

Group presentations

Applications of the GTAP-AEZ model



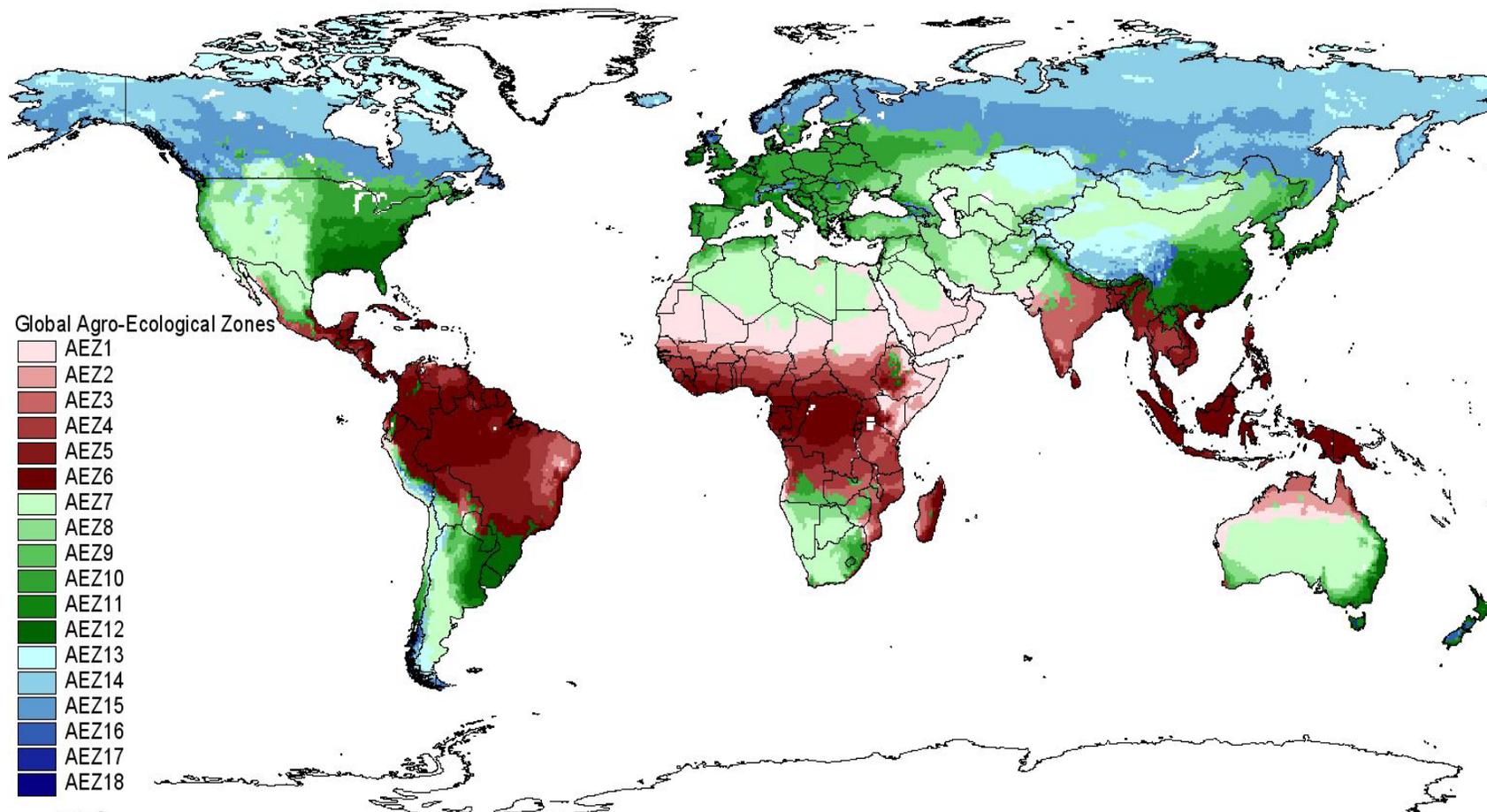
GTAP-AEZ Model

- **Standard GTAP model (Hertel 1997) plus key elements for the analysis of competition for land and related issues:**
 - **Heterogeneous land endowment**
 - **Agro-Ecological Zones (AEZ)**
 - **Land supply to land using activities within AEZ**
 - **Changes in crop yields**
 - **Intensive margin**
 - **Extensive margin**
 - **Emissions from land use change**

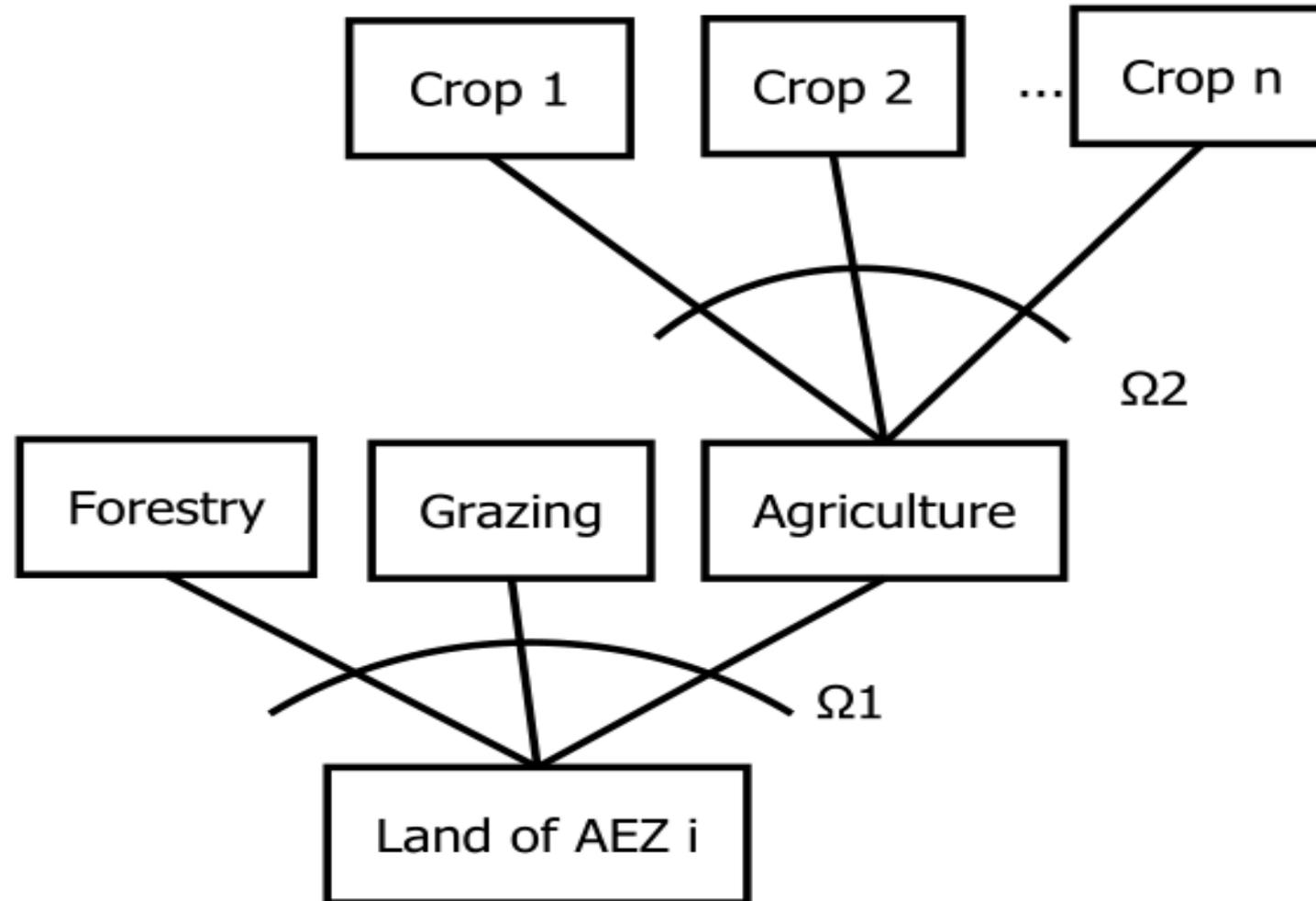
Heterogeneous Land: AEZs

- **18 Agro-Ecological Zones**
 - 6 growing periods (6 categories x 60 day intervals)
 - 3 climatic zones (tropical, temperate and boreal)
- **The competition for land within a given AEZ across uses is constrained to include activities that have been observed to take place in that AEZ**

Global Distribution of AEZs



Land Supply in the GTAP-AEZ Model



Application 1

Experiment motivation

- **Climate change is expected to decrease yields (on average) world wide**
 - In the absence of tech developments, what does this infer for land use change?
- **Does trade liberalization provide a ‘countervailing’ force**
 - What does it mean for de/re-forestation?

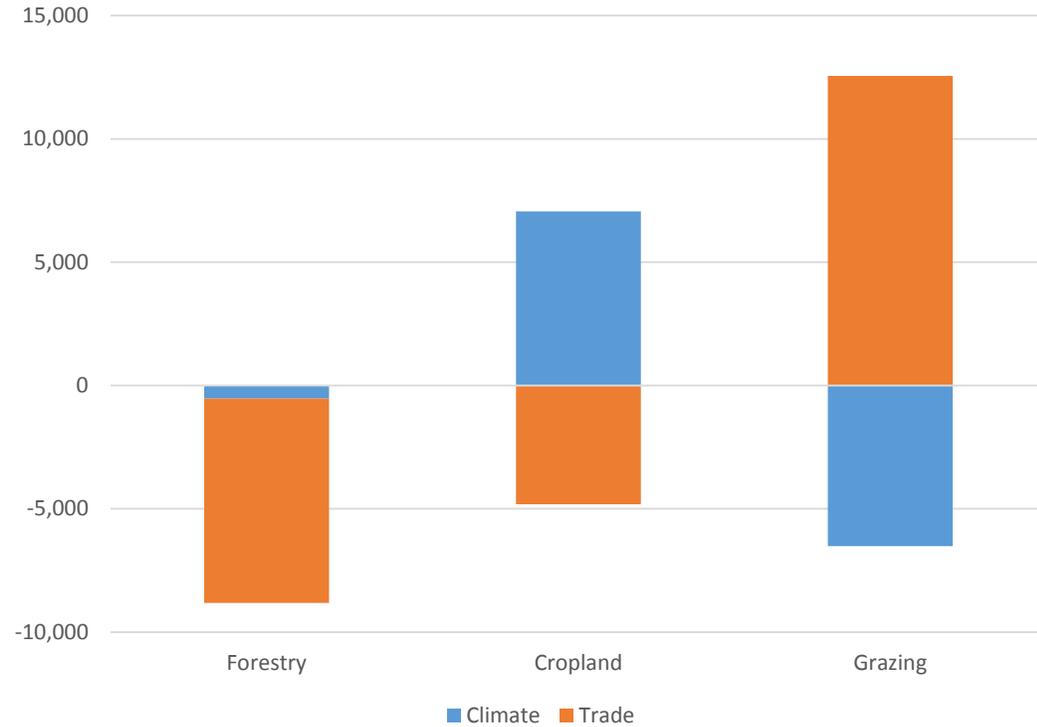
How was this implemented?

Two steps

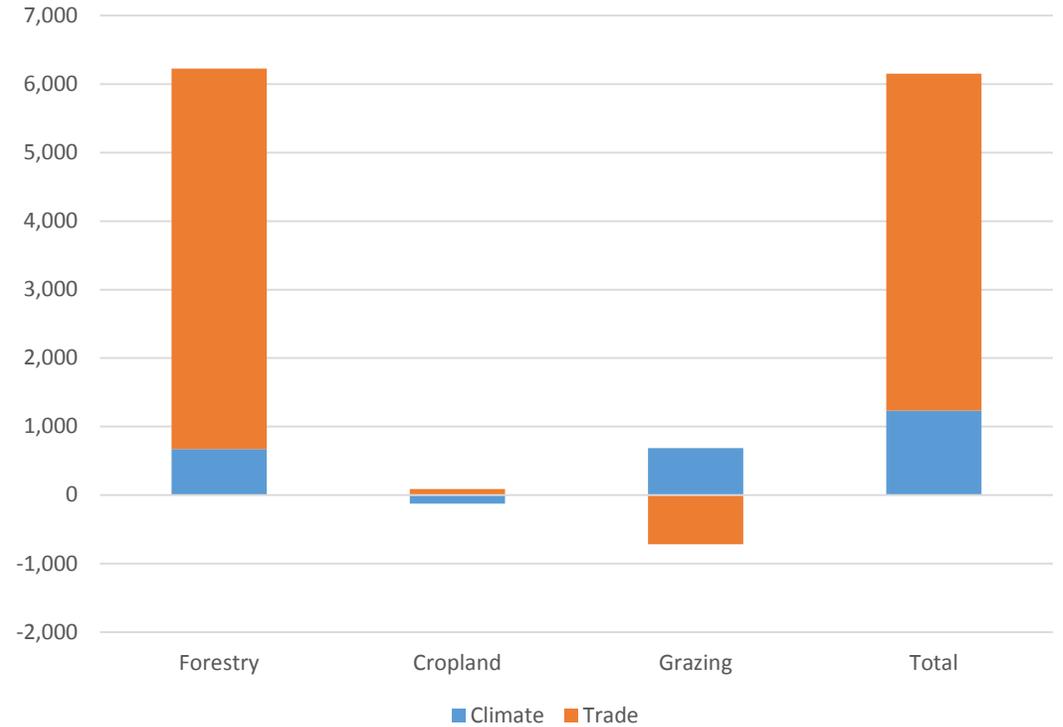
- **Yield changes explored as:**
 - What if today's crops grew in 2025's climate?
... infers a lower production per ha for a given set of inputs
... shock to productivity terms α_{all}
- **Estimates were taken from IFPRI differentiated by developed and developing countries**
 - Oilseed and wheat effects in developing less than developed, opposite rice and maize (other grains)
- **What about trade?**
 - Tariffs on agro-food products set to zero worldwide (tms)
 - Note: tariff levels are high relative to climate shocks

Starting at the end

Land use change (000s ha)



Emissions from land cover change (CO2 tons)



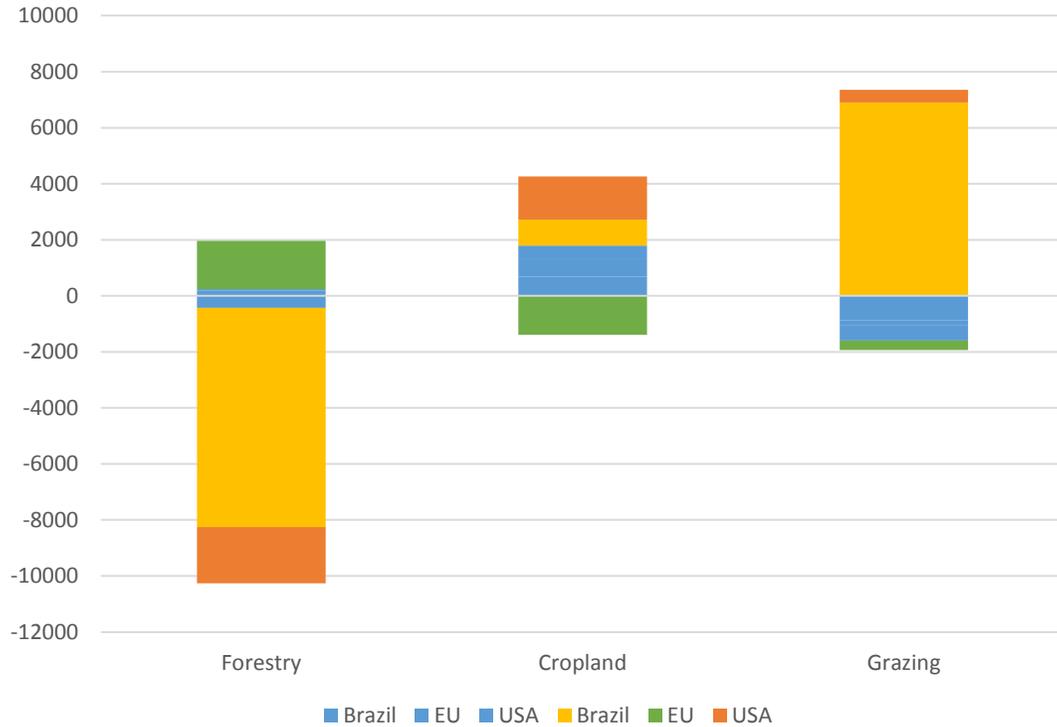
Closer look at Europe and the America's

Climate effects

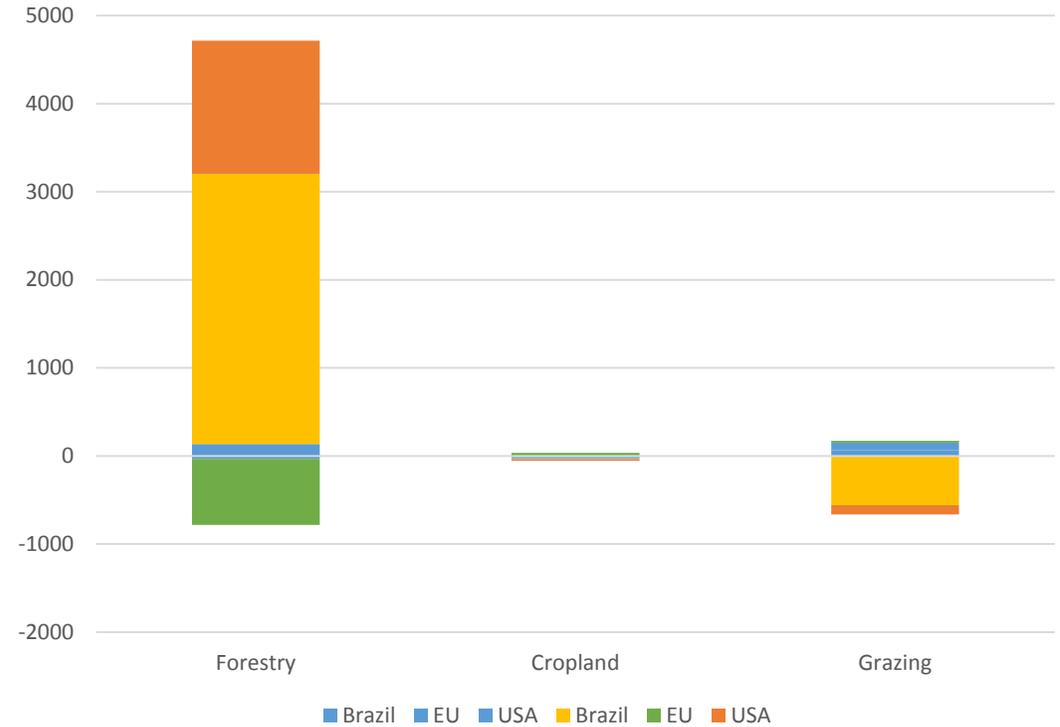
- **Demand inelastic for staples**
 - Prices for good rise – across agrofood, but fall for services and mnfcs
 - ... But change in quantity produced is generally smaller than the fall in productivity
 - Result due to shock to worldwide productivity
 - Land shifts out of forestry to agriculture as a result
- **With trade...**
 - Reduction in tariffs sees America's production increase, and a fall in Europe (existing high tariffs)
 - Brazil has a large increase in grazing production driven by domestic demand (from food sector which is exporter)
 - Agriculture sector expands increasing deforestation

Europe and the America's: land and emissions

Land use change (000s): deforestation



Emissions from land cover change (CO2 tons): increase!



The key drivers: Brazil re-enforcing influences

Brazil

- **Relative effects of climate effects on yield play to its strengths**
 - Oilseed and wheat sectors expand
 - Driven by additional exports at the expense of other developed country producers who face larger yield losses
- **Trade liberalization encourages trade growth for agro-food sector overall**
 - Large increase in livestock sector, plus expansion of crops
 - Drawing land out of forestry into agriculture

The key drivers: USA & EU – a tale of competing effects

USA

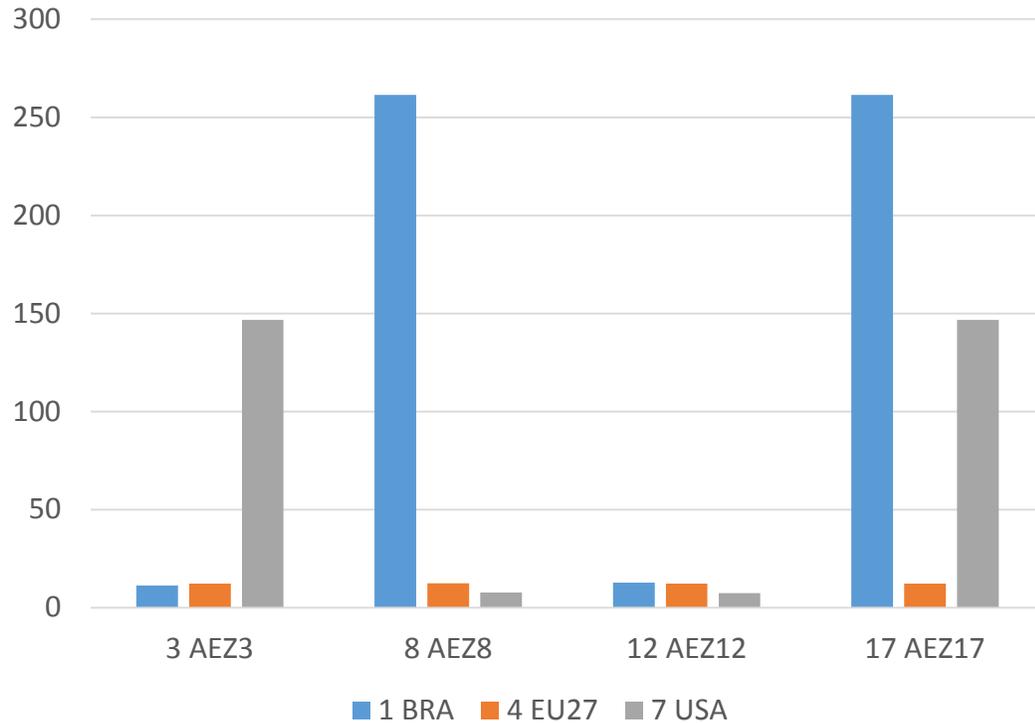
- **Climate induced effects**
 - Initial fall in crop production – relatively worse off due to productivity effects
 - Land shifts to forest sector
- **Trade induced effects**
 - Expansion in agriculture to increase world demand for US produce
 - Mainly wheat, maize, rice but also livestock sector
 - Land shifts out of forestry

EU-27

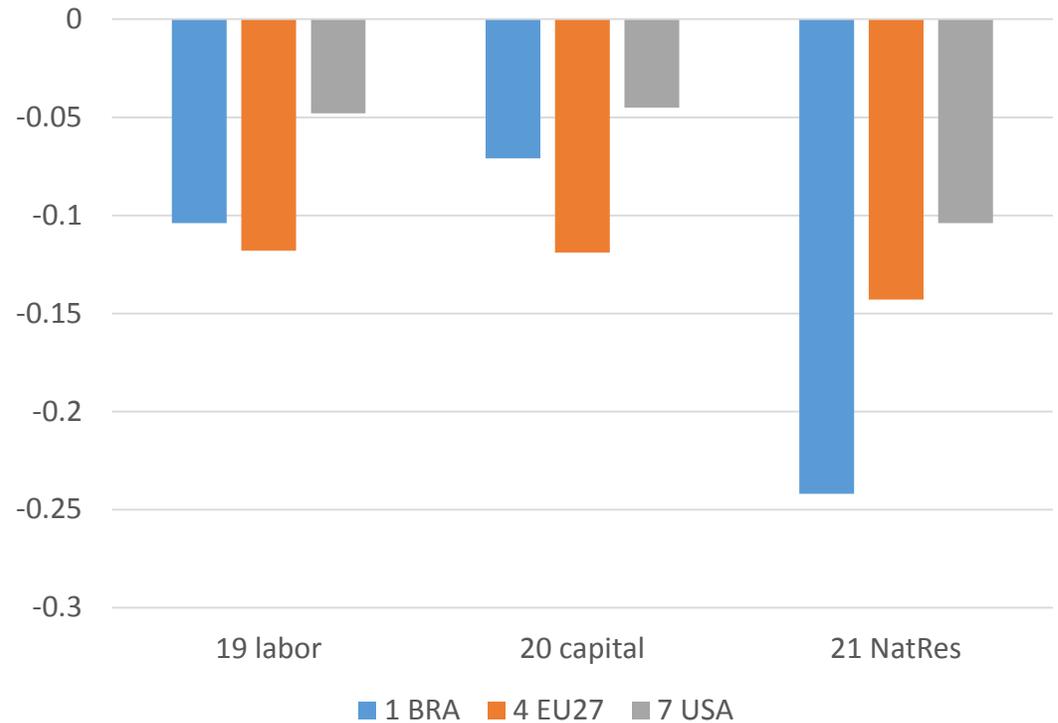
- **Climate effects see push towards crops and deforestation**
- **Trade liberalization works the other way – output in forestry expands and ag production falls due to removal of relatively large tariffs**
- **... But a shift in location forestry area expands greater than output change (%)**

Factor prices with climate effects: an illustration of scarcity [ps()]

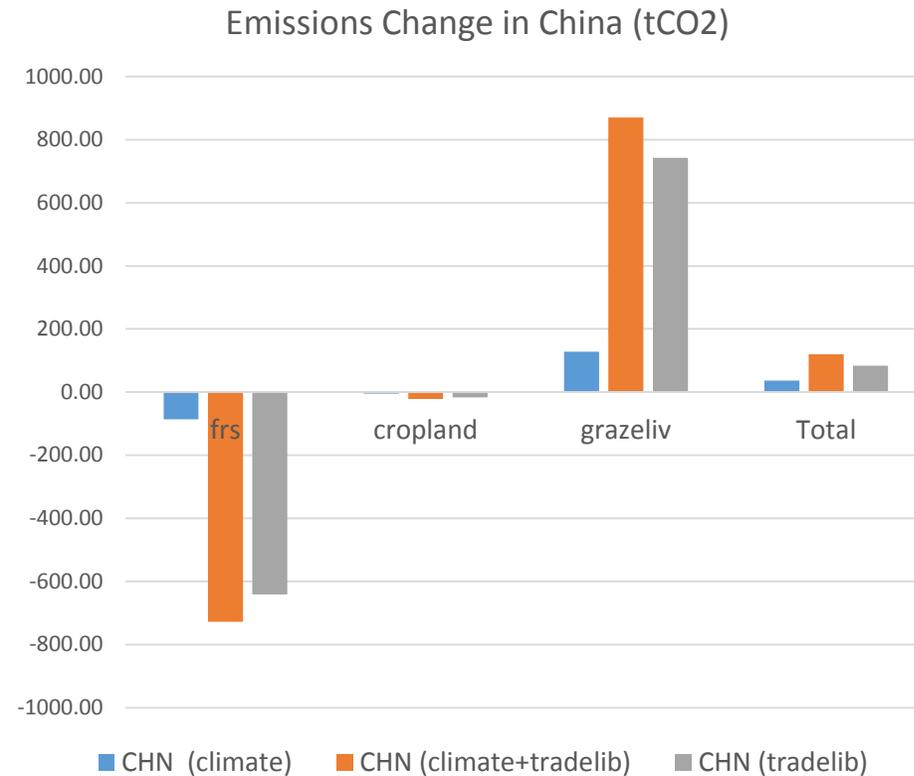
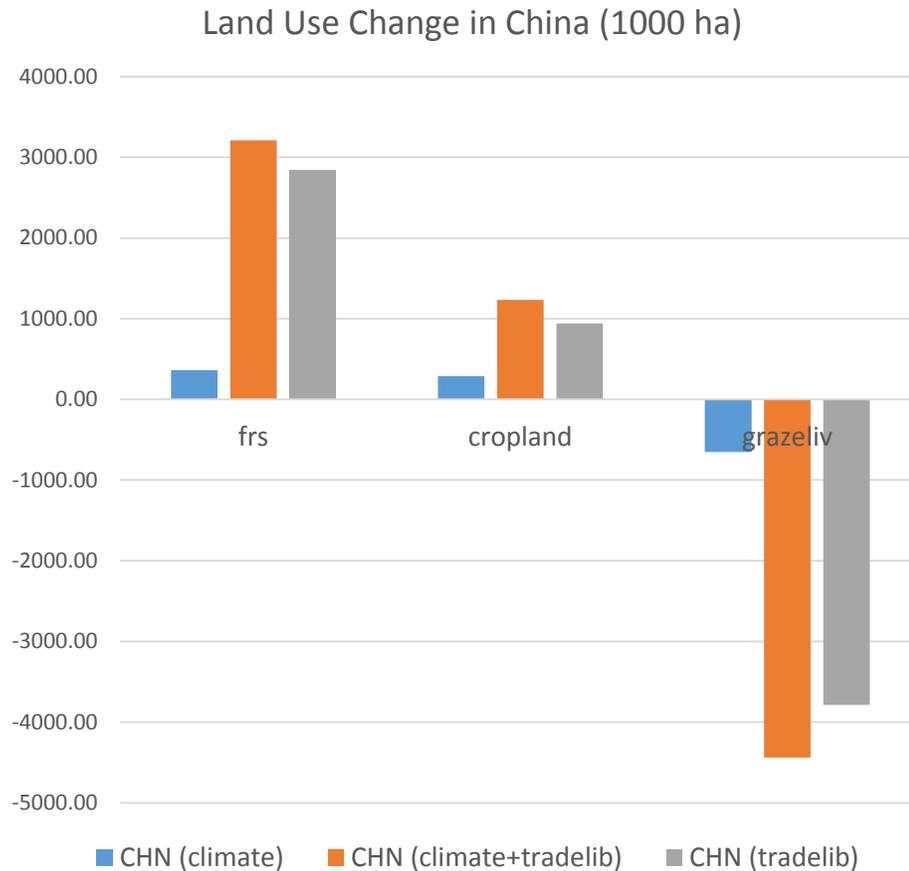
Land (selected zones)



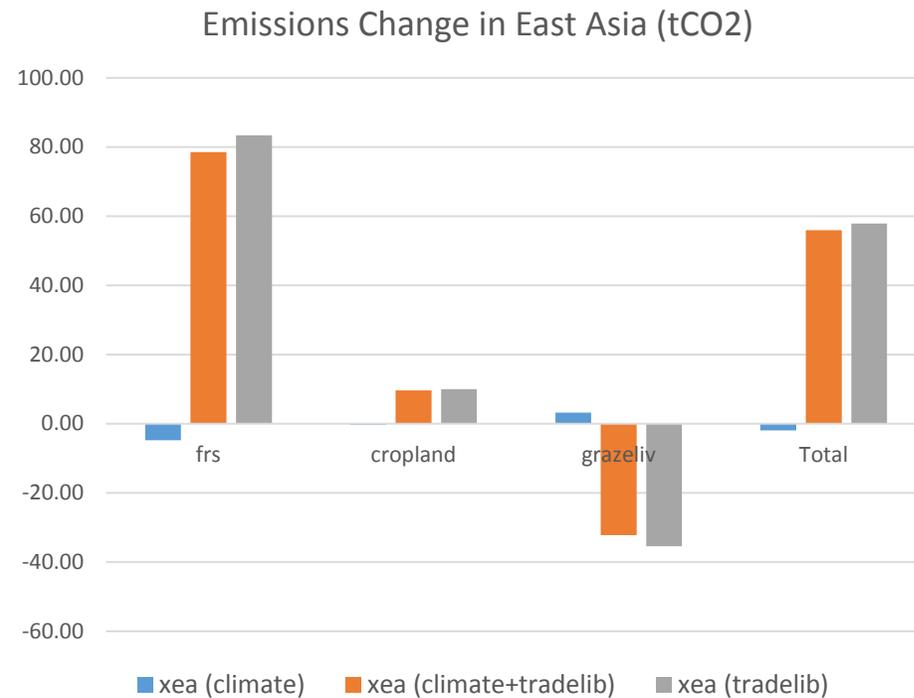
Other value added



Land Use and Emissions Change in China



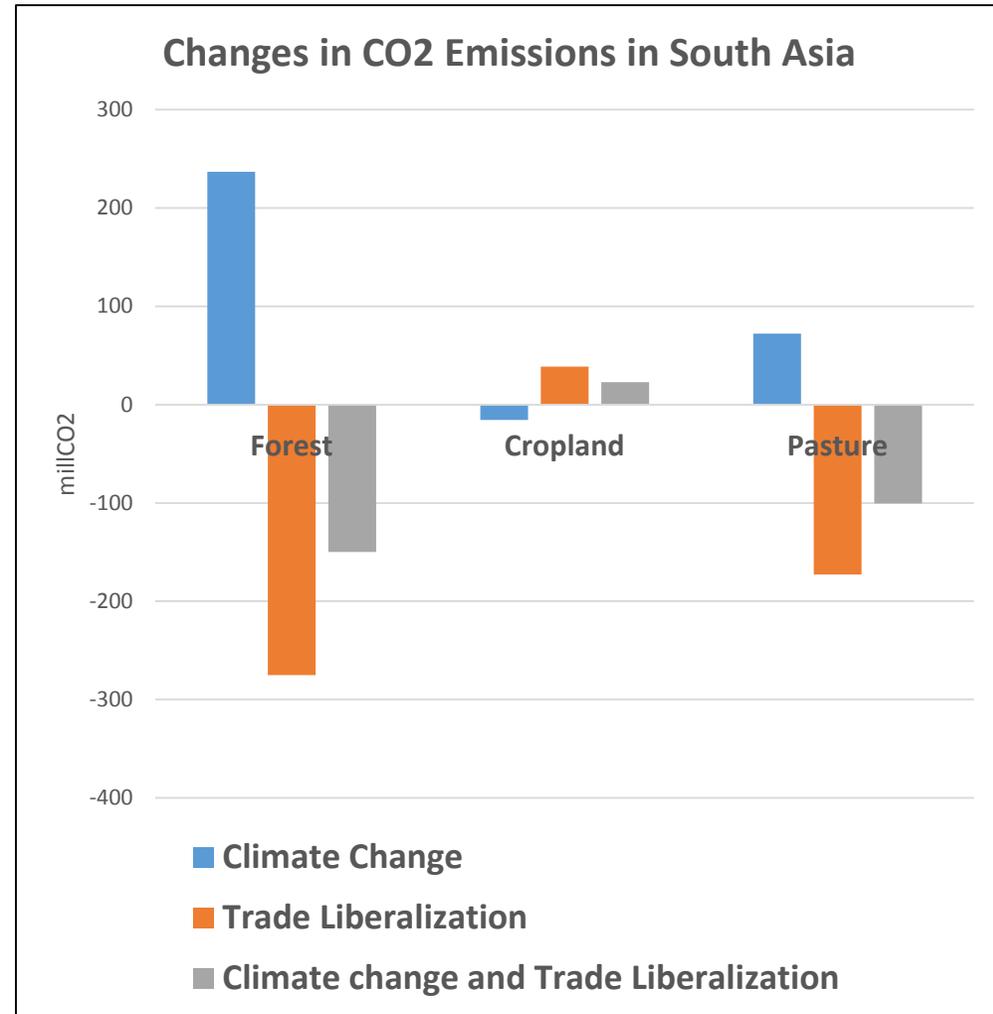
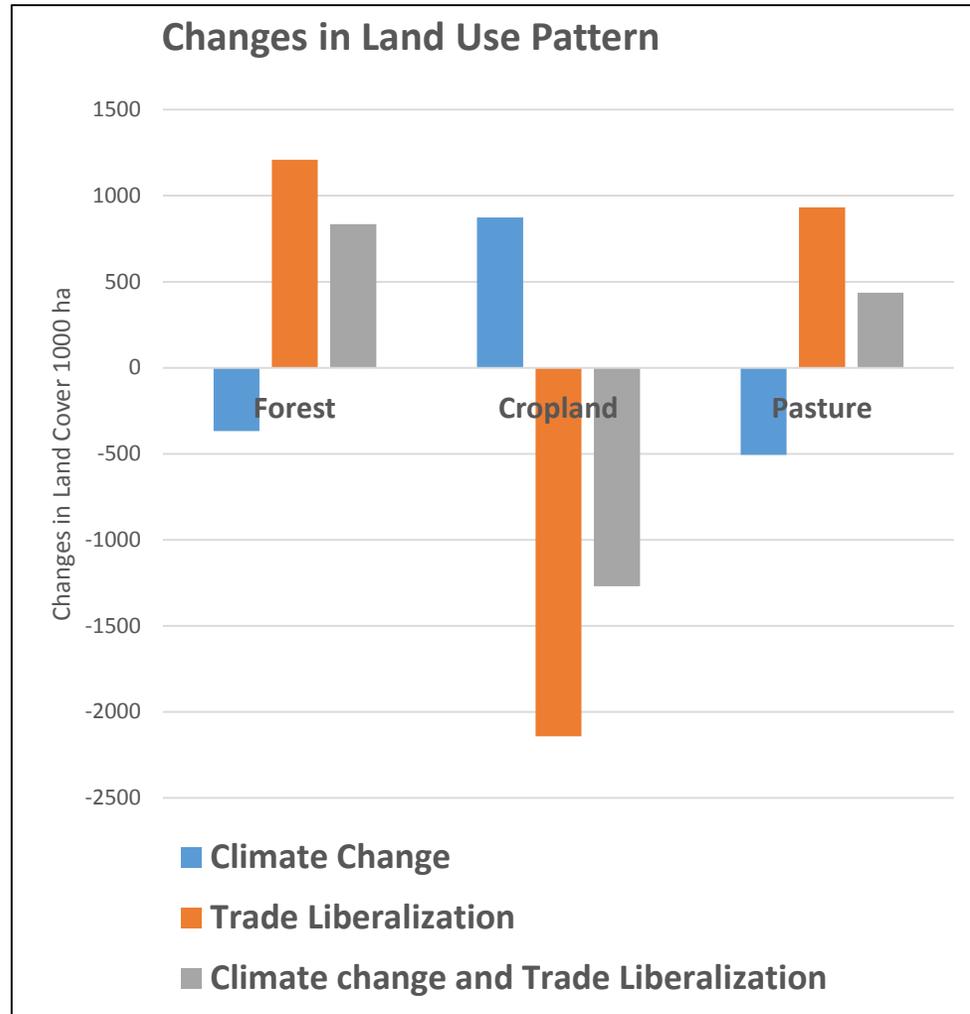
Land Use and Emissions Change in East Asia



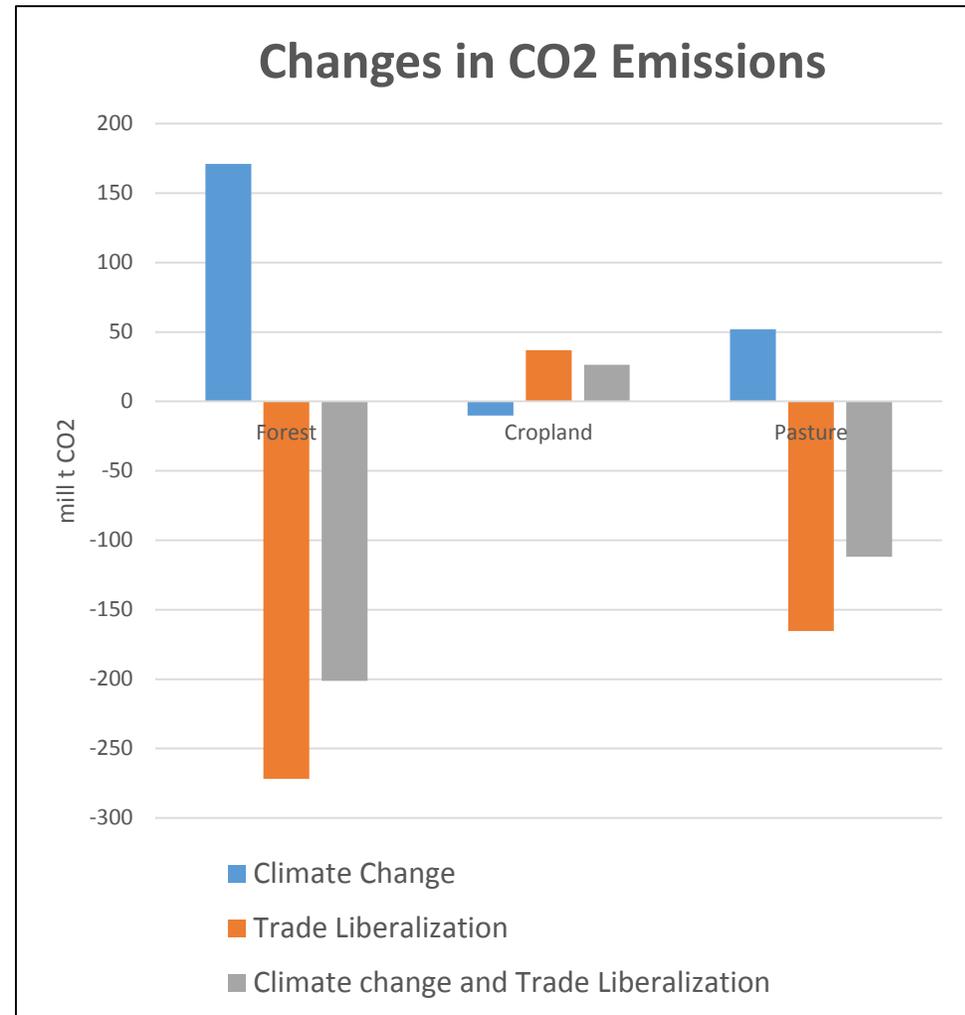
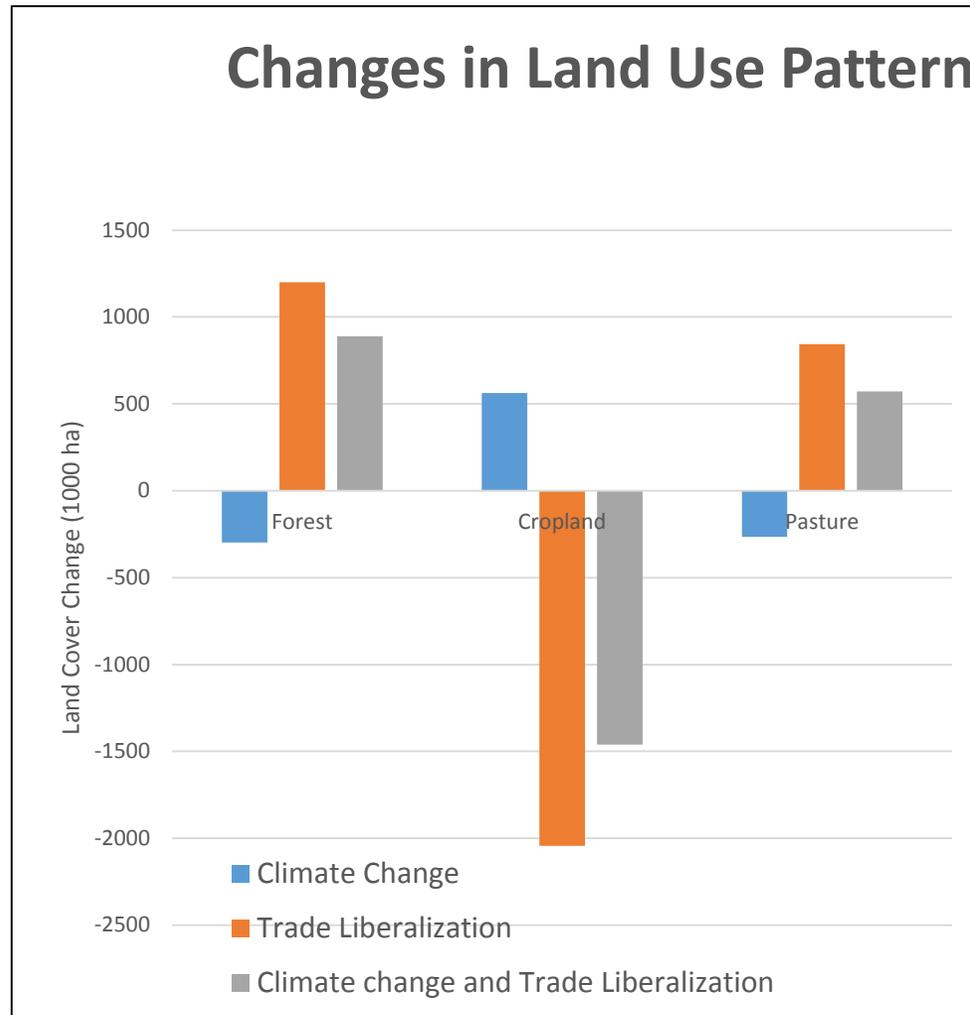
China and East Asia

- **Climate Change**
 - Helps reforestation and increase the use of cropland however, causes to decrease the use of pasture
 - Correspondingly, CO2 emissions decreases due to climate change
- **Trade Liberalization on AGROFOOD**
 - Dominates the productivity impacts by climate change
 - Leads to further reforestation both in China and East Asia
 - However, causes to increase in cropland in China yet decrease in East Asia.
 - On the other hand, helps expand pasture in East Asia and reduce pasture in China
- **Explanation on China's Forestry Expansion**
 - $qo(\text{forestry, China}) = -0.8\%$
 - $qfeland(\text{forestry, China}) = -0.8\%$
 - $p_LANDCOVER = 2\%$

Changes in Land Use Patterns and CO2 Emissions in South Asia



Changes in Land Use Patterns and CO2 Emissions in India



South Asia – Land Use Pattern

- **Climate change caused**
 - **Deforestation**
 - **Decrease in pasture lands**
 - **More land allocation for crop production**
- **Trade Liberalization in Agri-food industry caused**
 - **More land allocation for forestry and pasture and reduced land allocation for crop production.**
- **Net Effect**
 - **Dominates by India**
 - **Increased land use for forestry and pasture**
 - **Reduced land use for cropland**
 - **Dominates by trade liberalization effect in the agri-food sector**

Major driving factors of the Net Effect

- **Impact on output (qo) of agri-food sector**
 - Total = -4%
 - Vegetable oils and fats = -44.7
 - Oil seeds (shocked) = -17.5
 - Livestock production increases but very small (0.4)
- **Supply price in agri-food sector (ps)**
 - Total = -3%
 - Oil seeds (shocked) = -7.1
 - Price increased in paddy rice (2.2)

A note on forestry

- **Output of forestry has increased (1.55)**
 - **Forestry area is expanding**
 - **Increase in output is driven by both increases in domestic and export demands.**

South Asia – Changes in Emissions

- **Deforestation due to climate change has increased CO2 emissions.**
- **Net Effect is dominated by trade liberalization in Agri-Food sector.**

Application 2

Effects on Land Use

Based on improvements in technology in soybean production in Brazil

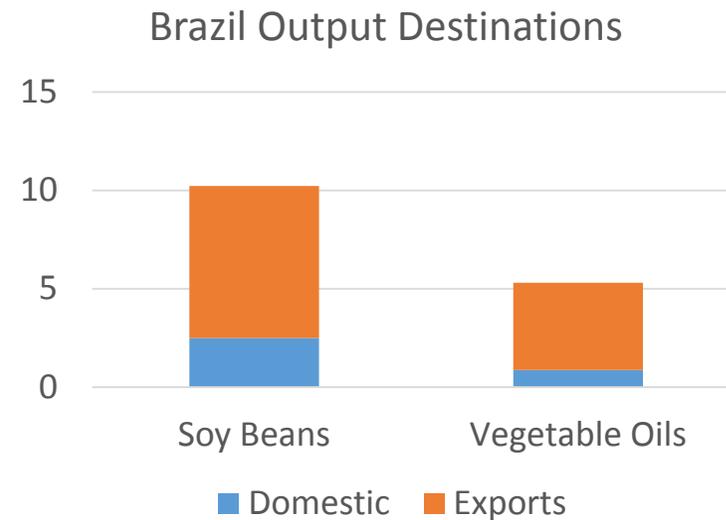
Experiment design

- ▶ Scenario 1: shock $aoall("osd", "BRA") = 6.38$;
 - ▶ Technological improvement in soybean production
 - ▶ Yearly tech/yield improvement improvement of 0.66% (Ludena, 2006)
 - ▶ Reduced final shock value to 85% based on ratio of soybeans in the "osd" aggregation
- ▶ Scenario 2: S1 + improved conversion ratio of forest/grazing land to cropland.
 - ▶ 0.66 Universal 2004 ratio updated to more recent and more accurate ratios.
 - ▶ Provide comparison of results of changes in land use

Impact of TFP improvement in Brazil and World markets

	Soy Beans (\$1)	Vegetable Oils (\$1)
Brazil Output	10.23	5.31
Brazil Supply Price	-5.36	-2.20
Brazil Exports	14.6	11.7
World Price	-0.93	-0.40
World Output	-0.081	0.053

*Brazil accounts for 24% of all world exports of Soybeans



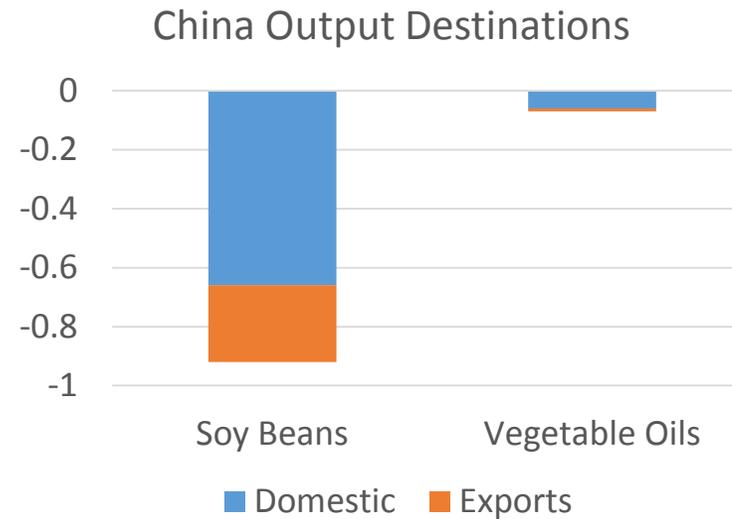
Changes in land cover (1,000 ha)

S1 Land cover type	Brazil	China	EU27	RoW	Global
Forests	-130.8 (-0.08%)	-31.2 (-0.02%)	52.6 (0.03%)	71.8 (0.004%)	-37.7 (-0.002%)
Cropland	281.2 (0.46%)	-13.0 (-0.02%)	-75.8 (-0.06%)	-488.8 (-0.032%)	-296.3 (-0.019%)
Pasture	-150.4 (-0.09%)	44.2 (0.03%)	23.2 (0.04%)	417.0 (0.015%)	334.0 (0.012%)

S2 Land cover type	Brazil	China	EU27	RoW	Global
Forests	-102.8 (-0.07%)	-31.2 (-0.02%)	52.6 (0.03%)	71.8 (0.004%)	-9.6 (-0.001%)
Cropland	202.0 (0.33%)	-13.0 (-0.02%)	-75.8 (-0.06%)	-488.8 (-0.032%)	-375.5 (-0.024%)
Pasture	-99.2 (-0.06%)	44.2 (0.03%)	23.2 (0.04%)	417.0 (0.015%)	385.2 (0.015%)

Impact of TFP improvement in Brazil on China

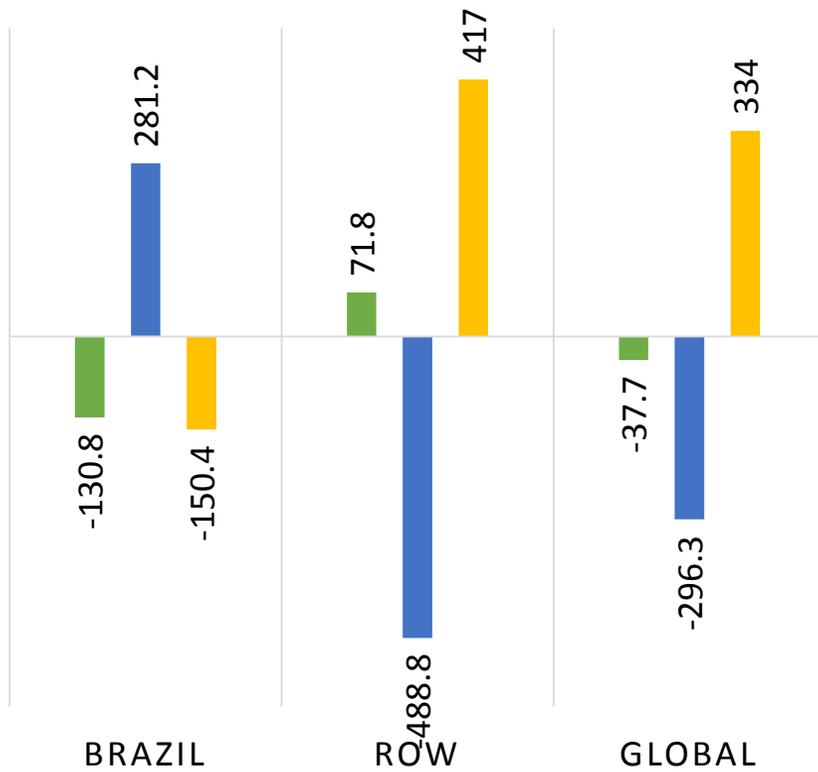
	Soy Beans (\$1)	Vegetable Oils (\$1)
China Output	-0.92	-0.07
China Supply Price	-0.36	-0.14
China Exports	-3.36	-0.81



Graphical comparison (1000 ha)

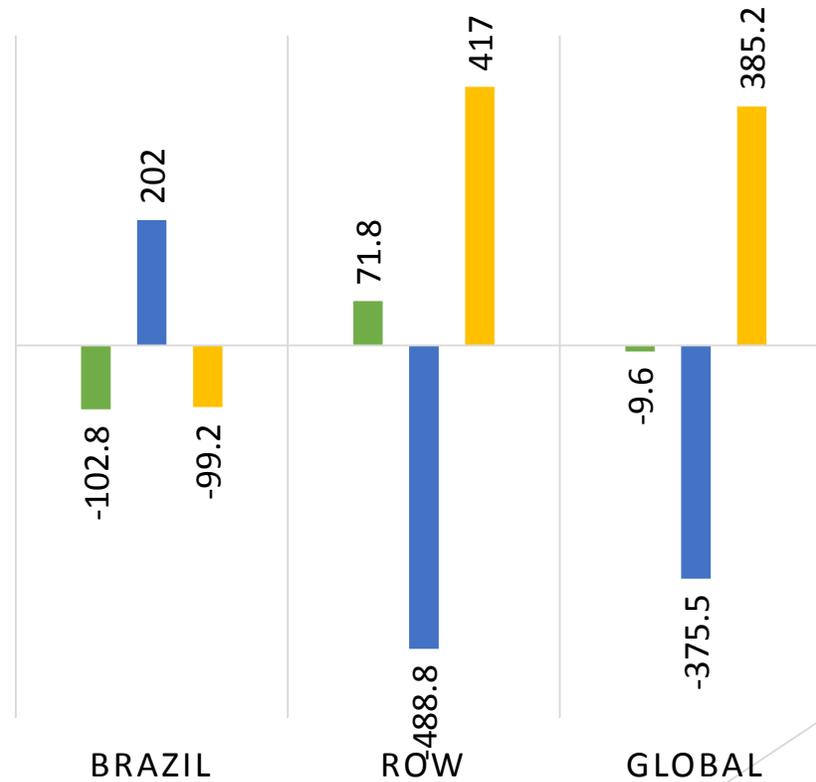
LAND COVERAGE CHANGE (S1)

■ Forests ■ Cropland ■ Pasture



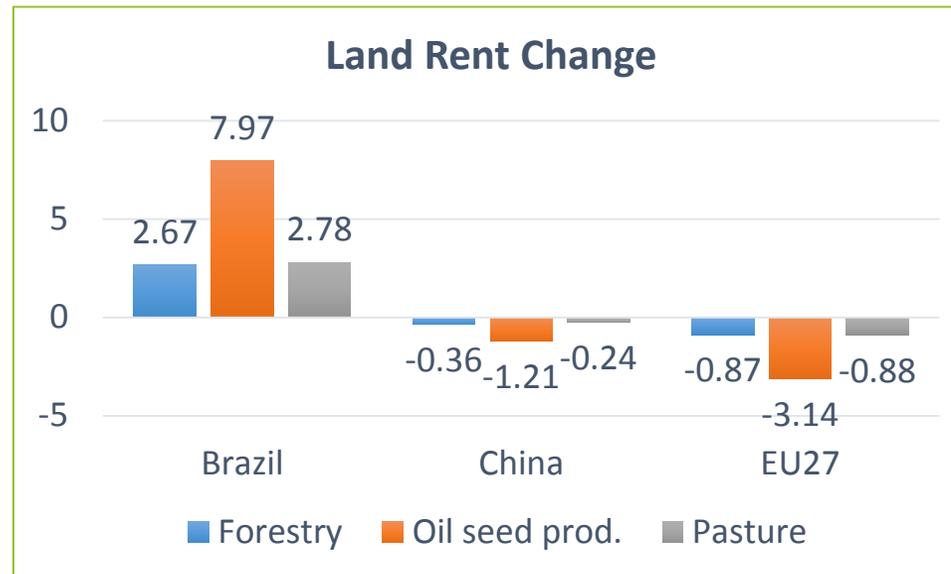
LAND COVERAGE CHANGE (S2)

■ Forests ■ Cropland ■ Pasture



Land rent change (%)

S1 Item	Brazil	China	EU27
Forestry	2.67	-0.36	-0.87
Oil seed prod.	7.97	-1.21	-3.14
Pasture	2.78	-0.24	-0.88



Emissions change from land cover change (Million Co2 tons)

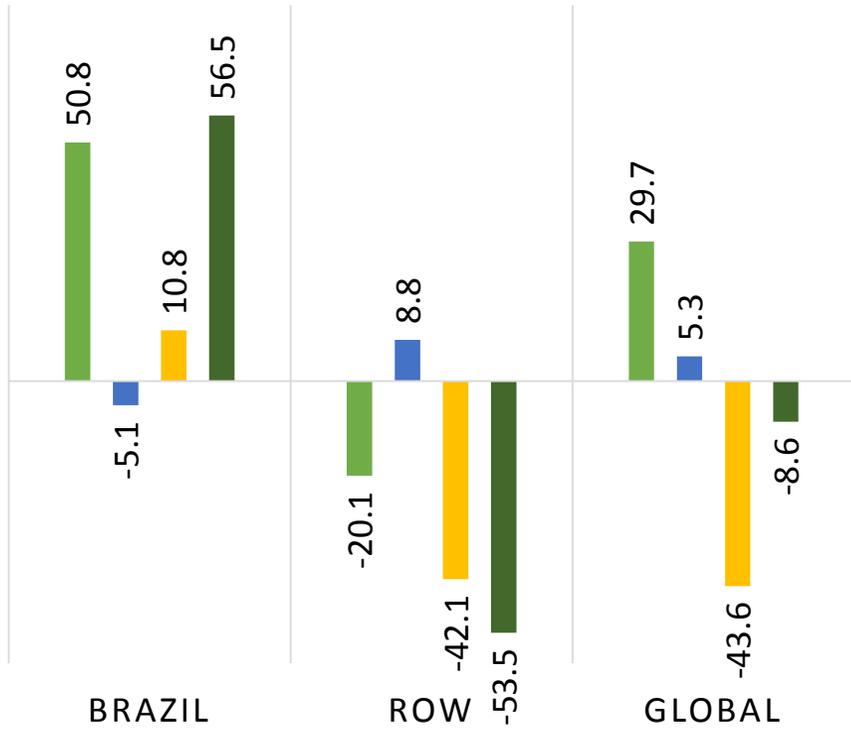
S1 Land cover type	Brazil	China	EU27	RoW	Global
Forests	50.8	17.9	-18.9	-20.1	29.7
Cropland	-5.1	0.2	1.4	8.8	5.3
Pasture	10.8	-8.7	-3.6	-42.1	-43.6
Total	56.5	9.5	-21.2	-53.5	-8.6

S2 Land cover type	Brazil	China	EU27	RoW	Global
Forests	39.9	17.9	-18.9	-20.1	18.8
Cropland	-3.6	0.2	1.4	8.8	6.8
Pasture	7.1	-8.7	-3.6	-42.1	-47.3
Total	43.4	9.5	-21.2	-53.5	-21.7

Graphical comparison (mill tonnes)

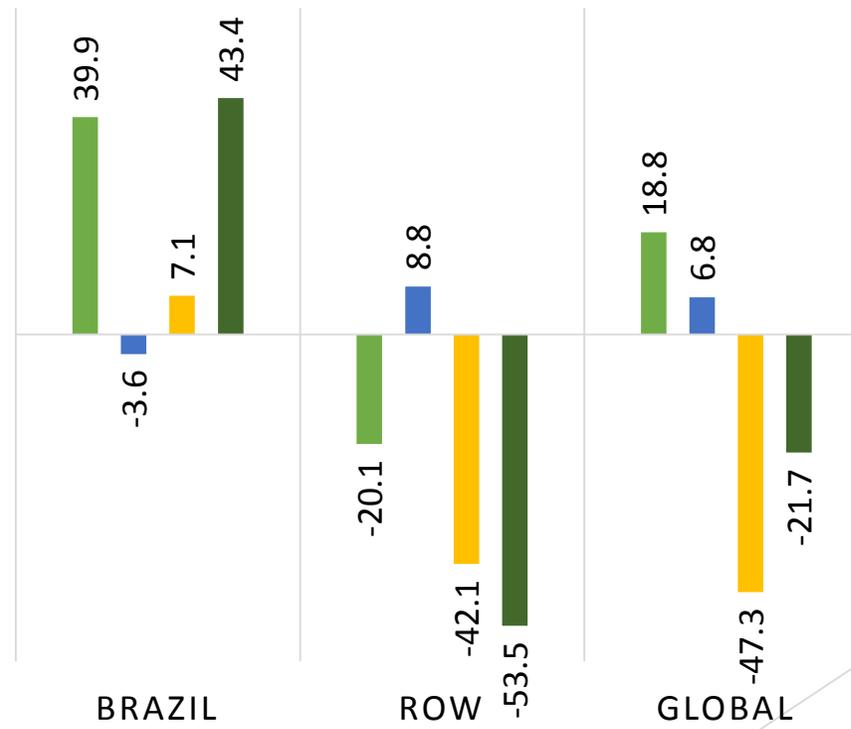
CHANGE IN CO2 EMISSIONS (S1)

■ Forests ■ Cropland ■ Pasture ■ Total



CHANGE IN CO2 EMISSIONS (S2)

■ Forests ■ Cropland ■ Pasture ■ Total



Final thoughts

Concluding comments

- **Deforestation has a regional element**
 - After liberalization, we see reforestation in East and South Asia, but further deforestation in the Americas
- **Points to significant contribution of technical advancement in reducing future deforestation**
 - And adapting to climate change
- **One market impacts are not sufficient to cope with carbon reduction...need global efforts**
- **Cost effective ways for land conversion would help reduce carbon emissions related to cropland expansion**