Sharing of Climate Risks across Macro Regions

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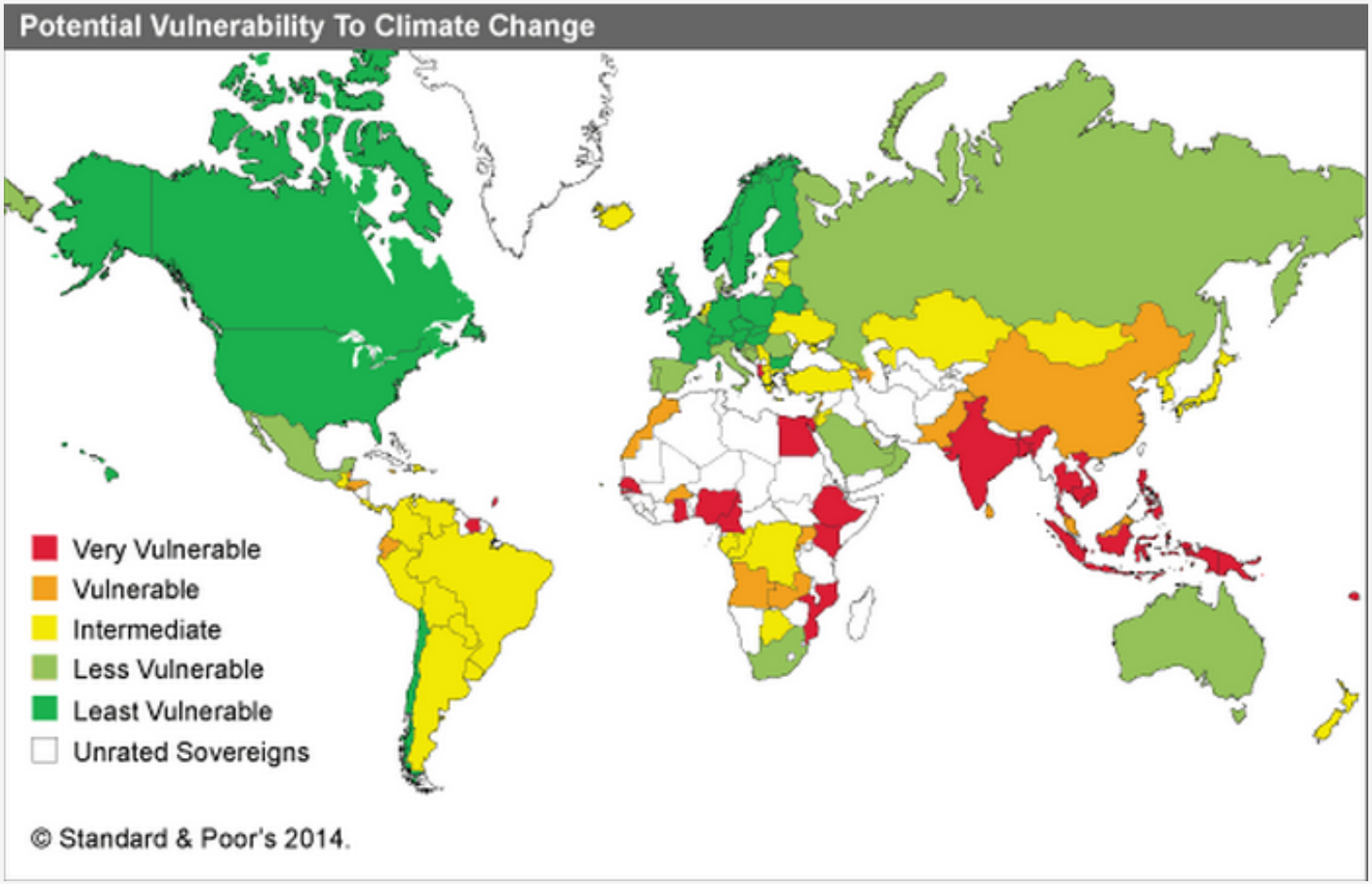
6th Atlantic Workshop on Energy and Environmental Economics, June 25-26, A Toxa

Motivation


Potential Vulnerability To Climate Change
Very Vulnerable
Vulnerable
Intermediate
Less Vulnerable
Least Vulnerable
Unrated Sovereigns
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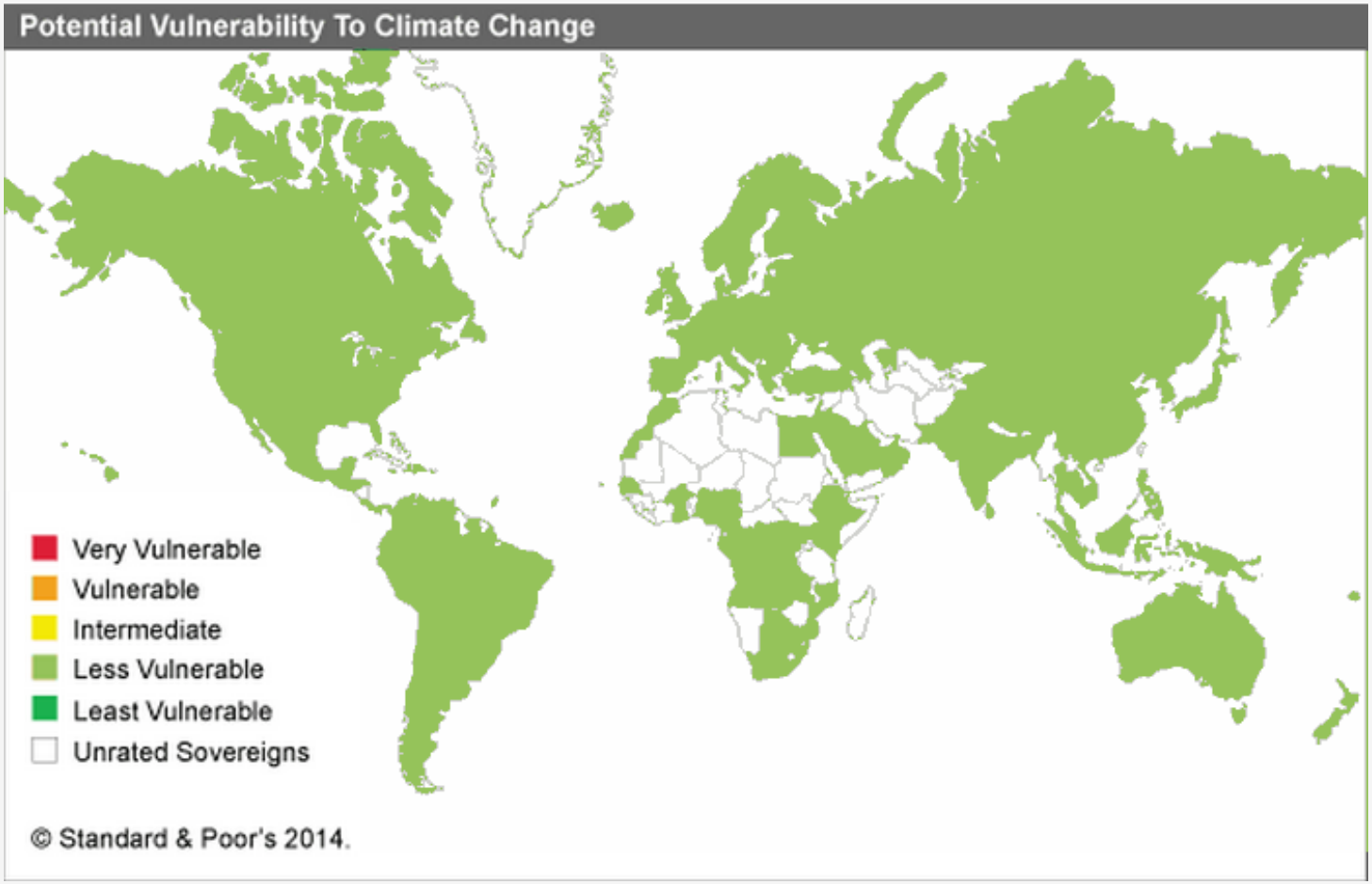
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Central question

Could regional differences alleviate risks from climate change? How does this affect the optimal climate policy?

Risk and Risk aversion

- Evaluation of climate related risks for non-catastrophic risks have a negligible effect on the optimal level of mitigation in CBA frameworks (Ackerman et al., 2013)
- Degree of risk aversion maybe too low? (Crost and Traeger, 2011; Traeger, 2009; Cai et al., 2013)

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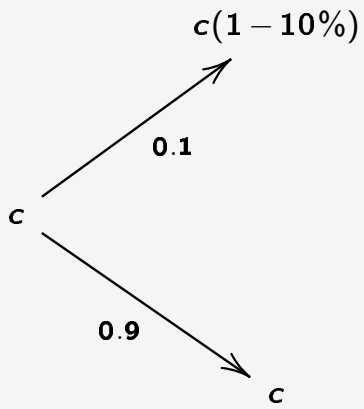

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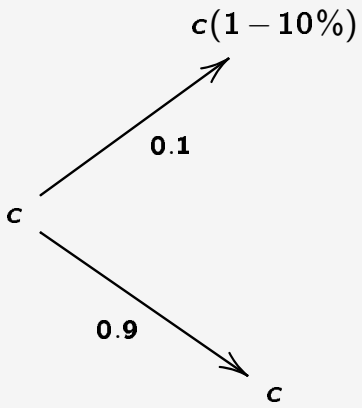

risk aversion	certainty equivalent
$\eta = 0$	1.0%
$\eta = 1$	1.05%
$\eta = 8$	1.5%
$\eta = 20$	2.6%

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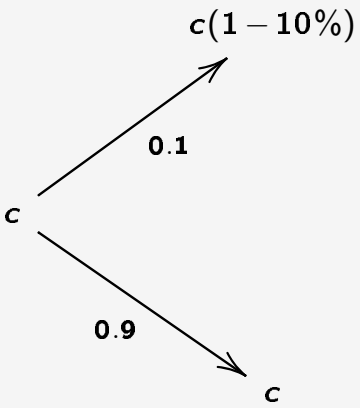

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- So far: higher degrees of risk aversion only in single-region models
- Regional heterogeneity and uncertainty might reinforce each other (Schmidt et al., 2012)

Disentangling Risk and Inequality Aversion

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situation A	s_1	s_2	situation B	s_1	s_2
n_1	10	5	n_1	10	5
n_2	5	10	n_2	10	5
global certainty			*global equality*		

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global certainty			*global equality*		

- Standard Utilitarian Expected Utility: both situations are indistinguishable
- With disentangled preferences, order of aggregation over $\{T, N, S\}$ matters ($3! = 6$ orders possible)
- Single agent: Two orders possible (Epstein and Zin (1989) and Kihlstrom and Mirman (1974) preferences)

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1. (Macroeconomic) Risk sharing through international markets & financial diversification (Obstfeld, 1994)
2. Risk sharing through relocation of capital and/or labour (migration?)
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- Standard IAMs: perfect risk sharing within regions, no risk sharing across regions

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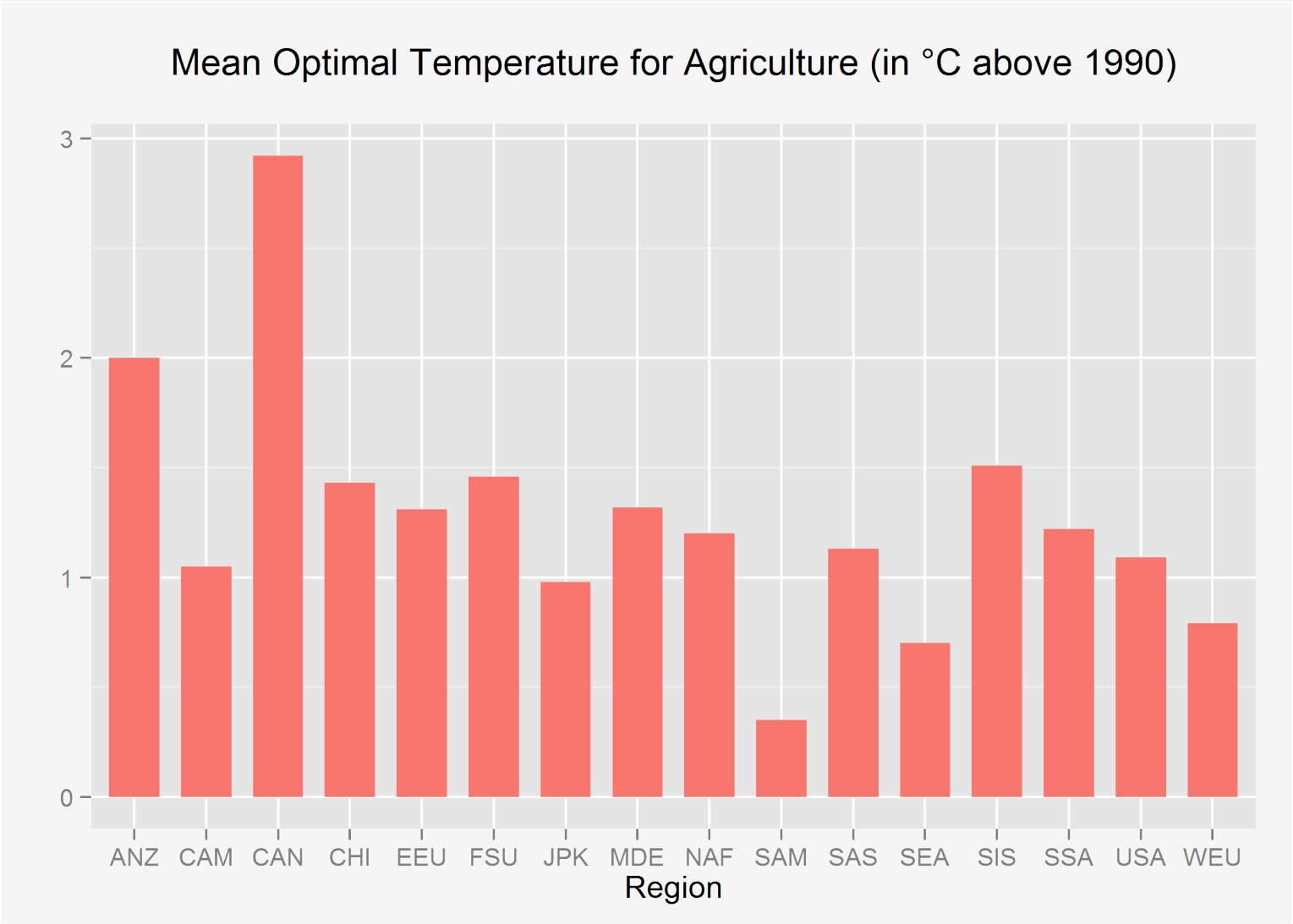

Source: Ackerman and Munitz (2012)

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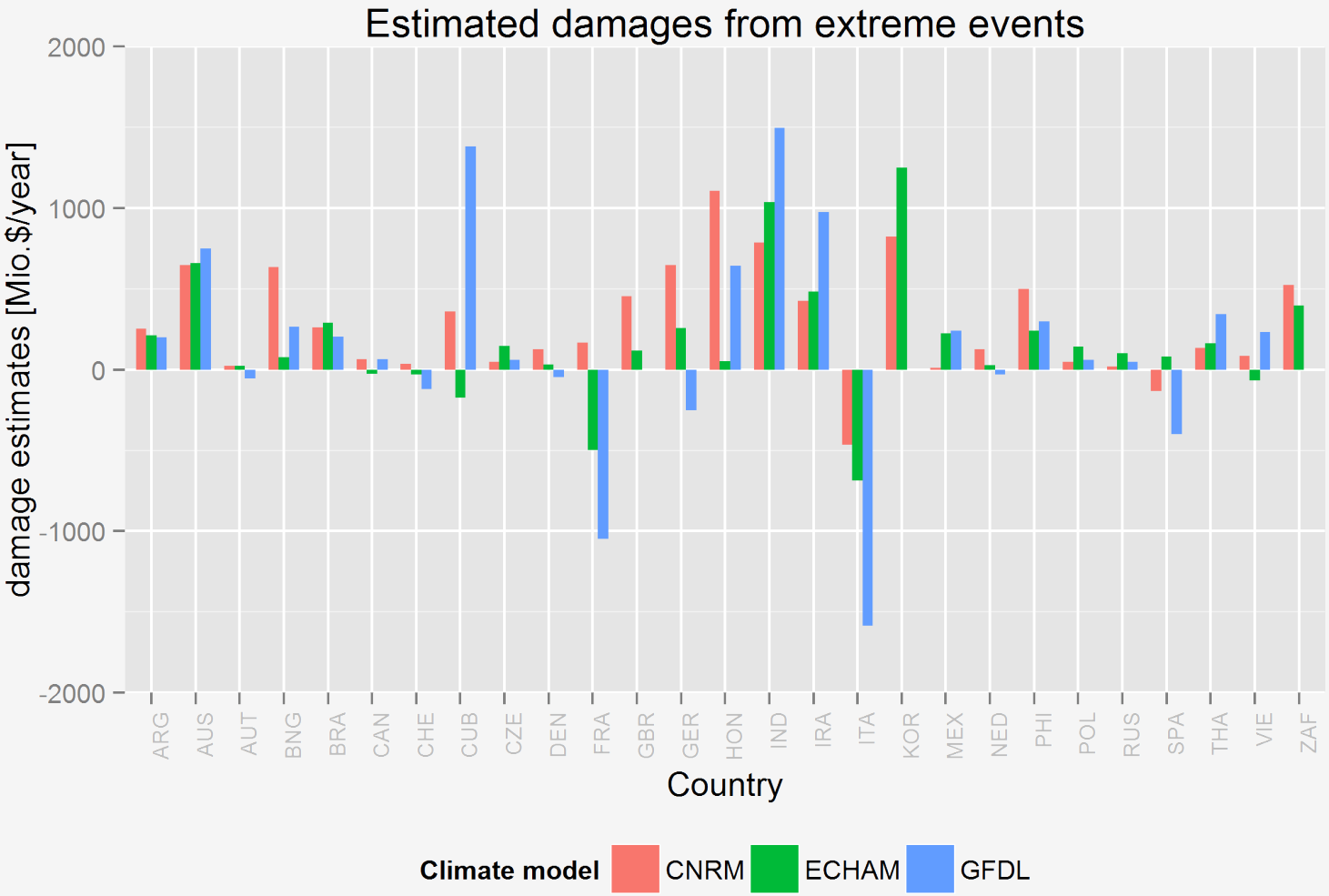
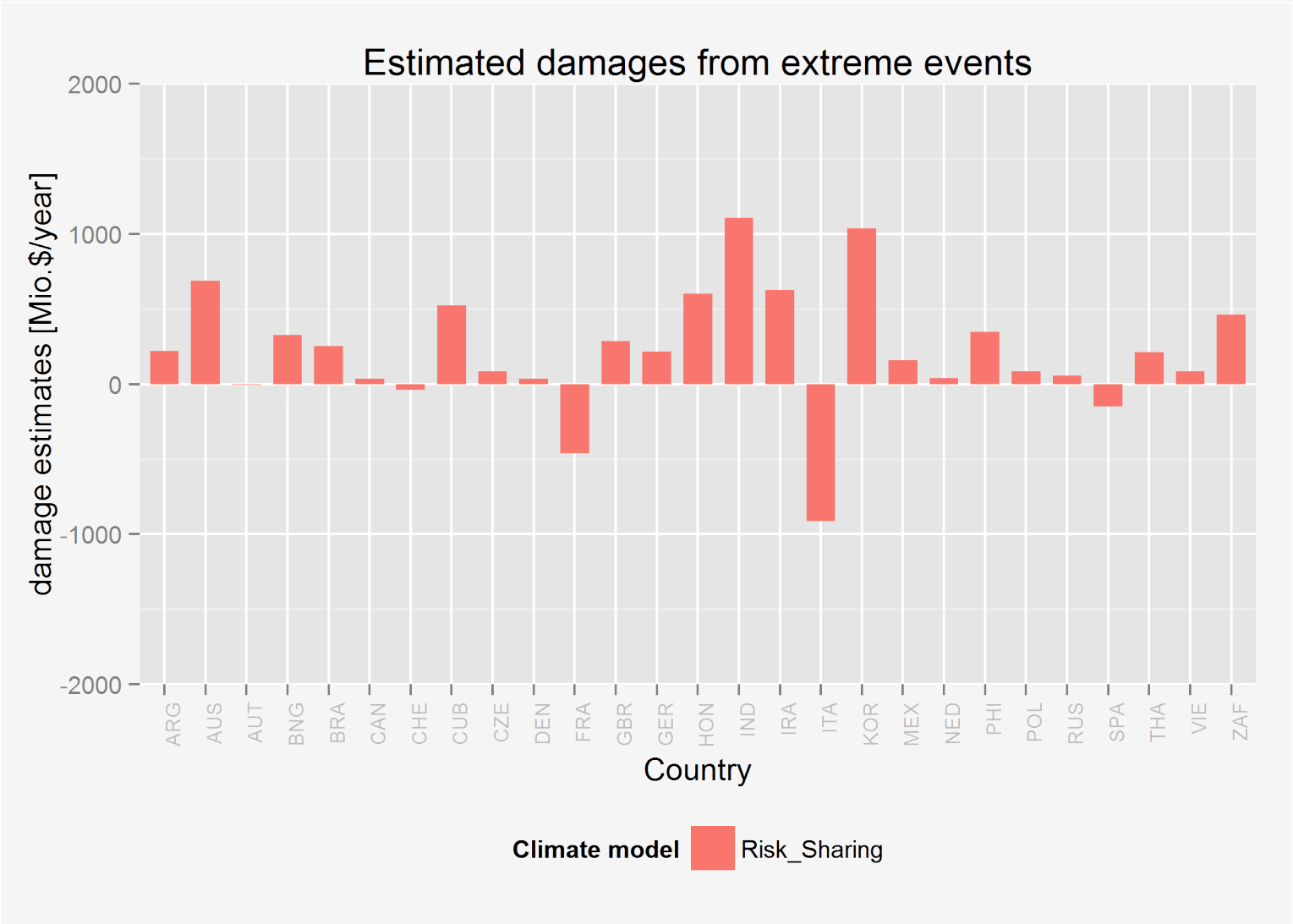


Source: Mendelsohn and Saher (2011)

Correlation of Risk an Climate Change: Risk shared



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A market for state-contingent claims

- Solve for open-loop Nash equilibrium across regions in an IAM
- Introducing a market for state contingent claims (Arrow-Debreu Securities)

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- Asset market equilibrium ($q_{s,n}$, p_s):

$$\begin{cases} \forall n: & max_{q_{s,n}} \left(e^{-\rho t_0} U(c_{t_0,n} - \sum_{s=1}^{S} p_s q_{s,n}) + e^{-\rho T} \sum_{s=1}^{S} \pi_s U(c_{T,s,n} + 1 \cdot q_{s,n}) \right) \\ s.t. & \forall s: \sum_{n=1}^{N} q_{s,n} = 0 \end{cases}$$

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- First-order conditions for each region and each possible state:

$$\forall n, s: p_s = \pi_s e^{-\rho(T-t_0)} \frac{U'(c_{T,s,n} + 1 \cdot q_{s,n})}{U'(c_{t_0,n} - \sum_{\sigma=1}^{S} p_\sigma q_{\sigma,n})}.$$

A market for state-contingent claims

With disentangled preferences and isoelastic specifications (η, rra) as before:

Proposition

*Assume $\rho > 0$: At equilibrium, **relative** differences in consumption are equalized across regions between any two states:*

$$\forall n \in N, s_1, s_2 \in S : \frac{(c_{T,s_2,n} + 1 \cdot q_{s_2,n})}{(c_{T,s_1,n} + 1 \cdot q_{s_1,n})} = RD_{s_2,s_1} = \left(\frac{p_{s_1}/\pi_{s_1}}{p_{s_2}/\pi_{s_2}} \right)^{1/\rho}$$

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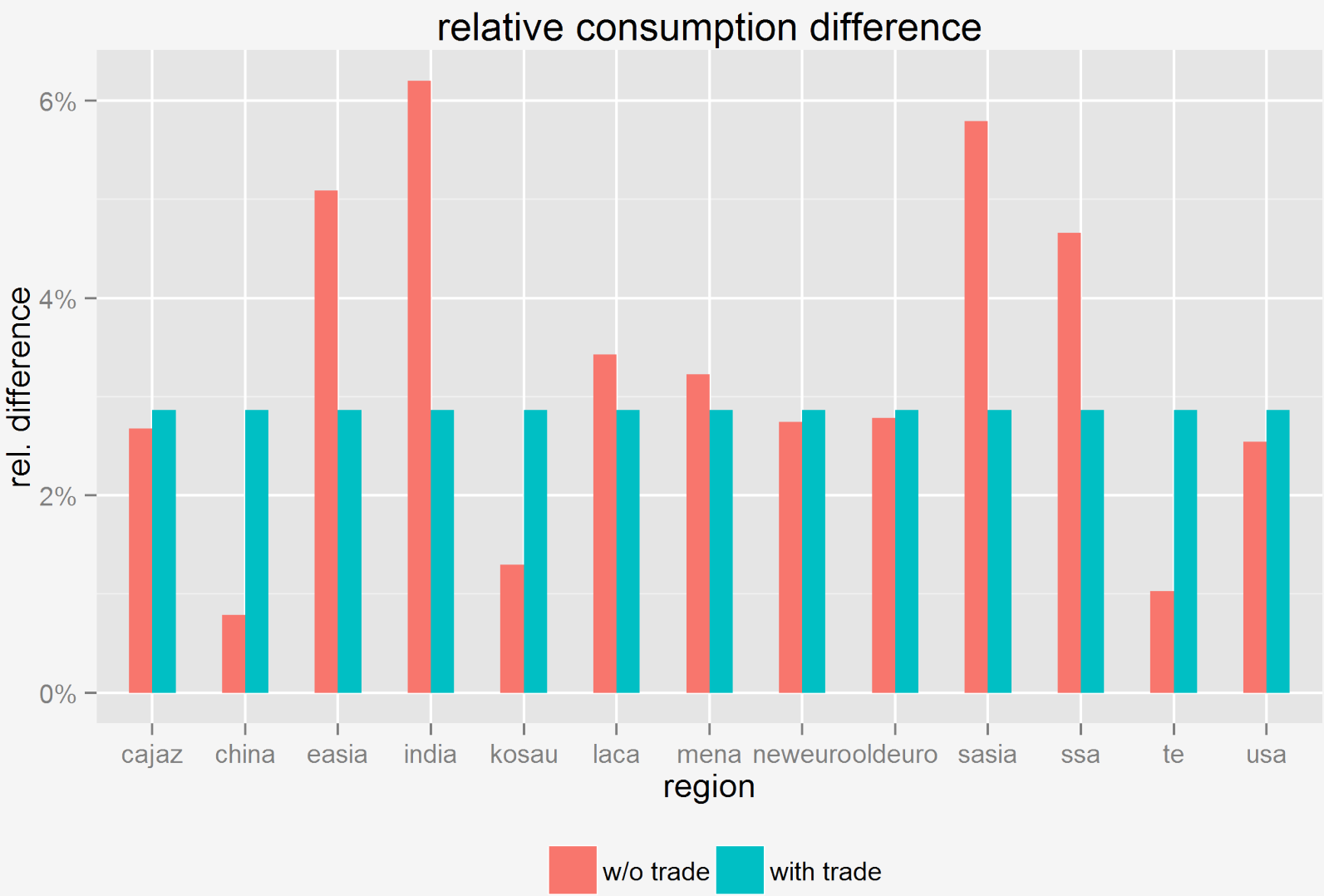
- Market implements optimal allocation of risk across regions (First Welfare Theorem)
- Extension to heterogeneity (Gandelman and Hernandez-Murillo, 2014) in risk preferences (ρ_n): higher risk aversion implies lower relative differences in consumption.

Risk Sharing - Results



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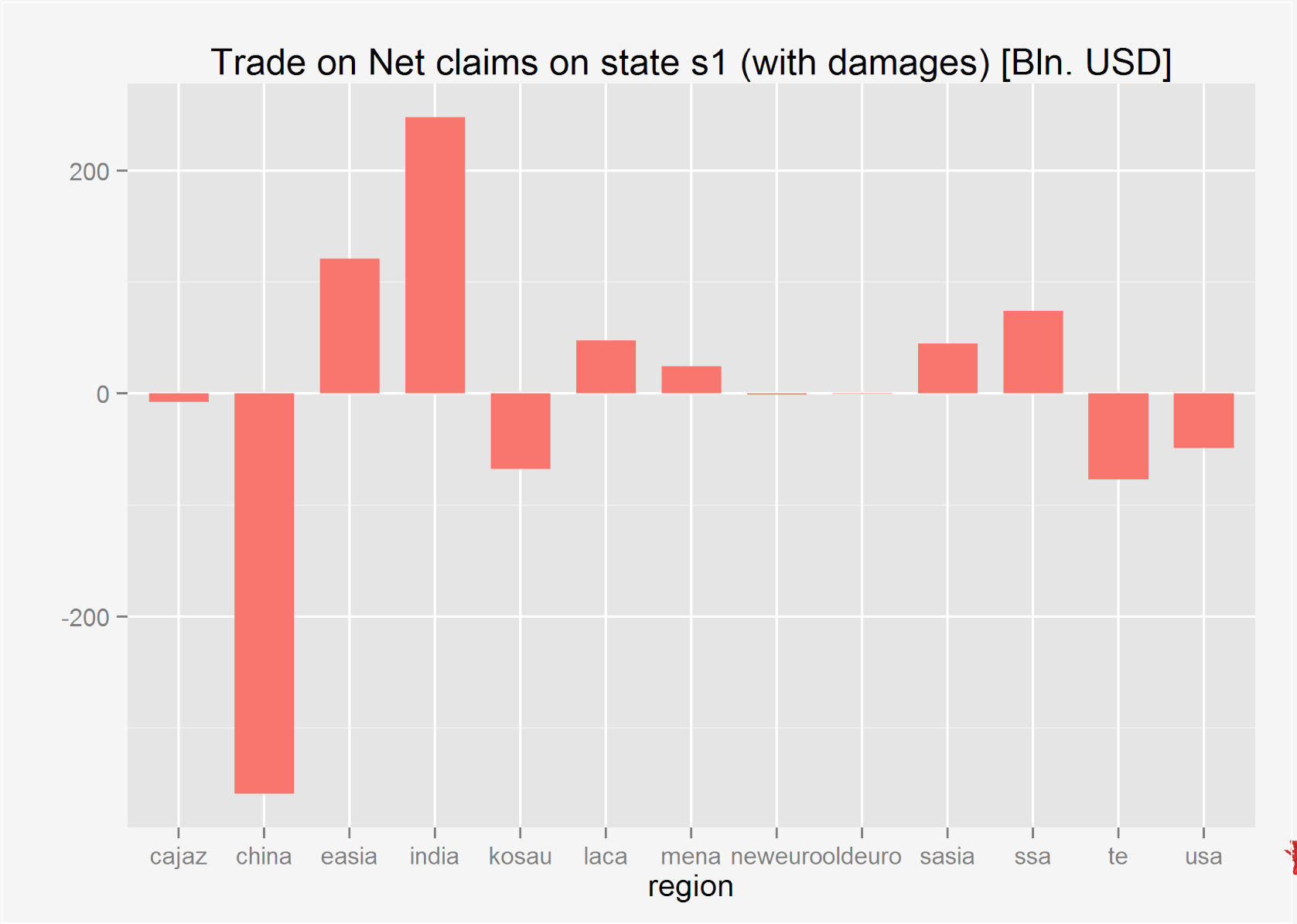
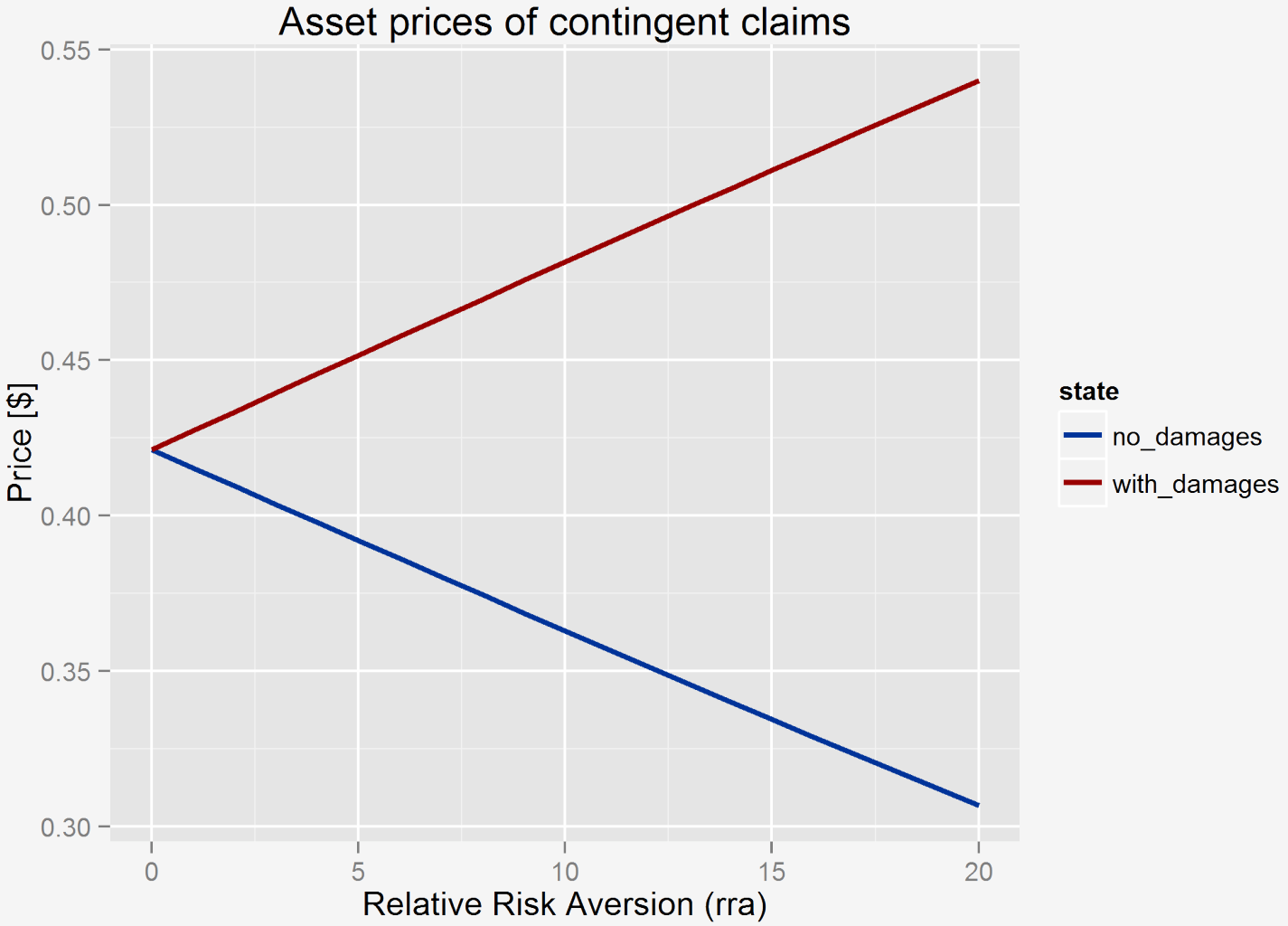


Risk Aversion



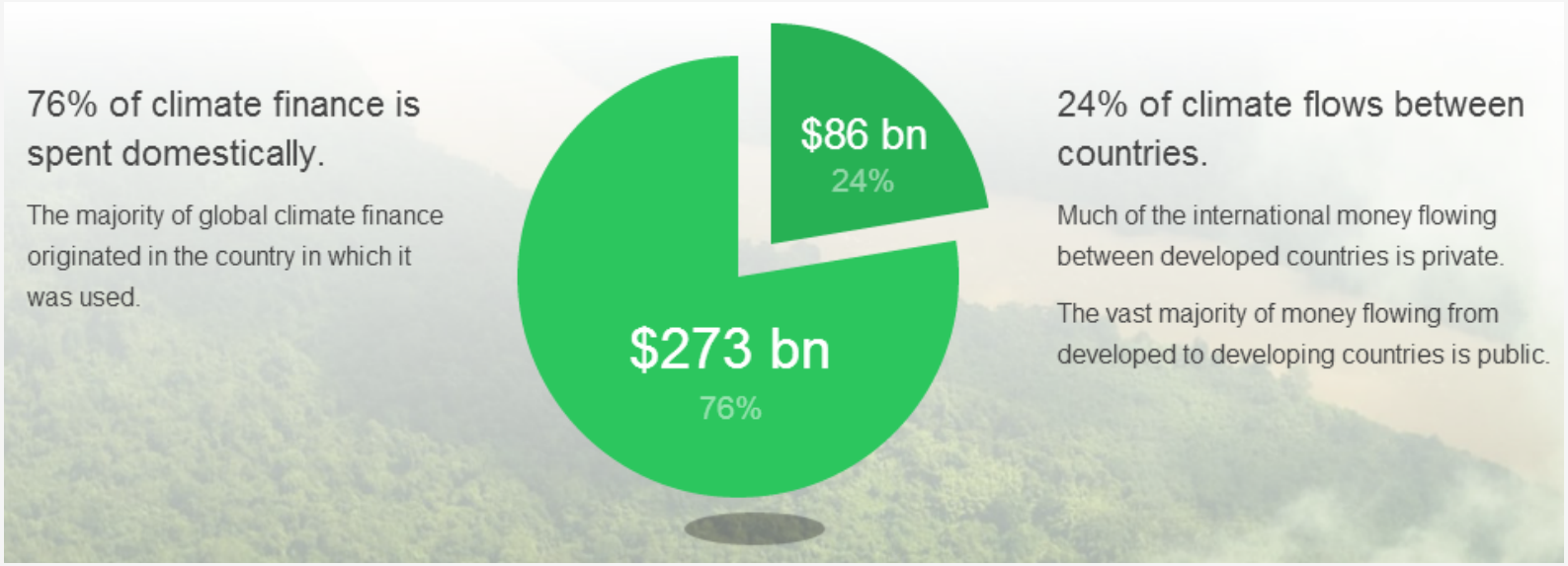
Summary

- Results of the market equilibrium:

	value ($\rho = 10$)	value ($\rho = \eta = 1.5$)
p_{s_1}	0.43\$	0.48\$
p_{s_2}	0.41\$	0.36\$
$\frac{1}{2}\sum_{s=1}^{S} p_s \sum_{n=1}^{N} \lvert q_{s,n} \rvert$	270 bln USD p.a.	240 bln USD p.a.
$\frac{1}{2}\frac{\sum_{s=1}^{S} p_s \sum_{n=1}^{N} \lvert q_{s,n} \rvert}{\sum_{n=1}^{N} c_{t_0,n}}$	0.21% of GDP	0.18% of GDP

Market volume - some comparisons

- Estimated potential market volume of optimal insurance/transfer scheme: $\sim 250 bln.USD$
- Clapp et al. (2012): 100 bln. USD commitment of climate finance
- Climate Policy Initiative (2013): 359 bln. USD



Source: CPI (2013)

Welfare Impacts

- "certainty, equity, and balanced growth equivalent" (CEBGE)

CC trade	impacts	CEBGE (ρ=1.5)	CEBGE (ρ=10)
no	never	3004.7$	3004.7$
no	always	2870.8$ (-4.5%)	2870.8$ (-4.5%)
no	yes (in s_1)	2936.6$	2929.2$
yes	yes (in s_1)	2962.4$ (+0.88%)	2959.9$ (+1.05%)

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- Caveats & Constraints:
  - Perfect Competition, no constraints, enforcement mechanism
  - Observability and Verifiability of the "true" state

Political will and reality

Conference of the Parties
Nineteenth session
Warsaw, 11–22 November 2013

Agenda item 3(b)
Reports of the subsidiary bodies
Report of the Subsidiary Body for Implementation

Warsaw international mechanism for loss and damage associated with climate change impacts

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The New York Times

LOG IN

Climate Change Deemed Growing Security Threa by Military Researchers

By CORAL DAVENPORT MAY 13, 2014

Secretary of State John Kerry indicated that a report's findings on the rate of climate change would influence

WASHINGTON — The accelerating rate of climate change poses a severe risk to national security and acts as a catalyst for global political conflict, a report published Tuesday by a leading government-funded military research organization concluded.

The CNA Corporation Military Advisory Board found that climate change-induced drought in the Middle East and Africa is leading to conflicts over food and water and escalating longstanding regional and ethnic tensions into violent clashes. The report also found that rising sea levels are

Conclusion

- Climate risks and uncertainty along with heterogeneity gives rise to welfare-improving risk sharing schemes
- IAM models implicitly convey assumptions about risk sharing
- Risk sharing of impacts could mitigate global CC impacts by up to one fifth
- Important limitation by institutional and political factors

Conclusion

Thank you!

The research leading to these results has received funding from the European Union Seventh Framework Programme FP7/2007-2013 under grant agreement No. 266992 (Global-IQ) and No. 282846 (LIMITS).

GLOBAL IQ
IMPACT QUANTIFICATION OF GLOBAL CHANGES

LIMITS

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