

The Impact of High-End Climate Change on Agricultural Welfare

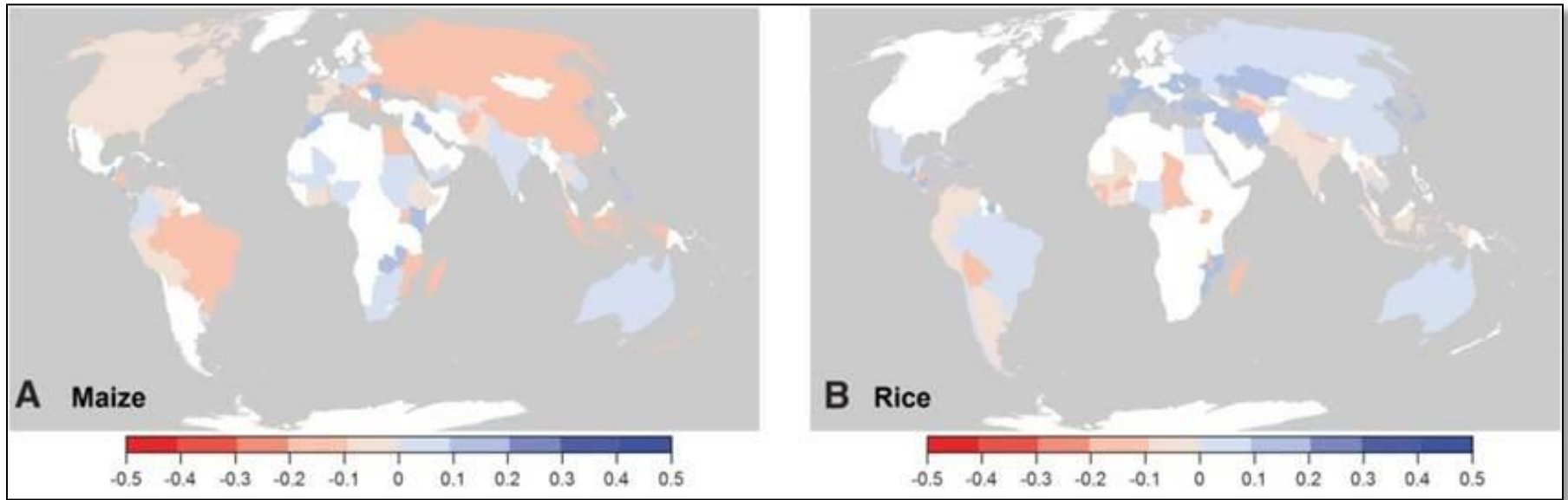
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IAMO Forum 2017, Halle
22.06.2017

Introduction

- Observed regional patterns of temperature warming effects:



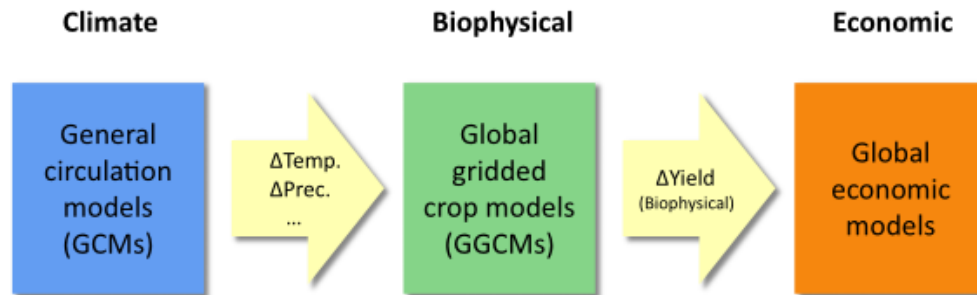
*Source: Lobell et al. 2011, Science

- Climate change as a challenge for agriculture:
 - Heat and water stress
 - Frequency of extreme weather events
 - Realization of CO₂ fertilization effect



Assessment of Future Climate Change Impacts in Agriculture

- Assessment of long-term dynamics in agricultural markets under climate change
- Analysis of market and regional distributional effects
 - A time dynamic framework, mathematical modelling of economic processes.
 - Assemble of local bio-physical properties and socio economic factors
 - Impact Modeling Chain:

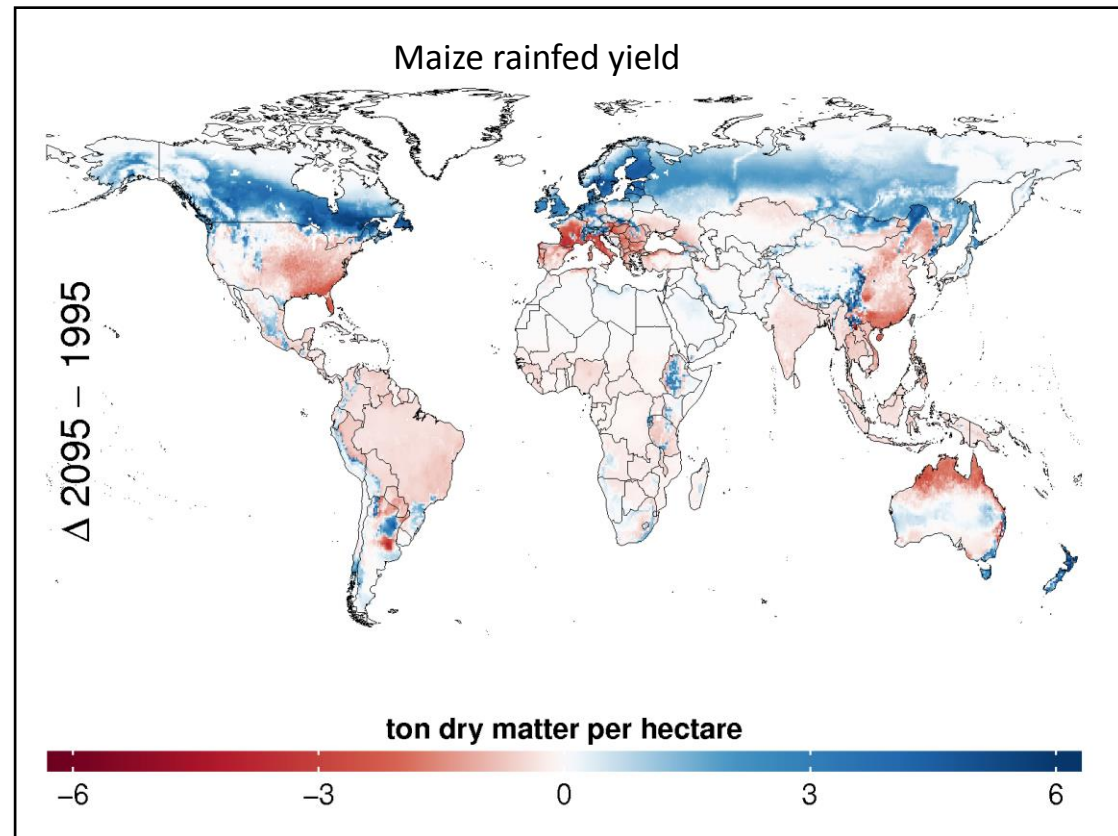


*Source: Nelson et al. 2014, PNAS

- **MAGPIE: Model of Agricultural Production and its Impact on Environment.**
 - Specially explicit
 - Agro-economic
 - Partial equilibrium
 - Minimization of total production costs to the fulfillment of Ag. demand

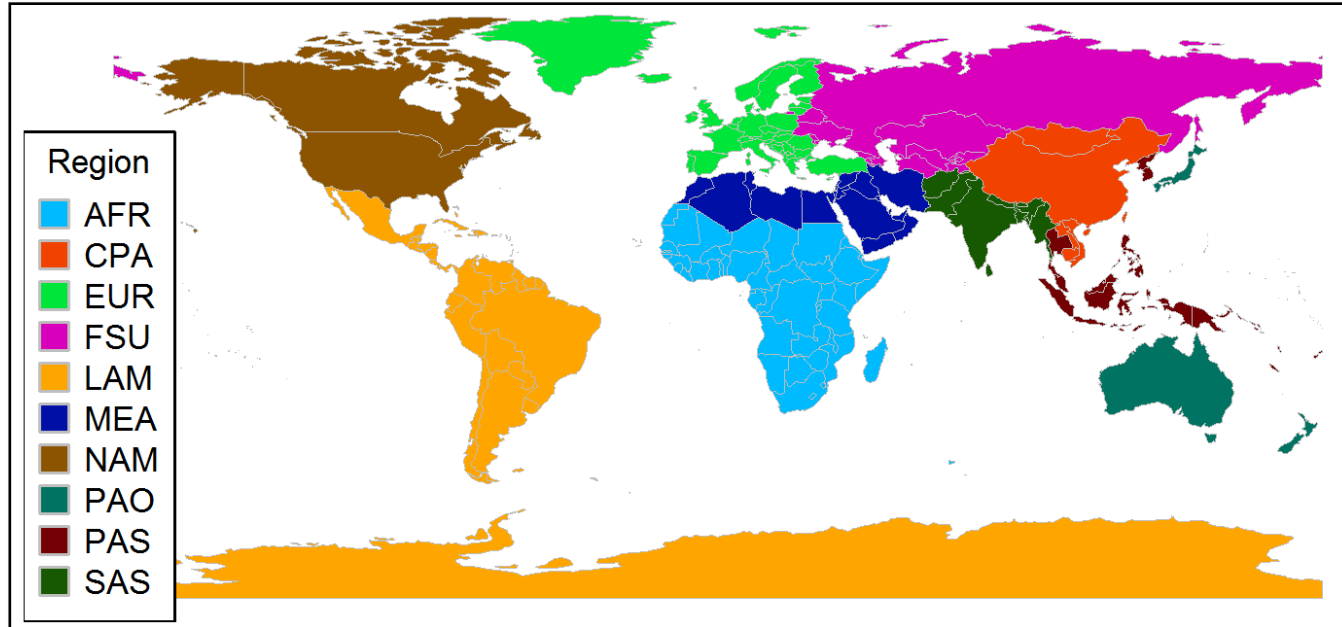
Methods: MAgPIE – spatial constraints

- Subject to bio-chemo-physical spatially explicit constraints:
 - potential rainfed and irrigated crop yields
 - water availability
 - terrestrial carbon content

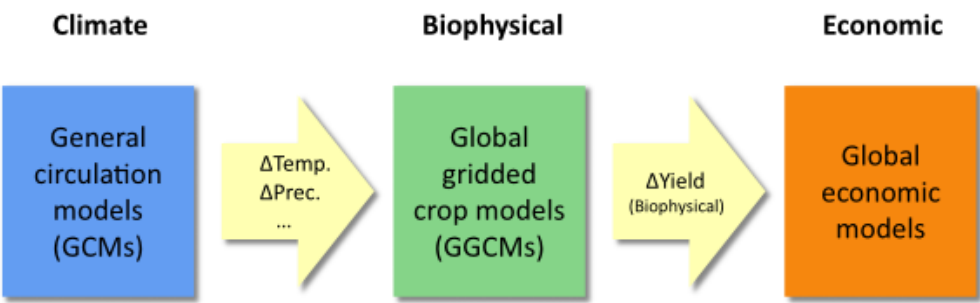


Methods: MAgPIE – regional constraints

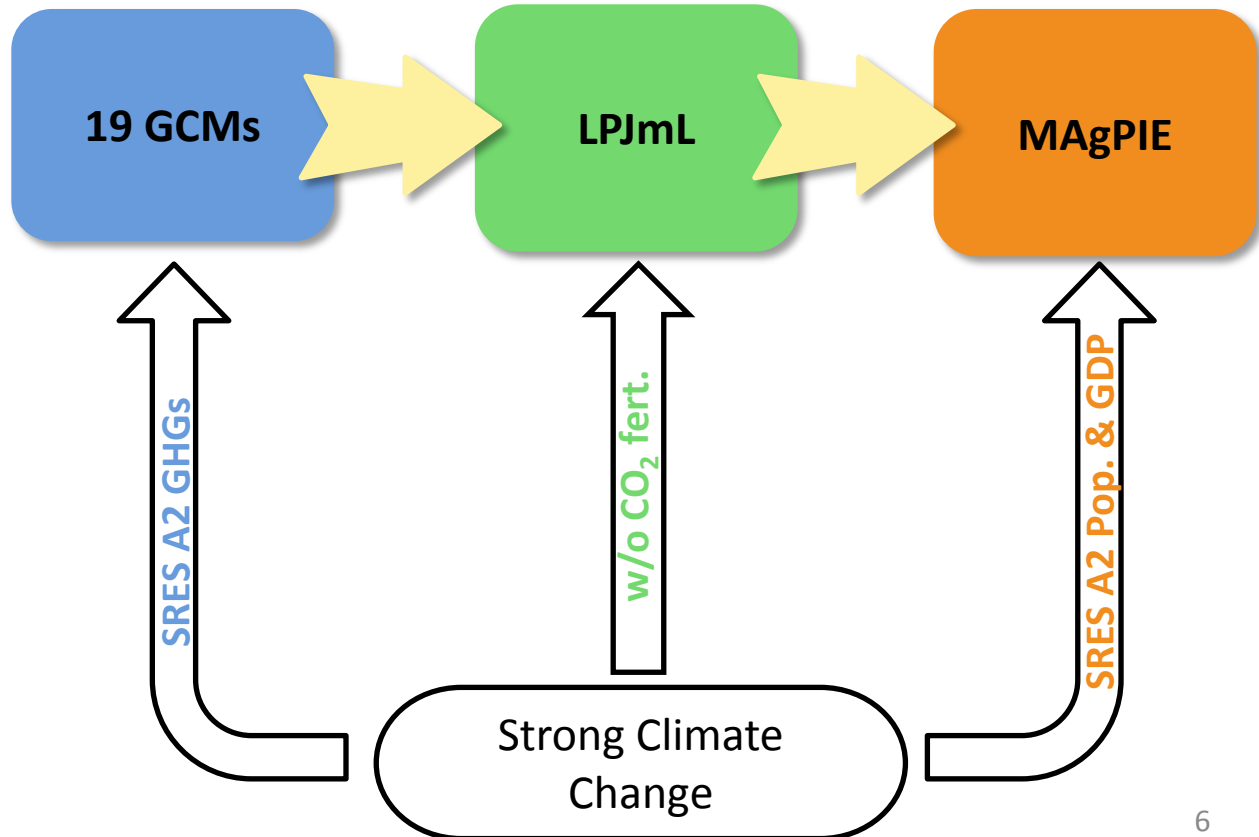
- Subject to regional economic constraints:
 - economic cost of agricultural production
 - exogenous agricultural demand
 - interregional trade barriers



Modeling Chain of High-End CC Impacts



*Source: Nelson et al. 2014, PNAS



Methods: Interregional Trade Scenarios

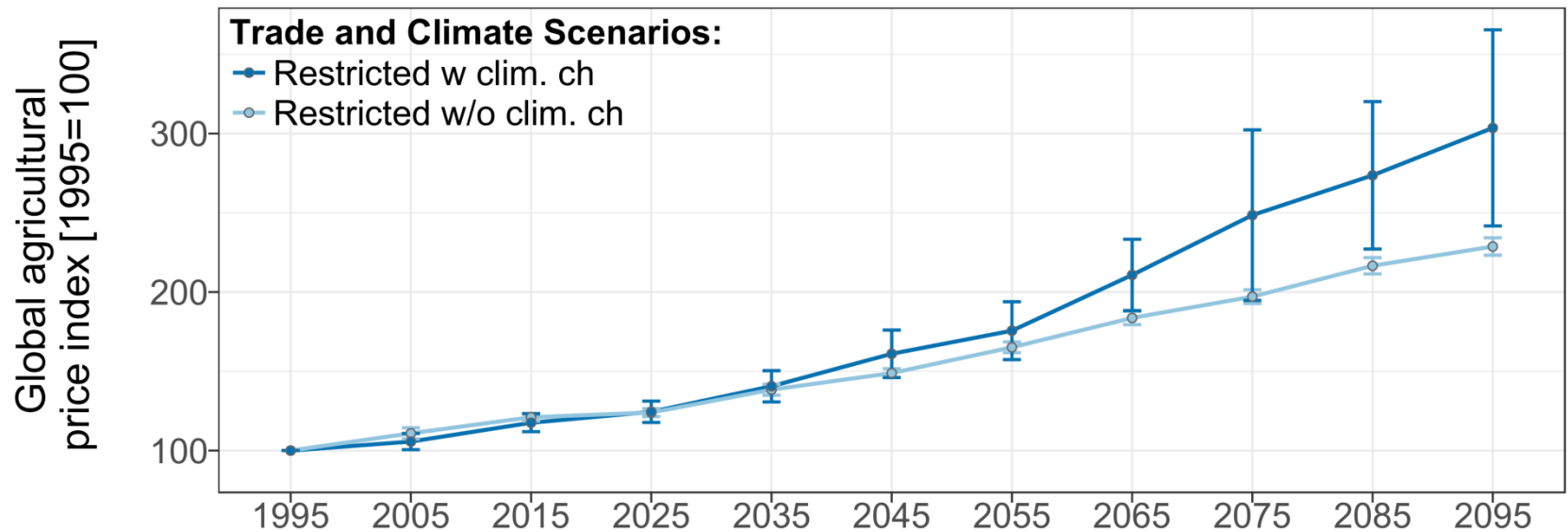
- The role of international trade as a response to climate change impacts in the agricultural sector.



- Assessment scenarios:
 - *Restricted Trade:*
 - trade patterns fixed to the year 1995 regional self-sufficiency ratios and export shares.
 - *Liberalized Trade:*
 - trade barriers are reduced by 10% each decade.

CC Impacts on Food Prices

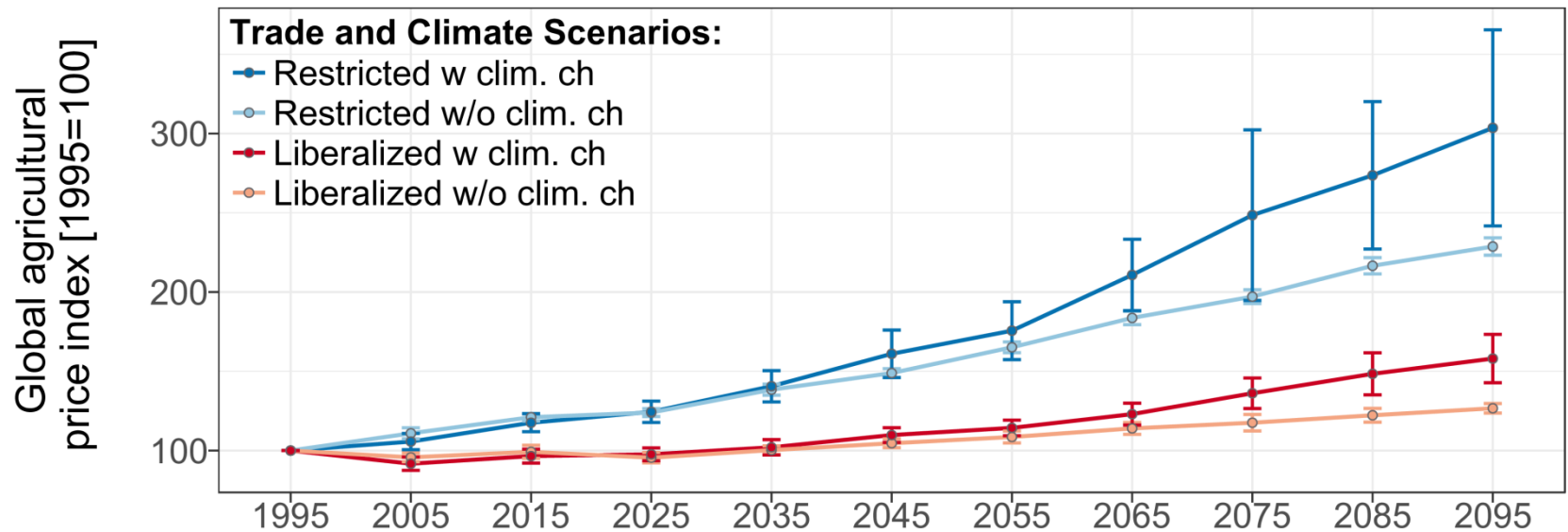
- Consumers bound to pay more for the same basket of good under climate shock



- Increasing food prices under climate change:
 - Decreases in crop yields in many locations
 - Rising production costs

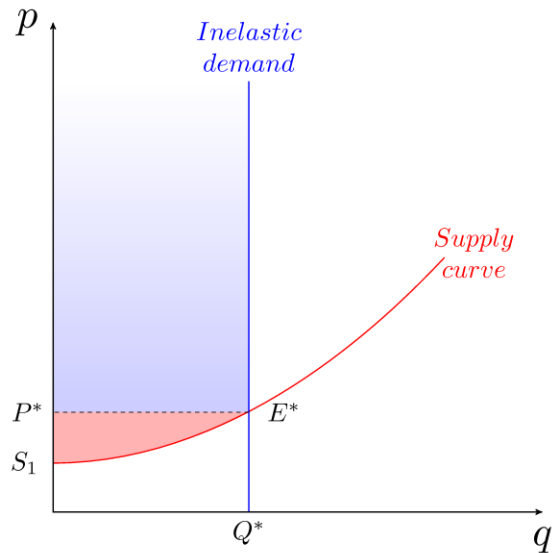
CC Impacts on Food Prices

- Alleviation of impacts on average consumer can come from further liberalization of agricultural trade.

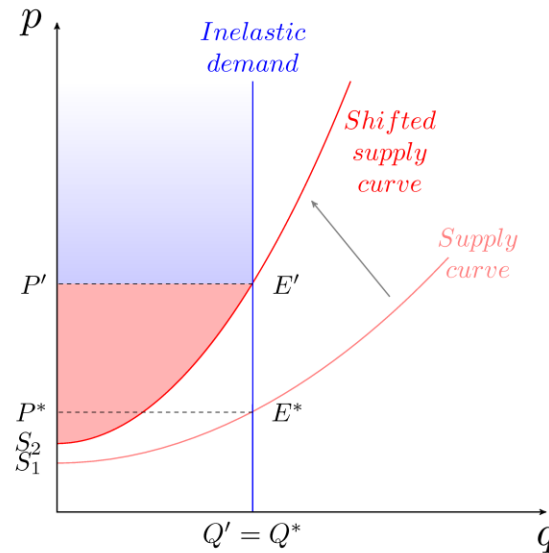


Welfare Indicators

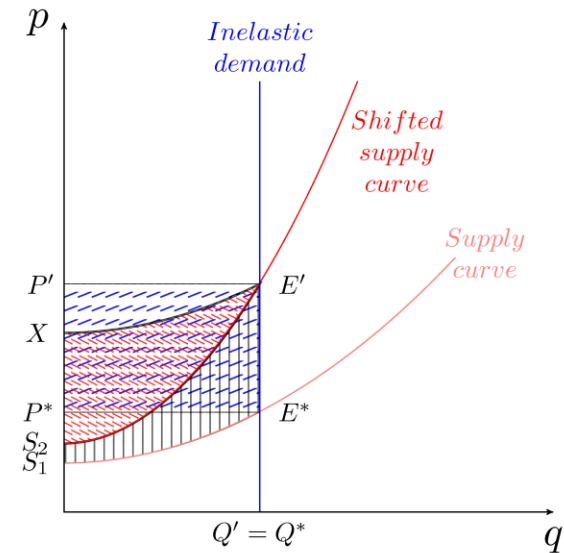
a)



b)



c)

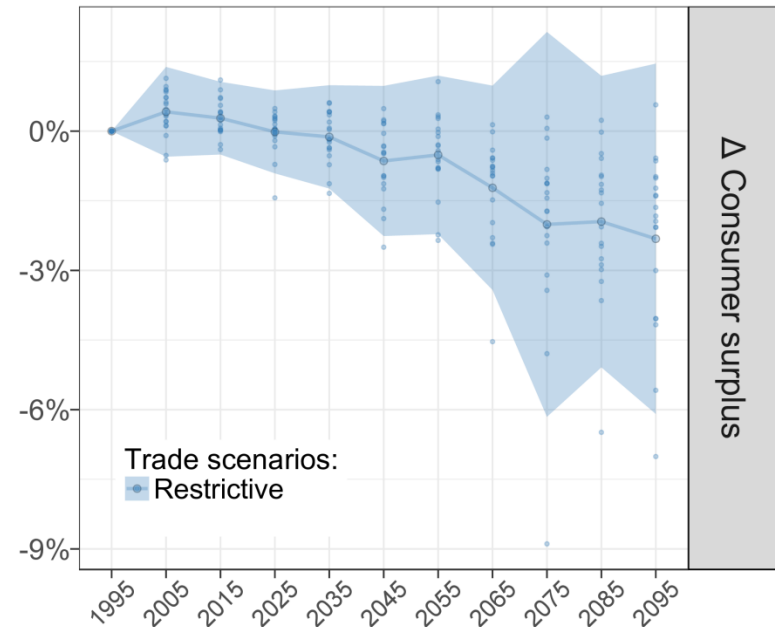


- Three indicators of welfare impacts:
 - Change in consumer surplus
 - Change in producer surplus
 - Change in total agricultural welfare

CC Impacts: Consumer Surplus

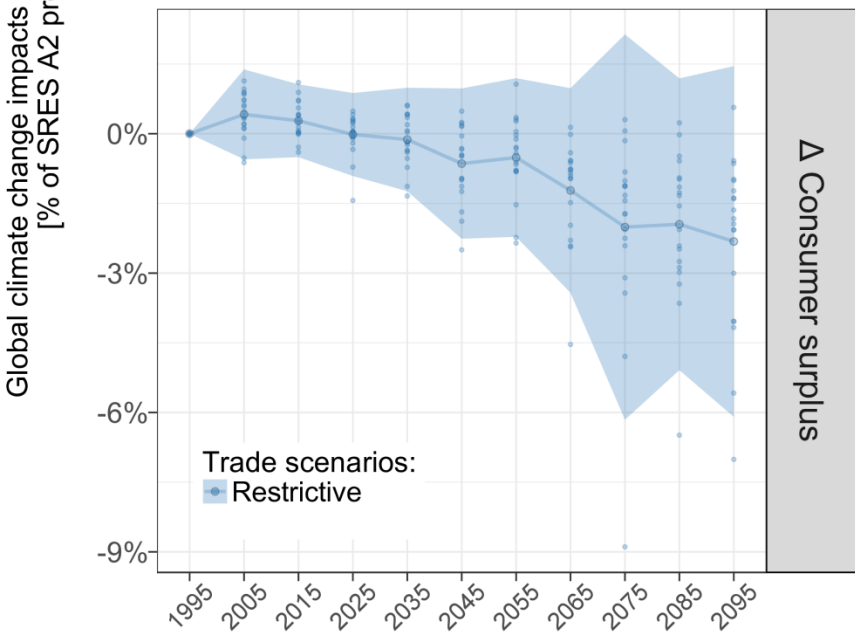
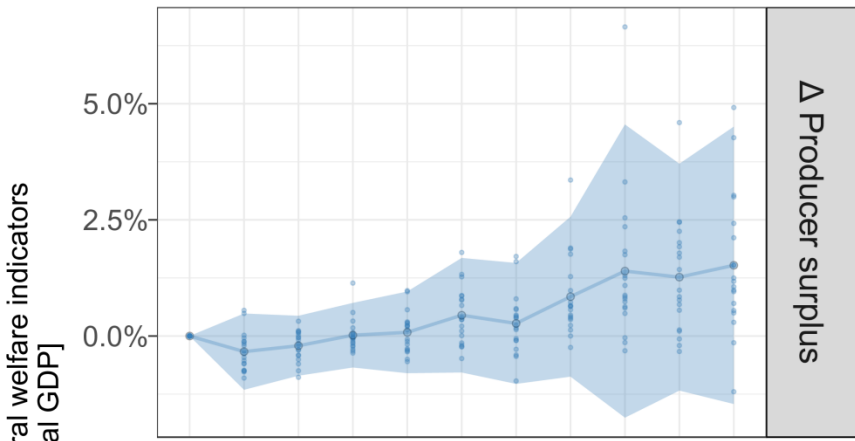
- Strong climate change can lead to increasingly negative impacts on global consumer surplus.
 - -2.3% of projected global GDP at the end of the century

Global climate change impacts on agricultural welfare indicators [% of SRES A2 projected global GDP]



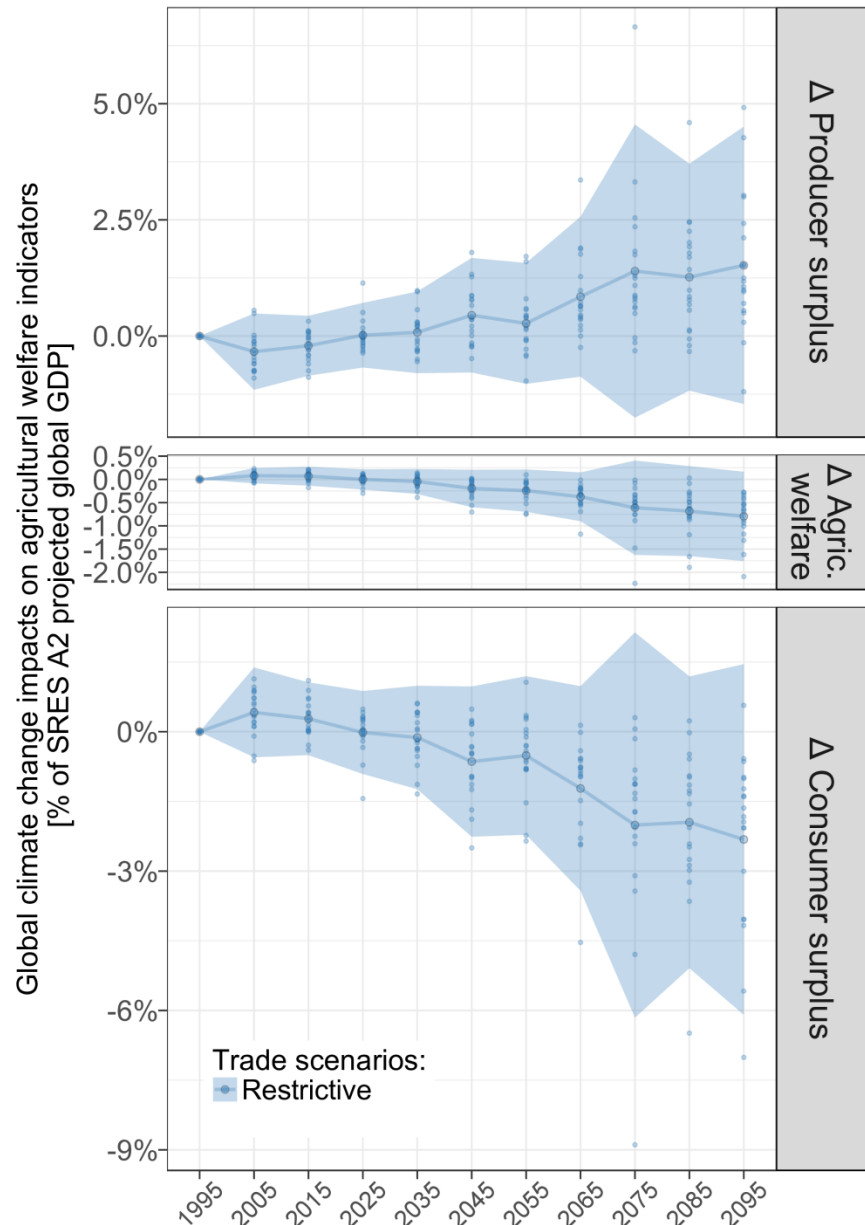
CC Impacts: Producer Surplus

- Producers benefit from high agricultural prices, on global average:
 - 1.5% of projected global GDP at the end of the century



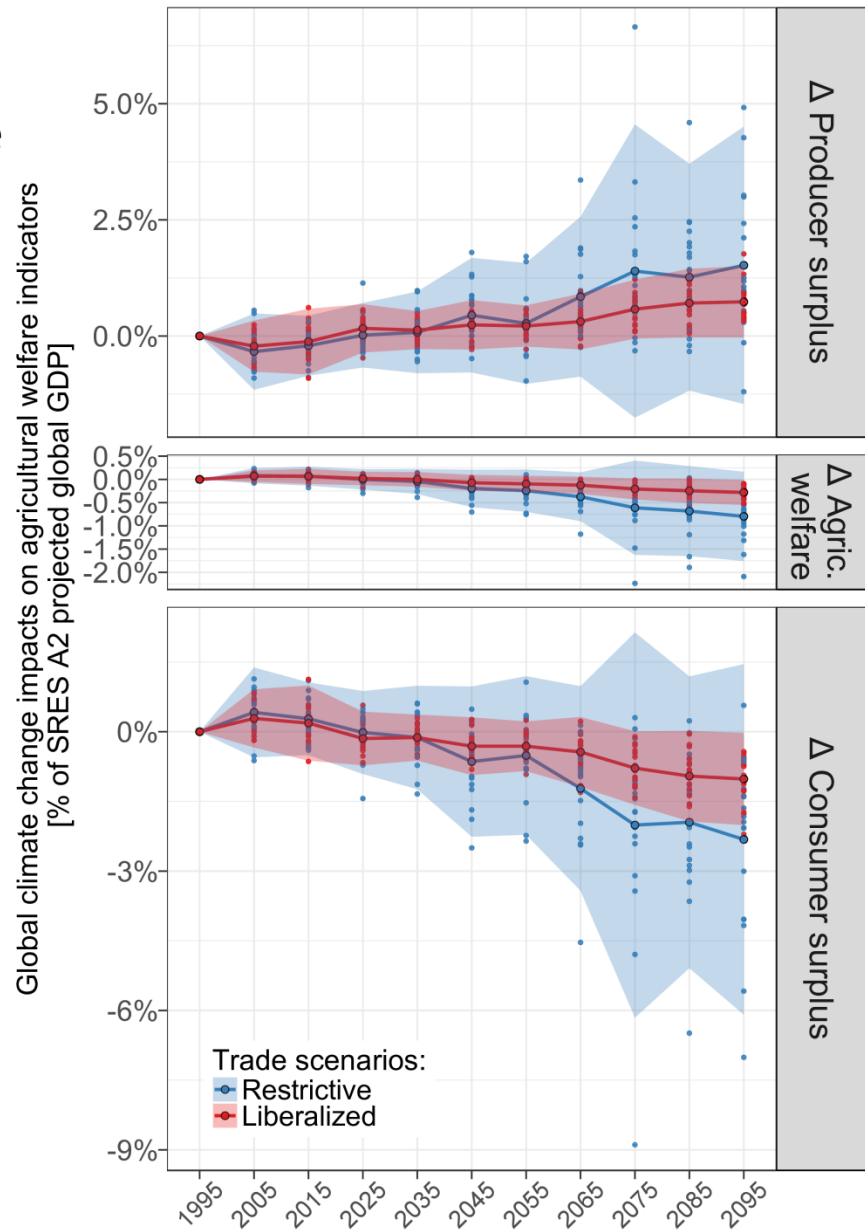
CC Impacts: Agricultural Welfare

- Agro-economic damage comes from losses on the consumer side.
- Strong climate change can lead to increasingly negative impacts on global agricultural welfare.
 - 0.8% of projected global GDP at the end of the century

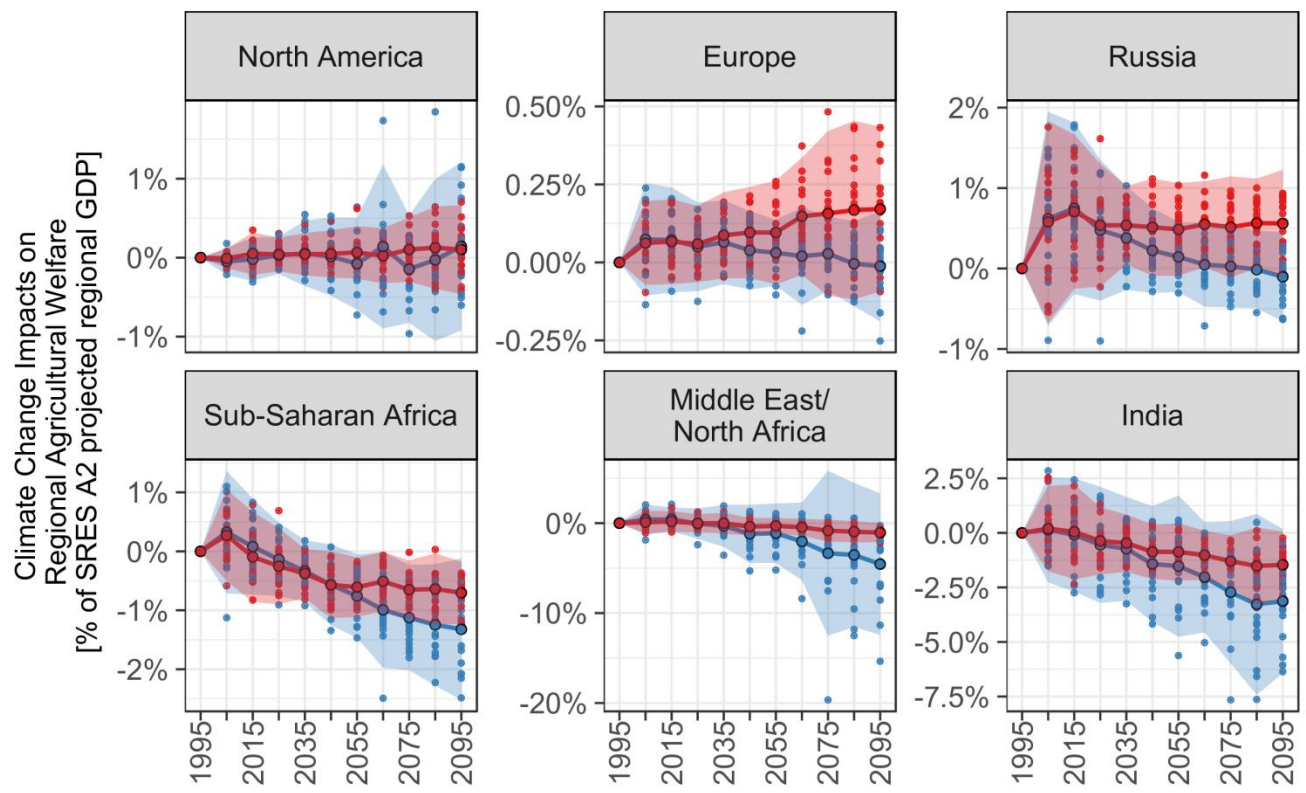


CC Impacts: Liberalized Trade Case

- Direct Impacts under a liberalized trade policy are strongly reduced.
- Great alleviation of impacts on the average consumer can come from further liberalization of agricultural trade:
 - 0.3% of projected global GDP at the end of the century
 - ~60% lower impacts



CC Impacts: Geographical Distribution



Trade scenarios: Restrictive Liberalized

	Restrictive [%]	Liberalized [%]	Δ
North America	0.1	0.1	0
Europe	0	0.2	0.2
Russia	0.1	0.6	0.5
Sub-Saharan Africa	-1.3	-0.7	0.6
Middle East/North Africa	-4.6	-1.1	3.5
India	-3.1	-1.5	1.6

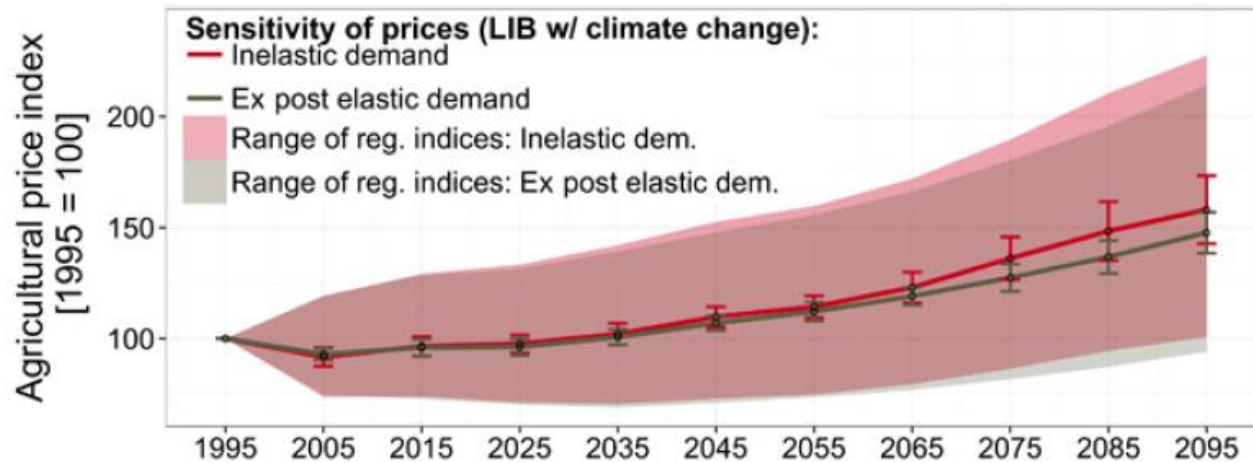
Key Messages

- Strong climate change effect on crop yields could cause significant global agricultural welfare loss by the end of the century.
- Geographical regions will be differently affected by climate change impacts, with more damage in low-latitudes.
- The weight of economic impacts will be higher for food consumers than for food producers.
- Adaptive potential of trade: ~60% reduction in global damages compared to restricted trade conditions.

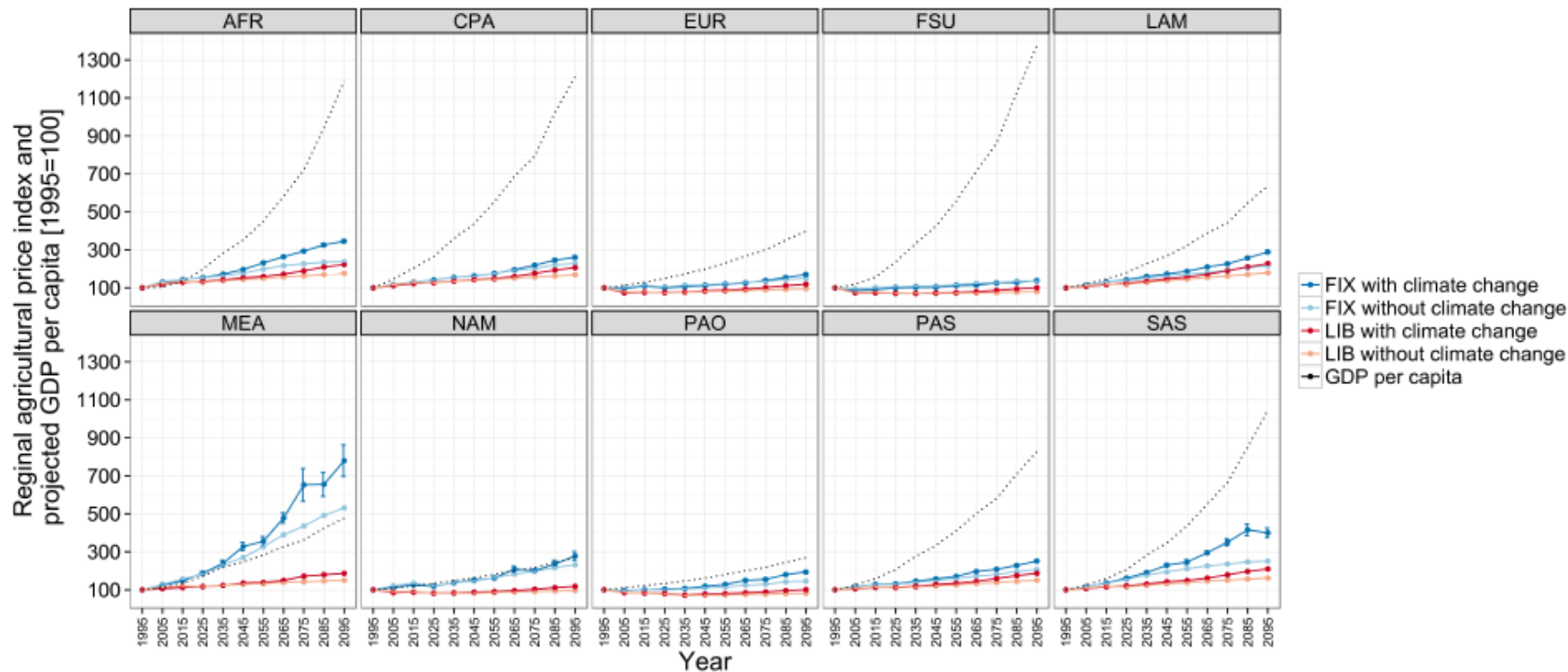
Thank you



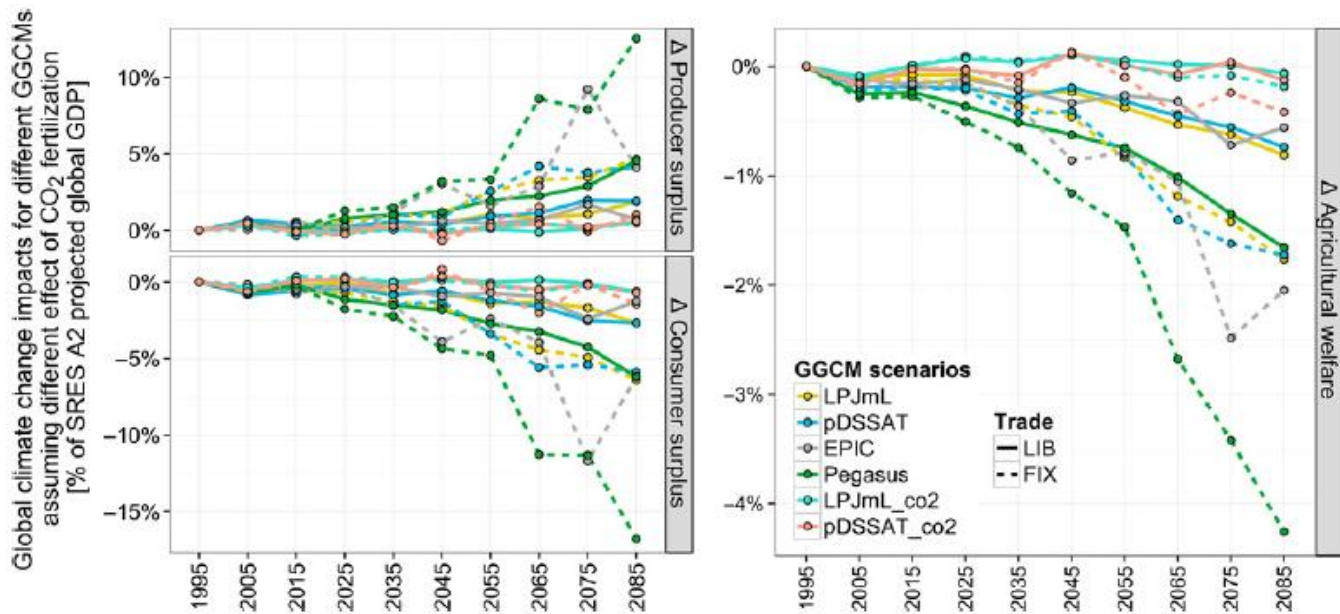
Back-up



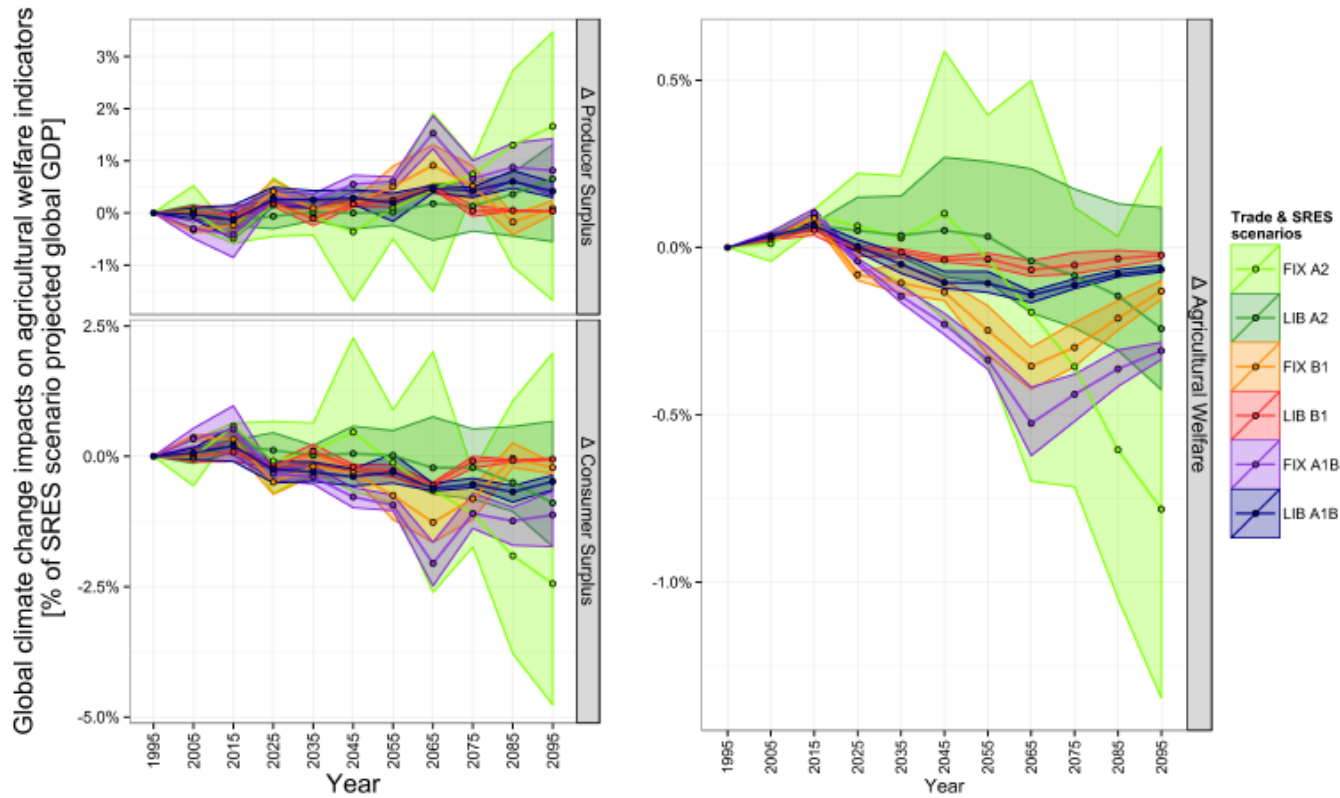
Analysis of an ex post demand reduction effect on agricultural price index for the LIB scenario with climate change. Lines connect global index mean values across all GCMs. Bars display 1 SD from the mean. Shades show the range of regional price indices.



Average values of price index across different climate scenarios (GCMs) with the standard error bars around each average point for "liberalized" (LIB) and "restrictive" (FIX) trade setting in combination with constant and dynamic climate conditions in the SRES A2 scenario.



LPJmL, pDSSAT, EPIC, and Pegasus without CO₂ fertilization effect and LPJmL and pDSSAT with CO₂ fertilization effect. Estimated impacts are simulated under HadGEM2-ES RCP8.5 climate projection and SRES A2 socioeconomic scenario. The GGCM data are obtained from Rosenzweig et al. as used in the study of Nelson et al. with projections running until 2085.



SRES A2, B1 and A1B. Solid lines connect average values across different GCMs, while the shaded area shows the range of results across given GCMs.

