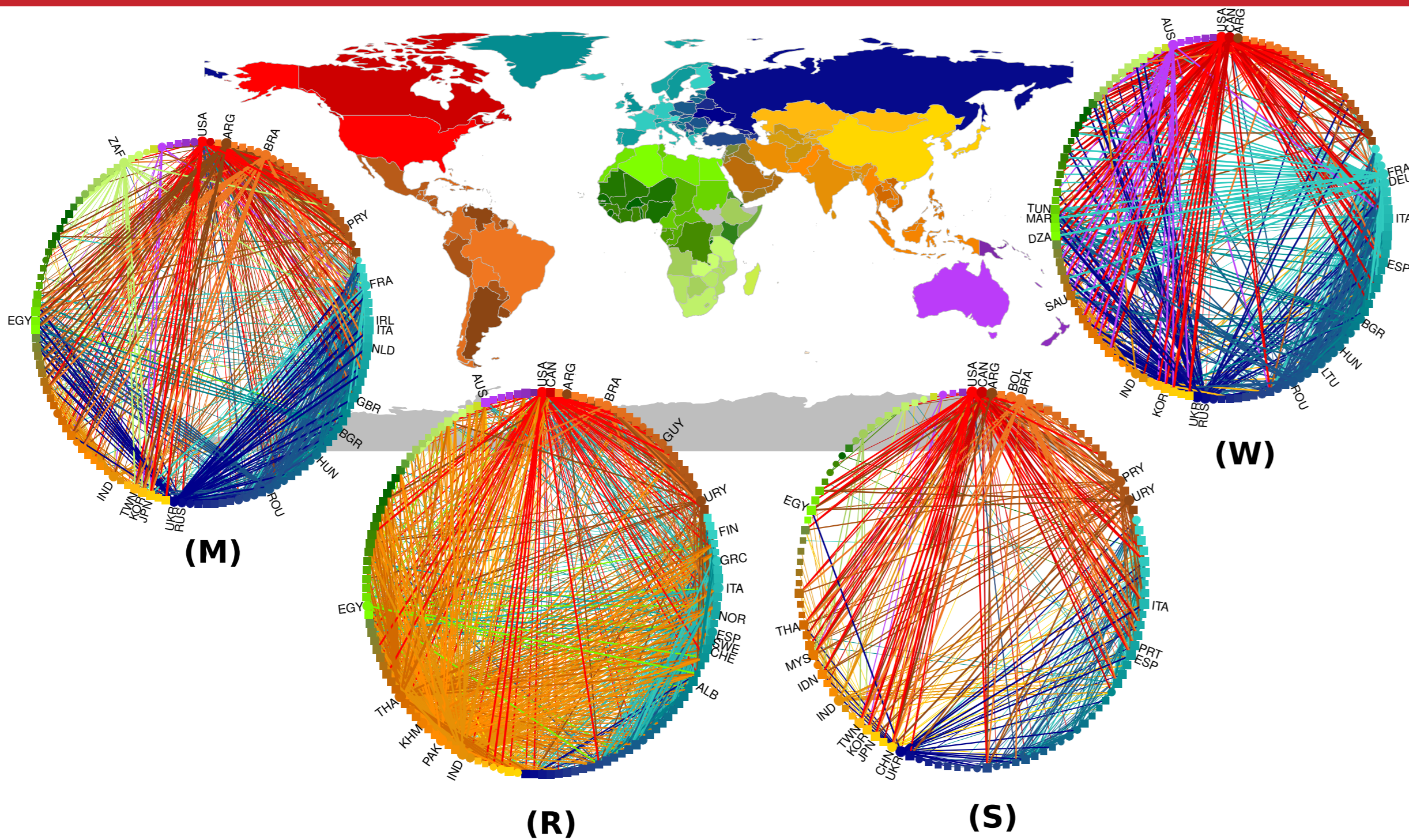


Cascading Crop Export Restrictions

Rebekka Burkholz, Frank Schweitzer

Crop trade networks in 2013

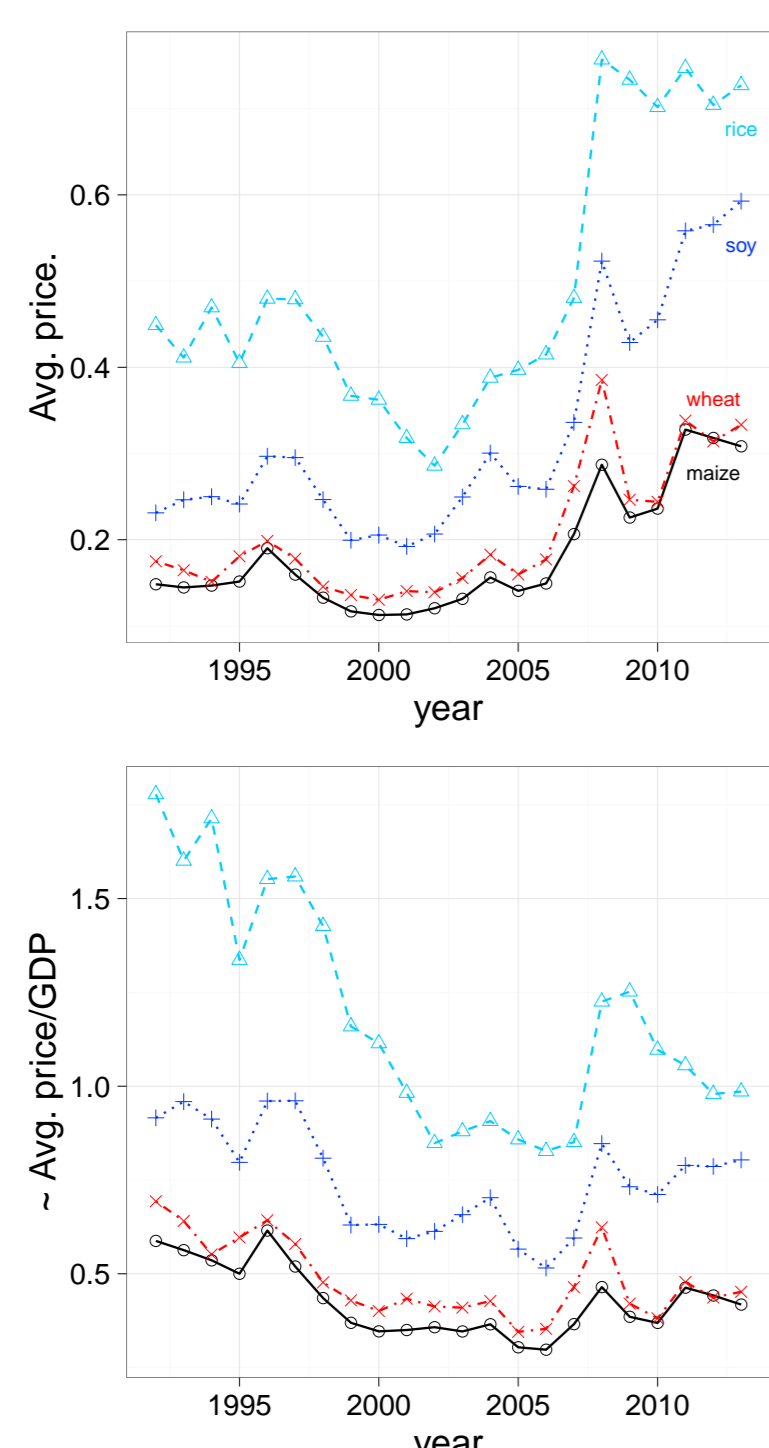
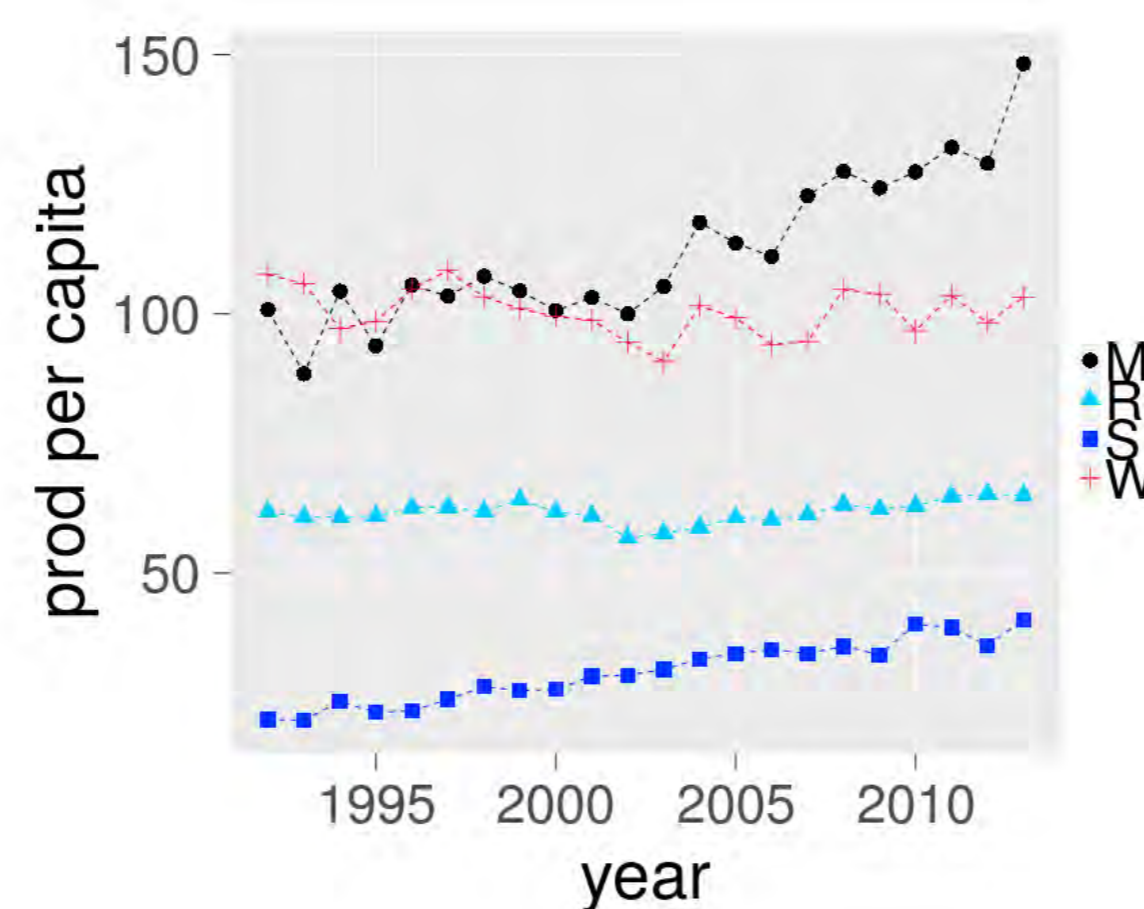


- Data: International trade of maize (M), rice (R), soy (S), and wheat (W) from 1992 to 2013:
- Networks: **nodes** = countries, **weighted link** $w_{ij}(y)$ = export volume from country i to country j in year y .
- Figure: trade networks in $y = 2013$, link color: determined by exporter; strength: prop. $\log(1 + w_{ij})$
- 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**.

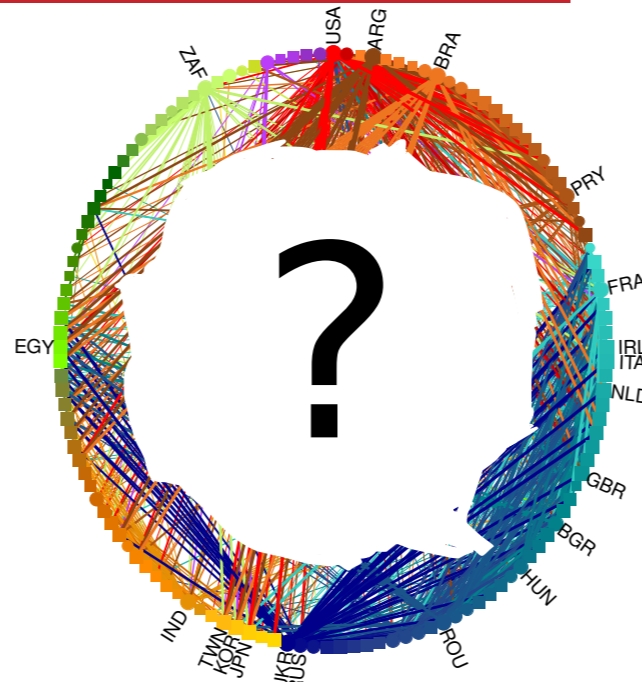


- Still **price crises**: 1996, 2007/2008.
 - Average price per quantity: peaks!
 - Systematic price increase or spikes?
 - Possible **causes** for price increase:
 - demand increase: biofuel production, animal feed, speculation, ...
 - Herding/**panics** amplify small local shocks. \Rightarrow **cascades**.
 - Expected: more **production shocks** because of **climate change**.

How do trade networks change in crises?

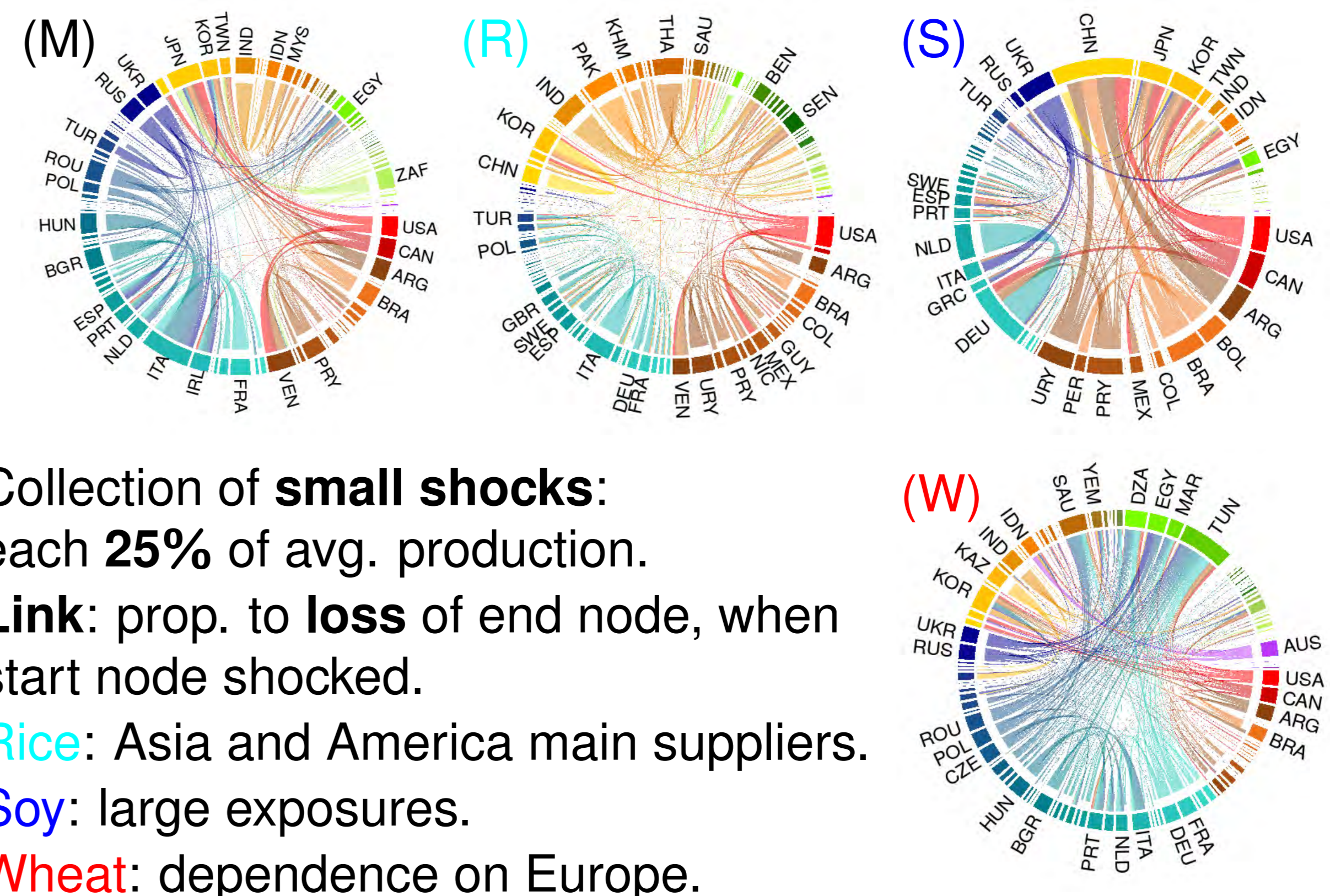
Trade network reorganization in response to shocks

- Idea**: Network formation model requires:
 - subsidies, internat. trade agreements, crop type, value chain info., ...
- Instead**: Shock response as network distortion. \Rightarrow **Model**: overload **cascade**.



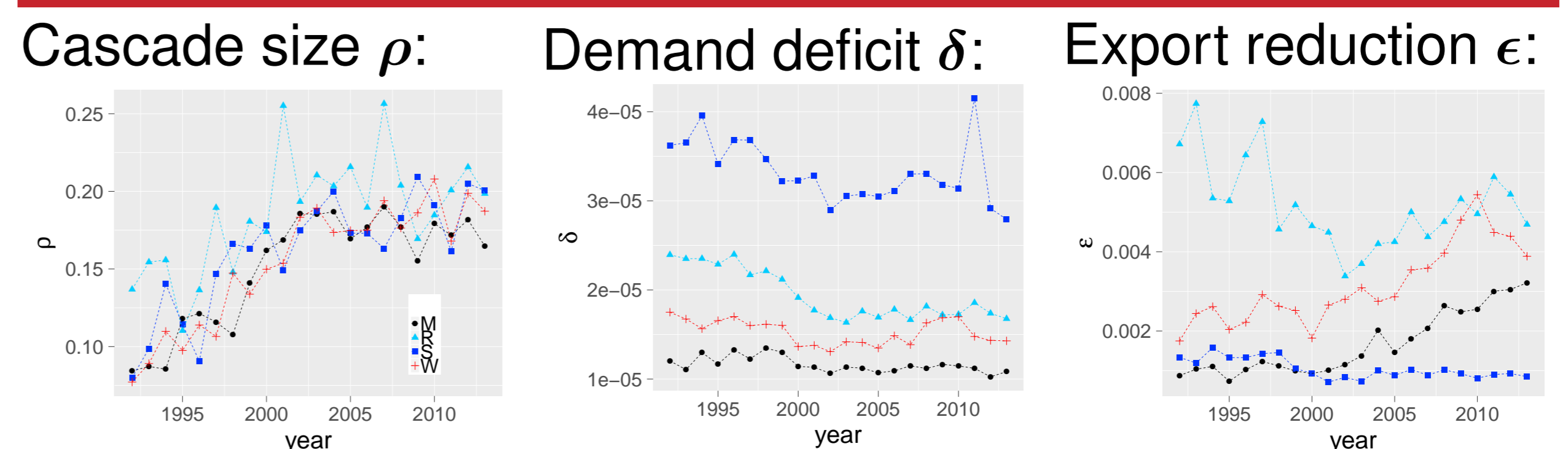
Cascading export restrictions as shock response

- Input**: trade volumes w_{ij} , productions in year y .
- Cascade** evolves in time t (while year y fixed).
- Initial shock** of **single** country i by production decrease/ demand increase. \Rightarrow demand deficit dd_i .
- Assumption**: **Compensation** of deficit by **decreasing exports** ex_i : $w_{ij}(t+1) = \frac{w_{ij}(0)}{ex_i(0)} \cdot \min(dd_i(t), ex_i(t))$
- Results: **Networks of Economic Dependencies 2013**



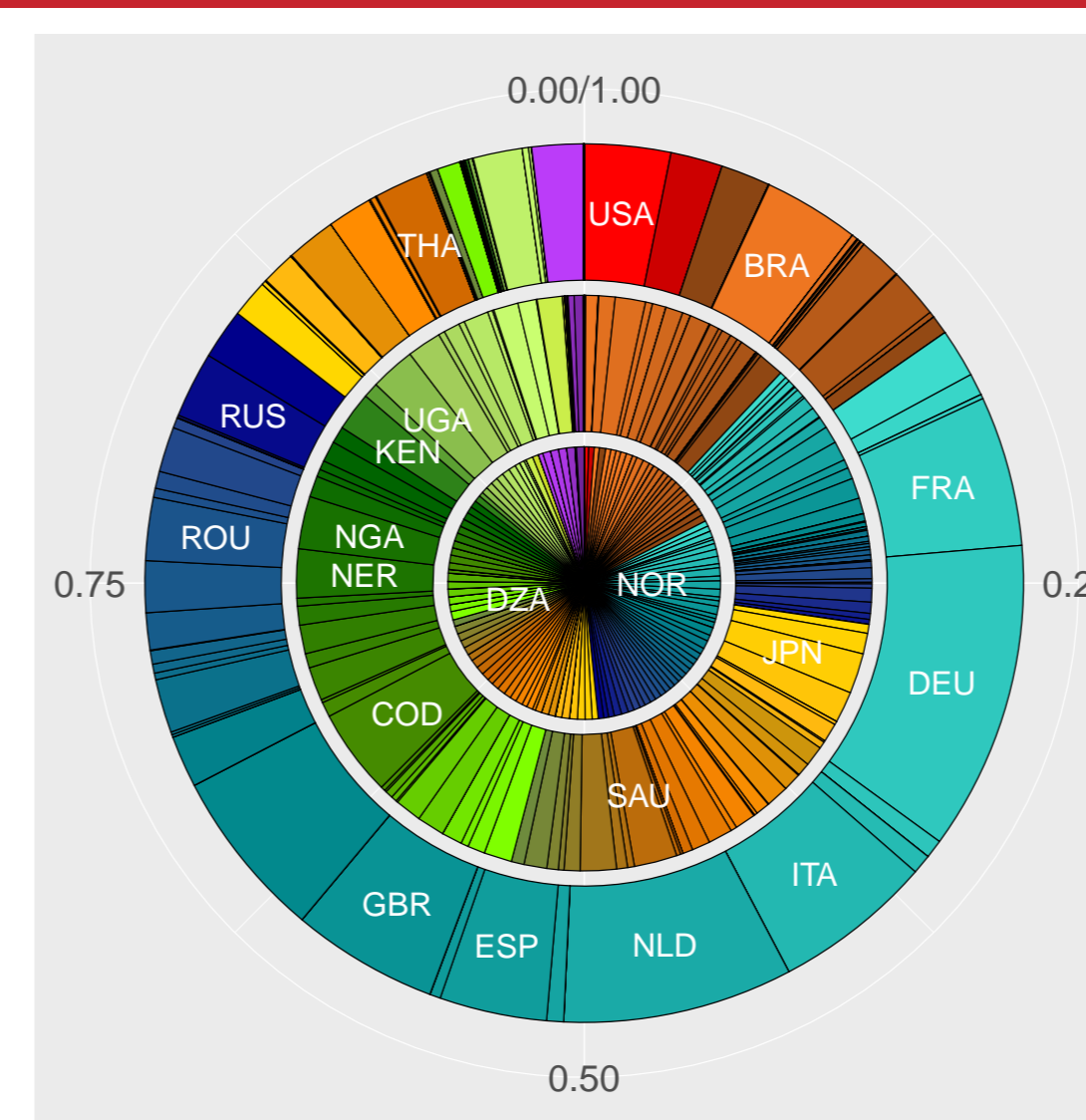
- Collection of **small shocks**: each **25%** of avg. production.
- Link**: prop. to **loss** of end node, when start node shocked.
- Rice**: Asia and America main suppliers.
- Soy**: large exposures.
- Wheat**: dependence on Europe.

Evolution of cascade indicators



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

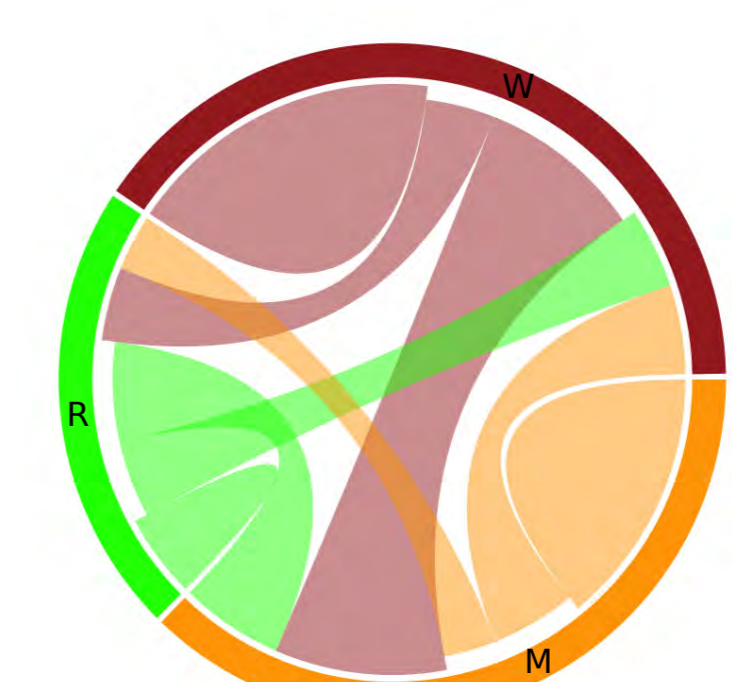
Aggregated country exposures in 2013



- Aggregation: maize, rice, wheat.
- Avg. cascade **exposure** of countries with respect to:
 - outer circle**: ϵ , **middle circle**: δ , **inner circle**: ρ .
- 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.