A Quantity-Based Approach to Constructing Climate Risk Hedge Portfolios

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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
    \[ \text{ClimateNews}_t = \beta^Z Z_t + e_t \]
  - 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 weather-related 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 changing climate change beliefs?

- Active holdings change of fund $f$ in industry $I$, scaled by industry size:

$$
ActiveChanges_{f,I}^{I,t} = \left( \frac{\Delta^{Active} IndPFShare_{f,I}^{I,t,t-1}}{IndMarketShare_{I}^{I,t}} \right)
$$

- Industry $I$’s “climate quantity beta” is then determined by regressing

$$
ActiveChanges_{f,I}^{I,t} = \beta_{I}^{I} S_{f,t} + \delta_{I}^{I} + \epsilon_{f,t}^{I}
$$

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:

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<th>Fat./Inj.</th>
<th>Indemnities</th>
<th>Extreme Temperature</th>
<th>Report: CC</th>
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- Similar industries selected in split samples across time, space, funds

→ 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
Hedge Performance - Main Results
Out-of-sample correlation between hedge portfolio and climate news innovation
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Out-of-sample correlation between hedge portfolio and climate news innovation

![Graph showing correlation between hedge portfolio and climate news innovation](image)
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 $0.3XLE + 0.7KOL − SPY$
  - Long-Short Sustainalytics E-Score portfolio
Hedge Performance - Main Results

Out-of-sample correlation between hedge portfolio and climate news innovation
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
Hedge Performance - Main Results

Out-of-sample correlation between hedge portfolio and climate news innovation
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