Food Policy in a Warming World

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Three perspectives on India's export ban

Indian Ministry of Commerce & Industry
May 13 statement

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Farmer Ranbeer Singh Sirsa of Punjab
May 14 *New York Times*

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Questions

1. **How do governments intervene in response to agricultural shocks?**
2. **What are the aggregate and distributional consequences?**

This paper

1. **Empirics:** new global data by country, crop, year (1980-2011)
   - Domestic shocks lead to consumer aid, especially during elections
   - Foreign shocks lead to producer aid, possibly offsetting consumer aid
   - Persistent effects, including for longer-run changes

2. **Theory:** model of agricultural policy and trade
   - To rationalize observed policy responses
   - Government considers redistribution and revenues

3. **Contribution:** endogenous government policy and climate adaptation
   - Policy responses shield domestic consumers by stabilizing prices

Data by country ℓ, crop k, year t

- **Shocks:** extreme heat exposure
  - ERA-5 re-analysis data on temperatures
  - EarthStat data on geography of crop production (Monfreda et al. 2008)
  - ECOCROP data on crop-specific temperature sensitivity (Moscona & Sastry 2022)

- **Policy:** nominal rate of assistance (Anderson & Valenzuela 2008)
  - 80 products, 82 countries, 85% of global production (1955-2011)
  - Wedge between domestic and international prices
  - "Pro-consumer" if $NRA_{\ell kt} < 0$

Empirical Results

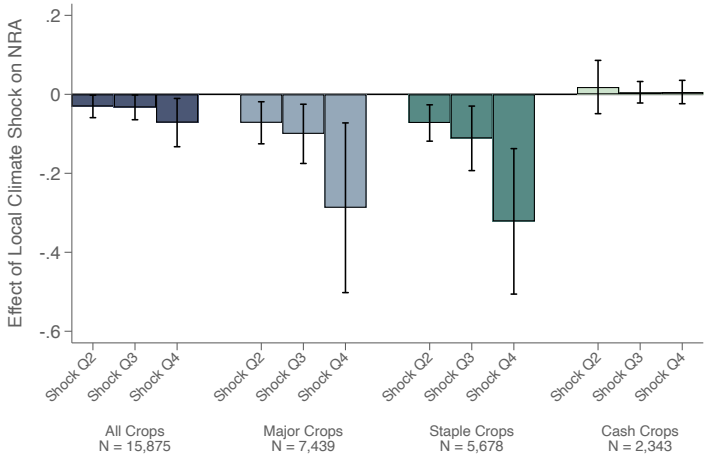
1. How does extreme heat affect trade policy?

$$\text{NRA}_{\ell kt} = g(\text{ExtremeHeat}_{\ell kt}) + \gamma_{\ell t} + \delta_{kt} + \mu_{\ell k} + \varepsilon_{\ell kt}$$

- Country ℓ, crop k, year t, quartile dummies $g(\cdot)$
- Fixed effects by country-year, crop-year, country-crop

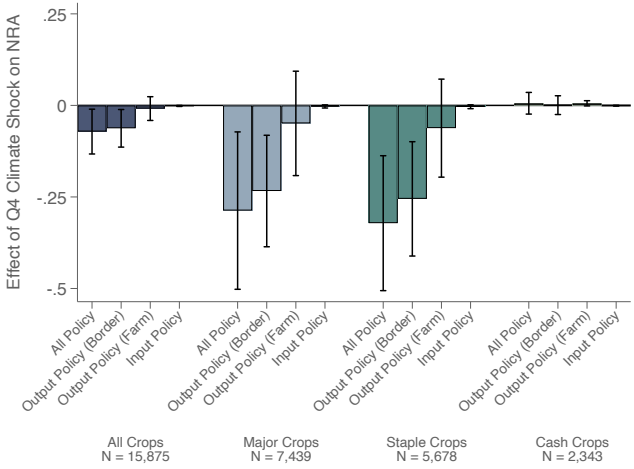
- **Identification:** some crops get worse shocks due to physiology, geography

Extreme heat induces pro-consumer policy



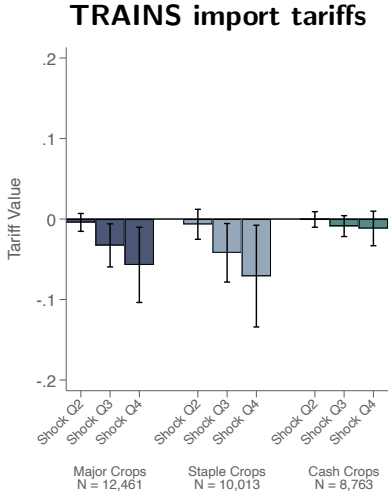
$$\text{NRA}_{\ell kt} = g(\text{ExtremeHeat}_{\ell kt}) + \gamma_{\ell t} + \delta_{kt} + \mu_{\ell k} + \varepsilon_{\ell kt}$$

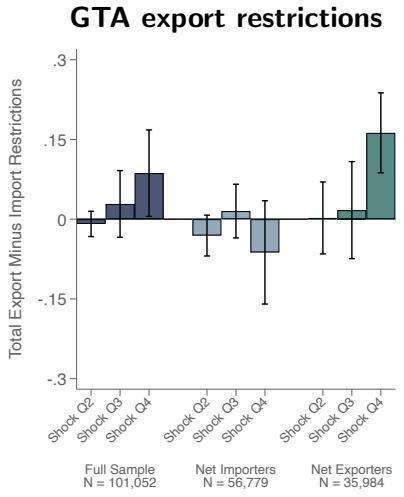
Effects concentrated in border policies



$$\text{NRA}_{\ell kt}^{\text{type}} = g(\text{ExtremeHeat}_{\ell kt}) + \gamma_{\ell t} + \delta_{kt} + \mu_{\ell k} + \varepsilon_{\ell kt}$$

With lower import tariffs and more export restrictions





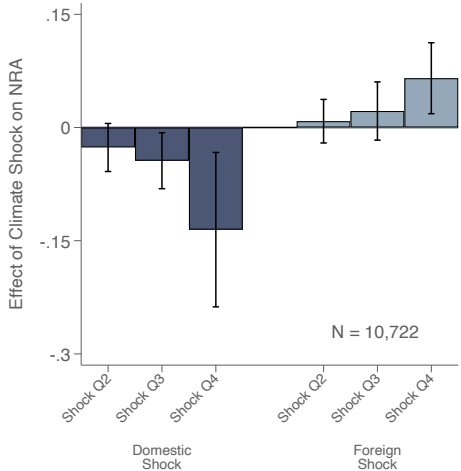
$$\text{Policy}_{\ell kt} = g(\text{ExtremeHeat}_{\ell kt}) + \gamma_{\ell t} + \delta_{kt} + \mu_{\ell k} + \varepsilon_{\ell kt}$$

2. How do foreign shocks affect trade policy?

$$\text{NRA}_{\ell kt} = g(\text{ExtremeHeat}_{\ell kt}) + h(\text{ForeignExtremeHeat}_{\ell kt}) + \gamma_{\ell t} + \delta_{kt} + \mu_{\ell k} + \varepsilon_{\ell kt}$$

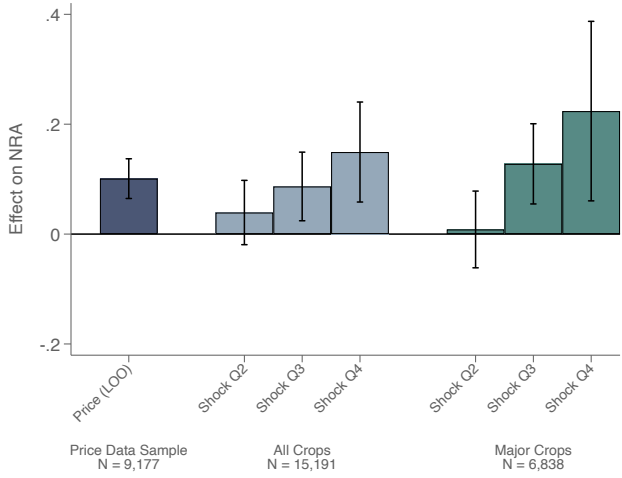
- Country ℓ, crop k, year t, quartile dummies $g(\cdot)$ and $h(\cdot)$
- Fixed effects by country-year, crop-year, country-crop
- ForeignExtremeHeat: trade partner shocks, weighted by pre-period trade shares

Foreign shocks induce pro-producer policy



$$\text{NRA}_{\ell kt} = g(\text{ExtremeHeat}_{\ell kt}) + h(\text{ForeignExtremeHeat}_{\ell kt}) + \gamma_{\ell t} + \delta_{kt} + \mu_{\ell k} + \varepsilon_{\ell kt}$$

Global shocks also induce pro-producer policy



$$\text{NRA}_{\ell kt} = g(\text{ExtremeHeat}_{\ell kt}) + h(\text{GlobalShock}_{kt}) + \gamma_{\ell t} + \mu_{\ell k} + \varepsilon_{\ell kt}$$

3. How does extreme heat affect longer-run policy?

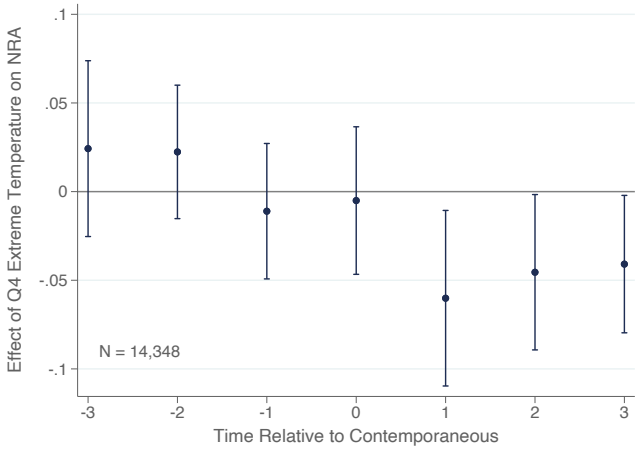
- Longer-run policy: country ℓ, crop k, years $t+s$

$$\text{NRA}_{\ell kt} = \sum_{s=-3}^{3} \text{ExtremeHeat}^{\text{Q4}}_{\ell kt+s} + \gamma_{\ell t} + \delta_{kt} + \mu_{\ell k} + \varepsilon_{\ell kt}$$

- Longer-run shocks: country ℓ, crop k, decade $\bar{t}$

$$\text{NRA}_{\ell k\bar{t}} = \beta\, \text{YearsHeat}^{\text{Q4}}_{\ell k\bar{t}} + \alpha\, \text{YearsForeignHeat}^{\text{Q4}}_{\ell k\bar{t}} + \gamma_{\ell\bar{t}} + \delta_{k\bar{t}} + \mu_{\ell k} + \varepsilon_{\ell k\bar{t}}$$

Annual shocks have persistent effects



$$\text{NRA}_{\ell kt} = \sum_{s=-3}^{3} \text{ExtremeHeat}^{\text{Q4}}_{\ell kt+s} + \gamma_{\ell t} + \delta_{kt} + \mu_{\ell k} + \varepsilon_{\ell kt}$$

Decadal shocks have similar effects

	All Policy	Output Policy	Output Policy (Border)	Output Policy (Farm)
Years of Extreme Heat (Local)	-0.0252**	-0.0251**	-0.0204**	-0.00468
	(0.0110)	(0.0111)	(0.00897)	(0.00471)
Years of Extreme Heat (Foreign)	0.0179*	0.0180*	0.0131***	0.00491
	(0.00969)	(0.00968)	(0.00463)	(0.00727)
Observations	1,951	1,951	1,951	1,951

$$\text{NRA}_{\ell k \bar{t}} = \beta \, \text{YearsHeat}^{\text{Q4}}_{\ell k \bar{t}} + \alpha \, \text{YearsForeignHeat}^{\text{Q4}}_{\ell k \bar{t}} + \gamma_{\ell \bar{t}} + \delta_{k \bar{t}} + \mu_{\ell k} + \varepsilon_{\ell k \bar{t}}$$

4. Does political economy drive policy effects?

$$\text{NRA}_{\ell kt} = g(\text{Heat}_{\ell kt} \times \text{No Election}_{\ell kt}) + h(\text{Heat}_{\ell kt} \times \text{Election}_{\ell t}) + \gamma_{\ell t} + \delta_{kt} + \mu_{\ell k} + \varepsilon_{\ell kt}$$

- Country ℓ, crop k, year t, $g(\cdot)$ and $h(\cdot)$ quartile dummies
- Fixed effects by country-year, crop-year, country-crop
- $\text{Election}_{\ell t}$: election year or one year before (Database for Political Institutions)

- Elections erode fiscal responsibility $\Rightarrow$ negative interaction coefficients
  - Political cycles, e.g. Alesina & Roubini 1992, Akhmedov & Zhuravskaya 2004

Stronger effects before elections

	Full sample		Major crops	
	Estim	SE	Estim	SE
Q2 Extreme Heat × No Election	-0.0249	(0.0299)	-0.0541	(0.0375)
Q3 Extreme Heat × No Election	-0.0114	(0.0387)	-0.0853	(0.0661)
Q4 Extreme Heat × No Election	-0.0996	(0.0698)	-0.155	(0.0974)
Q2 Extreme Heat × Election	-0.0234	(0.0196)	-0.0908***	(0.0280)
Q3 Extreme Heat × Election	-0.0576**	(0.0258)	-0.0991**	(0.0377)
Q4 Extreme Heat × Election	-0.145**	(0.0695)	-0.340**	(0.163)
Observations	10,711		5,580	

$$\text{NRA}_{\ell kt} = g(\text{Heat}_{\ell kt} \times \text{No Election}_{\ell kt}) + h(\text{Heat}_{\ell kt} \times \text{Election}_{\ell t}) + \gamma_{\ell t} + \delta_{kt} + \mu_{\ell k} + \varepsilon_{\ell kt}$$

Theory

Model

- Prices: redistributive motives (Grossman & Helpman 1994; Bates 2014)
- Revenue: terms-of-trade manipulation (Johnson 1951)

- Market clearing $q = y + m$

$$\underbrace{q = p^{-\epsilon_d}}_{\text{Domestic demand}} \qquad \underbrace{y = \omega p^{\epsilon_s}}_{\text{Domestic supply}} \qquad \underbrace{x = \omega' p^{-\epsilon_x}}_{\text{Foreign net demand}}$$

- Tax wedge α between domestic price p^* and international price $\frac{p^*}{1+\alpha}$
- Government maximizes weighted sum of surplus

$$\max_{\alpha \in [-1,\infty)} \left\{ \lambda^C CS + \lambda^P PS + \lambda^G G \right\}$$

Policy responses depend on redistribution vs. revenue

- **Revenue focus:** lower export share $\Rightarrow$ less profitable to tax exports
- **Redistribution focus:** lower export share $\Rightarrow$ best time to tax exports
  - Bigger gains for domestic consumers, smaller losses for domestic producers
  - Different initial levels, but same changes
- Corollary: opposite policy responses to foreign production shocks
  - Domestic and foreign shocks have opposite effects on export share
  - Distinguish this model from price stabilization, helping the poor

Conclusion

Summary

- **Policy responses** complicate global adaptation
  - Domestic agricultural shocks induce pro-consumer policy
  - Redistributes losses and can intensify pre-existing distortions
- Broader implications
  - For global trade liberalization
  - And other adaptation mechanisms