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

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Disclaimer: The views expressed herein are those of the presenter; they do not necessarily reflect those of the Federal Reserve Board or the Federal Reserve System

Summary

Objective: Construct a long-short portfolio that has a high correlation with a chosen measure of climate news

Possibilities:

A. Standard time-series approach to constructing "climate-mimicking" hedging portfolios:
   1. Using historical data: Determine which stocks (industries) go up in price in response to bad global heat news
   2. Going forward: These stocks should *go up* in price with bad global heat news

   Problem: Limited historical data for step 1, though this is a problem that will get smaller over time

B. "Narrative" approach: Just conjecture which portfolios are likely to mimic climate news

C. Quantity approach of current paper:
   1. Determine which stocks (industries) are *bought* by locals (local equity mutual funds) in response to bad local heat news
   2. These stocks should *go up in price* with bad global heat news

Comment 1. Defend the research question better. What would Greta Thunberg say about hedging?

"**Why should I be studying for a future that soon may be no more**, when no one is doing anything to save that future? And what is the point of learning facts when the most important facts clearly mean nothing to our society?"

Comment 1. Defend the research question better. What would Greta say about hedging?

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Some possible answers:

1. If some are more willing/able to bear a risk than others, then trading a hedging portfolio is welfare-improving

- Natural clienteles in climate context: Importance of believers vs, deniers well documented in housing climate finance
  - Effect of sea level rise on prices depends on fraction of people who believe climate change is happening (Baldauf, Garlappi, Yannelis, RFS 2020)

- **Suggestion:** In a simple calibration, how large is the welfare gain of hedging for various assumptions about disagreement
  - Under people's own beliefs
  - Given realistic modesty about how well hedging can be done in practice, or with perfect hedging

- **Suggestion:** What evidence is there on amount of actual hedging?
  - Lots of "E-tils", but what fraction of "E-tilts" are hedging vs. "warm glow" vs. thinking it has high alpha? Survey?
  - Are the main climate hedgers in practice firms?
    - Polluting firms who hedge the price of carbon permits using carbon futures?
    - If so, we're done: Hedge target=carbon permit price, mimicking portfolio is based on carbon futures

Comment 1. Defend the research question better. What would Greta Thunberg say about hedging?

2. If hedging means tilting from brown to green stocks, then hedging helps the climate crisis (via costs of capital effects)
   - Hedging portfolios here don't look very green. Suggestions below
   - Does require that investors are correct about what is green

But, it's also possible that hedging climate risk could have negative climate impact:

- If the most concerned can hedge climate risk, they may do less to mitigate it

3. Financial stability: Hedging may prevent financial crises
   - Is climate risk special? Credit risk, interest rate risk, cyber, war, pandemics, politics …
   - Hedging vs. higher capital
     - Can you say something about the pros of hedging?
     - Or can correlation of bank stock returns with hedging portfolios be used to calibrate capital requirements?

Summary of quantity approach

Step 1. Estimate climate-quantity-betas for each industry with respect to heat shock series S using county-level variation

$$ActiveChanges^{I}_{f,t} = \beta^{I} S_{loc(f),t} + \delta^{I}_{t} + \epsilon_{f,t}$$

I=industry, f=fund, t=time, loc(f)=county of fund f

- You estimate one regression for each industry, using panel data across funds and time

Step 2. Quantity-based hedging portfolio, hedging US national heat shock series S (here *f* is riskfree, not fund)

$$QP_{S,t} = \sum_{I} \widehat{\beta^{I}_{S,t-1}} (R^{I}_{t} - R^{f}_{t})$$

- One time series of the hedging portfolio return for a given heat shock series S

Step 3. Does it work? Calculate correlation of hedging portfolio return with various national measures of climate news

- Testing period is 2015-2019. Portfolios are constructed based on 5-years of monthly data (backward, rolling)
- The national measure could be the same as the one used locally (why is this not emphasized?), but many are considered

Summary of quantity approach

Step 1. Local equity mutual funds buy auto, transportation, energy stocks when it's hot locally (measured several ways)

Table 4: Industry Climate-β Coefficients

GICS	Description	Avg.	Fat./Inj.	Indemnities	Record Temp.
2510	Auto & Components	0.12	0.07	0.15	0.15
4520	Tech. Hardw. & Equip.	0.10	0.05	0.20	0.06
2030	Transportation	0.08	0.02	0.14	0.08
4530	Semiconductors & Equip.	0.05	0.04	0.00	0.12
3010	Food & Staples Retailing	0.05	0.03	0.08	0.03
4020	Diversified Financials.	0.04	0.02	0.04	0.04
3020	Food, Bev. & Tobacco	0.03	0.01	0.10	−0.01
1010	Energy	0.03	0.02	0.07	−0.00
5010	Communication Services	0.03	0.04	0.03	0.00
5510	Utilities	0.02	0.01	0.04	0.02
2010	Capital Goods	0.02	0.00	0.07	−0.01
4030	Insurance	0.01	−0.03	0.06	−0.00
4010	Banks	0.01	0.04	0.01	−0.03
4510	Software & Services	0.01	0.01	−0.03	0.04
3520	Pharma., Biotech., & Life Sc.	−0.01	0.01	−0.02	−0.01
6010	Real Estate	−0.01	−0.03	0.00	−0.01
5020	Media & Entertainment	−0.01	−0.04	0.06	−0.06
1510	Materials	−0.03	−0.02	−0.02	−0.04
3030	Household & Pers. Prod.	−0.03	0.01	−0.07	−0.03
2530	Consumer Services	−0.03	−0.09	−0.03	0.02
3510	Health Care Equip. & Serv.	−0.04	−0.02	−0.07	−0.02
2550	Retailing	−0.04	−0.07	−0.00	−0.05
2520	Consum. Durables & Apparel	−0.07	0.02	−0.18	−0.07
2020	Commercial & Prof. Serv.	−0.11	−0.12	−0.28	0.08

"the identities of industries that are bought/sold are not necessarily those expected ex ante", but:

- Industries bought could, while currently potentially producers of emissions, be the source of innovation

  Heads-up: Cohen, Gurun & Nguyen paper on NBER LTAM April 9

- As long as investors react consistently across local and global shocks, it doesn't matter what they buy/sell

- There's estimation noise

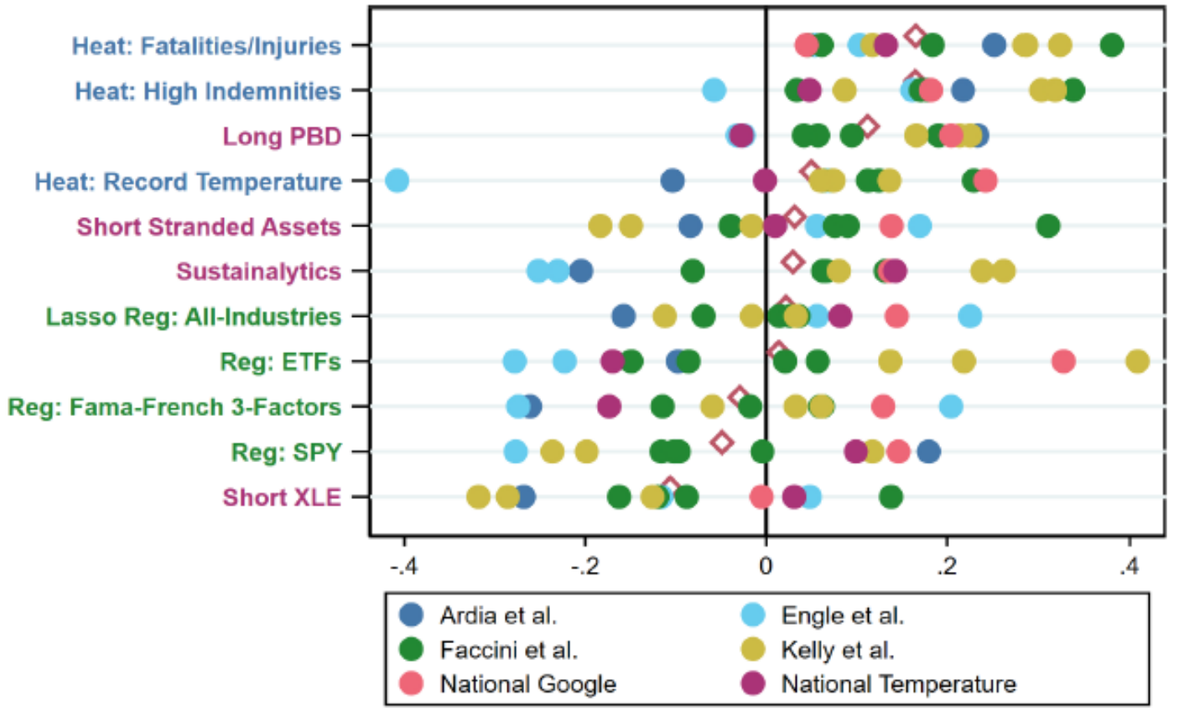
The proof is in the pudding

Summary of quantity approach

Step 3. Quantity based approach (blue labels) beats narrative approach (mostly) which beats standard approach (green labels).

But avg. correlation w/climate news<0.2. Climate hedging is hard

Figure 2: Climate Hedge Performance of Various Portfolios



Note: Dot plot of monthly return correlations for various climate hedge portfolios with various climate news series AR(1) innovations. Each dot represents one correlation coefficient. Different colors represent different groups to which the climate news series belong.

Comment 2. When does the quantity approach well? When not? Suggestions for improvements

Quantity-based approach used works well if:

- You have data on representative local investors
- Locals trade with non-locals in response to bad local heat news
- Investor demand reacts similarly to local and global heat news
  - Irrational reaction to local heat news that local investors *think* is global
  - Rational reaction to global heat news

Comment 2. When does the quantity approach well? When not? Suggestions for improvements

Quantity-based approach used works poorly if:

- You have data for sophisticated local investors
- Locals trade with each other in response to bad local heat news
  - Unsophisticated locals (retail investors) sell brown, buy green stocks in response to bad local heat news
  - Sophisticated locals take the other side: They realize unsophisticated locals are trading based on irrelevant information

Then the hedge portfolio is long brown, short green and thus may do *poorly, not well,* in response to bad global heat news

Comment 2. When does the quantity approach well? When not? Suggestions for improvements

Which case are we in? Evidence from Choi, Gao and Jiang, RFS 2020 show importance of the problematic case

- Temperature variation across cities of the world with stock exchanges (local=city for temp., country for holdings)
  - Stock trading of Emission-Clean (EMC) portfolio
  - Retail ownership=100%− DataStream blockholders' ownership − FactSet institutional ownership excluding blockholders

- Retail investors ("the majority of which are local") buy green & sell brown when local temperature is abnormally high
  Local blockholders do the opposite when local temperature is abnormally high

B. Stock trading on abnormal temperature

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	EMC_ΔRetail		EMC_ΔInstitution		EMC_ΔDomBlockholder		EMC_ΔForBlockholder	
Ab_Temp	−0.080*		0.003		0.047*		0.023	
	(−2.01)		(0.84)		(1.94)		(0.94)	
Ab_Temp Q2		−0.102		0.012		0.003		0.036
		(−0.67)		(0.89)		(0.02)		(0.39)
Ab_Temp Q3		−0.165		−0.001		0.147		−0.040
		(−1.18)		(−0.05)		(1.69)		(−0.48)
Ab_Temp Q4		−0.316**		0.005		0.277*		−0.006
		(−2.22)		(0.31)		(1.83)		(−0.08)
Ab_Temp Q5		−0.396		0.037*		0.128		0.172
		(−1.62)		(1.76)		(1.31)		(1.03)
Year × Quarter FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	2,008	2,008	2,008	2,008	2,008	2,008	2,008	2,008
Adj. R^2	.006	.003	.021	.021	−.006	−.007	.005	.005

Comment 2. When does the quantity approach well? When not? Suggestions for improvements

Suggestion: Use the quantity approach for unsophisticated locals

1. Really bad mutual fund managers (worst alpha? smallest funds?)
2. Local retail investors at the county level (but hard to get data)
3. Local retail investors at the country level (as Choi, Gao and Jiang, 2020).

Comment 2. When does the quantity approach well? When not? Suggestions for improvements

Suggestion: Use a standard time-series return approach with local (country) information to get more data. Avg. across countries

- For each country and industry: Estimate climate return betas relative to local heat news
- For a given industry: Average climate return betas across countries
- Construct world-wide climate-hedge portfolio based on average climate return betas and world industry returns (or US industry returns)

This works if local investors' trading affect prices in that country, which is true in Choi, Gao and Jiang (2020)

Comment 3. What should we focus on in climate finance to have climate impact?

How can investors have real climate impact?

1. "Market-efficiency ESG investing" (profitable): Get climate information (regulatory/physical) "priced in"
   - Ensures correct NPV calculations: If shareholders care, managers will need to care too
   - Many climate finance papers are about this. Good
   - But, "priced in" means prices reflect potential losses to current/future owners, not that carbon externalities are priced in

2. "Money-losing ESG investing": Investors with a preference for carbon reduction may be able to change relative costs of capital
   - Closer to addressing externalities. Tilts to/from has parallels to taxes/subsidies
   - Many climate finance papers assessing investors' willingness to lose money. Good
     - Mixed empirical results. We may just get sorting of ownership with modest changes to equilibrium costs of capital
     - Few investors appear willing to lose much

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In surveys of ESG investors, many are interested in "market-efficiency" ESG investing

- BlackRock 2020 Global Sustainable Investing Survey

03 What are the top three drivers of your adoption of sustainable investing?

Comment 3. What should we focus on in climate finance to have climate impact?

NORGES BANK
INVESTMENT MANAGEMENT

Responsible investment

Our motivation for responsible investment is to achieve the highest possible return with moderate risk. Companies' activities have a considerable impact on society and the environment around them. Over time, this could affect their profitability and so the fund's return. We therefore consider both governance and sustainability issues, and publish clear expectations of companies in the portfolio.

Comment 3. What should we focus on in climate finance to have climate impact?

So, realistically, to address externalities in a big way, government actions are important

- **Is there a role for climate finance here? Yes**
- There's already a large climate finance literature on how to value public investments in mitigation/adaptation
- And we can do more: Help ensure "program efficiency", in addition to market efficiency
  - Document what works well, theoretically and empirically
  - Document cross-location inefficiencies: Equalize carbon reduction per dollar spent across locations
  - Monitor cross-location evasion: Relocation of production reduces effectiveness

Am I the only one saying this? Not at all!

Comment 3. What should we focus on in climate finance to have climate impact?

Stroebel and Wurgler, 2021. Survey of 861 respondents about climate finance (academics, industry, government)

Table 5
Most influential forces for change.
Participants were asked: "Which mechanisms do you think are most important in moving corporations to reduce their climate risk exposures and/or carbon footprints? [Choose at most three]." Possible responses were ordered randomly, and listed below in order of their rank in the pooled sample.

		Role			Location				Climate Concern		Works in Climate Finance	
	Pooled	Faculty	Public Sector	Private Sector	North America	Europe	Asia	ROW	High	Low	Yes	No
Biggest force for change (% in top-3)												
Carbon Taxes	52	59	65	37	51	59	49	33	56	42	52	50
Institutional Investors	48	45	37	56	47	52	53	52	51	42	51	44
Government Subsidies	43	44	43	42	45	39	39	29	42	47	43	44
Customers	41	33	35	53	42	39	29	52	40	42	38	43
Non-financial regulation	27	34	31	15	25	35	27	38	28	24	27	28
Financial regulation	22	20	21	26	22	22	24	29	24	19	26	16
Banks/Creditors	16	12	21	20	15	15	22	10	17	13	19	10
Employees	6	5	4	8	6	4	10	14	6	6	5	8
Individual Investors	5	5	4	5	6	1	2	14	5	5	5	5
Voluntary	0	0	0	0	0	0	0	0	0	0	0	0
Nothing will lead to change	0	0	0	0	0	0	0	0	0	0	0	0

Comment 3. What should we focus on in climate finance to have climate impact?

Table 6
Most important climate finance research topics vs. SSRN topic frequency.
Participants were asked: "Which of the following research areas do you find most important? [Choose at most three]." Possible responses were ordered randomly and listed below in order of their rank in the pooled sample.

		Role			Location				Climate Concern		Works in Climate Finance		
	Pooled	Faculty	Public Sector	Private Sector	North America	Europe	Asia	ROW	High	Low	Yes	No	SSRN Topic Frequency
Important Research Topics (% in top-3)													
Effects of gov incentives to mitigate/adapt	35	36	39	37	38	34	34	8	39	30	38	35	22
Pricing climate risk in financial markets	34	33	34	36	35	30	31	52	36	30	37	30	36
Climate change effect on systemic risk	28	23	47	29	28	27	22	38	30	21	29	26	15
Real effects of SRI	23	22	9	27	21	22	36	29	22	24	23	22	8
New financial instruments	21	23	22	19	22	20	17	19	22	21	23	19	7
GE modeling of climate change & economy	19	20	22	17	19	25	15	19	18	22	18	21	6
Effects of green finance on transition	19	17	18	21	16	27	31	29	21	13	22	14	9
Measuring asset-level climate exposure	15	15	16	16	15	15	17	19	13	21	17	13	11
Pricing climate risk in real estate markets	17	15	29	16	19	10	7	14	17	16	15	20	6
Climate risk in the insurance sector	13	14	21	10	15	10	5	14	13	14	10	17	3
Developing climate stress tests	13	10	19	17	14	9	14	14	14	10	12	14	4
Refinement of ESG-type ratings	12	13	3	13	11	11	19	10	12	11	14	9	5
Finance address social disparities from CC	10	10	4	12	10	12	12	0	13	5	10	10	4