Regional Impacts of Climate Change and Trade Policies

Mathias Kirchner and Erwin Schmid
Agriculture and climate change

- Higher temperatures
  - Longer vegetation and growth period
  - Higher evapotranspiration rates

- CO$_2$ fertilization effect

- Changes in precipitation pattern (extreme events) → Crucial in arid and semi-arid areas (e.g. Marchfeld), but difficult to predict
  - Water balance
  - Soil erosion

Sources: Olesen et al. (2011); Strauss et al. (2012); Thaler et al. (2012) …
Agriculture and trade

- 1990ies → NAFTA, URAA
- Production shifts from North to South

- Generally expected impacts:
  - ‘North’ (e.g. Austria) \((p \downarrow)\)
    - Extensification and land abandonment in marginal areas
    - Intensification in productive areas
  - ‘South’ \((p \uparrow)\)
    - Expansion of agricultural land → deforestation (GHG emissions, loss of biodiversity)

Sources: Verburg et al. (2009); Schmitz et al. (2012); Briner et al. (2012) …
Case study
Marchfeld, Austria

- Not many studies assess the combined effects of trade and climate change
  → Case study for the Marchfeld region in Austria

- Intensive agricultural production area → Trade
- Semi-arid climate → Climate Change

- Special environmental concerns since the 70ies:
  - Groundwater pollution with nitrates
  - Groundwater scarcity due to large scale irrigation
Integrated modeling framework

- **CropRota**: Agronomic model (Schönhart et al., 2012)
  - i.e.: optimal crop rotations

- **ACLiReM**: Statistical climate model (Strauss et al., 2012)
  - i.e.: daily weather data

- **EPIC**: Biophysical process model
  - i.e.: crop yields, N & P cycles, SOC

- **Land Use**: Economic optimization model
  - i.e.: production choices

- **Climate Change Scenarios**: i.e.: precipitation

- **Trade Policy Scenarios**: i.e.: tariffs, domestic support policies

**Sustainability indicators**
- Regional producer Surplus
- Nitrogen losses
- Water use for irrigation
- …
## Reference and global change scenarios

<table>
<thead>
<tr>
<th>Climate Change</th>
<th>ClimPast</th>
<th>ClimA</th>
<th>ClimB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>Observed</td>
<td>+1.5°C</td>
<td>+1.5°C</td>
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<tr>
<td>Precipitation sums</td>
<td>Observed</td>
<td>No change</td>
<td>-20%</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Trade Policies</th>
<th>BAU</th>
<th>Partial</th>
<th>Full</th>
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</thead>
<tbody>
<tr>
<td>Domestic tariffs</td>
<td>Ø 1998-2011</td>
<td>-45%</td>
<td>-100%</td>
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<tr>
<td>Agri-environmental payments</td>
<td>ÖPUL 2007</td>
<td>ÖPUL 2007</td>
<td>-100%</td>
</tr>
<tr>
<td>Single farm payment</td>
<td>Observed</td>
<td>-50%</td>
<td>-100%</td>
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</table>
Scenario results
Shares of fertilization systems
Scenario results
Shares of irrigation systems

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Irrigation option</th>
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<tbody>
<tr>
<td></td>
<td>irrigated</td>
</tr>
<tr>
<td></td>
<td>rainfed</td>
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<tbody>
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<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>20%</td>
<td>0%</td>
<td>0%</td>
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Mathias Kirchner and Erwin Schmid
Institute for Sustainable Economic Development & Doctoral School Sustainable Development, BOKU
Scenario results
Regional producer surplus (RPS)
Scenario results
Total nitrogen losses

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>kg/ha a-1</th>
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</thead>
<tbody>
<tr>
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<td>80</td>
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<tr>
<td>Partial</td>
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<td>Full</td>
<td>100</td>
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<tr>
<td>ClimA</td>
<td>110</td>
</tr>
<tr>
<td>ClimB</td>
<td>120</td>
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<tr>
<td>ClimA + Partial</td>
<td>130</td>
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<tr>
<td>ClimA + Full</td>
<td>140</td>
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<tr>
<td>ClimB + Partial</td>
<td>150</td>
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<tr>
<td>ClimB + Full</td>
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</table>

Scenario Category:
- Reference
- Trade
- Climate
- Combined
Scenario results
Water use for irrigation

Scenarios

<table>
<thead>
<tr>
<th>Scenario Category</th>
<th>Reference</th>
<th>Trade</th>
<th>Climate</th>
<th>Combined</th>
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</thead>
<tbody>
<tr>
<td>max. sustainable water use = groundwater recharge rate minus</td>
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<tr>
<td>Industry (17 Mill. m³)</td>
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<tr>
<td>Municipalities (5 Mill. m³)</td>
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<tr>
<td>Subsurface net losses (14 Mill. m³)</td>
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<tr>
<td>only an approximation!</td>
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max. sustainable water use = groundwater recharge rate minus

see www.marchfeldkanal.at
Summary of the results

- **Trade impacts**
  - If partial → income losses, less irrigation
  - If *laissez-faire* → Intensification → **More fertilization** → Higher N loads

- **Climate change impacts**
  - Higher temperatures → **More irrigation**
  - + Drought → Unsustainable water withdrawals likely

- **Combined effects:**
  - Losses in income either amplified (ClimB+Trade) or mitigated (ClimA+Trade)
  - Water withdrawals **decrease** if trade added to CC (but not much)
Policy implications

- Need for sustainable regional water policies, e.g.:
  - water pricing, or
  - subsidies for more efficient irrigation systems (drip irrigation)

- Trade liberalisation / CAP post 2013
  - ensure that agri-environmental schemes persist as trade friendly support measures

- Importance to take into account both effects
  - Impacts may be amplified or reduced
Outlook

- Apply modelling framework to Austria
  → include *marginal areas*

- Include soil conservation measures
  → *reduce soil erosion*

- Account for uncertainty (e.g. prices, weather)

- More indicators, e.g.:
  - GHG emissions
  - Biodiversity …
Thank you!

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References

Cited:


Other:
