PURDUE UNIVERSITY | Department of Agricultural Economics

Could free trade alleviate effects of climate change: A worldwide analysis with emphasis on Morocco and Turkey

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Outline

- Motivation and research questions
- Methodology
- Results and discussion
- Conclusion

Agriculture, Climate change & Free trade

- Who are the 'Winners' vs. 'Losers'? (1)
  - Distribution of climate-induced productivity shocks?
  - Uncertainty in magnitudes?
- Who are the 'Winners' vs. 'Losers'? (2)
  - Producers? Consumers? Society?
- Mitigation vs. Adaptation?
  - Mitigation: Causes? *(ex-ante)* or Impacts? *(ex-post)*
  - Adaptation: Planned? vs. Autonomous?
- 'Global' free trade vs. 'Regional' free trade?
  - Trade creation vs. Trade diversion?
  - Beggar-Thy-Neighbors effects?
  - Trade warfare?

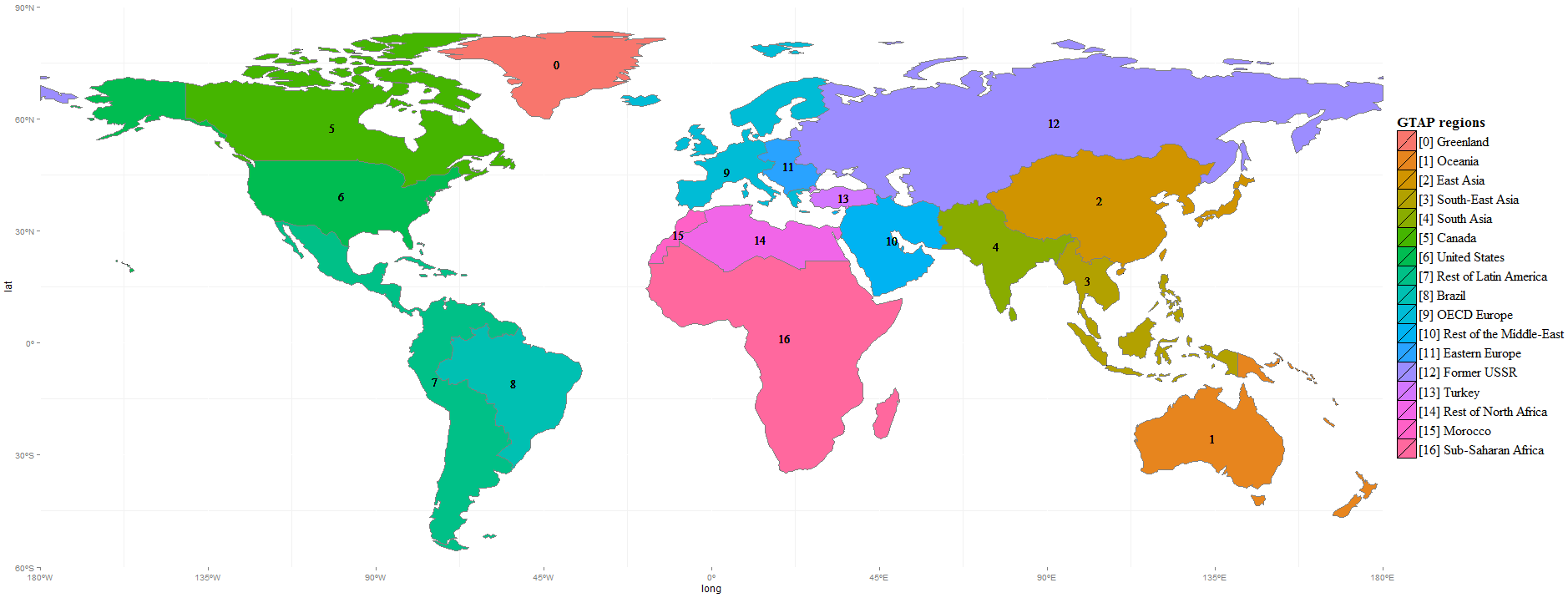
Motivation & Research Questions

- Are there gains to be had from liberalizing trade in the face of climate change?
  - If yes, under what conditions?
    - Global free trade vs. Regional free trade?
    - All sectors vs. Agricultural sectors?
- What is the extent of potential gains, if any?
  - Robustness of gains vs. Uncertainty of climate impacts
- A special focus on Morocco and Turkey

Methodology

- Standard GTAP model, database version 7
  - Reference year corresponds to the global economy in 2004
  - Regional and Sector disaggregation: 113 regions x 57 sectors x 5 factor endowments
- New Regional and Sector aggregation: 16 regions x 15 sectors x 5 factor endowments
  - (7x) Agricultural sector include: Rice, Wheat, Cereal grains nec, Vegetables, fruits & nuts, Oilseeds, Sugar crops, and Other crops nested
- Model analysis in a comparative static mode

Methodology – Regional aggregation



Scenarios Analysis

Table 1: Definition of simulation scenarios

Scenario	Description
CConly	Climate change only
CCMULTI	CConly + Global 100% tariff cut on all commodities
CCAGMULTI	CConly + Global 100% tariff cut on all agricultural commodities
CCTRLIBEU	CConly + 100% tariff cut on all commodities between OECD Europe + Eastern Europe and Morocco, and OECD Europe + Eastern Europe and Turkey
CCAGLIBEU	CConly + 100% tariff cut on all agricultural commodities between OECD Europe + Eastern Europe and Morocco, and OECD Europe + Eastern Europe and Turkey
CCMENA	CConly + 100% tariff cut on all commodities among all MENA regions
CCAGMENA	CConly + 100% tariff cut on all agricultural commodities among all MENA regions

Source: Authors' adaptation

Structure of analysis

Step 1:
Climate change only

- Yield impacts introduced as productivity shocks
- We capture equilibrium conditions via welfare, macroeconomic impacts

Step 2:
Climate change & Trade liberalization

- Yield impacts + 100% tariff elimination
- We capture new equilibrium conditions for welfare, macroeconomic

Step 3:
Net impacts

- We infer the net effects of trade liberalization by computing the differential between the two equilibrium conditions from Step 1 and Step 2.

Yield impacts

Source 1:
IFPRI Database

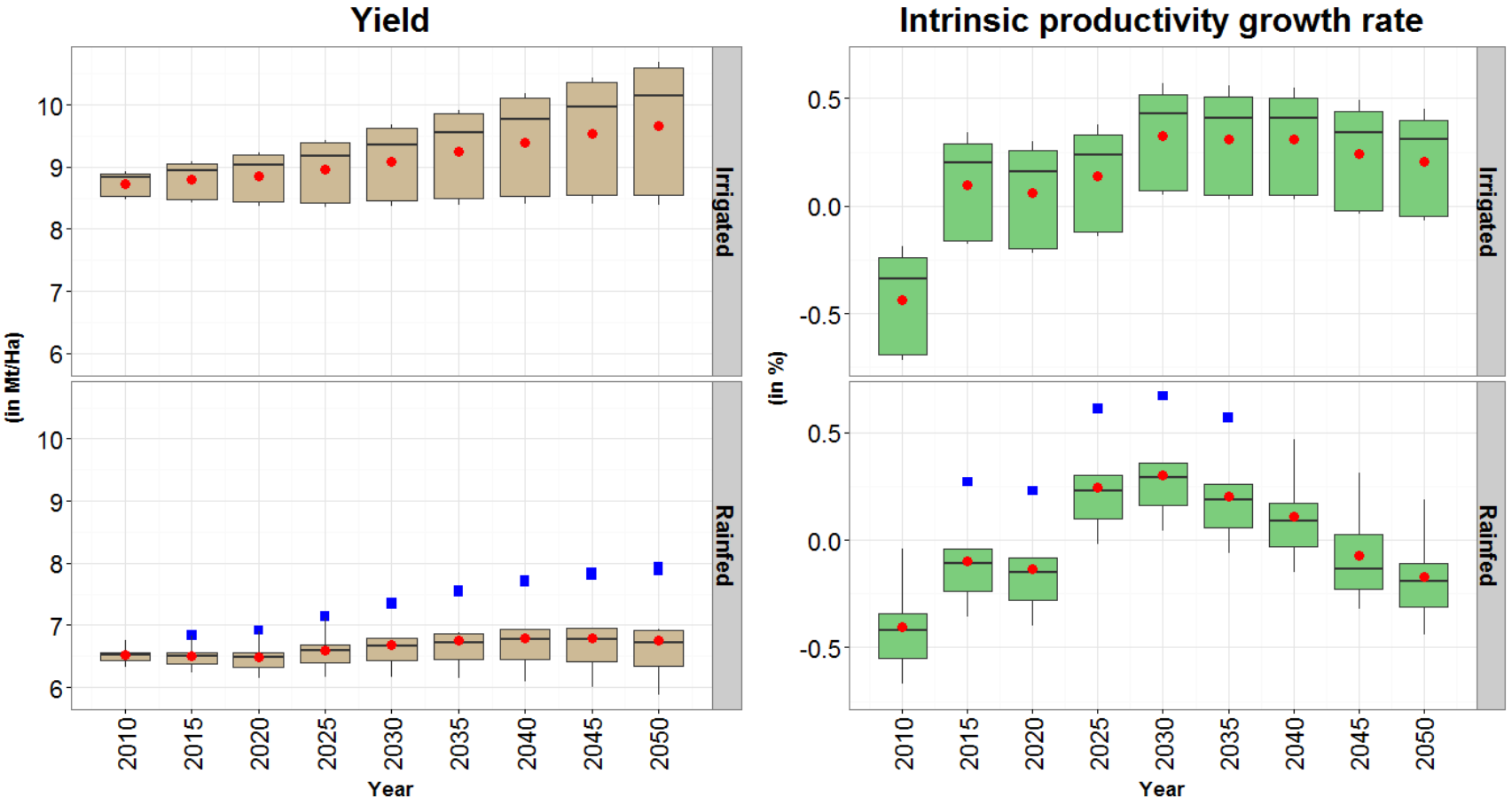
- Regions/countries (x114)
- Crops (x6): rice, wheat, maize, cassava, groundnut, and soybean
- Macro growth scenarios (x3): Pessimistic, Optimistic and Baseline
- SRES (x2): A1B and B1
- GCM (x2): CSIRO and MIROC

Source 2:
IMAGE Database

- Regions/countries (x26)
- Crops (x11): maize_f, maize_b, oilcrops, pulses, rice, roots & tubers, temperate cereals, tropical cereals, non-woody biofuels, woody biofuels, sugar cane
- SRES (x10): A1B, A1F, A1F_High, A1F_Low, A1T, A2, B1, B1_High, B1_Low, B2

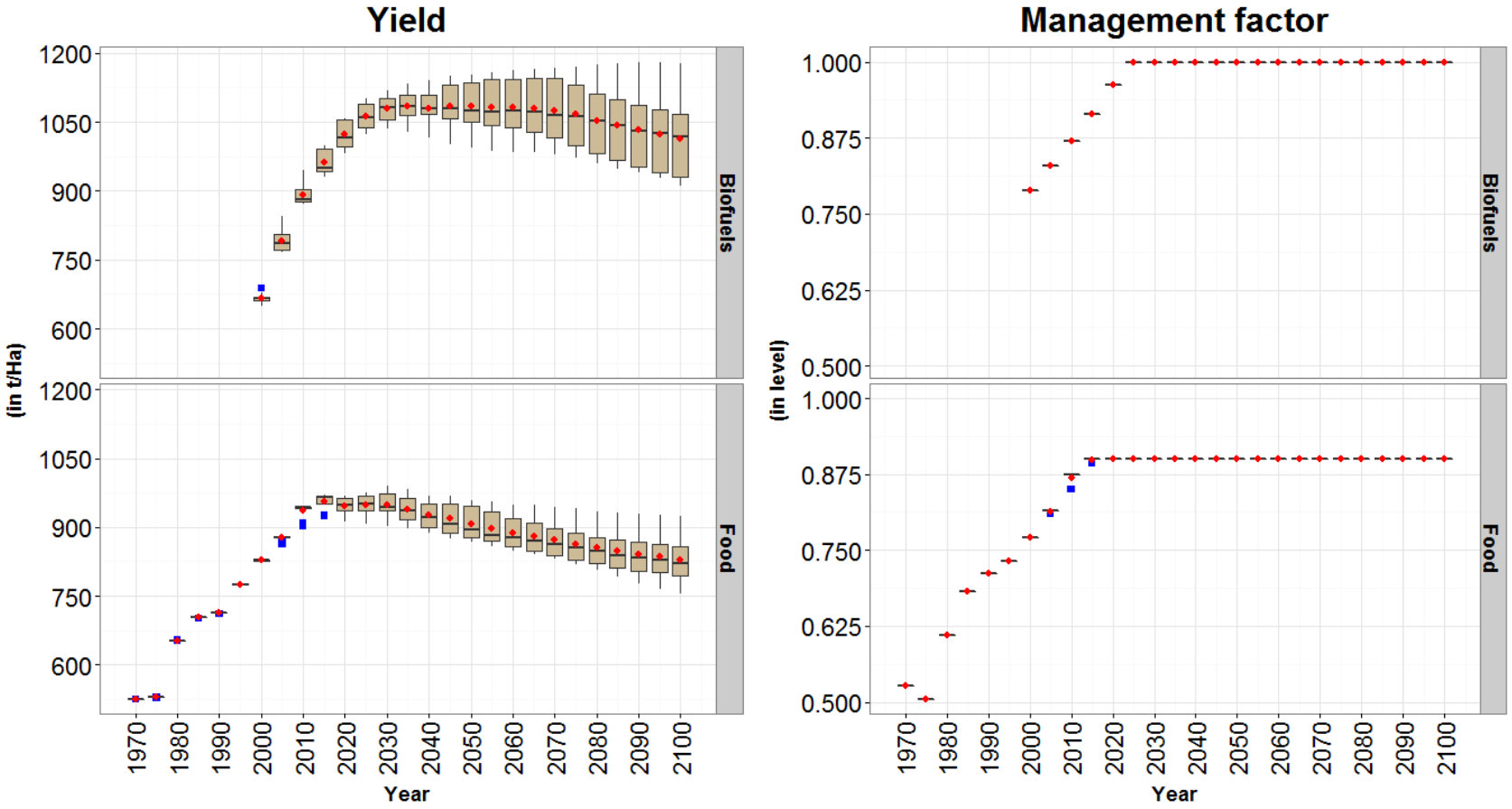
Yield impacts – IFPRI Database

Sample data: Wheat, France



Yield impacts – IMAGE Database

Sample data: Maize, United States



Yield Impacts – Final Database

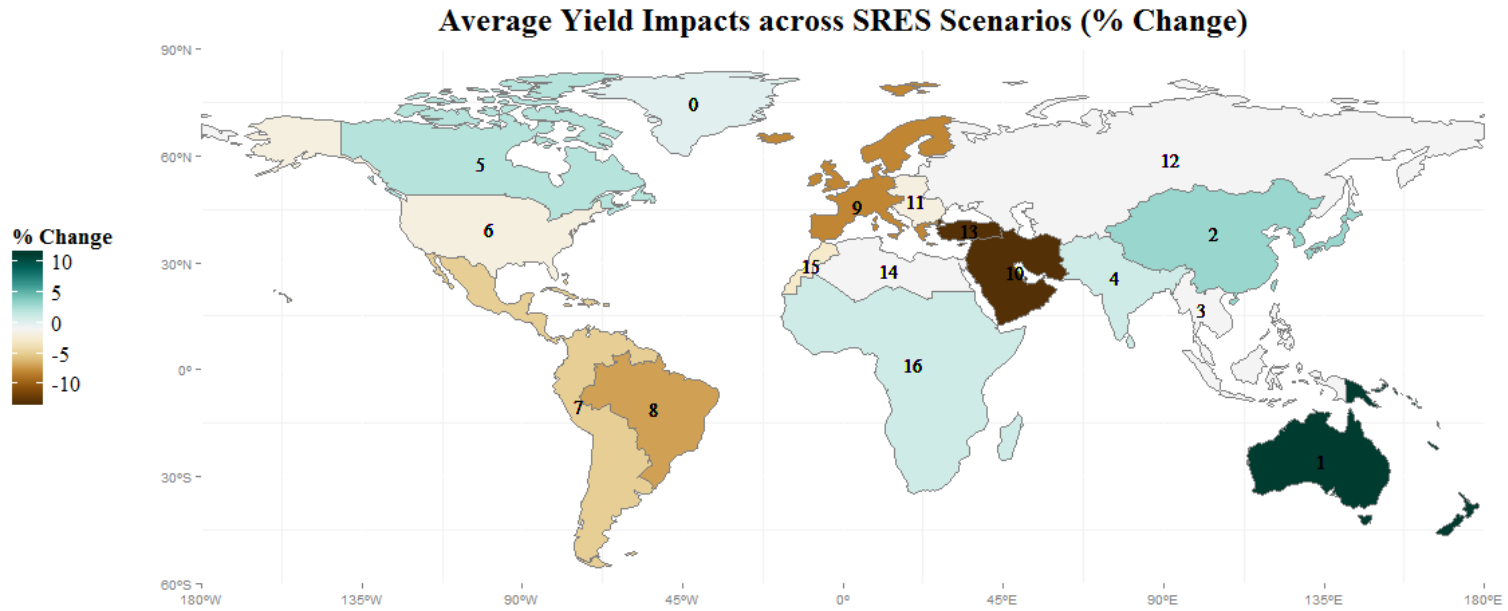
- **Irrigated-Rainfed aggregation**
  - IFPRI: $\Delta Y_{tot}^{r} = \sum_{i \in \{irr,rf\}} \omega_i^r Y_i^r$, where ω_i^r denotes production share
  - IMAGE: no action needed
- **Regional aggregation**
  - Production-weighted averages are used to estimate total impacts for each region in the GTAP aggregation
- **Crop aggregation**
  - Simple average across crops categories to match the GTAP crops aggregation

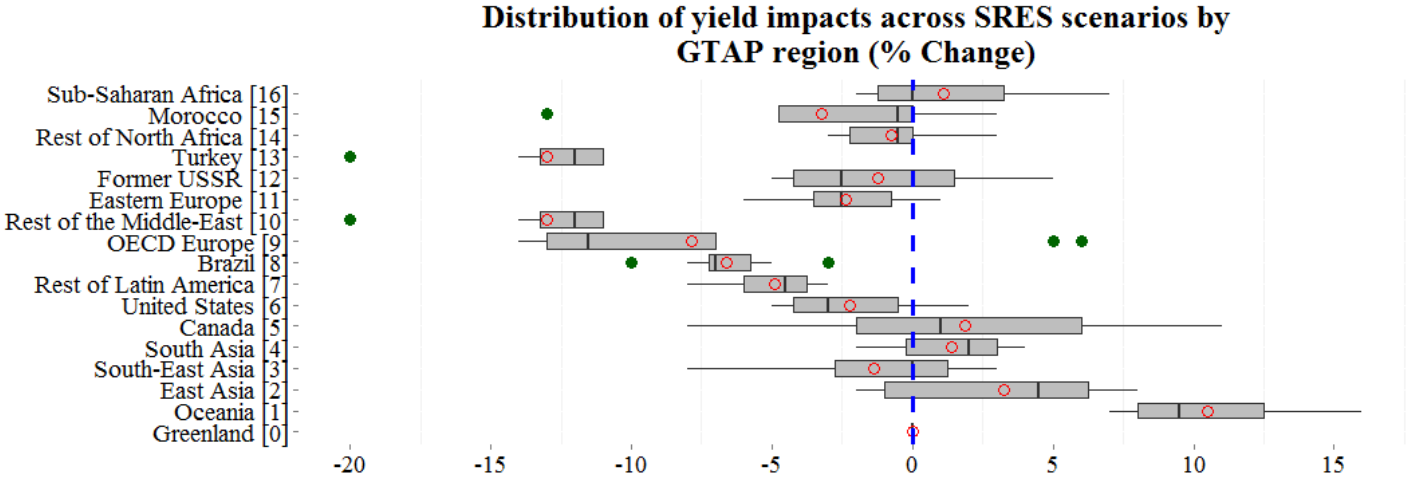
Yield Impacts – Final Database

Table 8: Summary of crop matching between GTAP, IFRPI and IMAGE crops

GTAP crops	Matching crops in:	
	IFPRI	IMAGE
Paddy rice	Rice	Rice
Wheat	Wheat	Temperate cereals, Tropical cereals
Cereal grains nec	Wheat, Maize	Temperate cereals, Tropical cereals, Maize
Vegetables, fruit, nuts	Rice, Groundnuts	Roots & Tubers, Pulses
Oil seeds	Soybeans	Oil crops
Sugar cane, sugar beet	Maize	Maize
Other crops	Rice, Wheat, Cassava, Soybeans, Groundnuts, Maize	Rice, Temperate cereals, Tropical cereals, Maize, Oil crops, Roots & Tubers, Pulses

Yield Impacts – Results (1)





Yield Impacts – Results by crop (2)

- **Rice (+4.1%)**
  - Positive for most regions (incl. majors producers and exporters) (12 out of 16 regions)
  - (-) Regions averaged -5%; (+) Regions averaged +8.1%
- **Wheat (-4%)**
  - Negative for most regions (incl. majors producers and exporters) (14 out of 16 regions)
  - (-) Regions averaged -5.5%; (+) Regions averaged +6%
- **Coarse grains (-4.9%)**
  - Negative for most regions (incl. majors producers and exporters) (14 out of 16 regions)
  - (-) Regions averaged -6.5%; (+) Regions averaged +5.9%
- **Oilseeds (-1%)**
  - Evenly split in terms of +/- projected impacts
  - (-) Regions averaged -9.7%; (+) Regions averaged +7.5%

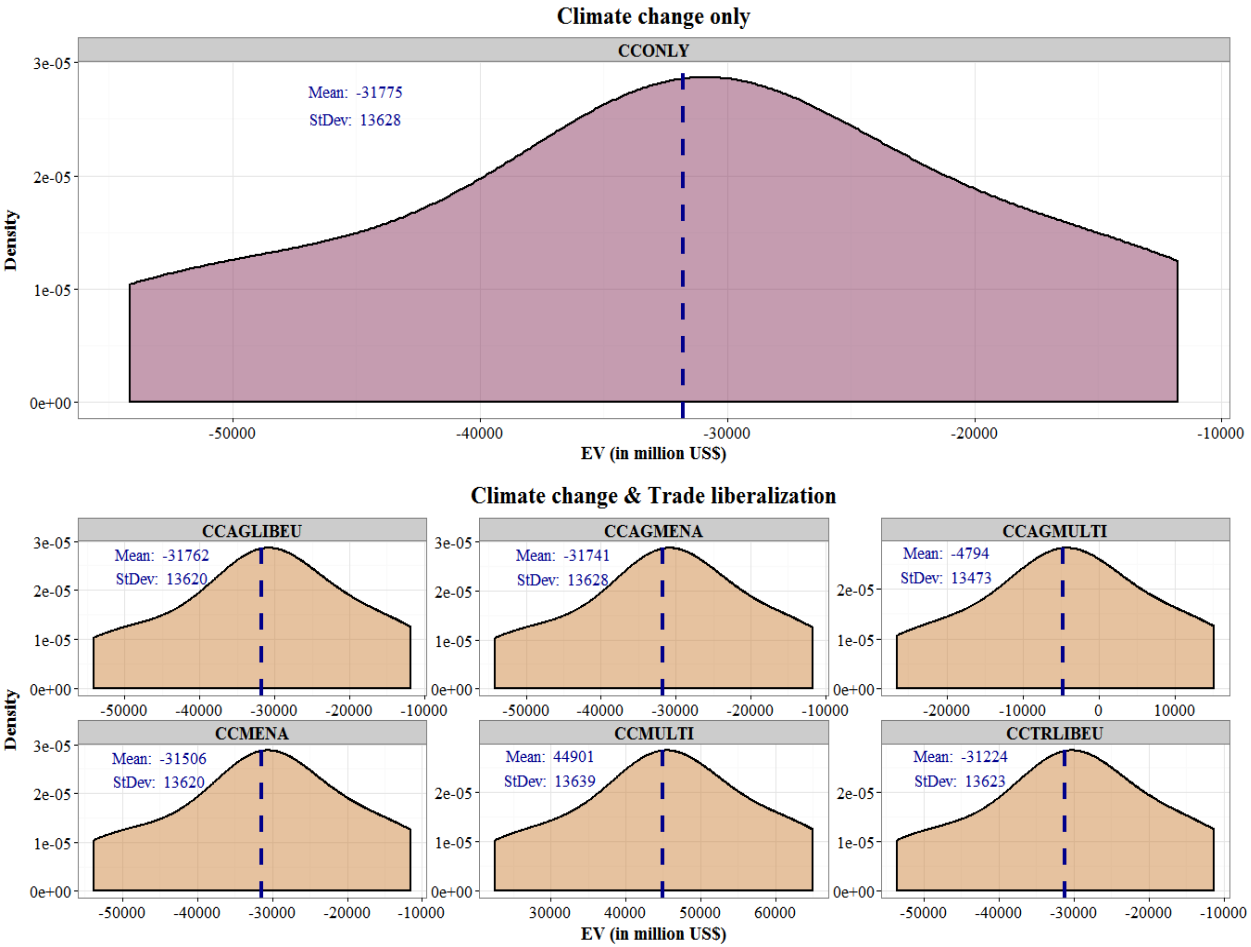
Yield Impacts – Results by crop (2)

- **Vegetables & Fruits (-2.1%)**
  - Negative for most regions (11 out of 16 regions)
  - (-) Regions averaged -5.4%; (+) Regions averaged +5.1%

- **Sugar crops (-6.6%)**
  - Negative for most regions (13 out of 16 regions)
  - (-) Regions averaged -10%; (+) Regions averaged +5%

- **Other crops (-1.8%)**
  - Negative for most regions (11 out of 16 regions)
  - (-) Regions averaged -4%; (+) Regions averaged +2%

Global welfare



- Climate change only: Welfare impacts range from US$ -11,784 million (A1F) to US$ -54,138 million (A2)
- Including trade liberalization: minor gains under most scenarios
- Trade liberalization effective only under ‘CCMULTI’ and partially under ‘CCAGMULTI’

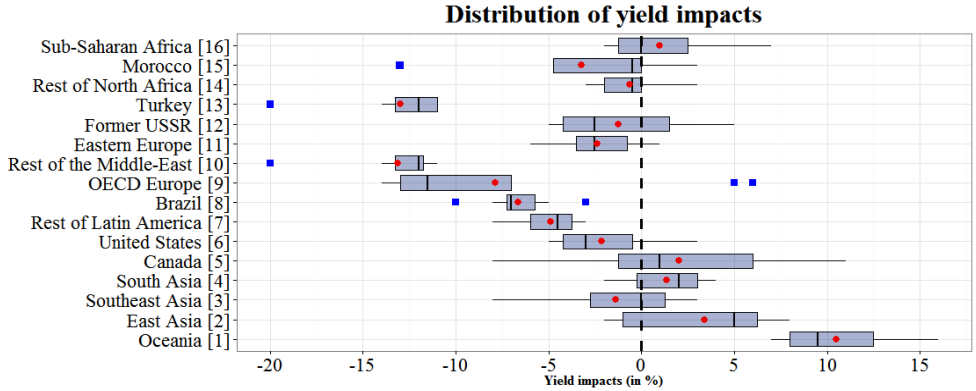
Global welfare decomposition

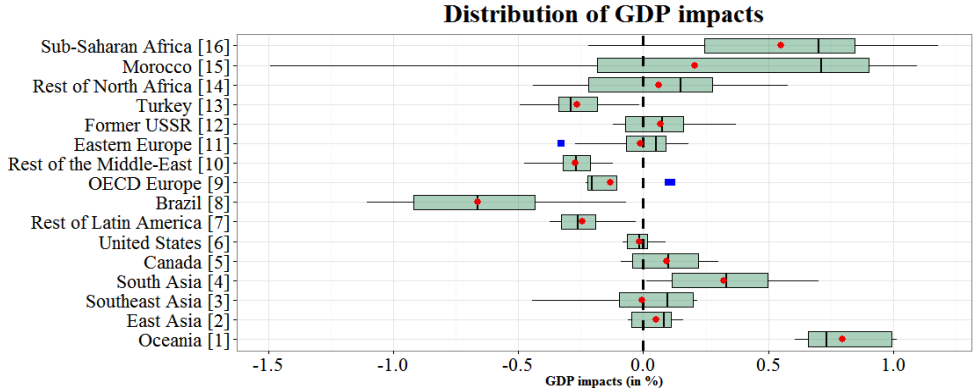
Table 14: Decomposition of average welfare impacts for the world by effects (in million US$)

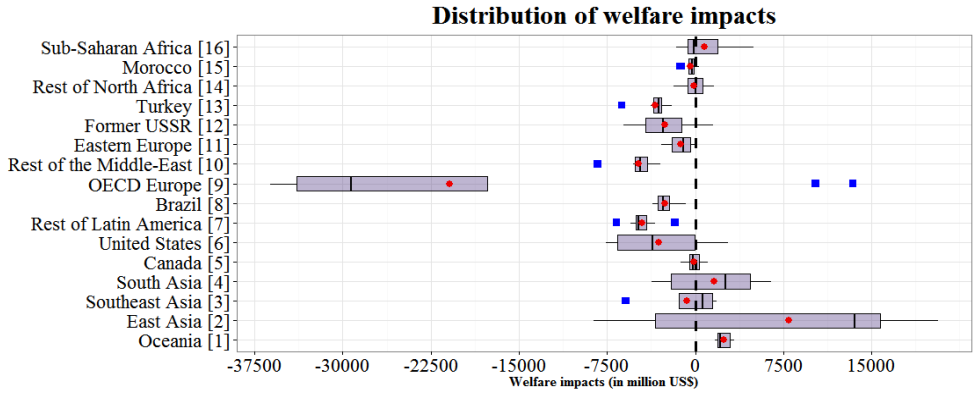
Scenario	Allocative efficiency	Technical efficiency	Terms of trade	Investment-Savings
		Climate change only		
CCONLY	-4,075.59	-27,699.19	-0.55	0.27
		Climate change & Trade liberalization		
CCAGLIBEU	-4,076.47	-27,684.05	-1.61	0.19
CCAGMENA	-4,030.87	-27,709.61	-0.43	0.27
CCAGMULTI	22,334.47	-27,111.75	-16.23	-0.2
CCMENA	-3,718.04	-27,740.84	-42.65	-4.3
CCTRLIBEU	-3,524.84	-27,693.09	-5.48	-0.63
CCMULTI	72,854.81	-27,332.46	-671.4	50.42
		Trade liberalization net		
AGLIBEU	-0.88	15.14	-1.06	-0.08
AGMENA	44.72	-10.42	0.12	0
AGMULTI	26,410.06	587.44	-15.68	-0.47
MENA	357.55	-41.65	-42.1	-4.58
TRLIBEU	550.75	6.1	-4.93	-0.9
MULTI	76,930.39	366.73	-670.85	50.14

Source: Simulation results

Regional Yields, Welfare and GDP







- (-) yield impacts correlated with (-) welfare and GDP impacts; and vice-versa for the (+) cases
- Direction and magnitude of change depend on
  - Share of agriculture in the economy (i.e. production, trade)
  - Which crops are most affected
  - Irrigated vs. Rainfed
  - Traditional vs. Industrial agriculture

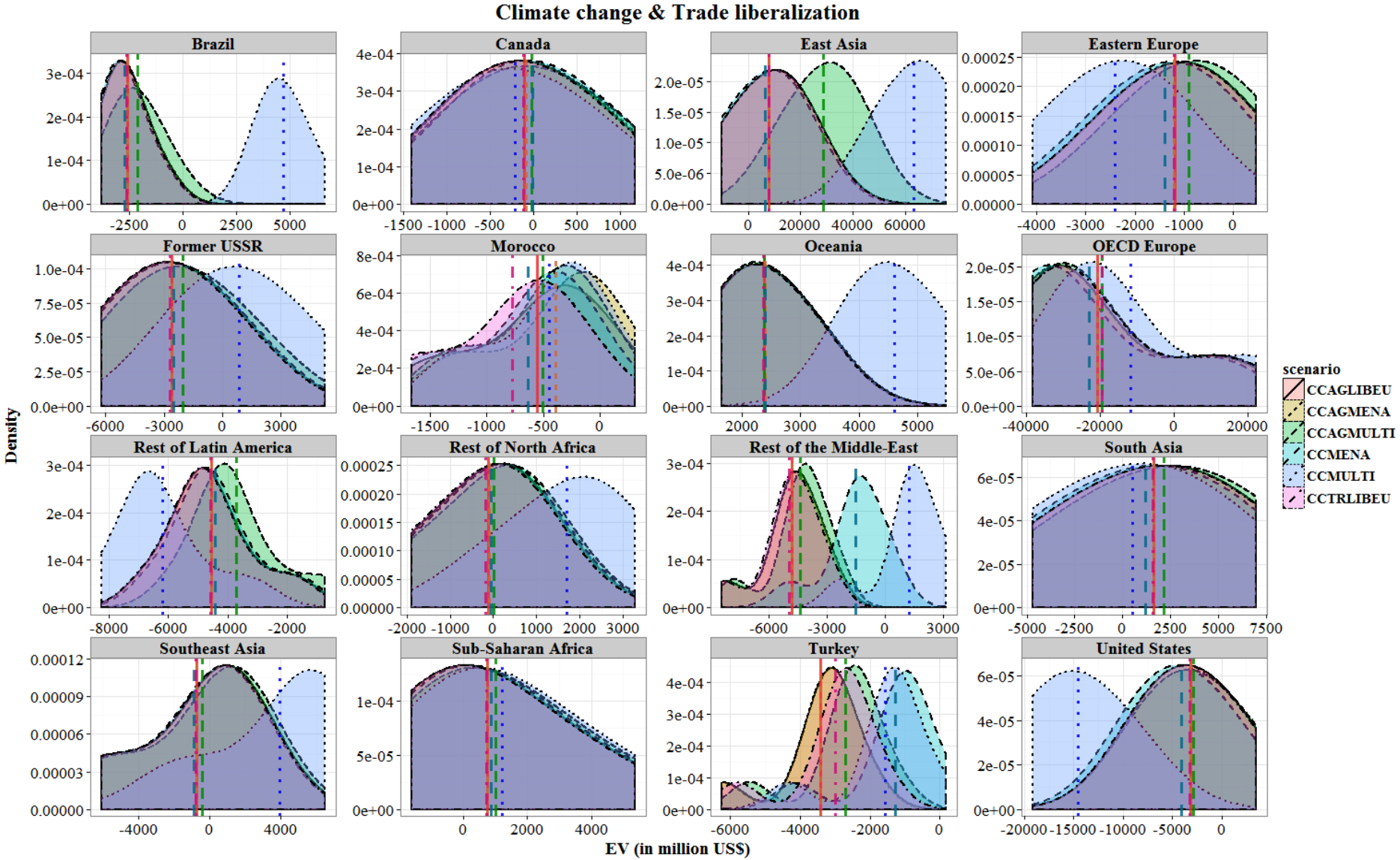
Regional welfare

- Group 1: countries/regions that benefit under climate change and gain under trade liberalization scenarios, but not all;
  - Oceania, East Asia, South Asia and Sub-Saharan Africa

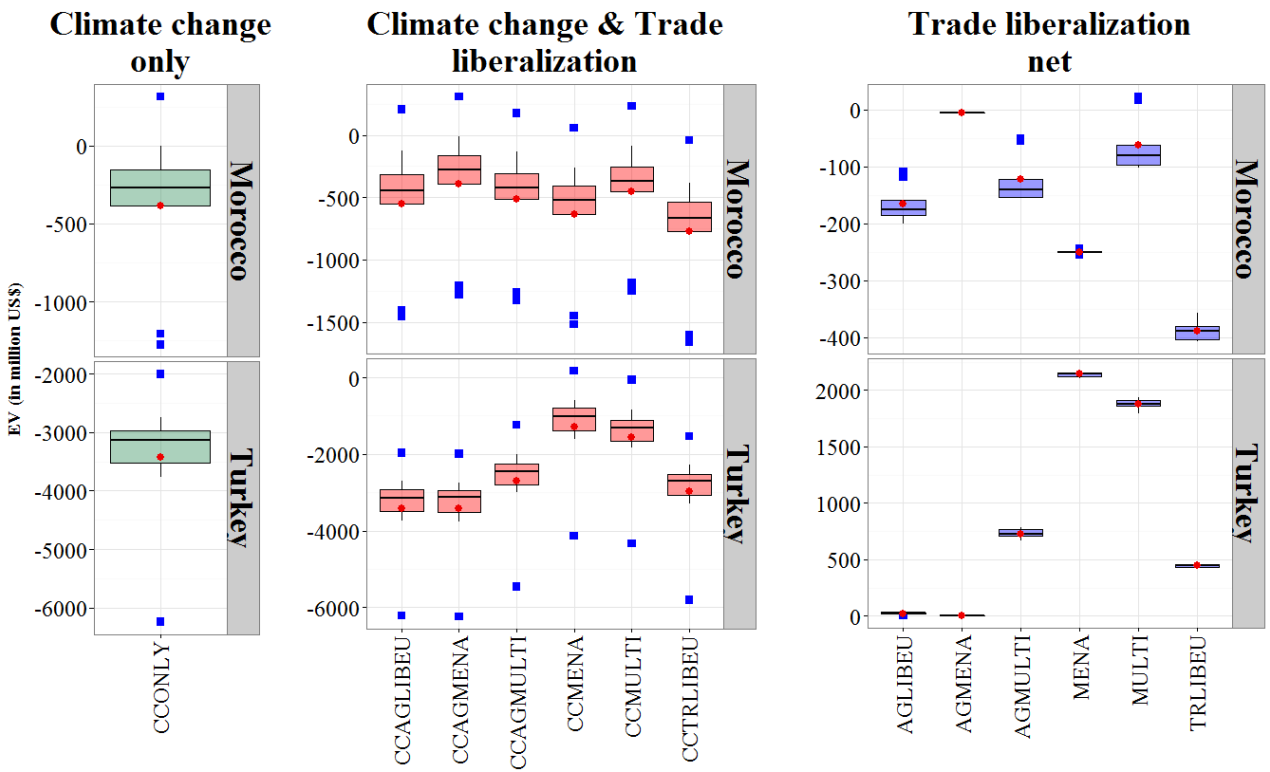
- Group 2: countries/regions that lose under climate change and benefit under trade liberalization scenarios, but not all;
  - Southeast Asia, Canada, United States, Brazil, Rest of Latin America, OECD Europe, Eastern Europe, Former USSR, Turkey, Rest of MENA, Rest of North Africa

- Group 3: countries/regions that lose under climate change and further loose under all trade liberalization scenarios.
  - Morocco

Regional welfare

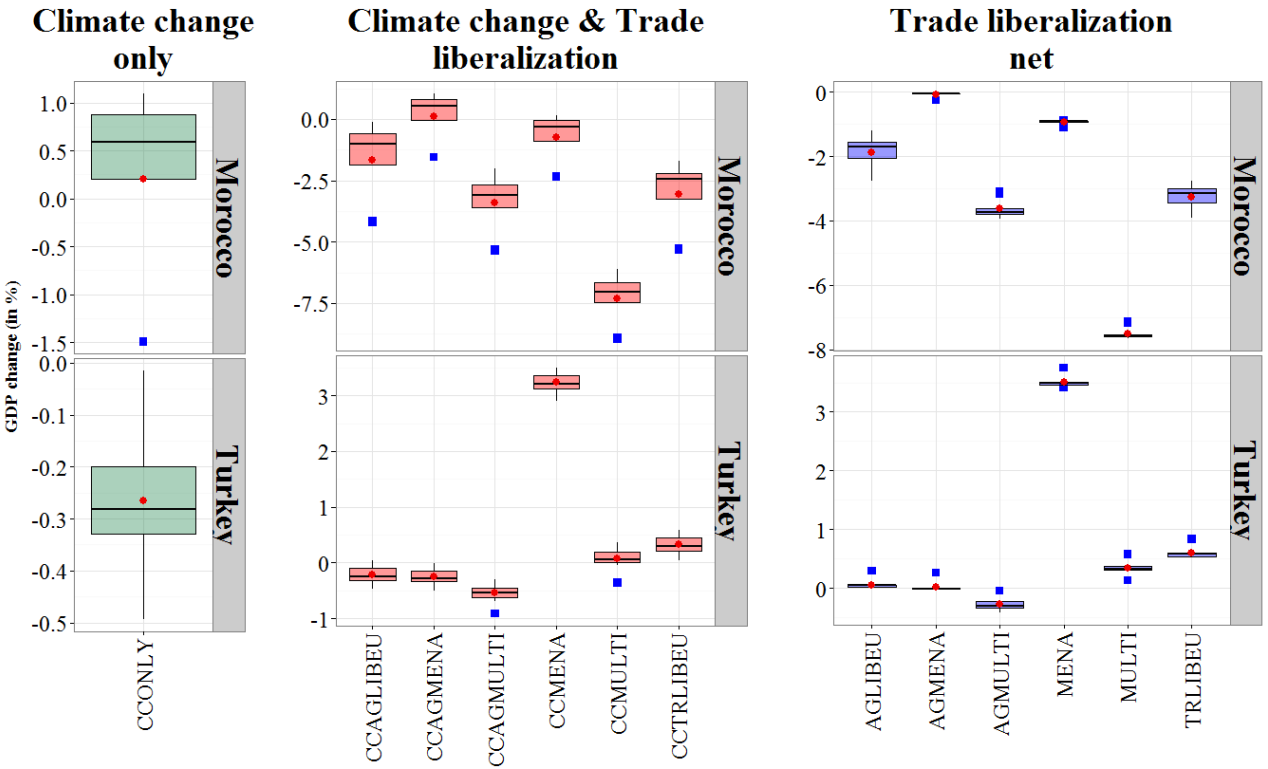


Welfare impacts – Morocco & Turkey



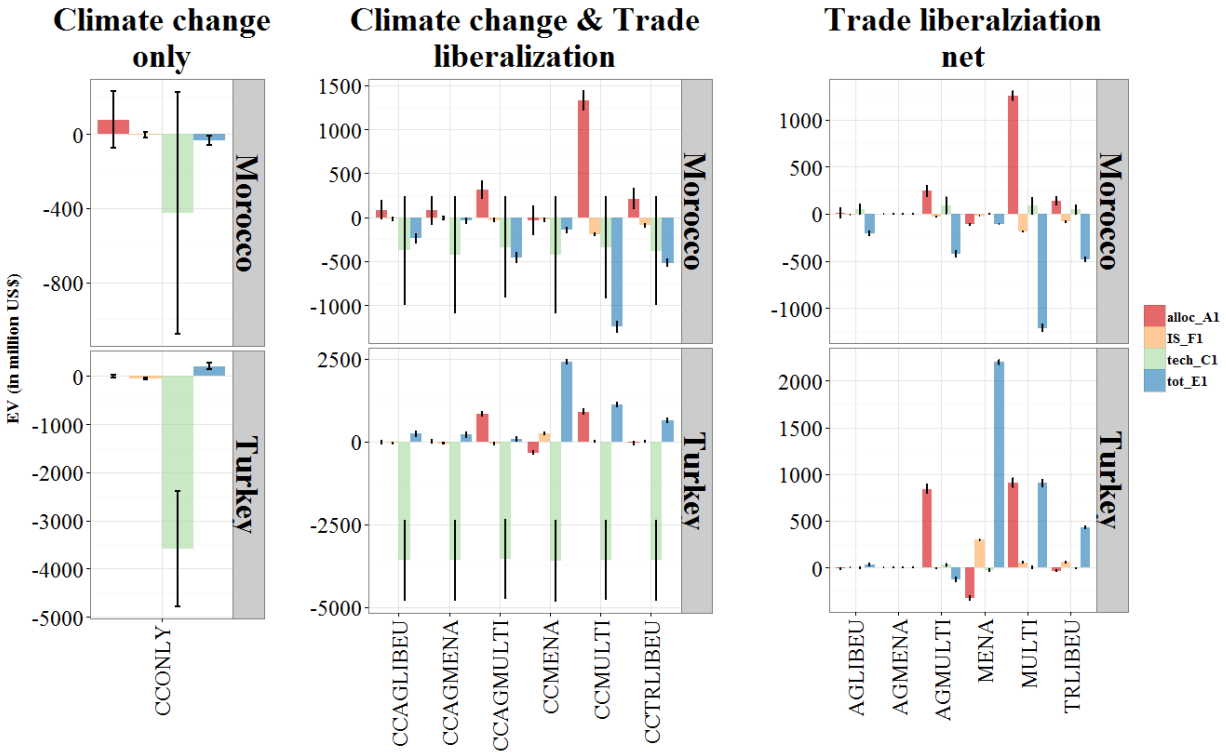
- Morocco experiences (-) net welfare effects ex-post trade liberalization
  - Highest loss under 'CCTRLIBEU'
- Turkey benefits from tariff elimination
  - Highest net welfare gain under 'CCMENA'

GDP impacts – Morocco & Turkey



- Magnitude of CC effect on GDP higher in Morocco than in Turkey
- Very contrasting results of trade liberalization effects on GDP
  - Negative for Morocco;
  - Positive for Turkey

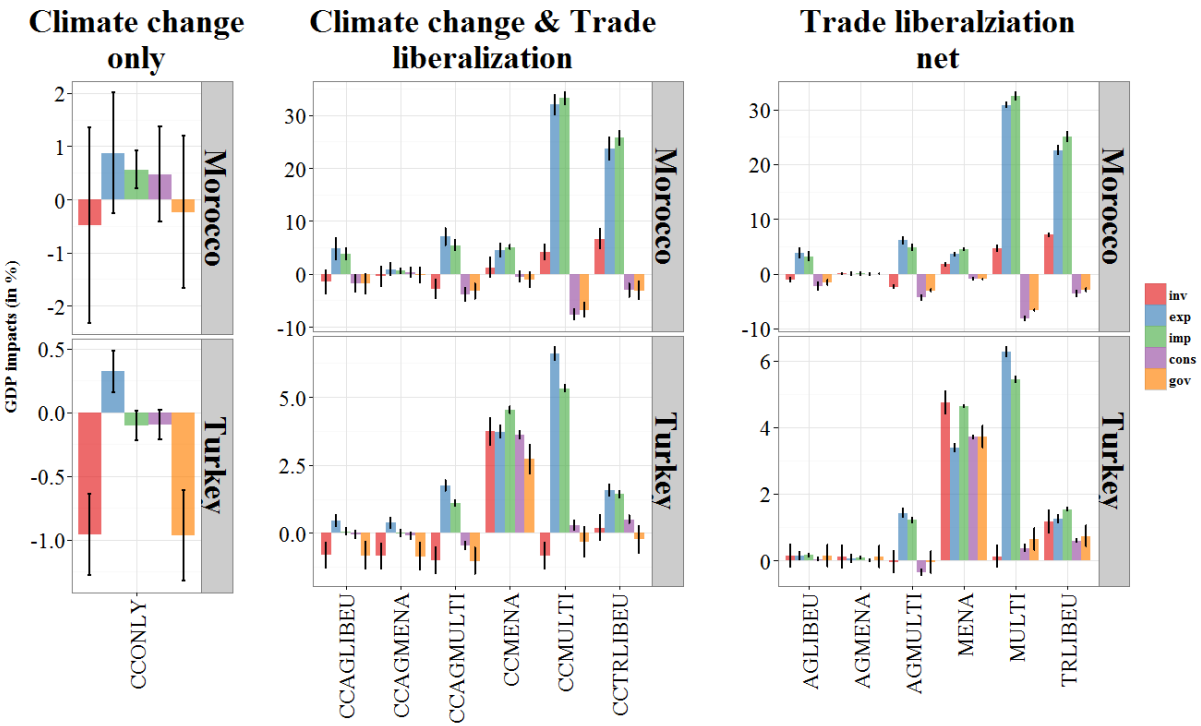
Welfare impacts decomposition – Morocco & Turkey



Investment-Savings can tilt the balance for the final effect

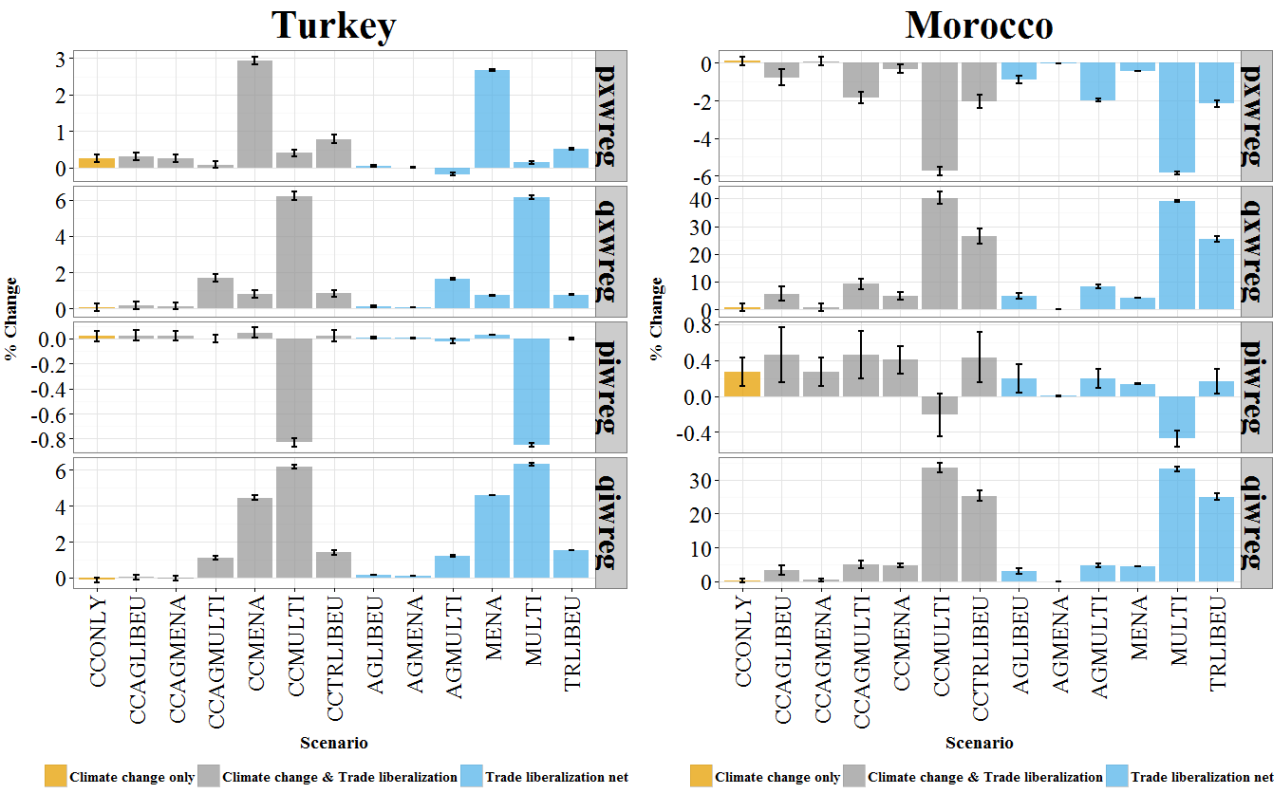
- Trade liberalization main channels of impact: Terms of Trade and Allocative efficiency
- Under most scenarios, Investment-Savings and technical efficiency are negligible

GDP impacts decomposition – Morocco & Turkey



- Large impacts on exports and imports in both countries
  - Magnitudes larger for Morocco
- Effects on consumption and government spending dominates final effect on GDP
  - Negative in Morocco
  - Positive in Turkey

Imports & Exports – Morocco & Turkey



- Morocco
  - ↑ Qty of Exports & Imports
  - ↓ Prices of Export, ↑ Prices of Import
- Turkey
  - ↑ Qty of Exports & Imports
  - ↑ Prices of Export, ↓ Prices of Import

Conclusions

- Globally, the main conclusions of the analysis suggest that:
  - Trade liberalization induces partial offset of welfare loss;
  - Total offset occurs under 'unrealistic' tariff elimination scenarios (e.g. CCMULTI)
- At the regional level, and depending on the scope of the trade liberalization, we notice that:
  - Region with (+) projected yields benefit the most
  - Regions with (-) projected yields benefit marginally, but not under all scenarios

Conclusions

- Morocco
  - Net welfare losses
  - (+) net allocative efficiency contribution, but overshdowed by (-) contribution of the terms of trade and investment-savings effects
  - ↑exports, but ↓prices
  - ↑imports, with ↑prices, especially for crop and food commodities
- Turkey
  - Net welfare gains, but not big enough to offset initial loss
  - (+) net allocative efficiency and terms of trade effects drive most of the results;.
  - ↑exports qty, ↑exports prices
  - ↑imports, driven primarily by intermediate demand and low import prices

Comments & Remarks

Domestic markets

- For both countries
  - (-) climate shocks $\Longrightarrow$ ↓Domestic supply $\Longrightarrow$ ↑Domestic prices $\Longrightarrow$ ↓Private & Intermediate domestic demand, which shifts to increased demand for imports (despite ↑import prices)
  - Magnitudes larger for Morocco compared to Turkey
- For Morocco
  - (-) climate shocks + tariff elimination ('CCMULTI')

  $\Longrightarrow$ ↓Import prices $\Longrightarrow$ ↑Imports, displacing domestic output on domestic markets $\Longrightarrow$ ↑Exports, but with falling export prices (due to deflationary impacts of relatively cheap inflows of imports)
- For Turkey
  - (-) climate shocks + tariff elimination ('CCMULTI')

  $\Longrightarrow$ ↓Import prices $\Longrightarrow$ ↑Imports for **intermediate consumption**, displacing domestic output on domestic markets $\Longrightarrow$ ↑Exports, but with increasing export prices

Yield impacts – IFPRI Database

- IFPRI yield data assumed to incorporate both climate change effects (CC) and technology improvements (IPR) defined as follow:

$$(Eq.\,3) \qquad Y_{p+1} = Y_p\left(1 + CC_p + IPR_p\right)^5$$

- Thus, we can isolate the CC effects as:

$$(Eq.\,4) \qquad CC_p = \left\{\left[\left(\frac{Y_{p+1}}{Y_p}\right)^{1/5} - IPR_p\right] - 1\right\} \times 100$$

Yield impacts – IMAGE Database

- IMAGE yield data capture the effects of climate change and management factor

- The management factor (MF) the exogenous assumptions about potential technology-driven yield enhancement

- We isolate the CC effects as follows:

$$Y_t^{CC} = \frac{Y_t^{reported}}{MF_t} \qquad (Eq.\,6)$$

Yield Impacts – Final Database

IFPRI Database

- Regions (x114)
- Crops (x6)
- Macro scenarios (x3)
- SRES (x2) x GCMs (x2)

+

IMAGE Database

- Regions (x26)
- Crops (x11)
- SRES (x10)

→

Final Database

- Regions (x16)
- Crops (x7)
- SRES (x8)