaled by industry size:

$$\textit{ActiveChanges}_{f,t}^{\textit{I}} = \left( \frac{\Delta^{\textit{Active}}\textit{IndPFShare}_{f,t,t-1}^{\textit{I}}}{\textit{IndMarketShare}_{t}^{\textit{I}}} \right)$$

Industry I's "climate quantity beta" is then determined by regressing

ActiveChanges<sup>*I*</sup><sub>*f*,*t*</sub> = 
$$\beta_t^I S_{f,t} + \delta_t^I + \epsilon_{f,t}^I$$

where  $S_{f,t}$  is a time-varying fund-specific climate belief shock

- We re-estimate  $\beta^I$  for each month with a five-year rolling window to create a series of five-year rolling industry climate betas
- The  $\beta^{I}$  coefficients give the portfolio weights in the hedge portfolio

# **Industry Climate Quantity Betas**

- While the shocks are almost independent sources of information, they select similar hedge portfolios
- Correlation among climate quantity betas calculated over 2015-2019

	Fat./Inj.	Indemnities	Extreme Temperature	Report: CC
Fat./Inj.	1.00			
Indemnities	0.57	1.00		
Extreme Temperature	0.34	0.65	1.00	
Report: CC	0.21	0.29	0.18	1.00

- Similar industries selected in split samples across time, space, funds
- $\rightarrow\,$  Strong consistent signal from these quantity responses

# Hedge Performance?

- Can these quantity portfolio returns hedge national climate news?
- We attempt to hedge 12 climate news series produced in literature
  - Capturing both physical and transition risk
- How does our quantity-based approach perform in terms of hedging innovations in these climate news series?
  - Measure of success: Out-of-sample correlation with news innovations
  - Test period: Monthly innovations between 2015-2019
  - For data-driven approaches (quantity or mimicking portfolio): Use 5-year rolling window
  - Out of sample hedges approximate performance achievable in real time



















# **Comparison to Existing Hedging Strategies**

- Narrative portfolios: Beliefs of how climate change risk affects company returns
  - Long PBD:US (Invesco Global Clean Energy ETF)
  - Short XLE:US (Energy Select SDPR Fund ETF)
  - Short stranded assets portfolio 0.3*XLE* + 0.7*KOL SPY*
  - Long-Short Sustainalytics E-Score portfolio



# **Comparison to Existing Hedging Strategies**

- **Mimicking portfolio:** Data driven; regress each news series on base asset returns (five-year rolling window)
  - Projection on SPY
  - Projection on market, size, and value
  - Projection on PBD, XLE, market, size, and value
  - Lasso projection on all industry portfolios



# Conclusion

- Propose new approach based on trading responses to news/attention shocks received by some investors
  - Additional information from the cross-section of investors
  - Useful for (i) structural breaks or (ii) new risks such as climate change
- Long-short portfolios on this characteristic outperform other approaches to hedging a variety of climate risk news series
- Approach also works well for hedging national house price and unemployment series