Climate Risk and Commodity Currencies

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BI

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BI Norwegian Business School (Centre for Applied Macroeconomics and Commodity Prices) and Norges Bank

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The New York Times

Norway's Supreme Court Hears Rights Challenge to Arctic Oil Drilling

Environmental groups argue that exploratory drilling licenses violate a constitutional right to a healthy environment. It's a test case taking on an industry that is key to the country's economy.

VOICE

How Biden's Climate Plans Will Shake Up Global Energy Markets

The new administration will use foreign policy tools to promote climate goals, boost clean energy, and punish carbon-intensive production.

BY JASON BORDOFF | DECEMBER 4, 2020, 4:52 PM

the Biden transition

This article is part of The Biden Transition, Foreign Policy's ongoing coverage of how U.S. President-elect Joe Biden builds a new White House administration—and what the new team's policies might be.

Joe Biden vil stoppe oljeboring i Arktis – og vil ha Norge med på laget

USAs påtroppende president vil ha med seg alle landene i Arktisk råd på et midlertidig forbud mot oljeboring i Arktis. – Kommer til å være aktivitet i Barentshavet i mange år fremover, sier regjeringen.

Joe Biden planlegger en helomvending fra politikken Donald Trump førte i Arktis.
FOTO: LEAH MILLIS / REUTERS

Milana Knežević
Journalist

David Vojislav Krekling
Journalist

Publisert i dag kl. 07:49
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The recent weakness of commodity currencies (Norway)

BEER model: $REER_t = \Gamma(Controls_t) + \beta(CommodityPriceX_t) + u_t$

REER (black) and in-sample fitted values (grey).

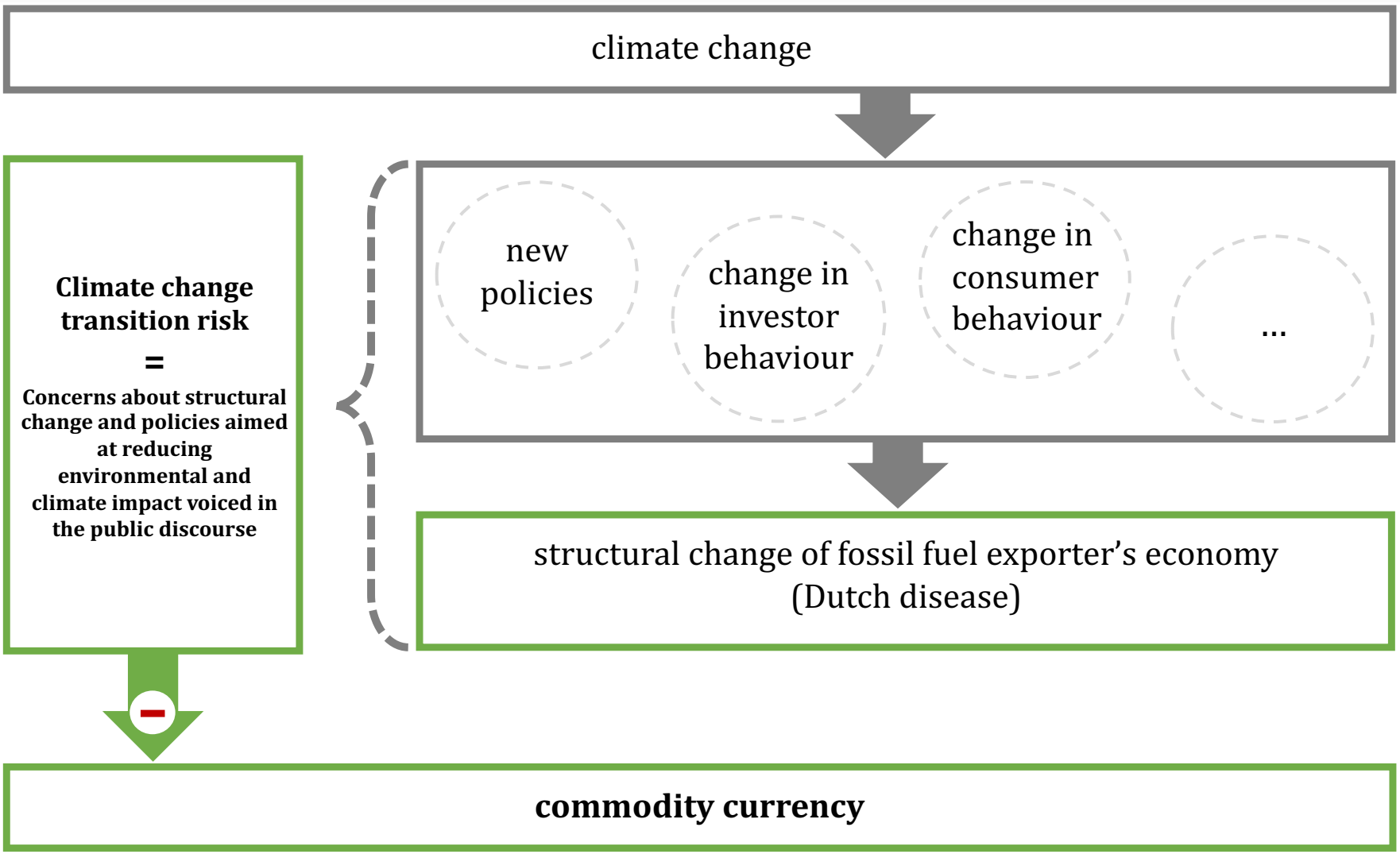
"The krone has been weaker for some time than projected in the Monetary Policy Report."

— Norges Bank Monetary Policy Report 3/2019

Our research question:

Can **climate risk** explain weak **commodity currencies**?

Mechanism


climate change
Climate change transition risk
=
Concerns about structural change and policies aimed at reducing environmental and climate impact voiced in the public discourse
new policies
change in investor behaviour
change in consumer behaviour
...
structural change of fossil fuel exporter's economy (Dutch disease)
commodity currency

The challenge: How to measure climate change transition risk?

- Climate change is not new, but the discussion about weak commodity exchange rates and climate risk seems to be
- Not directly related to either physical or liability climate risk (Carney, 2015), but rather to transition risk capturing expectations about production shortfall or lack of further exploration

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The challenge: How to measure climate change transition risk?

- This type of climate risk, i.e., transition risk, is potentially driven by many factors (politics, public opinion, investor sentiment, etc., etc.) and no quantitative measure exists in the current literature
- Thus, we propose to use news coverage to measure climate change transition risk

> "[S]ignificant market events generally occur only if there is similar thinking among large groups of people, and the news media are essential vehicles for the spread of ideas."
>
> — Shiller (2001)

This paper

What we do:

1. Use a unique corpus from *Dow Jones Newswire Archive*, together with a ML based *Word Embedding* model, to estimate the association between *climate risk* and a particular fossil fuel exporting country.
2. Evaluate if unexpected *climate change transition risk* innovations lead to a real exchange rate depreciation in 8 commodity currencies: Australia, Brazil, Canada, Malaysia, Mexico, Norway, Russia, South Africa.

How we contribute:

1. New country-specific measures of climate change transition risk
2. Extend findings from recent asset pricing literature showing that climate risk matters not only for firms and firm value (Krueger et al. (2020), Bolton and Kacperczyk (2020), Hsu et al. (2020), Atanasova and Schwartz (2019)) but also at the national level for exchange rates.

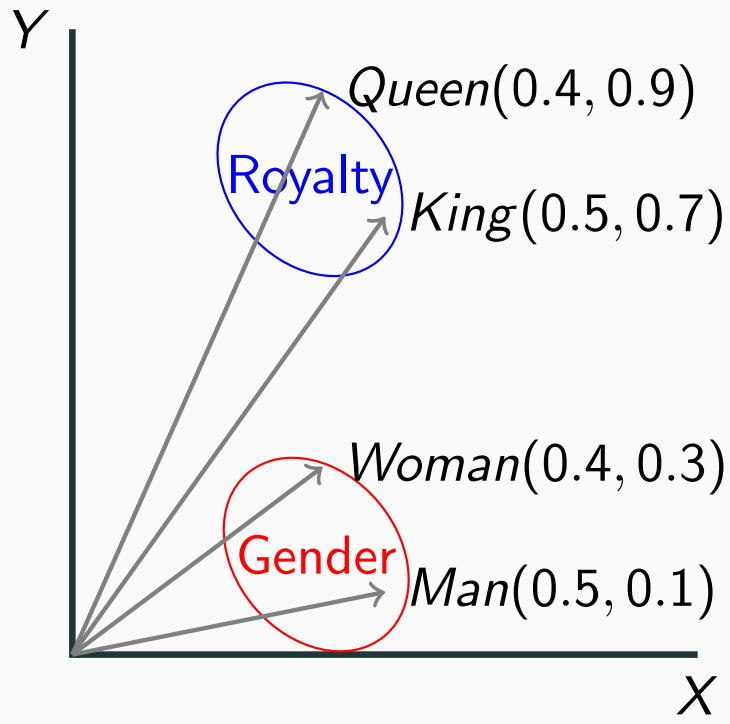
Word embedding model - basic intuition

Word embedding models turn something high-dimensional and unstructured (the corpus) into something small, dense, and interpretable.

- Represents words in a vector space by focusing on the context (co-occurrence) of words
- Recognizes linguistic regularities and patterns
- Allows for arithmetic operations which can capture associative meaning

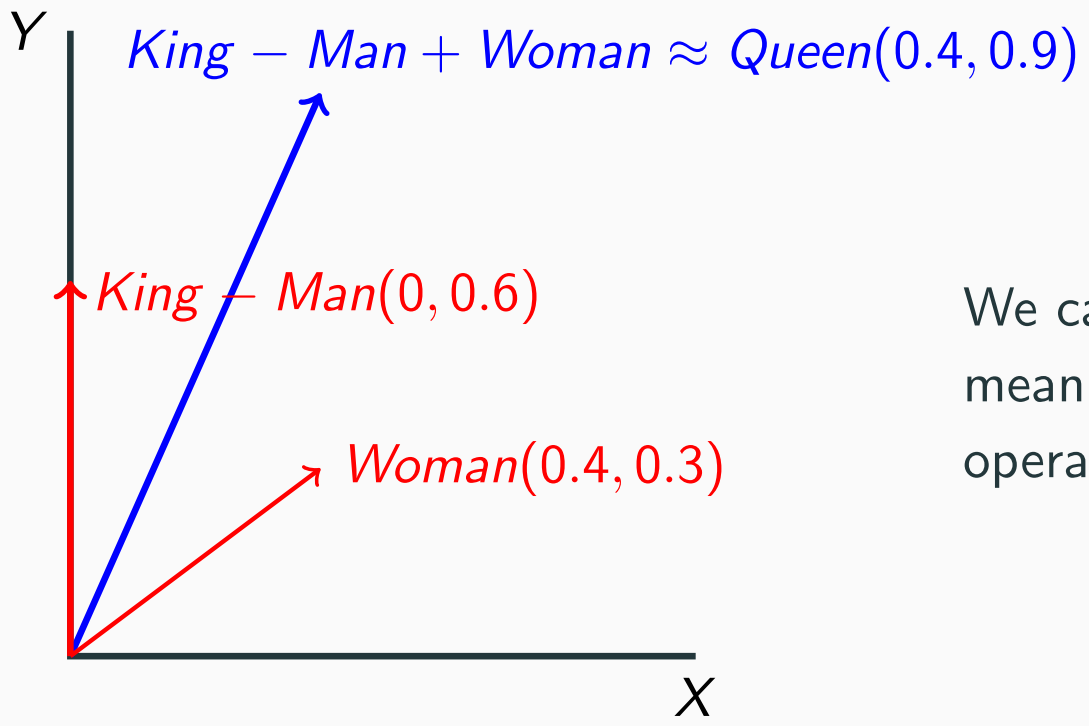
Word embedding model - basic intuition

Suppose a small vocabulary of four words: $\{Queen, King, Woman, Man\}$



Words of the same category are close to each other in the vector space.

Word embedding model - basic intuition



We can get associative meaning through arithmetic operations with word vectors.

More on the word embedding model

Our data

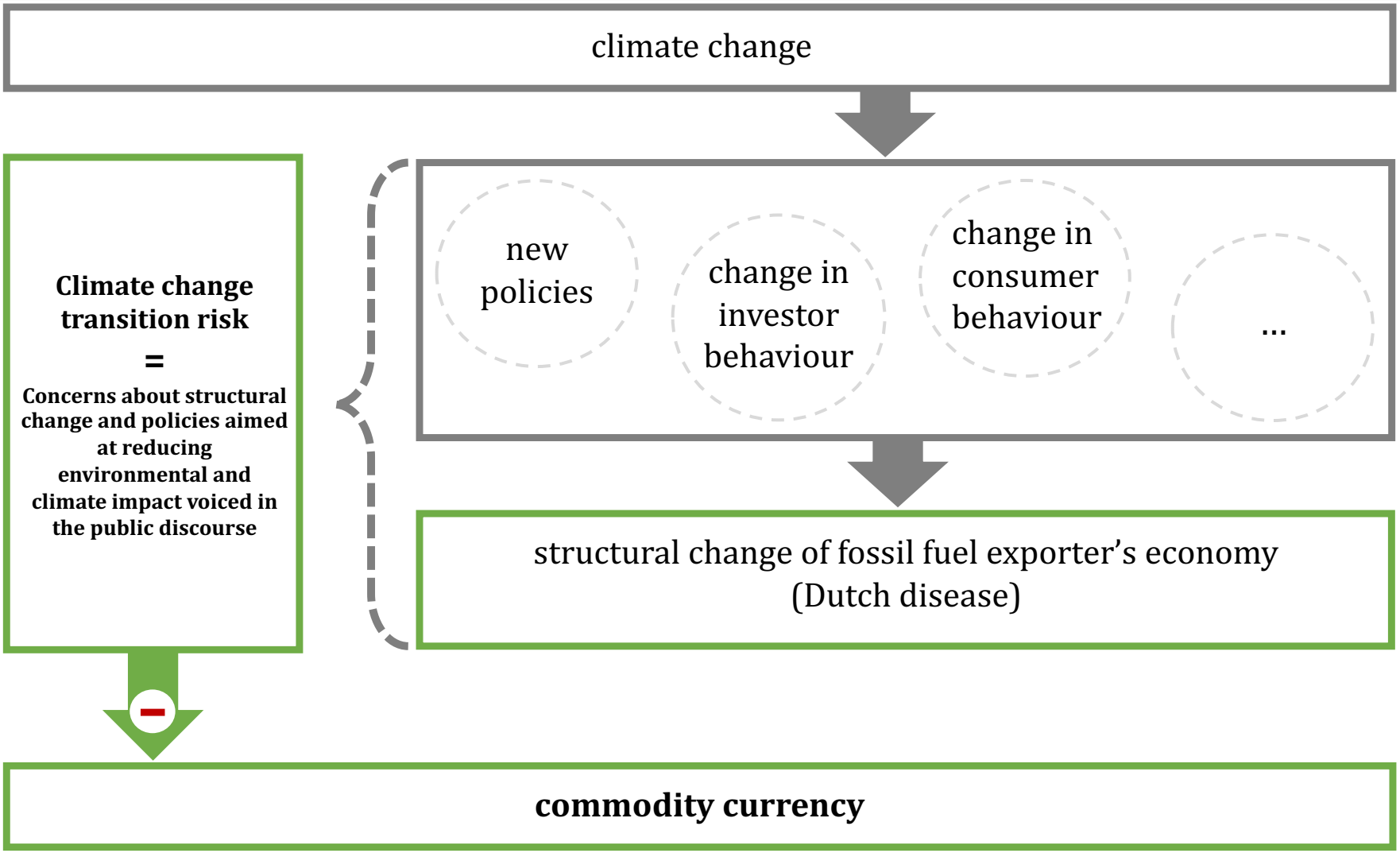
Unique corpus from *Dow Jones Newswire Archive*:

- International business news, e.g., *The Wall Street Journal*
- 25+ million articles in English language
- Daily frequency, from 10/2001 to 12/2019
- Perform customary pre-processing

Estimation

- Estimation method: *word2vec* algorithm (Mikolov et al. (2013) and Mikolov et al. (2013))
  - A two-layered neural network with a logistics (or sigmoid) cost function.
- Input:
  - Corpus of Dow Jones Newswire Archive.
  - Partitioned into monthly blocks of articles.
- Output:
  - For each month t, a matrix of word embeddings.
  - For each word, a word vector representing its regularities and patterns (in a particular month).

The mechanism again



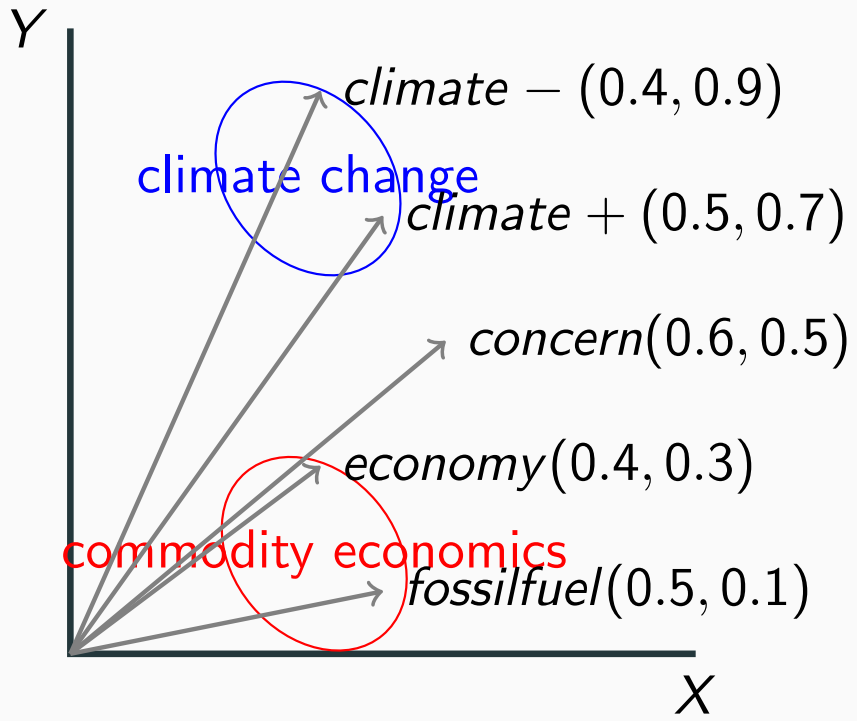
Climate change transition risk in word vector space

$$\textit{transition risk}_t \approx \underbrace{\tfrac{1}{2}\left(\textit{concern}_t + \textit{fossil fuel}_t + \textit{economy}_t\right)}_{\text{economic risk dimension}} + \underbrace{\tfrac{1}{2}\left(\textit{climate}_t^{+} - \textit{climate}_t^{-}\right)}_{\text{climate change dimension}}$$

- $\textbf{\textit{concern}}_t = \frac{1}{n}(\textit{concern}_t + \textit{concerned}_t + \textit{risk}_t + \textit{risky}_t + \ldots)$
- $\textbf{\textit{fossil fuel}}_t = \frac{1}{n}(\textit{extract}_t + \textit{mine}_t + \textit{fossil}_t + \textit{fuels}_t + \textit{oil}_t + \textit{coal}_t + \ldots)$
- $\textbf{\textit{economy}}_t = \frac{1}{n}(\textit{economy}_t + \textit{economic}_t + \textit{economics}_t + \textit{business}_t + \ldots)$
- $\textbf{\textit{climate}}_t^{+} = \frac{1}{n}(\textit{climate}_t + \textit{green}_t + \textit{clean}_t + \textit{renewable}_t + \textit{protect}_t + \ldots)$
- $\textbf{\textit{climate}}_t^{-} = \frac{1}{n}(\textit{emissions}_t + \textit{dirty}_t + \textit{fossil}_t + \textit{exploit}_t + \ldots)$

▸ full word list

Climate change transition risk in word vector space



Climate change transition risk is latent, but might be approximated by:

$\approx concern_t + fossil\ fuel_t + economy_t + (climate_t^+ - climate_t^-)$

Relating climate change transition risk to individual countries

Country specific word vectors, e.g.:

- $country_{jt} = \frac{1}{n}(norway_t + norwegian_t)$

How associated is country j with climate risk? Simple OLS:

$$country_{jt} = \beta_{jt}(transition\ risk)_t + e_{jt}$$

- β_{jt} measures the similarity between $country_{jt}$ and $transition\ risk_t$ for each country and month.
- The higher β_{jt}, the stronger the association between the two word vectors.

The time-varying association between climate change transition risk and Norway

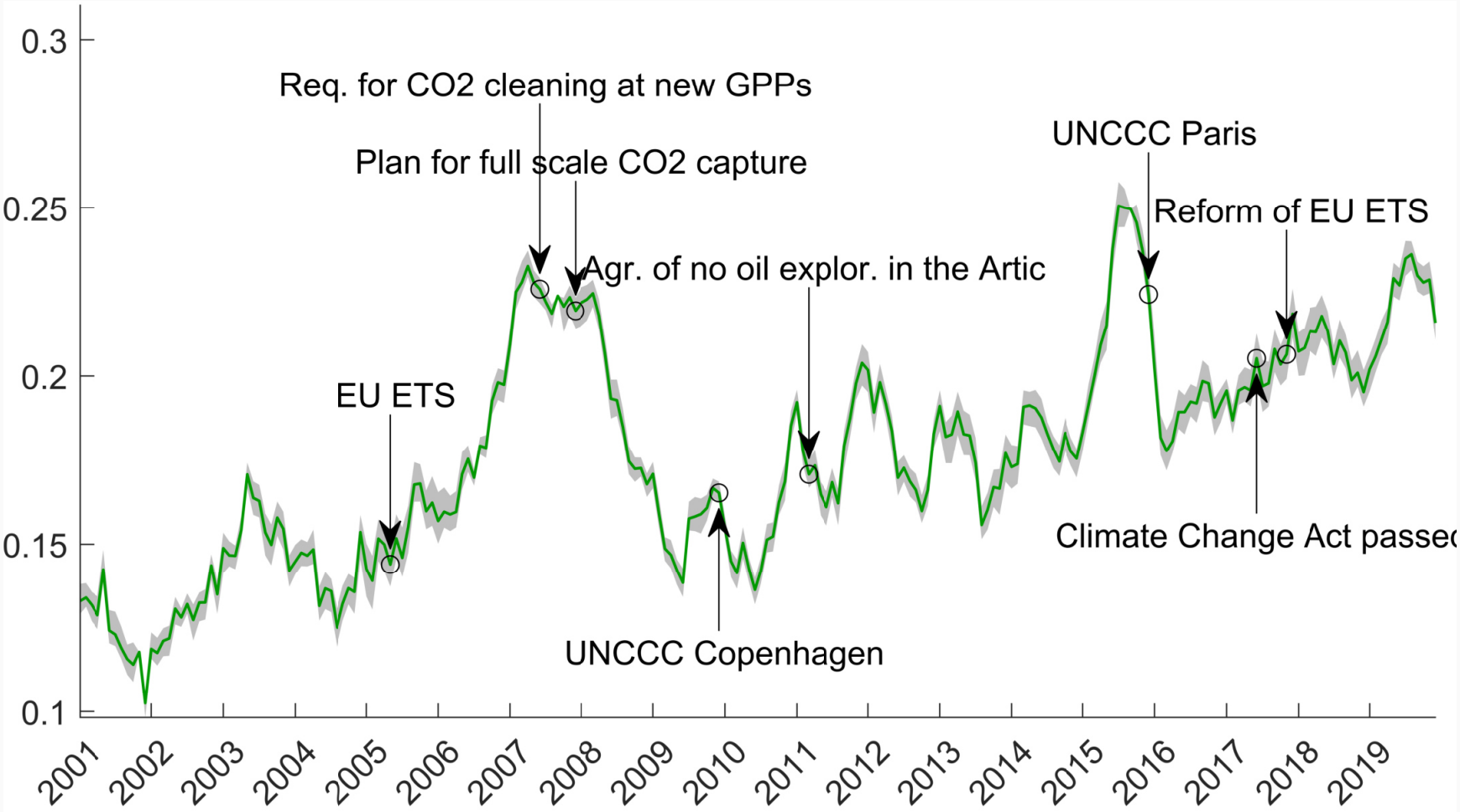


Figure 1: Climate risk for Norway

Comparison with temperature anomalies

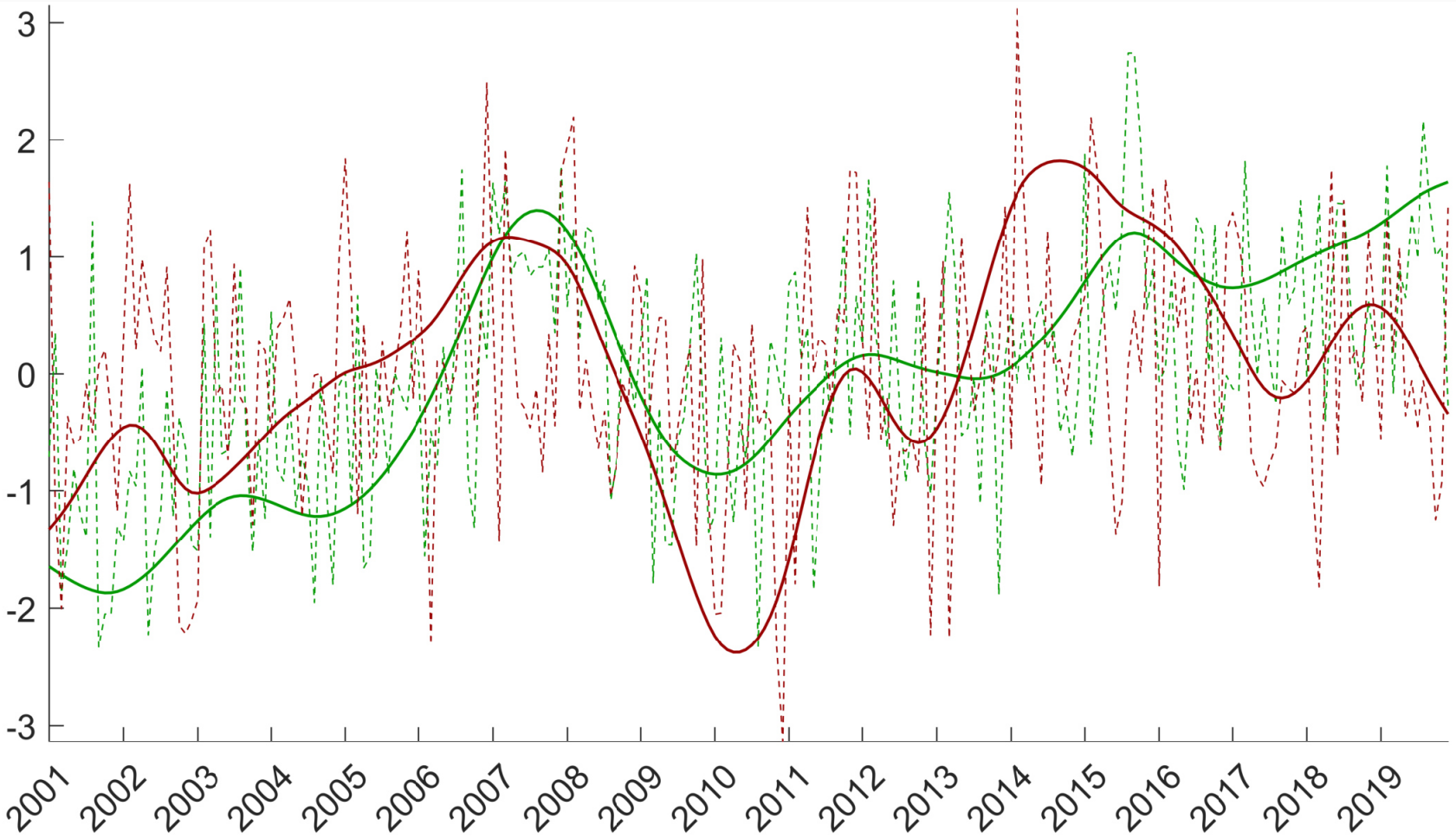
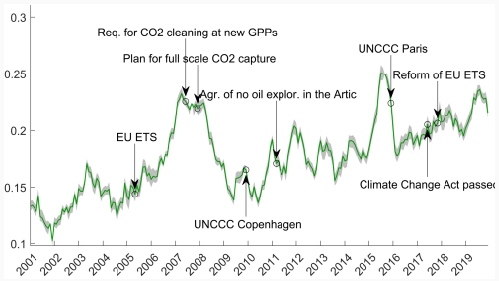
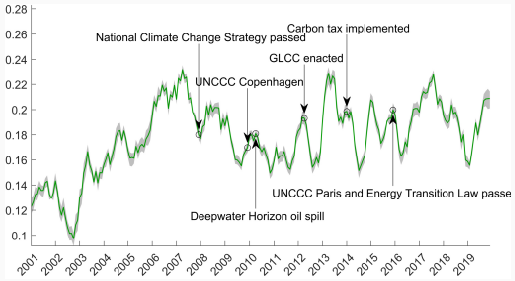


Figure 2: Climate risk (green) and temperature anomalies (red) for Norway

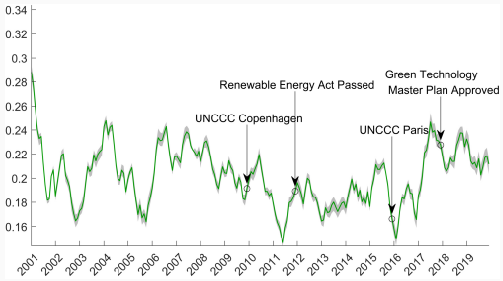
Country-specific measures



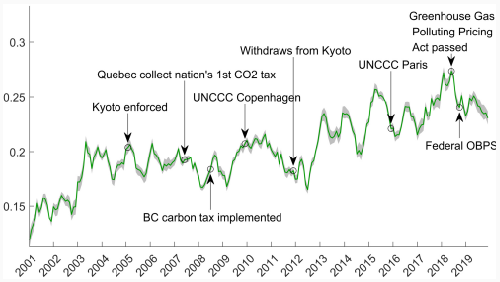
(a) Norway



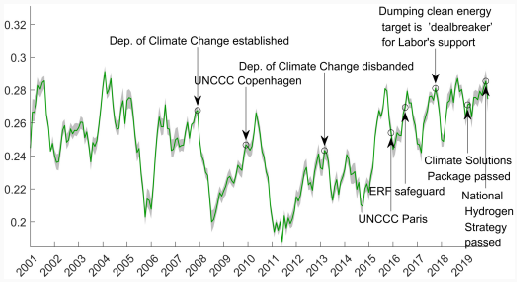
(b) Mexico



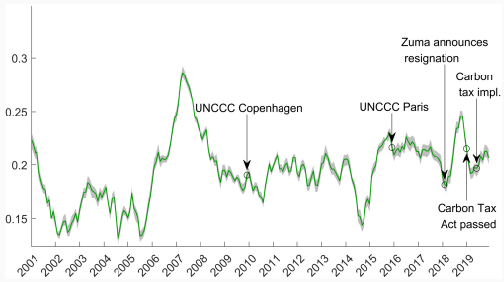
(c) Malaysia



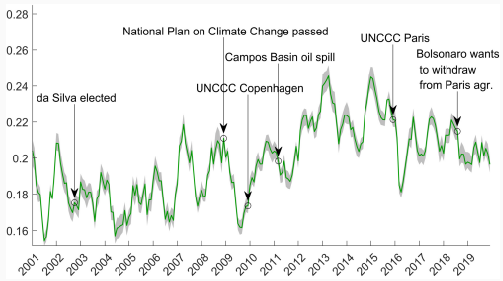
(d) Canada



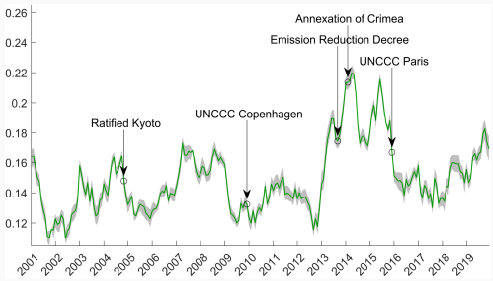
(e) Australia



(f) South Africa



(g) Brazil



(h) Russia

Exchange rate modeling

VAR model:

- Taking into account the potential dyanmic interaction between a set of endogenous variables
- Identify unexpected climate change transition risk innovations using a recursive ordering

Monthly data January 2002 – December 2019:

$REER_t$: Real Effective Exchange Rate

r_t^S: Trade-weighted short-term real interest rate differential

BC_t: Business cycle index

VIX_t: Financial market volatility

GPR_t: Geopolitical risk (Caldara and Iacoviello (2018))

$ComX_t$: Commodity price index (Gruss and Kebhaj (2019))

TR_t: Climate change transition risk

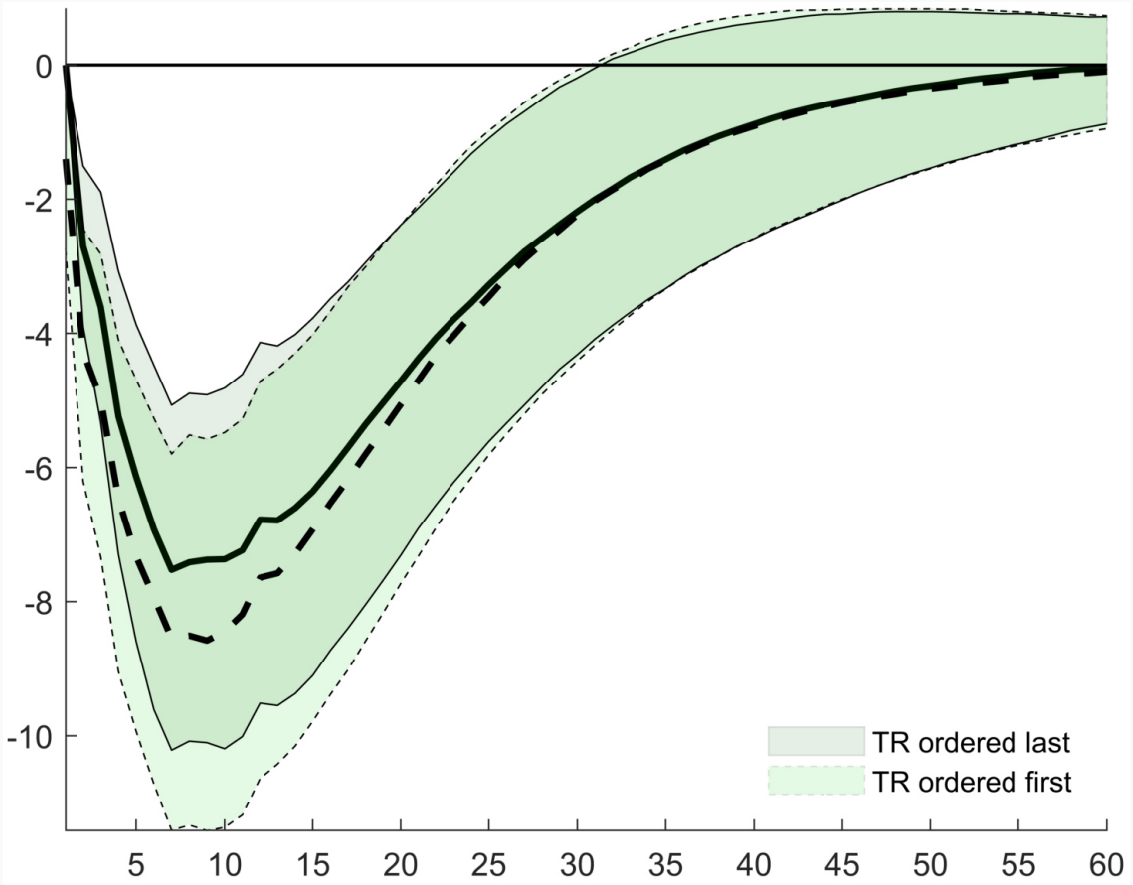
Exchange rate modeling

Estimate:

$$\boldsymbol{y}_{c,t} = \boldsymbol{A}_{c,1}\boldsymbol{y}_{c,t-1} + \ldots + \boldsymbol{A}_{c,p}\boldsymbol{y}_{c,t-p} + \boldsymbol{C}_c\boldsymbol{x}_t + \boldsymbol{e}_{c,t} \quad \boldsymbol{e}_{c,t} \sim i.i.d.N(0, \boldsymbol{\Sigma}_c) \tag{1}$$

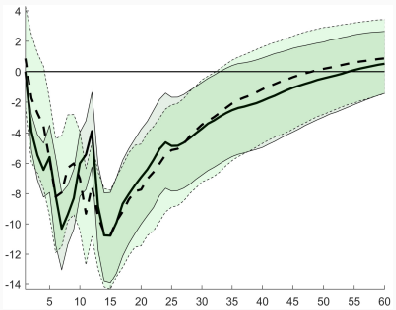
- As a Panel VAR using a standard pooled (Bayesian) estimator
- As a Panel VAR using a partly pooled (Bayesian) estimator, allowing for random effects
- As individual country VARs

Main results: Pooled estimates, climate risk innovation, REER response



Warning: preliminary results

Main results: Random effects, climate risk innovation, REER response



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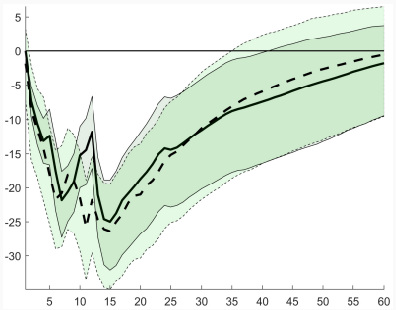
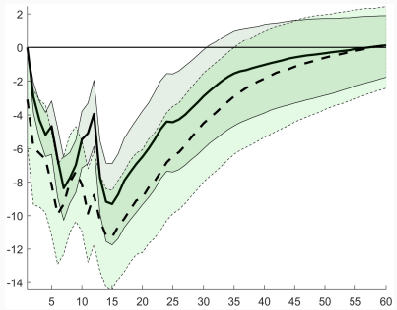


(b) Brazil



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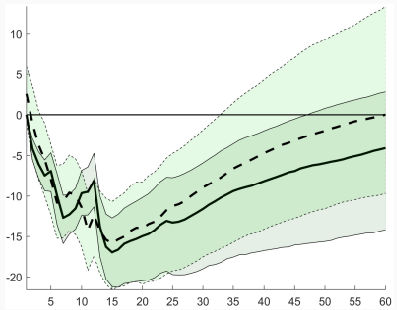

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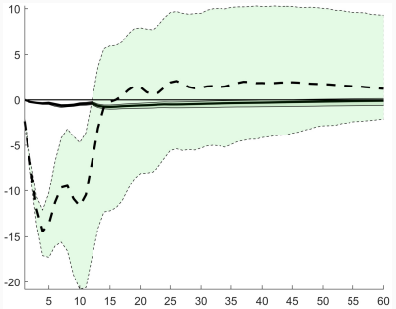

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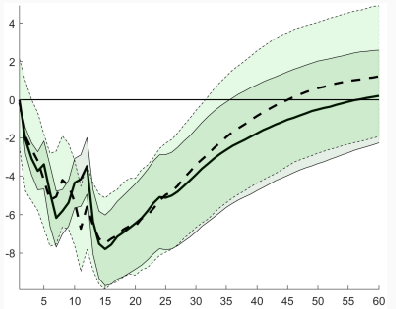
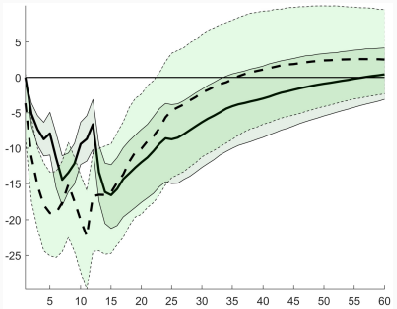


(f) Norway



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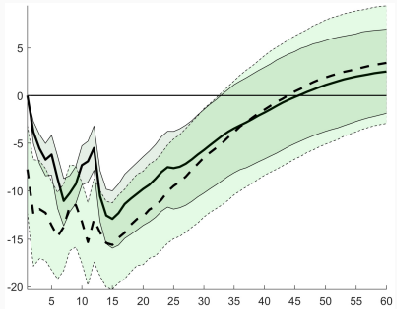


(h) South Africa

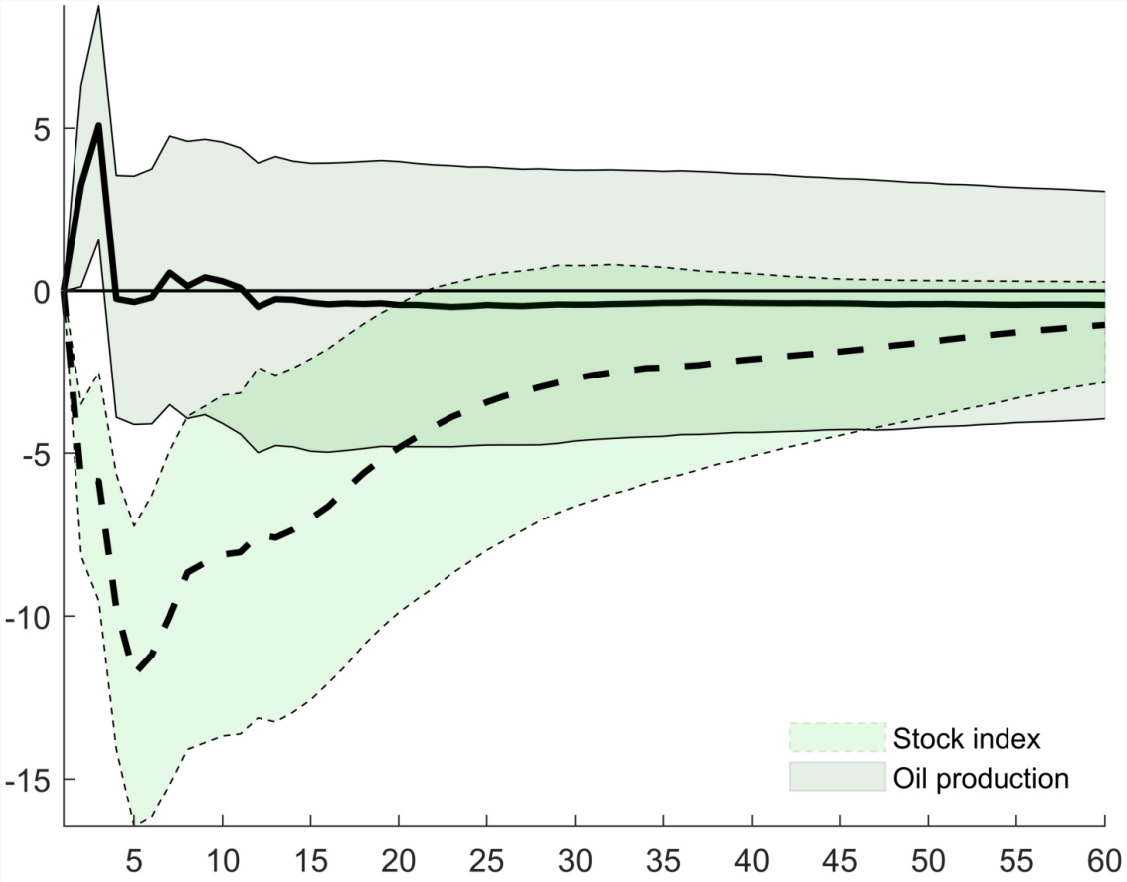
Warning: preliminary results

Additional testable hypothesis

- Climate change transition risk should be negatively associated with future commodity production outcomes
- Stock market should respond negatively, at least if commodity sector is large part of the domestic economy

- Both effects seem to be present in our data and models. However, sign of "green-paradox"

Additional testable hypothesis



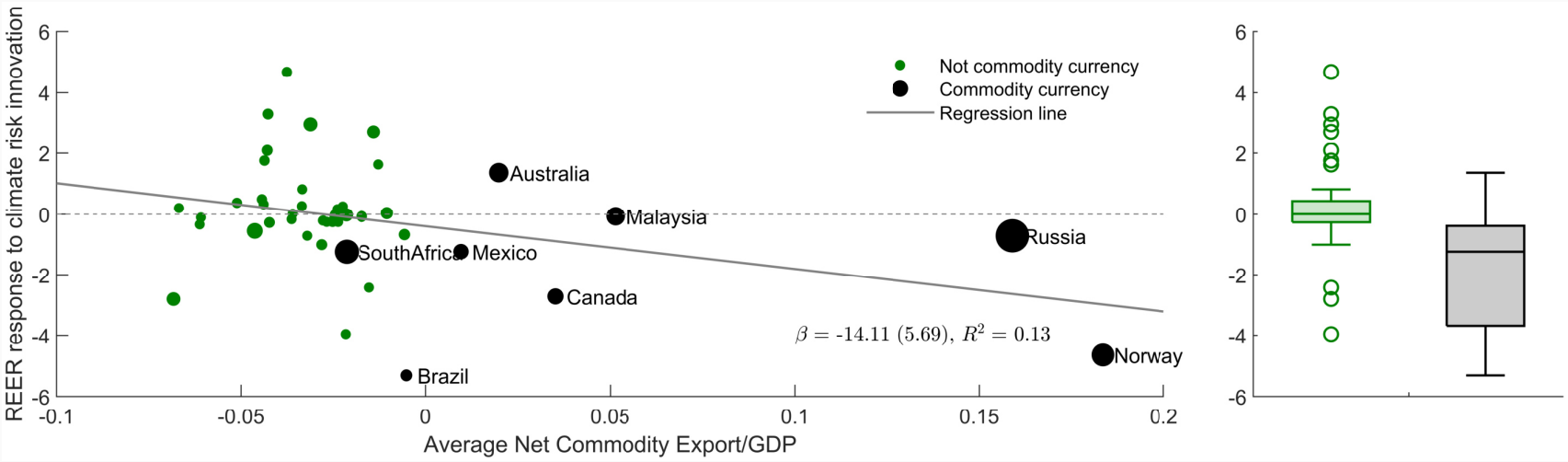
Warning: preliminary results

Two "falsification" experiments

1. Theory related: Across a large number of countries we should expect to see a significant negative correlation between a country's fossil fuel export dependency and the real exchange rate response following innovations in transition risk.
2. Measurement related: Do existing climate risk measures produce the same results? Three candidates
   - Temperature anomalies: Widely used, but mostly related to physical climate risk?
   - Engle et al. (2020): News-based measure, but not country-specific and not transition risk specific
   - **?**: News-based measure, but not country-specific. Related to uncertainty and policy/regulation, i.e., closer to our motivation

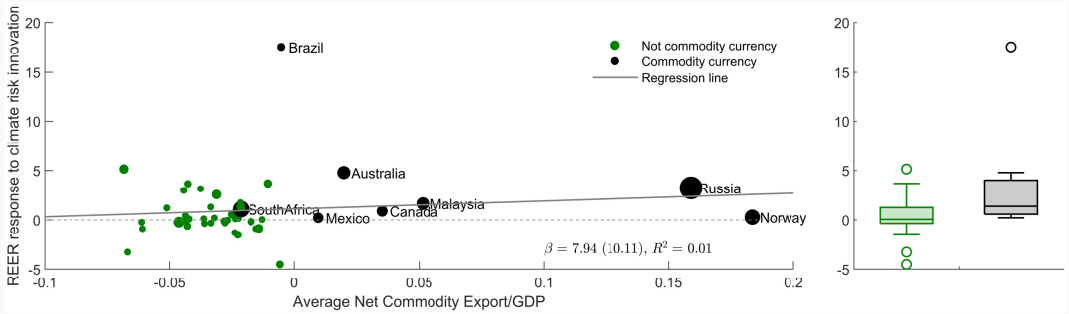
Investigate both by estimating country specific VARs for all 8 commodity exporters plus 50 other countries with floating exchange rates.

Commodity export dependency and REER responses

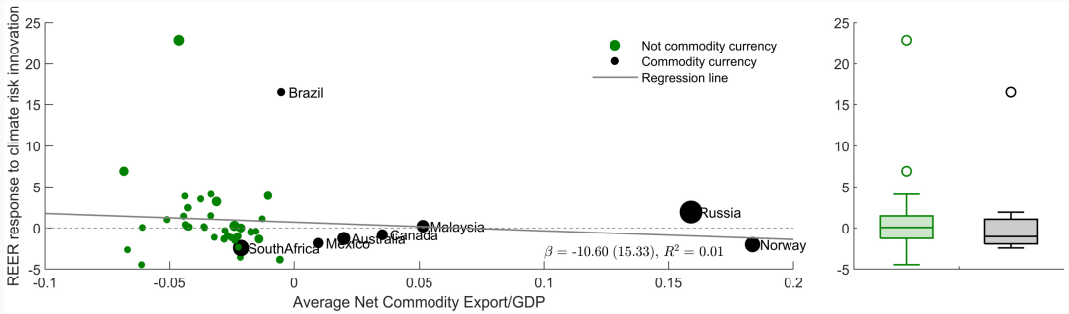


Warning: preliminary results

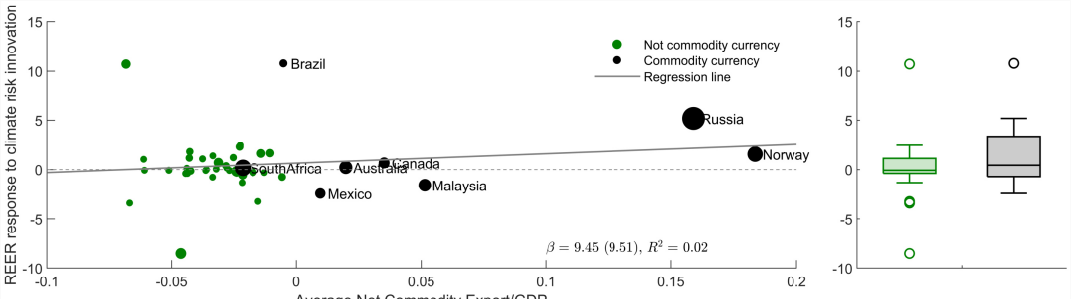
The value added of our proposed transition risk measure



(a) Engle et. al. : Climate risk - 5-year horizon



(b) Gavriilidis: Climate policy uncertainty - 5-year horizon



Robustness checks and additional results

- In earlier WP we used a single equation framework - same qualitative conclusions
- Robust to alternative commodity price indices
- Robust to word selection when constructing climate change transition risk embedding
- Robust to including global activity measure and economic policy uncertainty measures in the VARs

Conclusion

Results:

- If climate change transition risk increases, commodity currencies experience a persistent depreciation in line with traditional "Dutch Disease economics"
- Negative correlation between fossil fuel export dependency and exchange rate responses: "The more brown you are the harder you are hit"

Contributions:

- New and novel measure of climate change transition risk. Potentially useful in other applications
- Pricing implications of climate risk mostly investigated for firms and firm values. We show how it matters at the national level
- Economic climate change literature has foremost focused on risks related to climate and weather events. We document the importance of transition risk as a separate component

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Word embedding model - more formally

Word Embedding models solve a predictive problem:

- $P(+|ta, co)$ is the probability that the context word *co* is a real context word for the target word *ta*.
- $P(-|ta, co) = 1 - P(+|ta, co)$ is the probability that it is not.

Word embedding model - more formally

The goal is to maximize:

$$L(\theta) = \sum_{(ta,co)\in+} P(+|ta, co) + \sum_{(ta,co)\in-} P(-|ta, co),$$

- which can be written for a single target/context word pair (ta, co) as

$$L(\theta) = log \frac{1}{1 + e^{-co \cdot ta}} + \sum_{i=1}^{k} log \frac{1}{1 + e^{n_i \cdot ta}},$$

- where k is the total number of noise terms n_i added.
- The logistic (or sigmoid) function is used to turn the similarity measure (approximated by the dot product) between the word vectors for *co* and *ta* into probabilities.
- Intuition: A context word is likely to occur near the target word if its embedding is similar.

Back

Complete list of words

Specifically, we apply the word2vec method to every word in the following groups

- *country*: norway, norwegian
- *concern*: concerned, concern, risk, risky, worried, worrying, uncertain
- *commodities*: extract, mine, fossil, fuels, fuel, oil, crude, petroleum, coal, lignite
- *economy*: economy, economic, economics, business, sector, sectors
- *climate*$^{+}$: climate, green, clean, renewable, oxygen, recycling, ecosystem, cooling, protect
- *climate*$^{-}$: emissions, dirty, fossil, dioxide, methane, pollution, warming, exploit

back