We Are All in the Same Boat: Cross-Border Spillovers of Climate Shocks Through International Trade and Supply Chain

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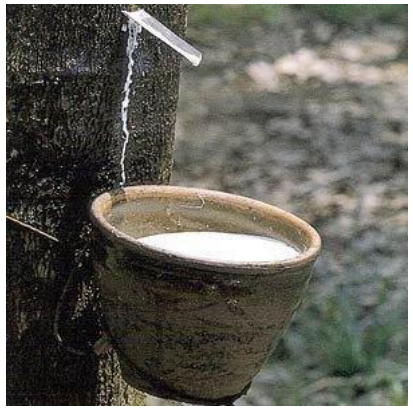
Alan Feng (IMF)
Haishi “Harry” Li (HKU)
Yulin Wang (HKU)

Cross-border Propagation of Climate Risks Through Trade

- Fighting climate change requires international collaboration
- However, the consequences of climate change are unevenly distributed across countries
- Why should countries with low climate risks at home care about climate change?
- In this paper we propose a new mechanism by which climate change affects countries' macro-financial performance: cross-border propagation of climate risks through international trade

Upstream and Downstream Countries

Upstream



Rubber Production in Thailand

Midstream

Tire Production in China

Downstream

Car Production in Japan

This Paper

1. Construct datasets on global macroeconomy, trade, stock market indices, climate disasters, transport infrastructures, and climate risks for the past half century
2. Link each climate disaster to the country directly affected and main upstream and downstream trade partners and determine whether the disaster hits transport infrastructure
3. To investigate the impact of climate disasters on the real economy, use a matching-and-stacking difference-in-differences strategy
4. To study how climate disasters affect stock returns in main trade partners, use a financial market event study method
5. Study the relationship between stock market valuation and exposure to foreign long-term climate change risks

Preview of Results

- Climate disasters that **affect ports** significantly reduce the affected countries' **imports, exports, and output** and undermine GDP of **main international trade partners**
- Climate disasters restructure supply chains: they **disrupt trade in downstream** (reducing export shares) but **strengthen trade in upstream** (increasing import shares)
- Climate disasters have **negative impact** on main international trade partners' stock returns **for aggregate market and tradable sectors**
- Exposures to **foreign long-run climate change risks undermine** asset valuation for **aggregate market and tradable sectors**

II. Impact of Climate Disasters on Home Macroeconomy

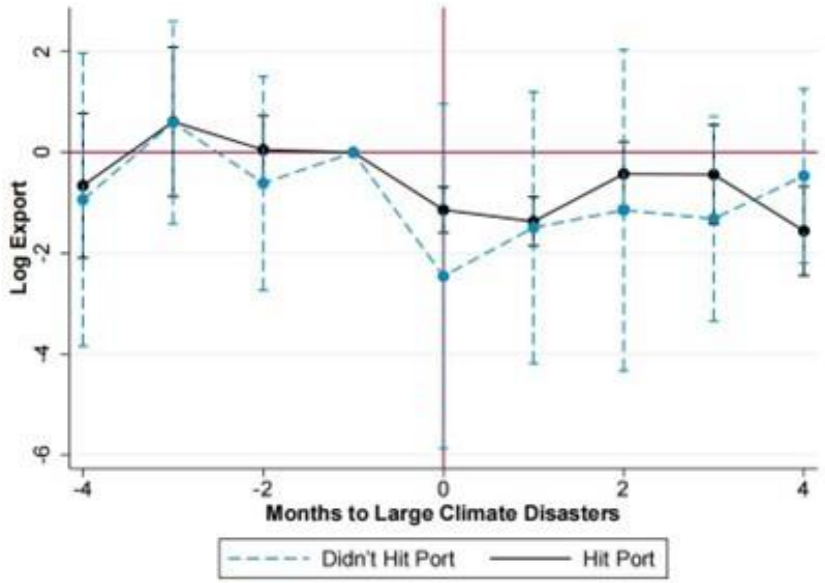
Event Study: Stacked Difference-in-Differences with Matching

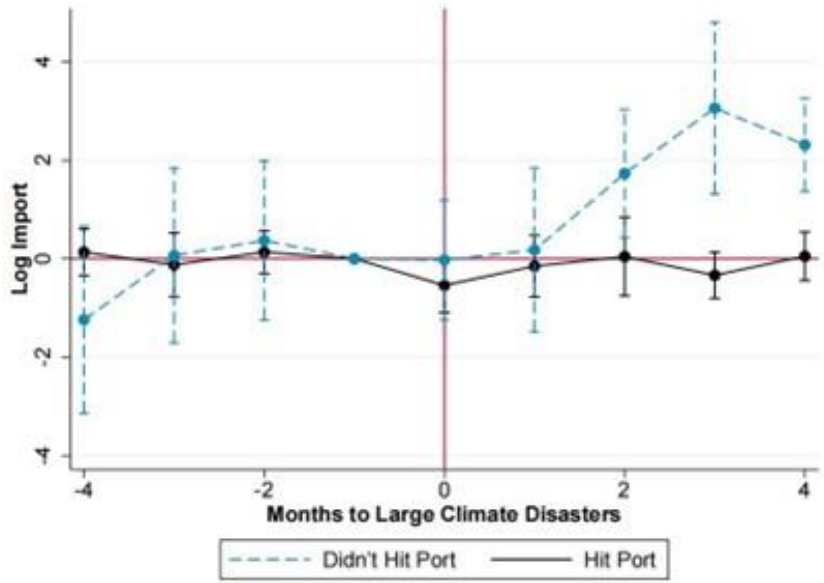
- **Events:** 430 non-overlapping climate disasters
    - Disaster: (1) affected more than 0.5 percent of the country's population; or (2) caused a damage of greater than 0.05 percent of GDP (IMF 2020)
    - Keep disasters whose event windows do not overlap
- **Event window:** from 4 months before the disaster start date to 4 months after the disaster start date, $[t-4, t+4]$
- **Control:** For each large climate disaster d hitting country $i(d)$, find a "clean" country, $i'(i,d,t)$, as the control group
    - Controls are not hit by any climate disaster within the event window
    - Most similar to treatment in terms of GDP and population, according to PSM

II. Impact of Climate Disasters on Home Macroeconomy

Climate Disasters that Hit Ports Significantly Reduce Both Imports and Exports

- An average such disaster reduces affected country's GDP by **0.36%**, its exports by **0.54%**, and its imports by **0.26%** in the first month





III. Impact of Climate Disasters on Foreign Macroeconomy

Output and Expenditure Shares of International Trade

- **Output share:** share of midstream country's output sold to a downstream country: $$S_{k,i,t} = \frac{x_{k,i,t}}{Y_{i,t}}$$
- **Main downstream** country, k:

$$k(i,t) = argmax_{k \neq i} S_{k,i,t}$$

- **Expenditure share:** share of midstream country's expenditure sourced from an upstream country: $$\pi_{i,j,t} = \frac{x_{i,j,t}}{X_{i,t}}$$
- **Main upstream** country, j:

$$j(i,t) = argmax_{j \neq i} \pi_{i,\mathrm{j},t}$$

III. Impact of Climate Disasters on Foreign Macroeconomy

Downstream Regression Specification

$$y_{k,d,t} = \sum_{m=-\bar{t}}^{\bar{t}} \beta_m^{down} \mathbb{I}_t \{m \text{ Months After Climate Disaster } d\} \frac{Damage_{i,d} \times S_{k,i,t}}{GDP_{k,\bar{y}}} + \alpha_{k,d} + \lambda_{t,d} + \epsilon_{k,d,t}$$

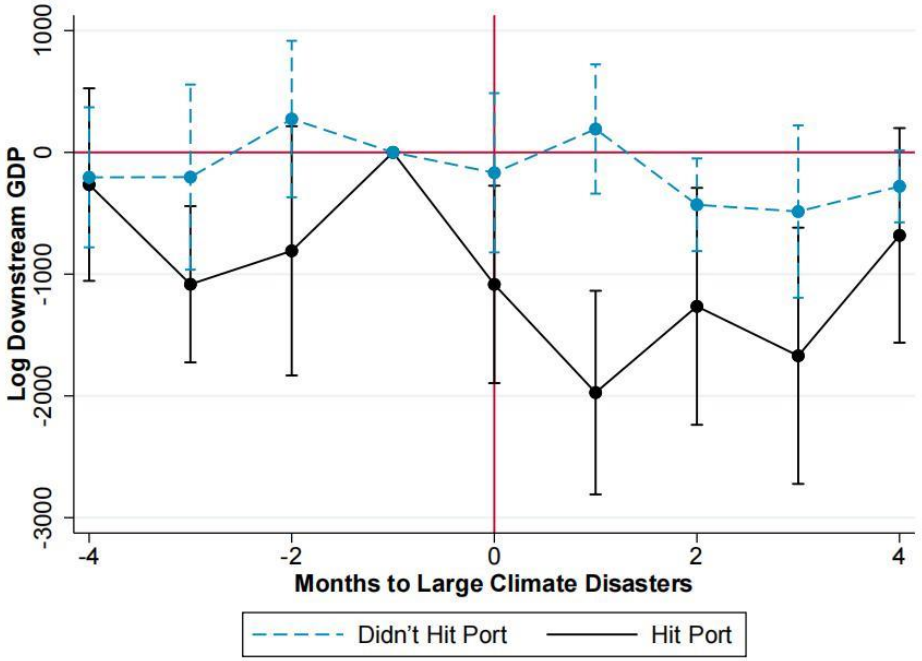
- k: downstream country
- $Damage_{i,d} \times S_{k,i,t}$: loss in supplies from midstream to downstream
- $\frac{Damage_{i,d} \times S_{k,i,t}}{GDP_{k,\bar{y}}}$: **downstream exposure** – supply shock relative to downstream GDP
- $\alpha_{k,d}$: disaster-country fixed effect; $\lambda_{t,d}$: disaster-time fixed effect
- Cluster standard errors on disaster-country level

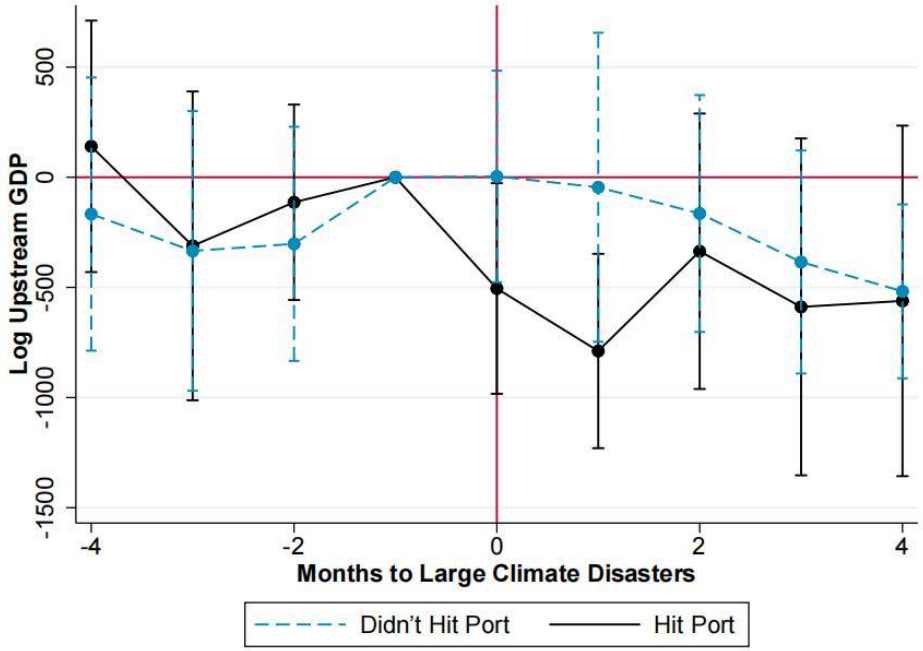
- **Control group:** (1) not affected by any climate disaster during the event window, (2) not midstream or main downstream, and (3) main downstream of the midstream control

III. Impact of Climate Disasters on Foreign Macroeconomy

Climate Disasters that Hit Ports Reduce Upstream and Downstream Production

- An average such disaster reduces main downstream country's GDP by **0.51%** and main upstream country's GDP by **0.36%** in the first month

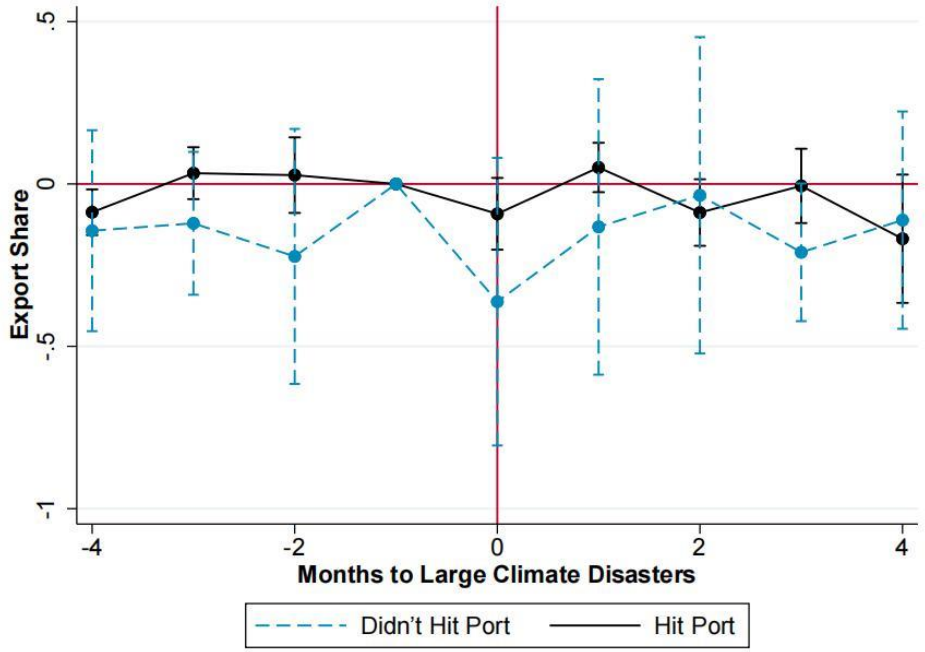


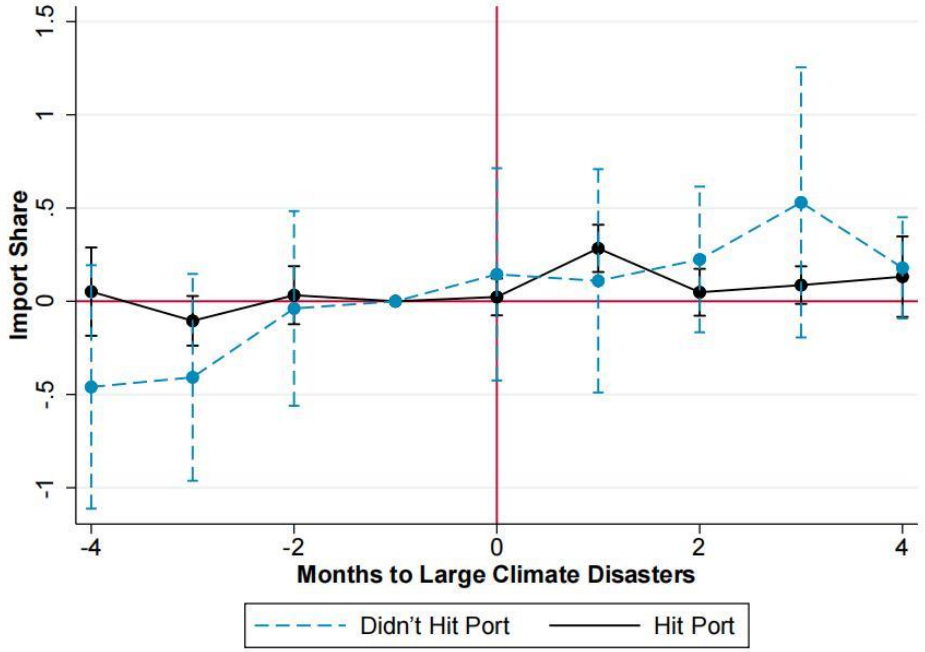


IV. Impact of Climate Disasters on Trade Disruptions

Affected Countries Have Less to Sell to Foreign Customers but Reply More on Upstream Foreign Suppliers

- An average climate disaster that hits ports (weakly) reduces affected country's export share, but makes the country reply more on foreign supplies (increase import share)





IV. Impact of Climate Disasters on Trade Disruptions

Decomposing Foreign GDP Effect into Supply/Demand Shock and Trade Disruptions

- Downstream:

$$y_{k,d,t} = \underbrace{\beta_1 \times Post_{d,t} \times \frac{\text{Damage}_{i,d} \times S_{k,i,\bar{y}}}{GDP_{k,\bar{y}}}}_{\text{Supply Shock}} + \underbrace{\beta_2 \times Post_{d,t} \times \frac{\pi_{k,i,t}}{S_{k,i,t}} \widehat{d(S_{k,i,d})}}_{\text{Trade Openness}} + \alpha_{k,d} + \lambda_{t,d} + \epsilon_{k,d,t},$$

  - $S_{k,i,\bar{y}}$: fixed, average output share in the previous year
  - ``Trade Openness'' uses predicted effect of climate disasters on midstream output share

- Upstream:

$$y_{j,d,t} = \underbrace{\beta_1 \times Post_{d,t} \times \frac{\text{Damage}_{i,d} \times \pi_{i,j,\bar{y}}}{GDP_{j,\bar{y}}}}_{\text{Demand Shock}} + \underbrace{\beta_2 \times Post_{d,t} \times \frac{S_{i,j,t}}{\pi_{i,j,t}} \widehat{d(\pi_{i,j,d})}}_{\text{Trade Openness}} + \alpha_{j,d} + \lambda_{t,d} + \epsilon_{j,d,t},$$

  - $\pi_{i,j,\bar{y}}$: fixed, average expenditure share in the previous year
  - ``Trade Openness'' uses predicted effect of climate disasters on midstream expenditure share

IV. Impact of Climate Disasters on Trade Disruptions

Decomposition Results

- Export disruptions weakly **decrease** downstream GDP
- Supply chain restructuring significantly **alleviates the negative impact** of climate disasters on upstream GDP

VARIABLES	(1)	(2)	(3)	(4)
	Log Downstream GDP		Log Upstream GDP	
	Coefficients	Contribution	Coefficients	Contribution
Supply/Demand Shock	-827.8**	97.6%	-848.5**	146.6%
	(383.8)		(399.7)	
Trade Openness	0.299***	2.4%	87.36*	-46.6%
	(0.0151)		(46.36)	
Observations	3,186		3,186	
Mean Dep. Var	12.36		12.21	
R^2	0.0759		0.0703	

V. Impact of Climate Disasters on Foreign Financial Markets

Financial Market Event Study Specification

- Understand impact on foreign economies at higher frequencies
- Examine heterogeneous effects across sectors
- Follow standard accounting/finance literature practices. Estimate CAPM model for downstream country k-sector level stock returns:

$$re^s_{k,t} = \beta^s_{0,k} + \beta^s_{1,k} re^s_{global,t} + \beta^s_{2,k} re^{mkt}_{k,t} + \epsilon^s_{k,t},$$

- where $re^s_{k,t} = RE^s_{k,t} - r^f_{k,t}$ denotes excess returns (returns minus 3m government bond yield)
- Estimation window $[t-12, t-1]$ months or $[t-240, t-21]$ trading days

V. Impact of Climate Disasters on Foreign Financial Markets

Financial Market Event Study Specification

- Compute abnormal returns and cumulative abnormal returns during event window:

$$AR^s_{k,\tau} = re^s_{k,\tau} - \widehat{\beta^s_{0,k}} - \widehat{\beta^s_{1,k}} re^s_{global,\tau} - \widehat{\beta^s_{2,k}}\, re^{\text{TOTMK}}_{k,\tau}\text{, where } \tau \in [t-20, t+80]$$

$$CAR^s_{k,x} = \sum_{\tau=t-20}^{t+x} AR^s_{k,\tau}\text{, where } x \in [-20, 80].$$

- Normalize month $t-1$/trading day $t-21$ cumulative abnormal returns to 0
- Cumulative abnormal returns measure the total loss in country k's sectoral stock market from month $t-1$
- Compute mean and confidence intervals of cumulative abnormal return on each day

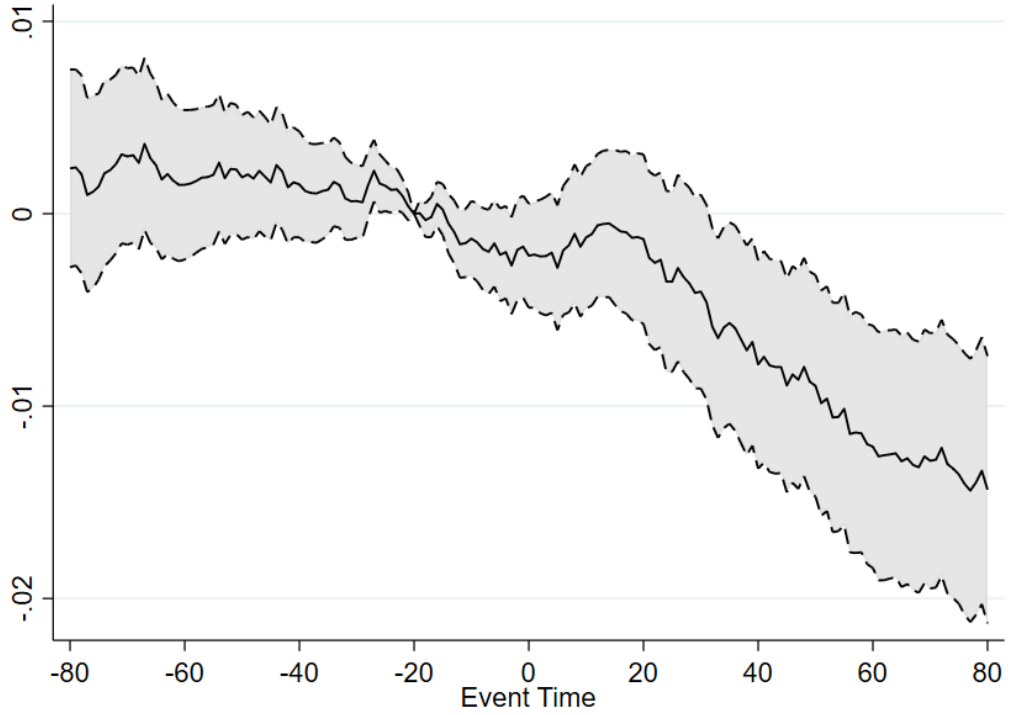
V. Impact of Climate Disasters on Foreign Financial Markets

Event Study Results

- Climate disasters reduce main upstream and downstream stock market returns by about -1% to -1.5%.

Downstream Stock Market CAR

Upstream Stock Market CAR

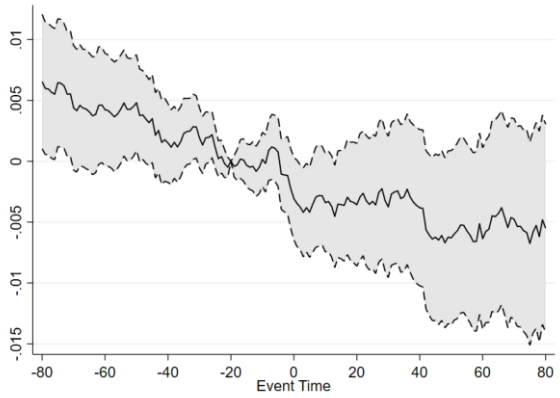


V. Impact of Climate Disasters on Foreign Financial Markets

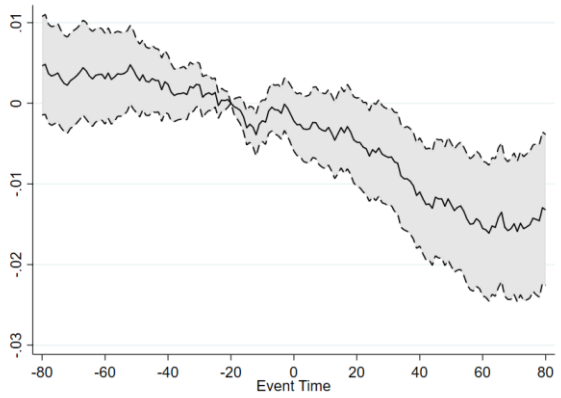
Climate Disasters Reduce Tradable Sector Stock Returns More

- For example, chemicals sector: -0.5% for downstream countries and -1.5% for upstream countries
- Automobile sector: - 2% for both downstream upstream countries

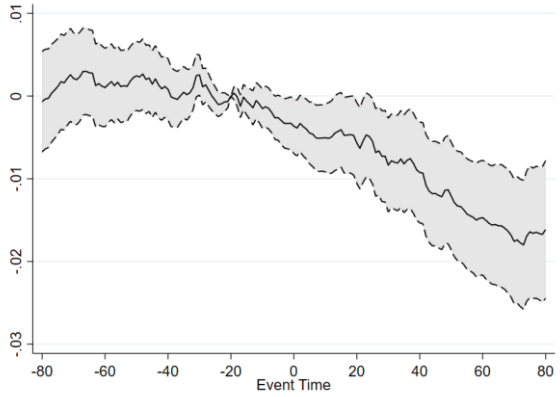
Downstream, Chemicals



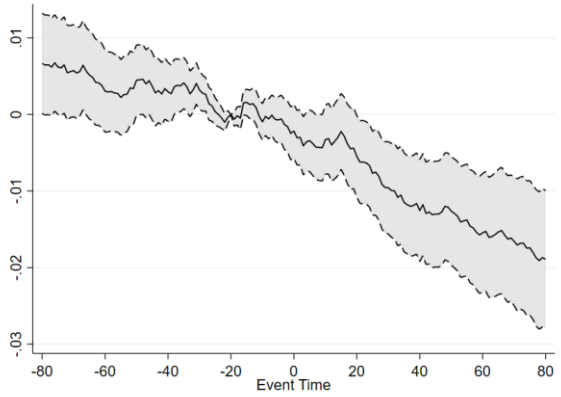
Upstream, Chemicals



Downstream, Automobile



Downstream, Automobile

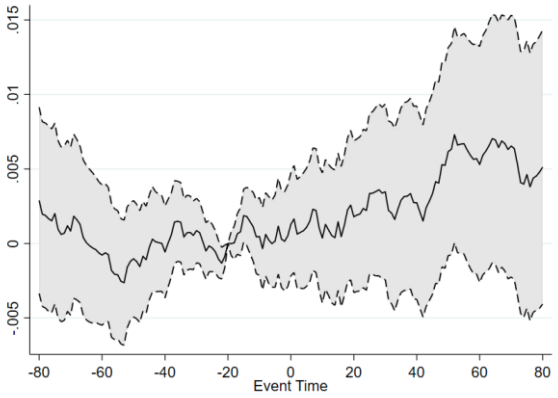


V. Impact of Climate Disasters on Foreign Financial Markets

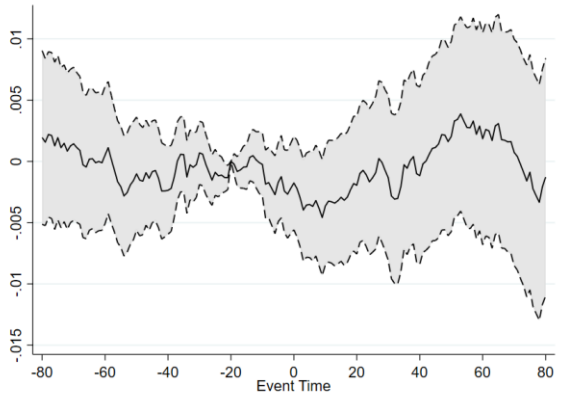
Climate Disasters Do Not Significantly Affect Stock Returns in Non-tradable Sectors

- For example, no significant effect on telecommunication and financial service sector returns in foreign countries

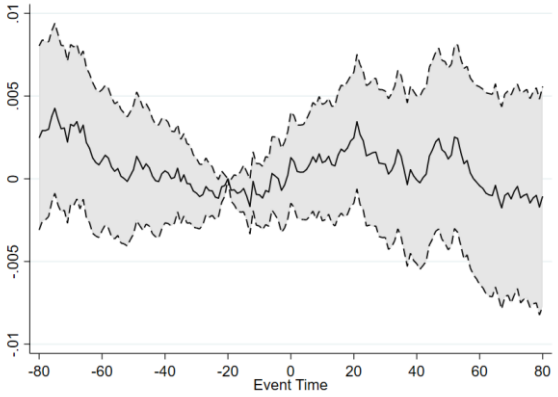
Downstream, Telecommunication



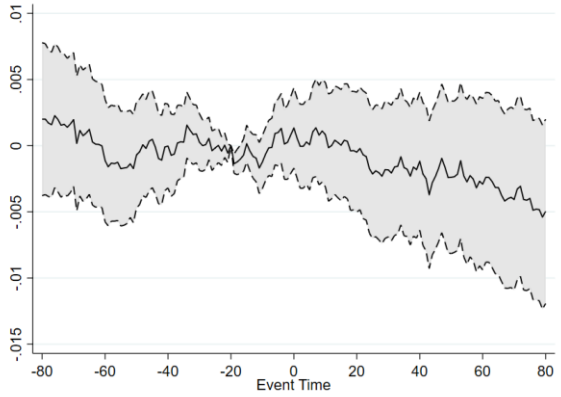
Upstream, Telecommunication



Downstream, Financial service



Downstream, Financial service



V. Impact of Climate Disasters on Foreign Financial Markets

Impact of Exposures to Foreign Climate Disasters on Stock Market Returns

- Use cross-disaster variation to study the impact of disaster damage/trade disruptions on stock market response in main trade partners:

$$CAR_{k,80}^{\text{TOTMK}} = \alpha_1^{TOTMK} \frac{Damage_{i,d} \times S_{k,i,t}}{GDP_{k,\bar{y}}} + \delta_i + \delta_k + \gamma_y + \epsilon_d^s.$$

- Run the specification for the aggregate market and individual sectors
- Control country/year fixed effects
- Cluster standard errors on the home country and trade partner level
- Ensure that the results are robust to different fixed effect controls and clustering

V. Impact of Climate Disasters on Foreign Financial Markets

Higher Exposures to Foreign Climate Disasters Reduce Domestic Stock Returns More

Dependent Variable: Cumulative Abnormal Return in Stock Market								
	With Fixed Effect						OLS	
	Downstream			Upstream			Downstream	Upstream
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Exposure to Foreign Disaster	-1,421***	-799.6*	-1,006**	-1,152**	-1,407***	-1,432**	-1,028**	-933.2**
	(369.3)	(456.8)	(385.7)	(500.4)	(436.5)	(536.6)	(402.9)	(446.7)
	[420.3]	[506.6]	[467.6]	[504.0]	[485.7]	[504.2]	[429.3]	[451.7]
Observations	381	381	381	381	381	381	396	396
Midstream Cou. FE	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Downstream Cou. FE	No	Yes	Yes	No	No	Yes	No	No
Upstream Cou.FE	No	No	No	No	Yes	No	No	No
Year FE	Yes	No	Yes	Yes	No	Yes	No	No
Mean Dep. Var	-0.00502	-0.00502	-0.00502	-0.0138	-0.0138	-0.0138	-0.00761	-0.0142
R^2	0.0767	0.0745	0.0725	0.0834	0.0830	0.0812	0.0814	0.0852
Effect in 4 Months	-0.711%***	-0.400%*	-0.503%**	-0.804%**	-0.985%***	-1.002%**	-0.514%**	-0.653%**

Description: This table presents the estimated parameters of model 10. The sample is composed of trade partners of countries hit by a large climate disaster. We constrained the sample to observations at 80 trading days after the disaster shock. "Average Effect in 4 Months" presents the damage effect on stock market returns in disaster-hit countries' main trade partners. The effect size is calculated based on the coefficients from model 10 and measured in percentage points, based on the coefficients estimated in columns 3 and 6. Robust standards error in parentheses are two-way clustered at disaster-hit country and stock market country level. Robust standards error in brackets are clustered at disaster-hit country level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

V. Impact of Climate Disasters on Foreign Financial Markets

Investigate Whether Tradable Sectors Are More Affected

- **Tradability**: ratio of a sector's world total trade value to the sector's value added

$$Trade_t^s = \frac{EX_t^s}{VA_t^s}$$

- Regress cumulative abnormal returns from a foreign disaster on the exposure measure and its interaction with sector tradability. For example, in the downstream country:

$$CAR_{k,80}^s = \mu \frac{Damage_{i,d} \times S_{k,i,t}}{GDP_{k,\bar{y}}} + \lambda \frac{Damage_{i,d} \times S_{k,i,t}}{GDP_{k,\bar{y}}} \times Trade_t^s + \delta_i + \delta_k + \gamma_y + \zeta^s + \epsilon_d^s,$$

V. Impact of Climate Disasters on Foreign Financial Markets

Climate Disasters Reduce Foreign Tradable Sector Returns More

Dependent Variable: Cumulative Abnormal Return												
	Full Sample				Hit Port				Didn't Hit Port			
	Upstream		Downstream		Upstream		Downstream		Upstream		Downstream	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Exposure to Foreign Disaster	123.0	161.3	-153.4	-187.9	400.5**	448.6***	-1,012***	-1,053***	-133.6	-102.0	-73.47	-91.49
	(105.1)	(108.5)	(144.1)	(139.8)	(167.5)	(171.3)	(289.8)	(277.3)	(153.6)	(158.6)	(199.6)	(198.8)
Exposure to Foreign Disaster	-321.3***		-262.8**		-494.4***		-581.0**		-172.9		-191.8	
$\times TS^s$	(114.2)		(128.0)		(158.3)		(256.2)		(159.1)		(152.1)	
Exposure to Foreign Disaster		-550.2***		-376.3*		-869.4***		-1,075**		-316.0		-266.8
$\times TD^s$		(174.9)		(209.1)		(256.5)		(452.0)		(235.3)		(246.2)
Observations	12,795	12,795	12,795	12,795	5,235	5,235	5,235	5,235	7,560	7,560	7,560	7,560
Midstream Cou. FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Downstream Cou. FE	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Upstream Cou. FE	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes	No	No
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean Dep. Var	-0.00918	-0.00918	-0.00758	-0.00758	-0.00959	-0.00959	-0.00899	-0.00899	-0.00890	-0.00890	-0.00661	-0.00661
R^2	0.118	0.118	0.107	0.107	0.104	0.104	0.0949	0.0949	0.125	0.125	0.114	0.114

Description: This table presents the estimated parameters of model 11. TS^s is a dummy variable that equals 1 if the sector belongs to basic material, industrial production, or consumer goods sectors. TD^s equals sector s' total trade divided by the sector's total GDP on the world level. The sample is composed of main trade partners of the countries hit by a large climate disaster. We pool all sectors' estimated cumulative abnormal returns to investigate the heterogeneity across sectors. We measure the cumulative abnormal returns with their values at 80 trading days after the beginning of the climate disaster. Standard errors are presented in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

VI. Foreign Climate Change Risk and Asset Valuation

- Investigate whether exposures to foreign climate risks reduce the stock market valuations at home (measured with P/E ratios)
- Climate change poses increasing long-term risks of larger, more frequent climate disasters
- When these disasters happen, the major trade partners' macroeconomy and financial market are negatively impacted
- The major trading partners of the high climate risk countries are more exposed to foreign climate risks
- Forward-looking, rational investors may price in these risks

VI. Foreign Climate Change Risk and Asset Valuation

Exposure to Foreign Climate Change Risk

- R_i: climate risk in country i
- Downstream country's exposure: $$D_{k,y} = \sum_{i \neq k} S_{k,i,y} R_i,$$
- Upstream country's exposure: $$U_{j,y} = \sum_{i \neq j} \pi_{i,j,y} R_i.$$
- **Robustness test:** replace foreign climate risks with all 1's, GDP, and GDP growth rate: negative association between the P/E ratio and foreign exposure is not driven by openness to trade alone or trade with countries that are richer/grow faster

VI. Foreign Climate Change Risk and Asset Valuation

Regress Country-sector Level P/E Ratios on Foreign Climate Risk Exposures

- Get sectoral residual P/E ratios, $RPE^s_{i,y}$: those cannot be explained by standard valuation predictors: interest rates, expected future earnings and equity risk premium (IMF 2020)

$$PE^s_{i,y} = a^s_0 + a^s_1 r_{i,y} + a^s_2 EXPFE_{i,y} + a^s_3 ERP_{i.y} + RPE^s_{i,y}$$

  - $r_{i,y}$, 3-month government bond yield in the stock market country
  - $EXPFE_{i,y}$, the mean annual growth of earnings per share over the past 5 years
  - $ERP_{i,y}$, measured with the standard deviation of annual growth of earnings per share over past 5 years

- Regress the residual P/E ratio on downstream/upstream exposures to foreign climate risks. For example:

$$\widehat{RPE}^s_k = b \times D_k + \zeta^s + \epsilon^s_k$$

- Investigate whether tradable sectors are more affected by exposures to foreign climate risks:

$$\widehat{RPE}^s_j = b \times U_j + \zeta^s + \epsilon^s_j$$

VI. Foreign Climate Change Risk and Asset Valuation

VARIABLES	(1) Up pooled	(2) Down pooled	(3) Up Interaction	(4) Down interaction	(5) Up placebo	(6) Down placebo	(7) Up placebo interaction	(8) Down placebo interaction
Exposure to Foreign Climate Risk	-143.2***	-146.5***	10.75	15.54	18.88	21.72	-5.837	-10.13**
	(39.44)	(53.65)	(23.64)	(22.87)	(32.04)	(37.77)	(7.915)	(4.582)
Exposure to Foreign Climate Risk			-349.0***	-375.8***			56.03	72.21
× Tradability			(106.8)	(119.4)			(77.63)	(92.93)
Observations	1,235	1,235	1,235	1,235	1,235	1,235	1,235	1,235
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean Dep. Var	-43.83	-43.83	-43.83	-43.83	-43.83	-43.83	-43.83	-43.83
R^2	374.8	374.9	374.4	374.6	375.5	375.5	375.6	375.5
Δ_{sd}	-0.0488	-0.0424	-0.0216	-0.0186	0.0115	0.0127	-0.00305	-0.00530
Δ_{interq}	-7.029	-7.185	-3.111	-3.154	2.489	3.236	-0.663	-1.354

Description: This table shows the association between home-country residual P/E ratio and upstream and downstream exposures to foreign climate risks. Columns 1 and 2 show the impact of upstream and downstream foreign climate risk exposures for all sectors. Columns 3 and 4 add to Columns 1 and 2, respectively, the interaction between upstream and downstream foreign climate risk exposures and the importing and exporting tradability. Columns 5 and 6 present the result with placebo upstream and downstream foreign exposures–openness to trade. Columns 7 and 8 add the interaction between openness to trade and importing and exporting tradability. In Columns 1-2 and 5-6, Δ_{sd} refers to the change in the standard error of the dependent variable associated with one standard deviation increase in the independent variable, Δ_{interq} refers to the change in the magnitude of the dependent variable associated with increasing the independent variable from its 25th percentile to 75th percentile. In Columns 3-4 and 7-8, Δ_{sd} refers to the change in the standard error of the dependent variable associated with one standard deviation increase in the exposure to foreign climate risks for sectors with median readability, Δ_{interq} refers to the change in the magnitude of the dependent variable associated with increasing the independent variable from its 25th percentile to 75th percentile, for sectors with median tradability. Robust Standard errors in parentheses are clustered at country level. *** p<0.01, ** p<0.05, * p<0.1.

Conclusion

- Climate shocks that happen to any country in global supply chain can have significant macro-financial implications on other countries
- A country’s climate change adaptation benefits the economic well-being of all countries, especially trade partners
- Beyond moral imperatives, advanced economies also have economic interests in supporting developing economies to adapt to climate change

Background Material

Additional Tables

Summary Statistics

Variable	N	Mean	St. Dev.	Min	Max
Panel A: Disaster Damage					
Affected Population (Million)	430	1.246	4.961	0.000	60.000
Affected Population Ratio (%)	430	2.396	6.245	0.000	71.525
Death Population (Thousand)	430	0.237	1.815	0.000	30.000
Death Ratio (%)	430	0.001	0.008	0.000	0.127
Monetary Damage (Million)	430	605.772	1,722.730	0.000	22,000
Damage Ratio (%)	430	0.587	2.186	0.000	31.403
Whether Affect Port (Indicator)	430	0.412	0.493	0	1
Whether Affected Airport (Indicator)	430	0.642	0.480	0	1
Panel B: Disaster-hit Country					
Advanced Economy (Indicator)	430	0.160	0.367	0	1
GDP (Billion)	430	469.528	1,643.988	0.143	18,715.050
Population (Million)	430	92.891	239.449	0.083	1,390.080
CPI (2011 = 100)	430	71.687	44.052	0.00000	432.913
Export (Billion)	430	82.311	256.952	0.012	2,262.559
Import (Billion)	430	79.871	228.830	0.075	2,241.454
Number of Port	430	5.453	7.306	0	48
Number of Airport	430	17.979	35.173	1	267
Panel C: Trade Structure					
Main Upstream as Advanced Economy (Indicator)	430	0.693	0.462	0	1
Main Downstream as Advanced Economy (Indicator)	430	0.812	0.391	0	1
Output Share to Main Downstream (%)	430	4.496	4.932	0.306	43.433
Expenditure Share on Main Upstream (%)	430	4.472	4.266	0.217	33.771
Upstream GDP (Billion)	430	4,885.645	4,793.811	13.565	18,569.100
Downstream GDP (Billion)	430	6,370.663	5,514.826	8.954	18,569.100
Upstream Exposure to Midstream Disaster (‰)	430	0.007	0.021	0.000	0.231
Downstream Exposure to Midstream Disaster (‰)	430	0.005	0.017	0.000	0.216

Additional Tables

Impact of Climate Disasters on Midstream Production, Price and Trade: Port Interaction Specification

VARIABLES	(1) Log GDP	(2) Log CPI	(3) Log Export	(4) Log Import	(5) Log Export to Main Downstream	(6) Log Import from Main Upstream
Damage Ratio	-0.621	0.255	-1.138	1.652**	0.347	1.642
	(1.184)	(0.362)	(1.110)	(0.688)	(1.165)	(1.252)
Affect Port	-0.00830	0.00128	-0.00410	-0.0126	-0.00398	-0.0408**
	(0.0128)	(0.00724)	(0.0137)	(0.0124)	(0.0396)	(0.0178)
Damage Ratio × Affect Port	-0.271	-0.102	0.181	-1.781**	-2.152*	-2.264*
	(1.215)	(0.366)	(1.156)	(0.689)	(1.195)	(1.267)
Observations	7,740	7,740	7,740	7,740	7,740	7,740
Cou. X Dis. FE	Yes	Yes	Yes	Yes	Yes	Yes
Time X Dis. FE	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Dis.	Dis.	Dis.	Dis.	Dis.	Dis.
Mean Dep. Var	8.416	4.091	20.68	20.89	19.09	19.26
R^2	0.190	0.115	0.193	0.148	0.513	0.280

Additional Tables

Impact of Climate Disasters on Foreign Country's Production, Price and Trade: Port Interaction Specification

VARIABLES	(1) Log Downstream GDP	(2) Log Downstream CPI	(3) Log Downstream Import	(4) Log Upstream GDP	(5) Log Upstream CPI	(6) Log Upstream Export
Exposure to Foreign Disaster	-172.1	37.27	43.48	-15.77	-73.81	220.3
	(202.4)	(66.28)	(276.5)	(177.4)	(53.02)	(258.5)
Affect Port	0.00394	-0.00307	-0.00212	0.00291	-0.00700**	-0.00777
	(0.00661)	(0.00209)	(0.00708)	(0.00658)	(0.00289)	(0.00618)
Exposure to Foreign Disaster	-733.4*	15.21	-77.59	-507.0*	152.0**	-292.3
× Affect Port	(422.2)	(77.42)	(497.1)	(272.8)	(57.36)	(315.9)
Observations	7,740	7,740	7,740	7,740	7,740	7,740
Cou. X Dis. FE	Yes	Yes	Yes	Yes	Yes	Yes
Time X Dis. FE	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Dis.	Dis.	Dis.	Dis.	Dis.	Dis.
Mean Dep. Var	12.16	4.422	24.24	11.96	4.412	24.04
R^2	0.0842	0.0255	0.0802	0.0747	0.0269	0.0574

Additional Tables

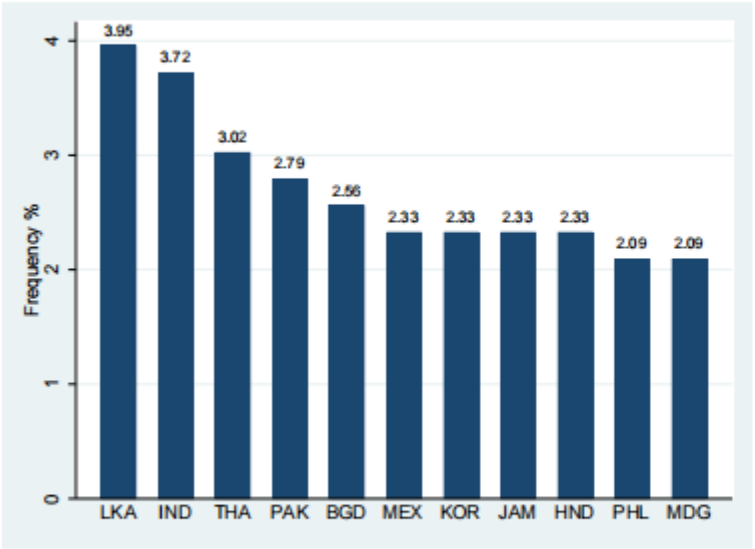
Gravity Effect on Disaster Spillovers

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Log Downstream GDP	Log Downstream GDP	Log Downstream GDP	Log Upstream GDP	Log Upstream GDP	Log Upstream GDP
Treated	-0.0879*	0.00294	-0.0706	-0.0388	-0.00432	-0.0619
	(0.0484)	(0.00661)	(0.0455)	(0.0451)	(0.00763)	(0.0521)
Treated×Log Distance	0.0103*		0.00847	0.00467		0.00699
	(0.00560)		(0.00525)	(0.00561)		(0.00624)
Treated×Contiguity		-0.0267	-0.0145		0.0213	0.0262
		(0.0264)	(0.0275)		(0.0178)	(0.0180)
Observations	3,186	3,186	3,186	3,186	3,186	3,186
Cou. X Dis. FE	Yes	Yes	Yes	Yes	Yes	Yes
Time X Dis. FE	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Dis.	Dis.	Dis.	Dis.	Dis.	Dis.
Mean Dep. Var	12.16	12.16	12.16	11.96	11.96	11.96
R^2	0.0759	0.0760	0.0760	0.0704	0.0703	0.0703

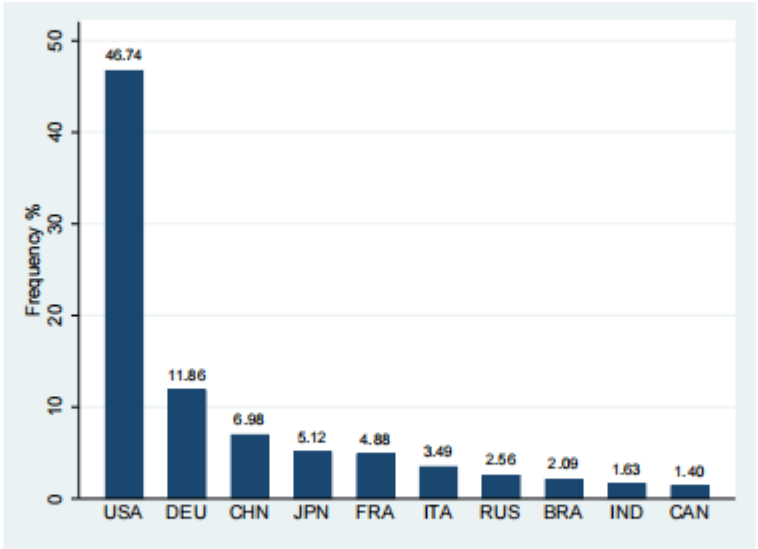
Additional Figures

Distribution of Disaster-hit Countries and Main Trade Partners

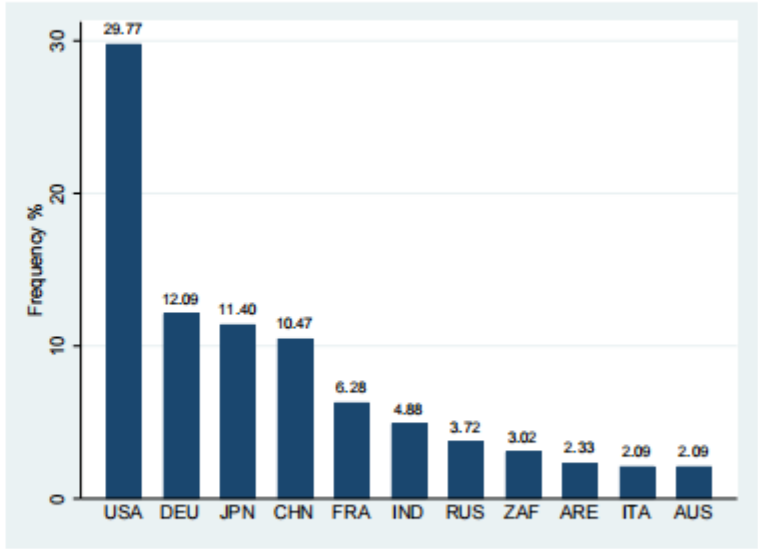
(a) Most Frequent Disaster-hit country



(b) Most Frequent Main Downstream Country



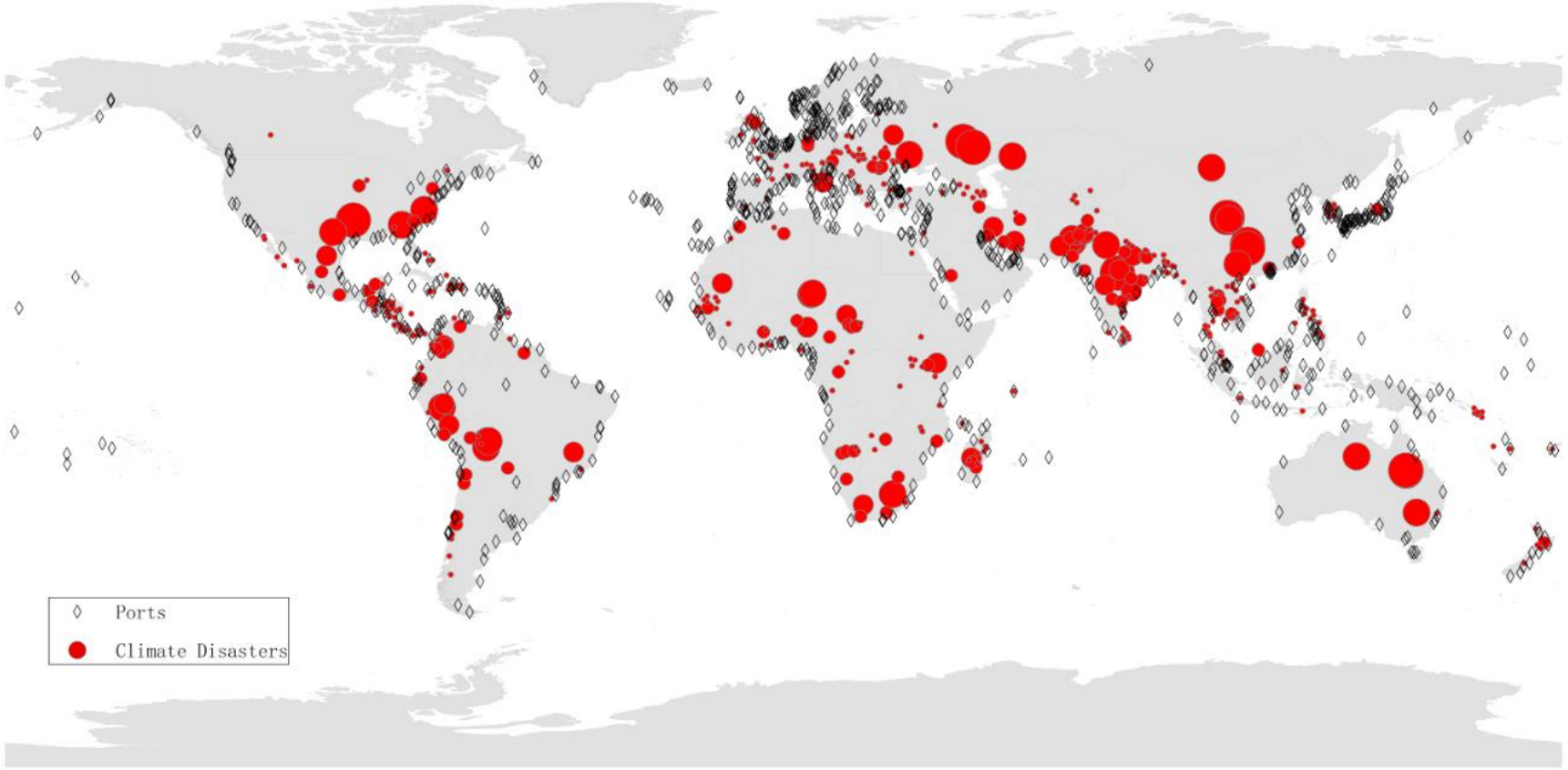
(c) Most Frequent Main Upstream Country



Description: Figure (a) shows the top 10 countries most frequently hit by a large climate disaster in our sample. Figure (b) shows the top 10 countries that disaster-hit countries most frequently export most to. Figure (c) shows the top 10 countries that disaster-hit countries most frequently import most from.

Additional Figures

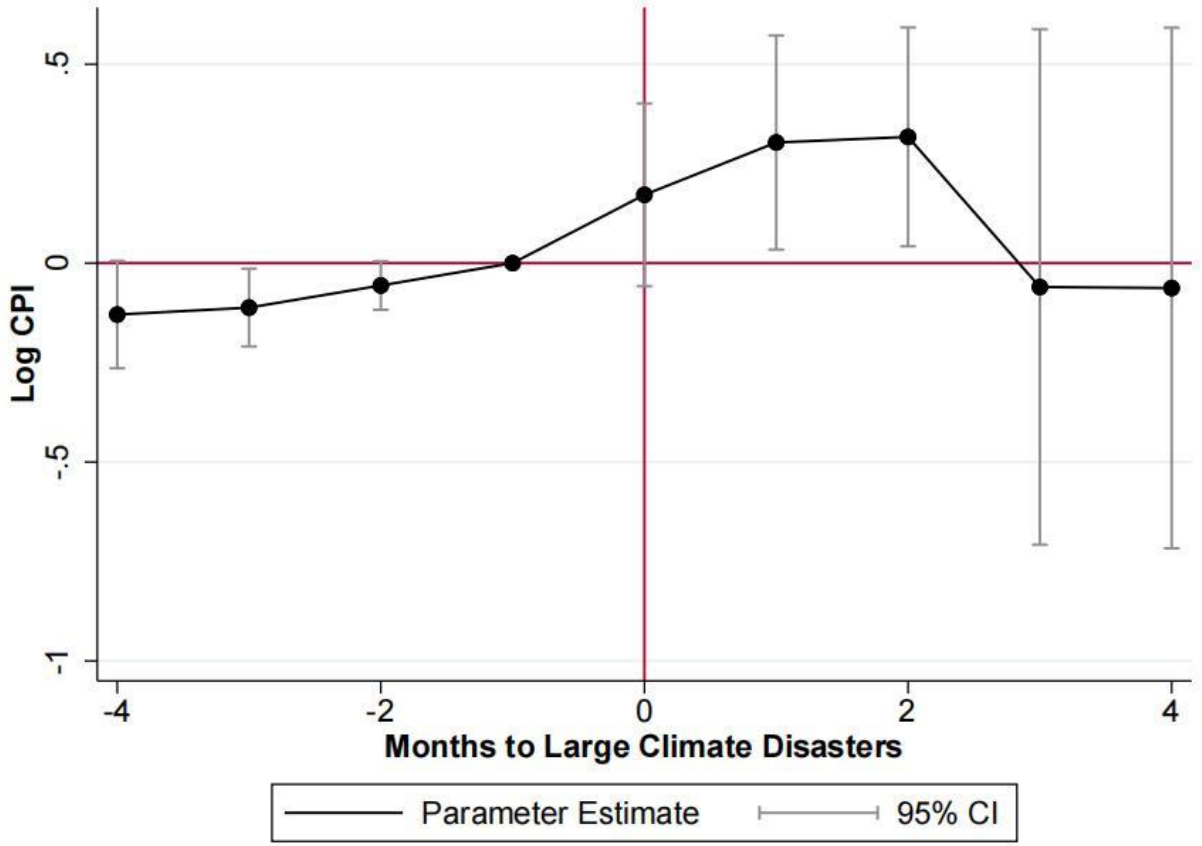
Distribution of Climate Disasters and Ports



Description: This figure shows the geographical distribution of the climate disasters and ports studied in our main sample. The red circle indicates the normalized size of the disaster area.

Additional Figures

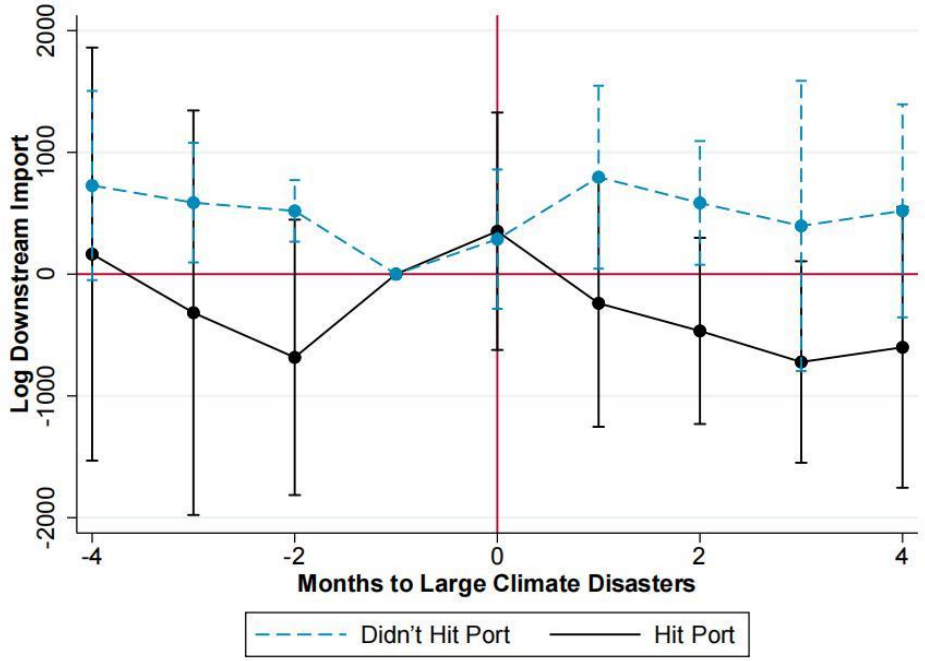
Inflation in home country

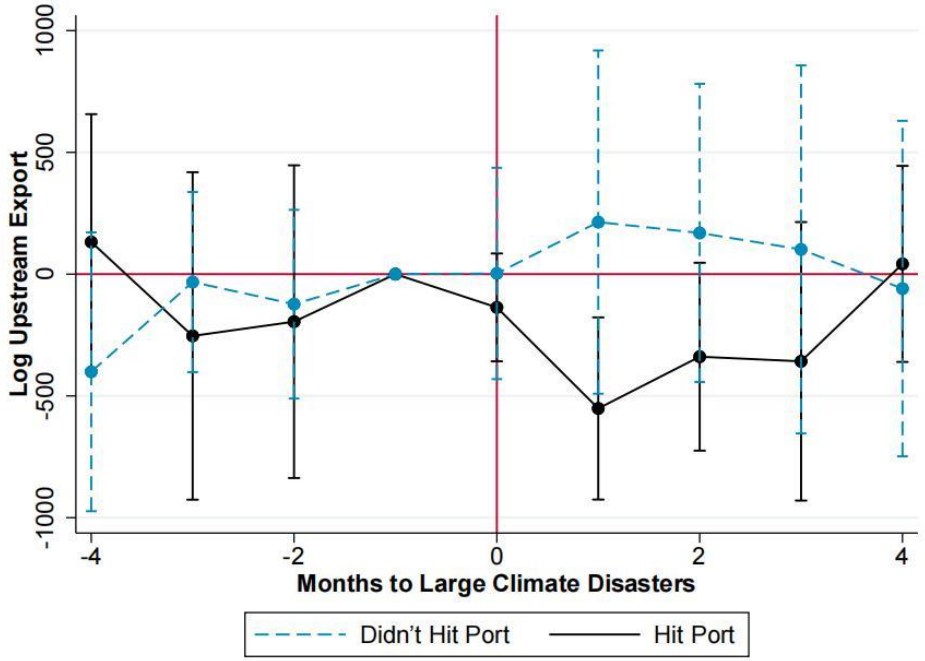


Additional Figures

Event-study results on trade partners – whether hit port

- Upstream export is significantly decreased.

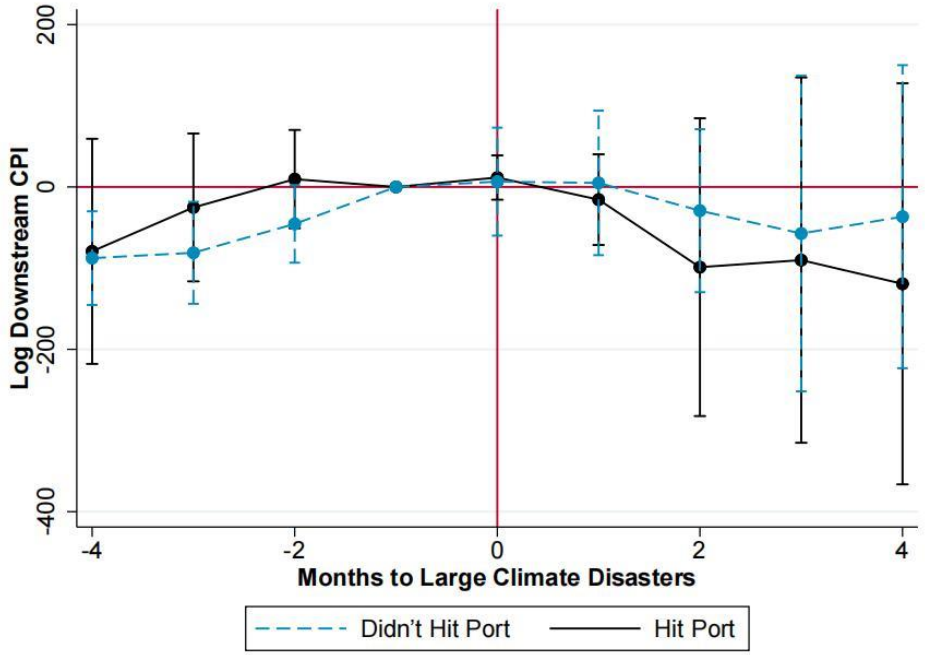


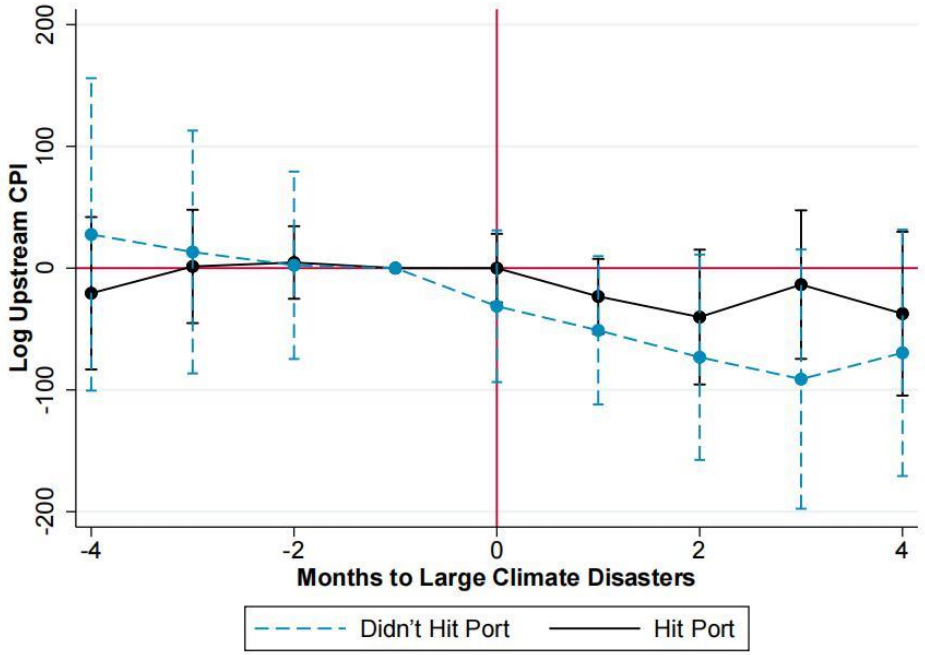


Additional Figures

Event-study results on trade partners – whether hit port

- No significant effect on foreign price

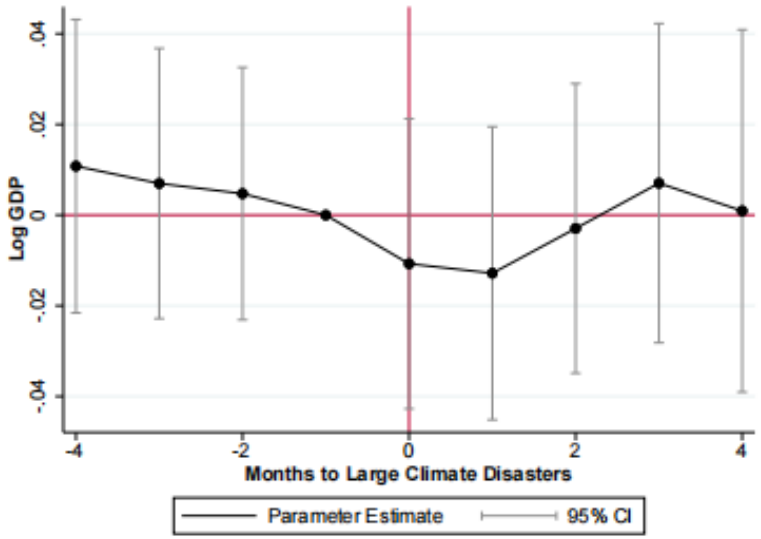




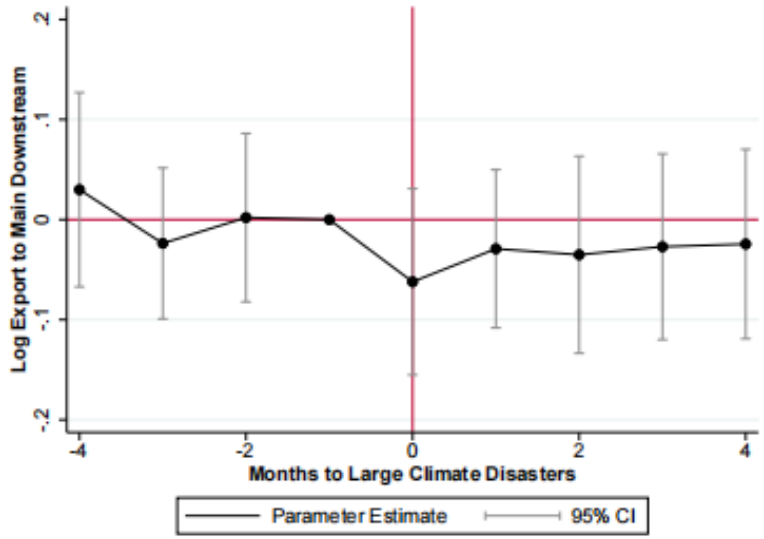
Additional Figures

Impact of Climate Disasters on Midstream Production and Trade: Using dummy as independent variable

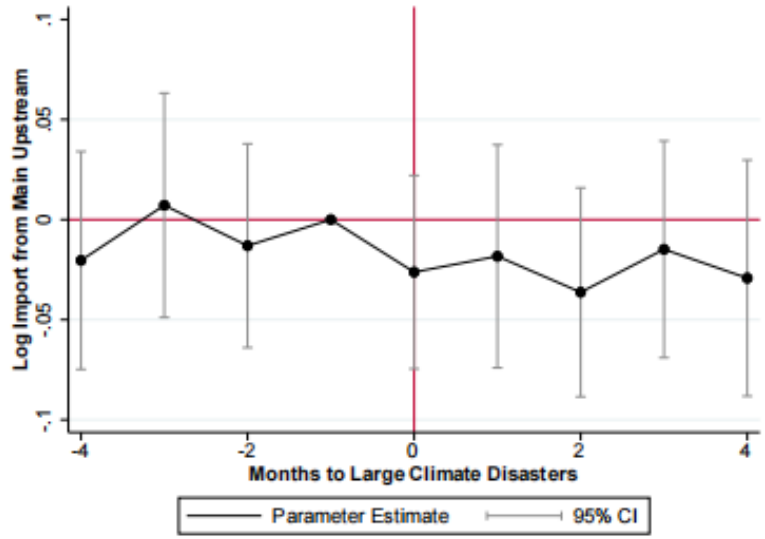
(a)



(b)

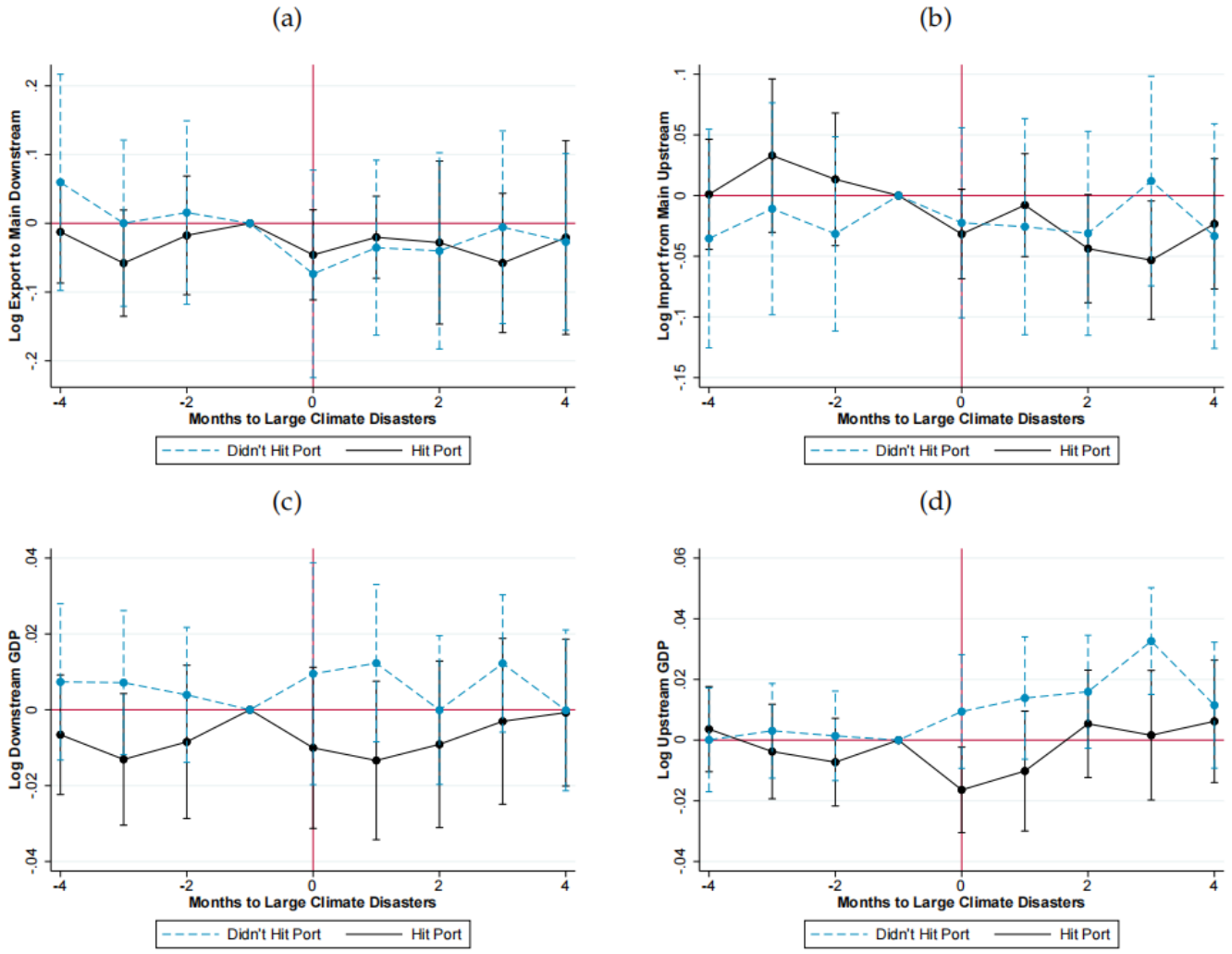


(c)



Additional Figures

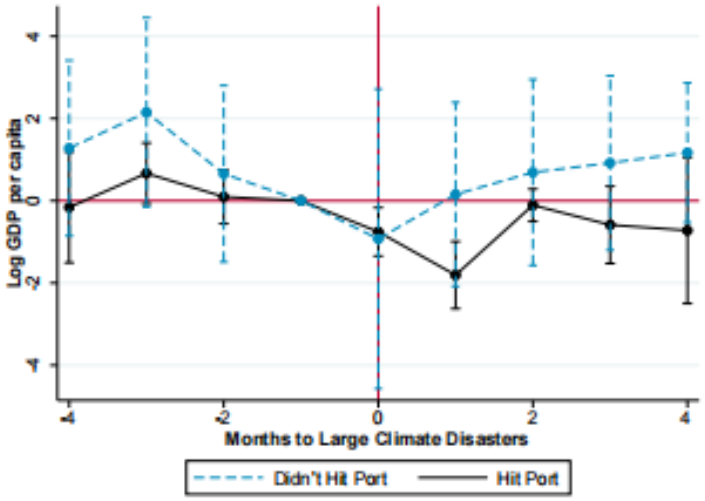
Disaster Spillover Effect: Using dummy as independent variable



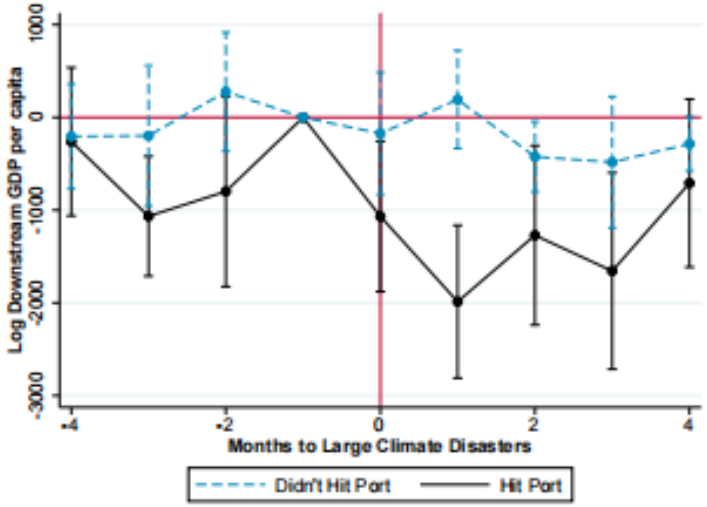
Additional Figures

Impact of Climate Disasters on GDP per capita

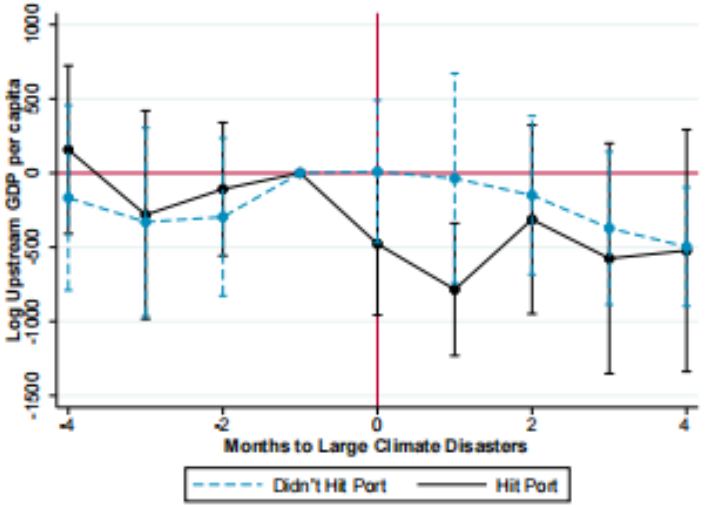
(a) Midstream



(b) Downstream



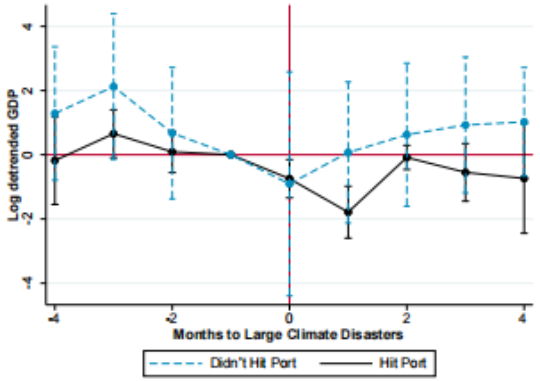
(c) Upstream



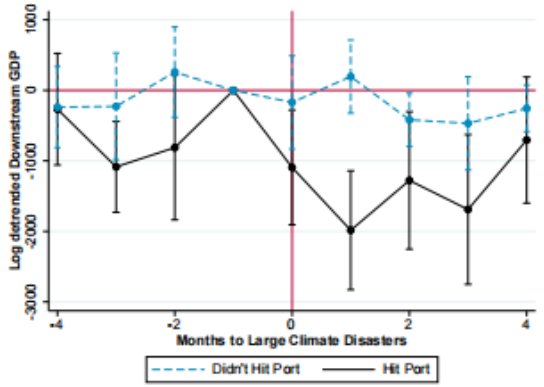
Additional Figures

Impact of Climate Disasters on GDP: Detrended and Seasonally Adjusted

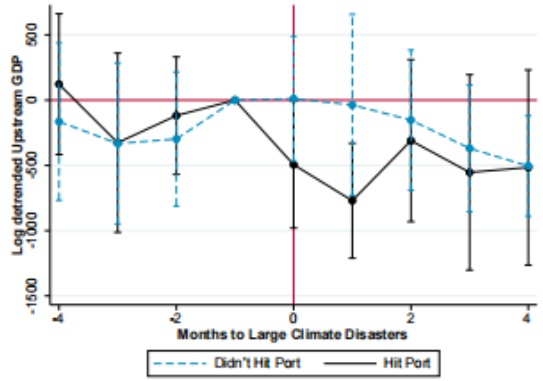
(a) Detrended Midstream



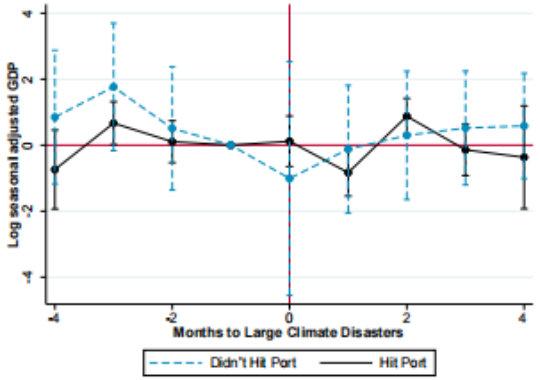
(b) Detrended Downstream



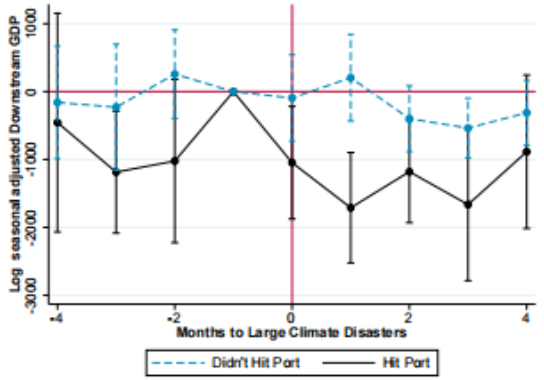
(c) Detrended Upstream



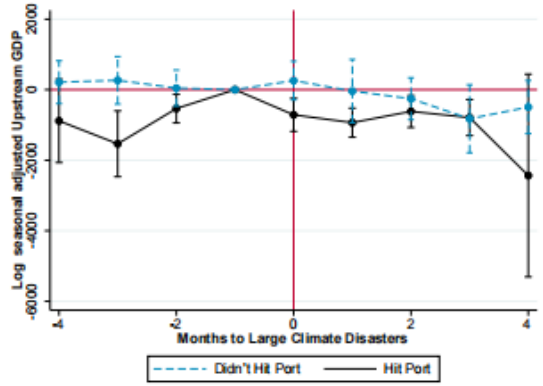
(d) Seasonally Adjusted Midstream



(e) Seasonally Adjusted Downstream

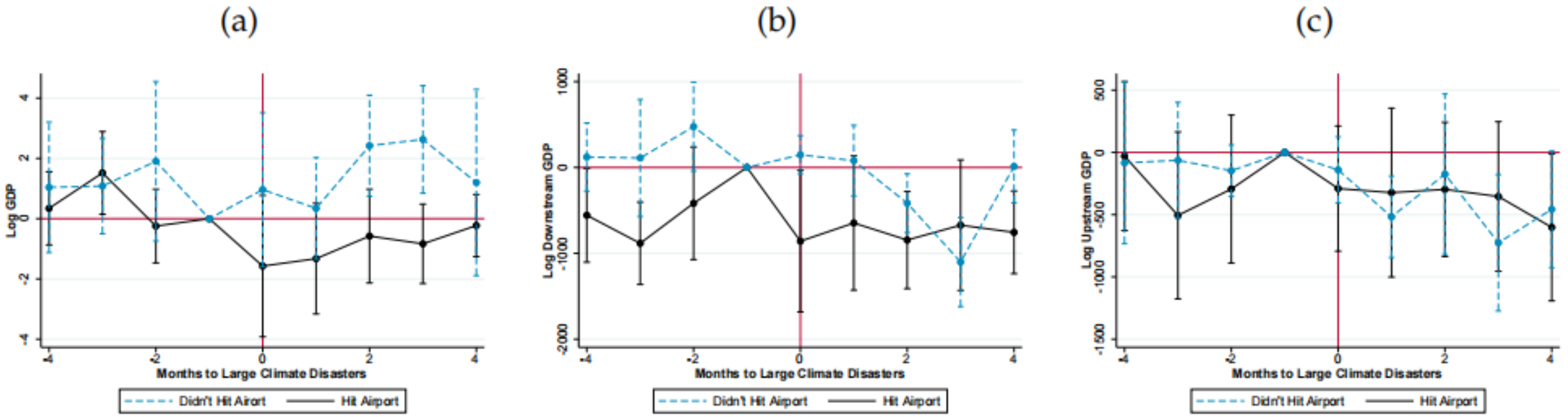


(f) Seasonally Adjusted Upstream



Additional Figures

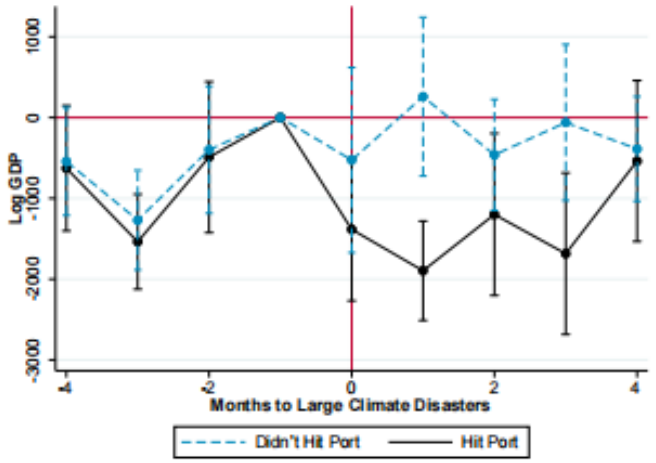
Impact of Climate Disasters on GDP by Whether They Hit Airport



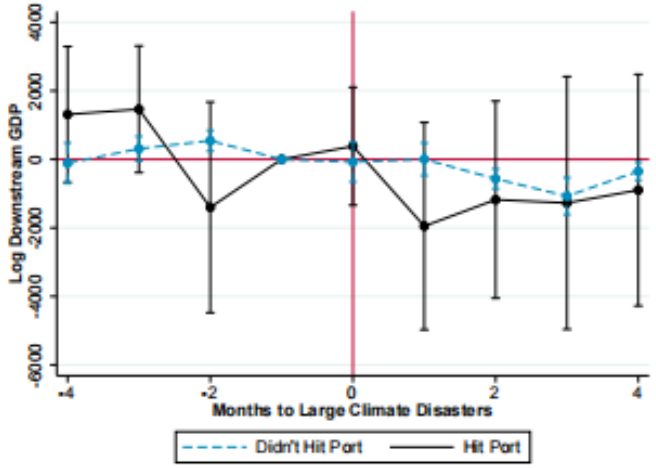
Additional Figures

Impact of Climate Disasters on Foreign GDP by Whether the Main Downstream Is Also the Main Upstream

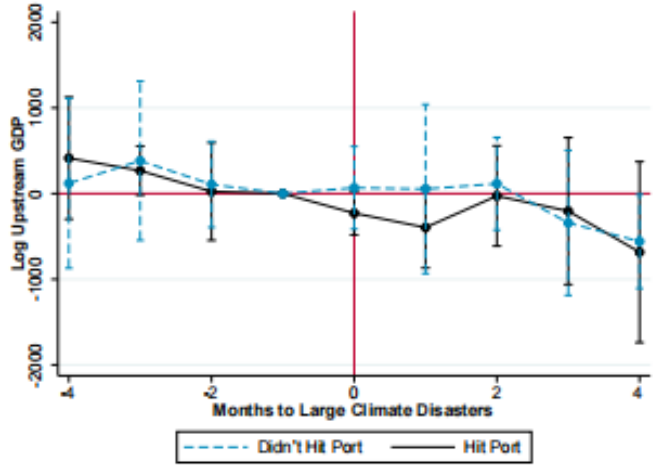
(a) Both Main Downstream and Main Upstream



(b) Only Main Downstream



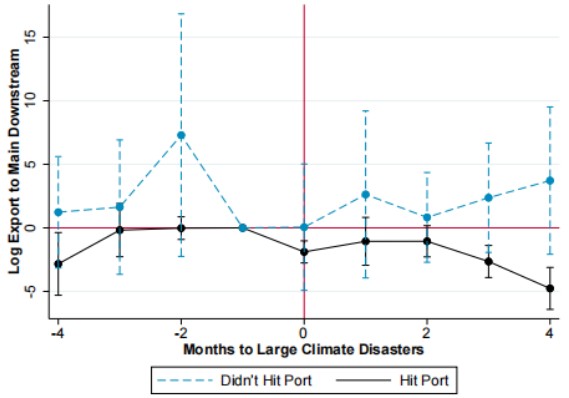
(c) Only Main Upstream



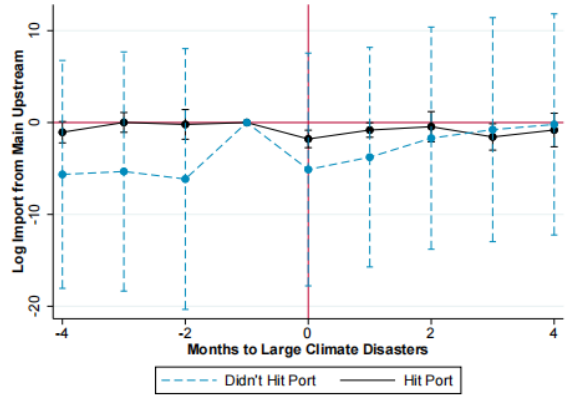
Additional Figures

Impact of Climate Disasters on Bilateral Trade by Whether the Main Downstream Is Also the Main Upstream

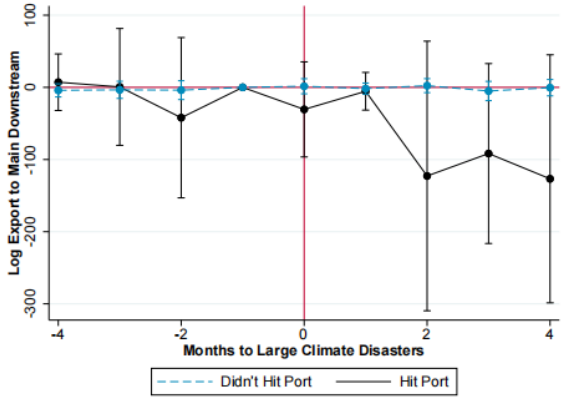
(a) Both Main Downstream and Main Upstream: Midstream Export to Downstream



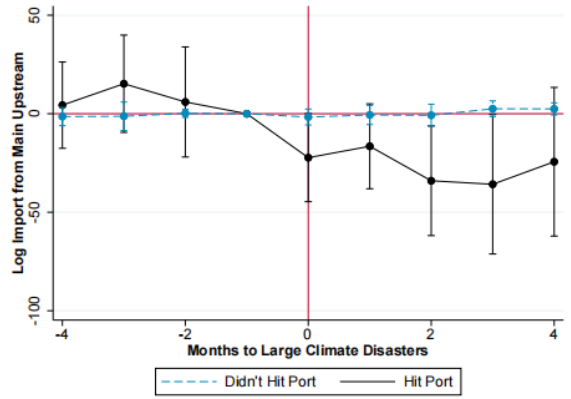
(b) Both Main Downstream and Main Upstream: Midstream Import from Upstream



(c) Only Main Downstream: Midstream Export to Downstream



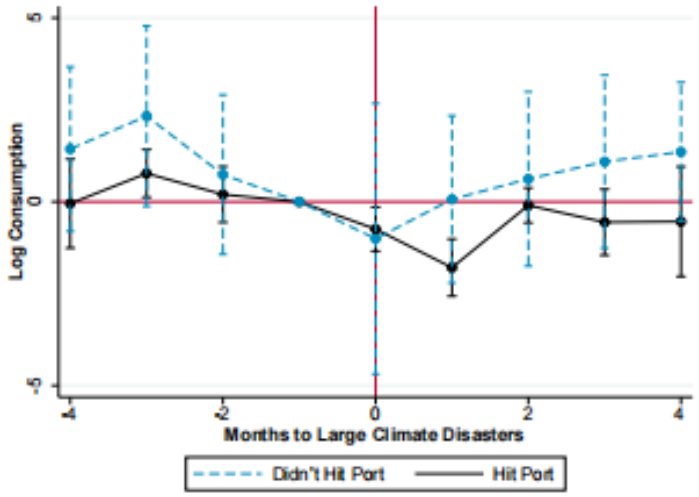
(d) Only Main Upstream: Midstream Import from Upstream



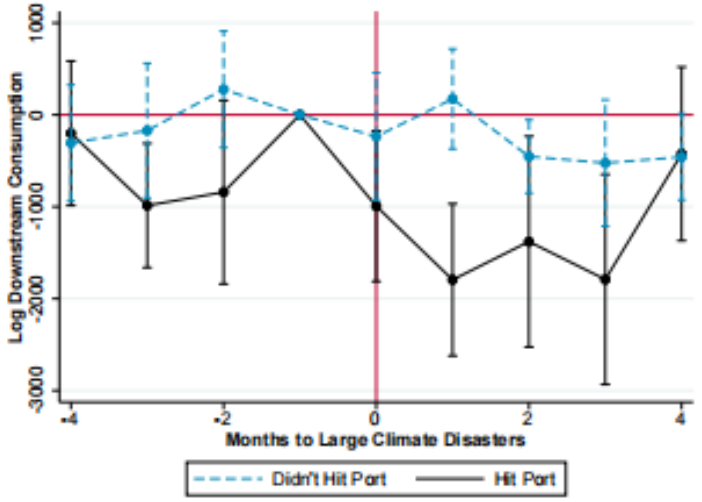
Additional Figures

Impact of Climate Disasters on Domestic and Foreign Consumption

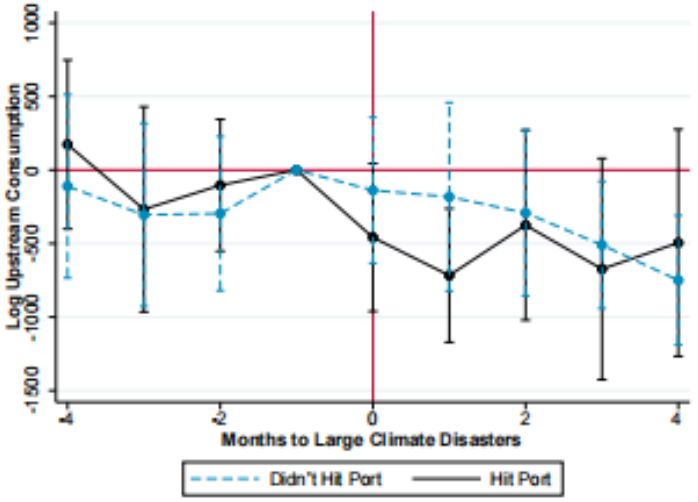
(a) Downstream Consumption



(b) Downstream Consumption



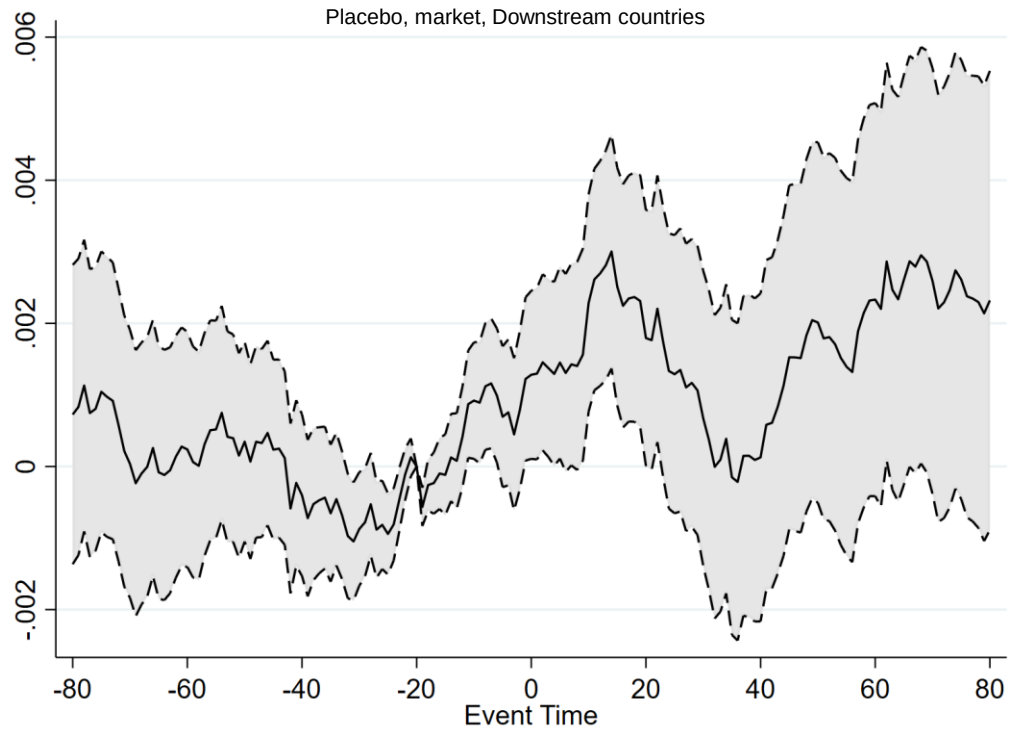
(c) Upstream Consumption

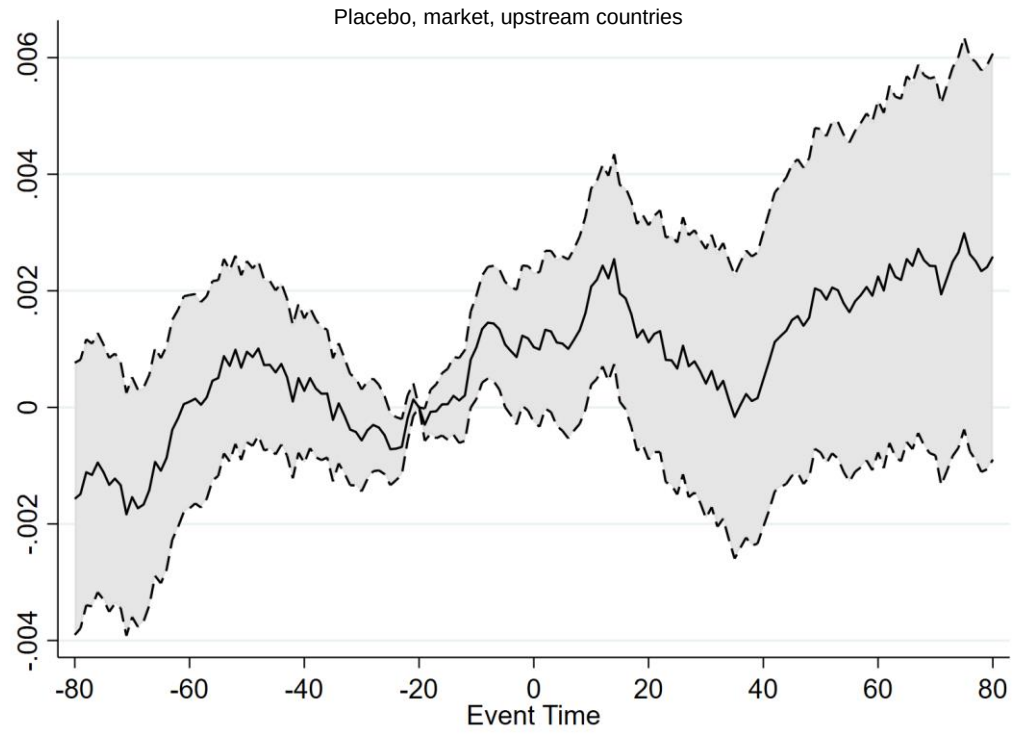


V. Impact of Climate Disasters on Foreign Financial Markets

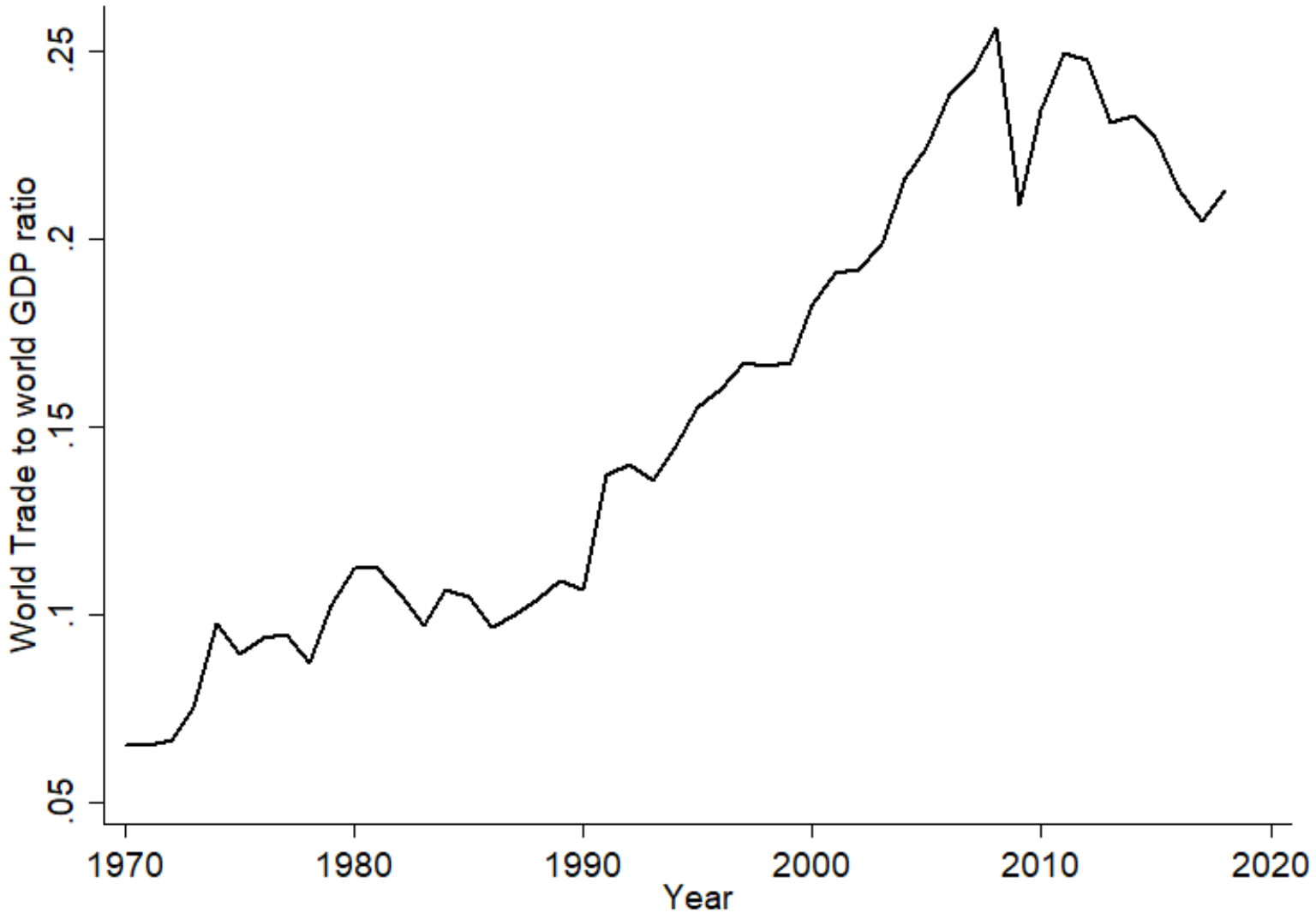
Non-major trade partner's stock market does not respond to the disaster

- Placebo test: stock market indices of the top 10 - 20 main (median) exporting and importing partner do not respond significantly to the disaster





Globalization trend



Examples

- COVID
  - Cerdeiro et al. (2020): Chinese exports declined by 30 percent from late January to early March 2020 when China imposed a COVID-19 lockdown
  - A second wave of global trade decline starting April 2020 when the US and European countries also imposed lockdown
  - Baldwin and Freeman (2020): global supply chain “contagion and reinfection”
- 2011 Thai flood
  - halted automobile parts production and assembly in Thailand
  - Toyota cut car production in Japan by 6,300 units due to part shortages (direct loss in Thailand 37,500)
  - Cumulative return in the automobile sector in Japan was -8.7 percent