Impacts of climate change for Swiss winter and summer tourism: a general equilibrium analysis

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Switzerland particularly affected by climate change
What adaptation strategies should be developed?

→ Need to understand economic impacts of climate change

Research project funded by the Swiss Federal Office for the Environment

• Report *Assessing the impacts of climate change for Switzerland* (Vöhringer et al., 2017)
• Database: http://swidchi.epfl.ch/
Why the tourism industry?

- Appreciable share of the economy, specially in some cantons: about 30% of employment and GDP in Graubünden
- Highly exposed:
  - Winter tourism affected by snowfall decrease, glacier melting
  - Summer tourism influenced by temperature and precipitation
- Adaptation capacity: artificial snowmaking, alpine summer tourism
- Winter tourism could gain from international effects: 83 million CHF in 2050 (Faust et al., 2012)

**Aim** Investigate the international effects of climate change on winter and summer tourism in Switzerland
Methodological steps

Climate scenarios (A1B and RCP3PD)

Temperature data

Snow data

Summer tourism flow (HTM model)

Swow valuation (Gonseth, 2013)

CGE simulation (GEMINI-E3)
GEMINI-E3 model characteristics

- Multi-sectoral, multi-regional Computable General Equilibrium

- Regional classification:
  - Switzerland (CHE)
  - European Union (EU)
  - United States of America (USA)
  - Other OCDE countries (OECD)
  - Brazil, Russia, India, China (BRIC)
  - Rest of the World (ROW)

- Industrial classification:
  1. Coal
  2. Oil
  3. Natural Gas
  4. Petroleum Products
  5. Electricity
  6. Public Heat Supply
  7. Grain Soys
  8. Other Crops
  9. Animal
  10. Forestry
  11. Industry
  12. Transport nec
  13. Sea Transport
  14. Air Transport
  15. Insurance
  16. Health
  17. Other Services
  18. Winter Overnight Tourism
  19. One-Day Winter Tourism
  20. Other Forms of Tourism
  21. Water
Tourism sectors: description

- Creation of a tourism sector disaggregated in:
  - Winter Overnight Tourism (WOT): overnight stays skiers
  - One-Day Winter Tourism (ODT): one-day skiers
  - Other Forms of Tourism (OFT): mainly summer tourism
- Two winter tourism sectors because their vulnerability differs:
  - One-day skiers go in lower altitude ski areas: near city centers
  - Overnight skiers go in higher altitude ski areas
Structure of household consumption

Total Consumption $\sigma_{hc}$

- Agriculture
- Housing
- Other
- Transport
- Tourism $\sigma_{htour}$
  - Snow dependent tourism $\sigma_{htsnow}$
    - Overnight $\sigma_{htreg}$
      - USA
      - CHE
      - EU
      - …
      - ROW
  - Other tourism $\sigma_{htreg}$
    - USA
    - CHE
    - EU
    - …
    - ROW

Boris Thurm (LEUrE, EPFL)
Winter tourism production function

Tourism

Snow
  - Natural
  - Artificial

Other factors
  - Capital
  - Material
  - Labor
  - Energy

Natural
  - Capital
  - Electricity

Artificial
  - Water
  - Labor

Capital
  - Raw
  - Drinking
Tourism production

- Substitution between natural and artificial snow
  - More difficult to produce artificial snow at lower altitude ski resorts
- Substitution between snow and other factors:
  - Investment to improve in ski area preparation and maintenance
  - Investment to modernize transport facilities
- Elasticities of substitution:

<table>
<thead>
<tr>
<th>Factor</th>
<th>Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snow and other factors</td>
<td>$\sigma$</td>
</tr>
<tr>
<td>Natural and artificial snow (WOT)</td>
<td>$\sigma_s$</td>
</tr>
<tr>
<td>Natural and artificial snow (ODT)</td>
<td>$\sigma_s$</td>
</tr>
<tr>
<td>Among inputs used to produce artificial snow</td>
<td>$\sigma_{as}$</td>
</tr>
<tr>
<td>Industrial and drinking water</td>
<td>$\sigma_w$</td>
</tr>
</tbody>
</table>
Climate Scenarios

- A1B: non-intervention scenario
- RCP3PD: ambitious climate mitigation
Natural snow resource

- Decrease in natural snow resource impacts winter tourism sector
- Snow resource from climate variable \textit{Fractional Snow Cover}
- Snow cover variation for Switzerland in 2060 w.r.t. 2010:

\begin{itemize}
  \item Natural snow resource economic value from Gonseth (2013)
\end{itemize}
# Results

- Natural snow → Production price → Consumption
- But higher ski resorts benefit from international gains
- Indeed Swiss ski-resorts located at higher altitude than EU, so less impacted by climate change
- Limited welfare gain: between 0% and 0.03%
- Vulnerability increases, specially for lower-altitude resorts

<table>
<thead>
<tr>
<th>Snowmaking</th>
<th>Winter overnight tourism</th>
<th>Oneday winter tourism</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RCP3PD</td>
<td>A1B</td>
</tr>
<tr>
<td>Snowmaking</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Natural Snow</td>
<td>-2.0%</td>
<td>-12.5%</td>
</tr>
<tr>
<td>Artificial Snow</td>
<td>1.4%</td>
<td>10.5%</td>
</tr>
<tr>
<td>Producer Price</td>
<td>0.2%</td>
<td>1.6%</td>
</tr>
<tr>
<td>Consumption</td>
<td>-0.2%</td>
<td>-1.2%</td>
</tr>
<tr>
<td>Exports</td>
<td>0.2%</td>
<td>2.3%</td>
</tr>
<tr>
<td>Imports</td>
<td>-0.4%</td>
<td>-3.7%</td>
</tr>
<tr>
<td>Production</td>
<td>0.03%</td>
<td>0.6%</td>
</tr>
</tbody>
</table>
Tourism flows

- Temperature changes affect countries’ attractiveness
- Reallocation of tourism flows calculated using HTM model (Hamilton et al., 2005)
- $\uparrow$ temperature $\Rightarrow$ $\downarrow$ international tourism flows
- Cold countries become more attractive
Results

- Swiss domestic tourism more than compensate ↓ arrivals
- ↑ production
- Moderate welfare gain: between 0.08% and 0.16%
- Development of summer tourism in cold alpine regions?

<table>
<thead>
<tr>
<th></th>
<th>RCP3PD</th>
<th>A1B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Departures</td>
<td>-6.0%</td>
<td>-12.0%</td>
</tr>
<tr>
<td>Arrivals</td>
<td>-0.7%</td>
<td>-1.6%</td>
</tr>
<tr>
<td>Consumption</td>
<td>0.1%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Production</td>
<td>1.4%</td>
<td>3.0%</td>
</tr>
<tr>
<td>Welfare</td>
<td>0.08%</td>
<td>0.16%</td>
</tr>
</tbody>
</table>
Conclusion

- Impacts on tourism using two climate variables: snow and temperature
- International effects translate into moderate welfare gain
- Contrasted regional situation
  - Lower-altitude ski resorts more vulnerable
  - Higher-altitude ski resorts have a comparative advantage
- Stronger effect on summer tourism: adaptation capacity of alpine resorts
- Some caveats:
  - Decrease in natural snow only increases production cost but preparation of ski slopes might be impossible
  - Fractional snow cover tells nothing about snow quality: people’s willingness to ski could decrease
  - People could get used to higher temperature: summer tourism flow more robust

