Cascading Crop Export Restrictions
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Crop trade networks in 2013

- Data: International trade of maize (M), rice (R), soy (S), and wheat (W) from 1992 to 2013.
- Networks: nodes = countries, weighted link \( w_i(y) \) = export volume from country \( i \) to country \( j \) in year \( y \).
- Figure: trade networks in \( y = 2013 \), link color: determined by exporter; strength: prop. \( \log(1 + w_i) \).
- Globalisation: network density grows over years, trade volumes and production increase.

Food availability at risk

- Green revolution & globalisation:
  - Trade and production volumes increase.
  - Despite population increase: growth of production per head.
  - Share of trade vol. in production increases only considerable for soy.

  - Average price per quantity: peaks!
  - Systematic price increase or spikes?
  - Possible causes for price increase:
    - demand increase: biofuel production, animal feed, speculation, ...
    - Herding/panics amplify small local shocks. ⇒ cascades.
    - Expected: more production shocks because of climate change.

How do trade networks change in crises?

Trade network reorganization in response to shocks

- Idea: Network formation model requires:
  - subsidies, internat. trade agreements, crop type, value chain info, ...

Cascading export restrictions as shock response

- Input: trade volumes \( w_i \), productions in year \( y \).
- Cascade evolves in time \( t \) (while year \( y \) fixed).
- Initial shock of single country \( i \) by production decrease/demand increase. ⇒ demand deficit \( d_i \).
- Assumption: Compensation of deficit by decreasing exports \( ex_i \): \( w_i(t + 1) = \frac{w_i(t)}{1 - \delta} \cdot \min (d_i(t), ex_i(t)) \)
- Results: Networks of Economic Dependencies 2013

Evolution of cascade indicators

- Saturation of risk/ diversification of shocks.
- Soy and rice trade most prone to cascades.
- Increasing intermediary trade (see \( \epsilon \)).

Aggregated country exposures in 2013

- Aggregation: maize, rice, wheat.
- Avg. cascade exposure of countries with respect to:
  - outer circle: \( \epsilon \), middle circle: \( \delta \), inner circle: \( \rho \).
  - Europe at risk as trade intermediaries, Africa and Asia face deepest demand deficits.

Outlook: multiplex cascades as result of substitutions

- Spill over effects. Countries can impose export restrictions on remaining crops to substitute for lost imports.
- Shocks of wheat cause highest spill overs.

Summary

We study the vulnerability of international crop trade networks to cascading export restrictions. This enables an in-depth analysis of economic dependencies.