CLIMATE CHANGE, AGRICULTURE AND TRADE LIBERALIZATION: A DYNAMIC CGE ANALYSIS FOR TURKEY

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Plan

- Motivation & Aim
- Model Structure: Climate, Crop, CGE
- Scenarios
  - Climate Change
  - Trade Liberalization
- Results
  - Welfare
  - Prices
  - Trade
  - Production
- Conclusion
Motivation

- Climate change is expected to have a significant impact through
  - Increasing mean temperature
  - Decreasing precipitation
  - Prolonged Growing-degree days
    - hotter and drier summers
    - milder and drier winters
- Increasing frequency of hydrological extremes:
  - more drought years: Higher variations
  - Less ice and frost days
- Impacts on crops: Yields ↓, irrigation requirements ↑
Aim

• Can trade policy be used to alleviate the effects of climate change?
• To what extent?
• For which activities?
• Winners? Lossers?
• What is the mechanism?
Modeling Approach

- GHG Emissions → Climate Change
  - Temperature Change
  - Precipitation Change

- Water Stress → Water Supply
  - Irrigation Requirement
  - Yield Change

- Agricultural Production

- Rest of the economy

- CLIMATE MODEL
- CROP MODEL
- CGE MODEL

References:
- Dalés et al., 2008
- Dudu and Cakmak, 2012
Climate Model

• Precipitation and mean temperature data for 81 NUTS3 Regions for the period 2001-2099 is obtained from “Climate Change Scenarios for Turkey” project (gaia.itu.edu.tr)
• Missing data are completed from different sources
Crop Hydrology Model

- Following Allen et al. (1998) [CropWAT]
- Min/max temperature spread, climatic constants, crop constants and coefficients, soil constants, sunlight data follows from Allen et al. (1998)
- First calculate the monthly reference evapotranspiration ($ET_0$) for each year and city
- Then actual ET is calculated
- Yield and irrigation water requirement is calculated from crop water stress determined by the difference between ET and $ET_0$
- Results are aggregated according to the CGE sectors
# CGE Model

- **Walrasian** CGE model
- **19 activities** producing 19 commodities:
  - Wheat
  - Rice
  - Oil seeds
  - Dairy
  - Oth. agr. activities
  - Other manuf.
  - Maize
  - Other cereals
  - Sugar beet
  - Meat
  - Food production
  - Private serv.
  - Oth. field crops
  - Fruits
  - Vegetables
  - Oth. livestock
  - Textiles
  - Public serv.

- **Factors:**
  - Nest 1: Labor, Capital, Rainfed land, Land-water comp.or industrial water
  - Nest 2: Irrigated land, Irrigation water composite
CGE Model

- I/O table is edited with *a priori information*
- **Subsidies** are updated acc. to from OECD data
- **ROW** account is **disaggregated** to five trading partners
  - EU - Other Europe
  - MENA - Rest of the World
  - North America
- **Tariffs** are updated according to GTAP data
- **One type** of HH with **endogenous labor** supply
- Households **consume only** food, dairy, meat, rice, vegetables and fruits and non-agricultural commodities
- Balanced closure
Dynamics

- **Recursive update** of sectoral capital stock, population and TFP
- **Capital** is accumulation: investment – depreciation
- Accumulated capital is **distributed** according to the return on capital in the **sectors**
- Population growth: **constant**; affects subsistence consumption and labor force
- TFP growth: **exogenous**; increase in shift parameter of CES
Scenarios

• Baseline
  • 2008 – 2099
  • 0.9% population growth
  • Labor force grows slowly, by responding to changes in real wage

• 3 Periods
  • 2008-2035
  • 2036-2060
  • 2060-2099
Baseline

- TFP Growth: 0.8% in agriculture, 1.06% in industry, 0.4% in services
- Capital/output ratio: 4.2
- Depreciation rate: 3%.
- Natural resource growth: 25% of capital growth
Baseline

- Factor growth paths:
  - Irr. water and land deviates significantly
  - Complementarity is important
  - Higher deviation in the second and last period
Climate Change Scenario

- Average yield and irrigation water requirement shocks at national level for crop production activities

<table>
<thead>
<tr>
<th></th>
<th>Irr. Wat. Req.</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P1</td>
<td>P2</td>
</tr>
<tr>
<td>Wheat</td>
<td>-3.30</td>
<td>-3.92</td>
</tr>
<tr>
<td>Maize</td>
<td>-3.30</td>
<td>-1.52</td>
</tr>
<tr>
<td>Oilseeds</td>
<td>-5.46</td>
<td>-6.62</td>
</tr>
<tr>
<td>Oth. Cereals</td>
<td>-6.92</td>
<td>-3.01</td>
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<tr>
<td>Fruit</td>
<td>-1.76</td>
<td>2.98</td>
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<tr>
<td>Vegetable</td>
<td>-4.44</td>
<td>1.09</td>
</tr>
<tr>
<td>Oth. Fld. Crp.</td>
<td>-7.10</td>
<td>-3.61</td>
</tr>
</tbody>
</table>
Trade Liberalization

• Unilateral tariff elimination of Turkey on imports from EU
  • EU is the most important trade partner of Turkey (25% to 50% share in agri-food imports)
• Results are presented as deviation from the CC scenario
Change in EV

- EV starts to **decline** in **P2**, falls **significantly** in the **P3** period
- **Difference** between CC and TL are **small**
- However, TL effects **increase** as CC worsens
Change in GDP

- Effect on GDP is relatively **small** in the **first two** periods
- Mostly + in **P1**, mostly – in **P3**
- Deterioration become **significant** in the **last period** (-1 to -3)
- Other macro indicators follow the same path
- Difference between TL & CC is **small** but **increases** over time.
Decomposition of GDP Change

- **Main driver** of change in GDP is **consumption**
- Exports increase, imports decline
- Capital accumulation slows down
- Effects are more amplified in P3
Decomposition of GDP (w.r.t CC scenario)

- The difference is small, but contribution of
  - consumption increases
  - Imports decline (~ imports increase)
  - Exports remains same
  - Investment (~capital accum.) increases
Domestic price (w.r.t CC scen.)

- Domestic **prices decline** in all sectors **except**:
  - Sugarbeet
  - Vegetables: low protection
  - Meat: low trade volume
  - Oth. Agriculture: low protection
- Change in maize, oilseeds, field crops, fruits and livestock is **low**
- Changes **get higher** as CC effects increase
Imports

- Wheat, dairy, cereals and food imports increase
- Manufacturing imports increase significantly. It is the main driver
- Agricultural imports increase more as CC worsen
Imports from EU

- Increase in imports from EU is high:
  - Wheat, Oth. Cereals, Fruits, dairy, meat, food
  - Oil seeds, livestock, Other agri., and non agri. commodities
- proportional to the amount of protection
- Other cereals: low trade volume in base
Imports from Other Regions

- Imports from other trading regions decline
  - Rice, Cereals, Food, Wheat
- MENA trade is not affected much.
- Imports from Oth. Europe and ROW are down
Exports

• Maize, oilseeds: significant increase (declining domestic prices)
  • Cost structure makes those sectors uncompetitive in factor markets compared to other agri. activities
• Wheat, rice, cereals (declining production)
• Manuf. exports decline (increasing domestic prices)
Production

- Wheat, rice, cereals & dairy production declines
- Maize and oilseed production increase

Main driver is substitution of imports with domestic products, as import prices decline.
Conclusion

- Main drivers of the loss in GDP are significant decline in private consumption and up to 2 percent increase in total imports
- Tariff elimination alleviates the negative effects of climate change only marginally for Turkey
- Wheat, rice and cereals are most affected from TL as their yields decline under CC
- Maize, oilseeds, fruits and processed food benefit from trade liberalization
- Significant trade diversion effect