Weather extremes and fiscal risk management

Reinhard Mechler, Thomas Schinko, Junko Mochizuki, Stefan Hochrainer-Stigler (IIASA)

Brussels, 27.9.2016
Adaptation problem
Budgetary implications of flooding (Austria)

Schinko et al., 2016
Adaptation problem
Total and insured flood losses on the rise (EU28)

Climate scenario: SRES A1B scenario (high emissions)

Jongman et al., 2014
## Balance sheet problem

<table>
<thead>
<tr>
<th>Liabilities</th>
<th>Direct: Obligation in any event</th>
<th>Contingent: Obligation if a particular event occurs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Explicit</strong></td>
<td>Foreign and domestic sovereign borrowing, expenditures by budget law and budget expenditures</td>
<td>State guarantees for non-sovereign borrowing and public and private sector entities, <strong>reconstruction of public infrastructure</strong></td>
</tr>
<tr>
<td>Government liability recognized by law or Contract</td>
<td>Future recurrent costs of public investment projects, pension and health care expenditure</td>
<td>Default of subnational government or public or private entities, <strong>disaster relief</strong></td>
</tr>
<tr>
<td><strong>Implicit</strong></td>
<td>A ‘moral’ obligation of the government</td>
<td></td>
</tr>
</tbody>
</table>

Mechler and Hochrainer-Stigler, 2014
Iterative climate risk management framework for adaptation

Watkiss et al., 2012

ECTONADAPT
The Economics of Adaptation

PACINAS
Public Adaptation to Climate Change

Funded by the European Union
Questions

• What are the levels of contingent liability due to future climate extremes (flooding in particular) and their primary drivers for EU member countries?

• How do they compare to other risks and liabilities?

• How to design an iterative climate risk management approach?
Methodological entry points

- IPCC, Working Group II, 2014

“Iterative risk management is a useful framework for decision-making in complex situations characterized by large potential consequences, persistent uncertainties, long timeframes, potential for learning, and multiple climatic and non-climatic influences changing over time”

“Economic thinking on adaptation has evolved from a focus on cost benefit analysis and identification of “best economic” adaptations to the development of multi-metric evaluations including the risk and uncertainty dimensions in order to provide support to decision makers.”
Three methodological suggestions

• Stochastic debt assessment
• Fiscal risk scorecard
• Co-generating an iterative policy process
Stochastic debt evaluation
Austria case
CATSIM: simulating and risk stress testing

**Loss Distribution**

- Probability of Exceedance
- Lower Confidence Interval
- Upper Confidence Interval
- Best Estimate

**Fiscal Resilience**

*Ex Post:*
- Diversion from budget
- Foreign reserves
- Domestic bonds and credit
- Multilateral borrowing
- International borrowing
- Aid

*Ex Ante:*
- Reserve funds
- Sovereign insurance
- Catastrophe bonds

**Fiscal Vulnerability**
Stochastic Debt Evaluation

Baseline GDP and Demographic Trajectories
Based on SSP1, SSP2, SSP3, SSP4, SSP5
(Cobb-Douglas Function of Age/Education Disaggregated Labor)

Other Baseline Macro Economic Projections

Baseline GDP and demographic trajectories (IIASA SSPs)
Other baseline macro projections
Stochastic shocks of macro and climate variables
Macro outcomes: e.g. debt accumulation due to climate risks

\[ d_t = a^n d_{t-1} \left( \frac{1+i_t}{1+g_t} + \alpha f d_{t-1} \left( \frac{1+i_t}{1+g_t e_t} - \frac{1+i_{t-1}}{1+g_{t-1} e_{t-1}} \right) \right) + J_t \]

Contingent Liability due to climate extremes

Mochizuki, 2015
Results-Austria

Baseline and stochastic debt trajectories for Austria under SSP2 scenario up to 2030
5th to 95th percentiles
Climate change extreme risk

- Annual average loss (AAL) 2015
- AAL projected for 2050 (relative to the size of projected government expenditure),
- Current availability of catastrophe reserve fund and budgetary allocation
- Historical observations of average insured losses
- Availability of other budgetary mechanisms
Fiscal Risk Scorecard

• Underlying fiscal pressures
• Macroeconomic & fiscal variability
• Climate change extreme risk (DRM Fiscal Resilience)
Indicators: Underlying fiscal pressures

- Current debt-to-GDP,
- Primary balance needed to stabilize debt at 60% in year 2030 (also known as the S1 indicator),
- Projected increase in fiscal burden due to demography-related costs (ageing, health, longer-term care, education),
- Projected changes in the fiscal burden as a result of climate change mitigation.
Indicators: macroeconomic and fiscal variability

- Growth adjusted interest rate
- Semi-budget elasticity parameters (response of budgetary expense and revenue to a percentage change in output)
# Fiscal Risk Scorecard

## Results EU

<table>
<thead>
<tr>
<th>Country</th>
<th>Underlying Fiscal Pressure</th>
<th>Variability</th>
<th>Climate Change Extreme</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Debt/GDP</td>
<td>SS Indicator</td>
<td>Ageing Cost</td>
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<tr>
<td>Belgium</td>
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<td>Bulgaria</td>
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<td>Czech Republic</td>
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**ECONADAPT**

The Economics of Adaptation

[Logo: Funded by the European Union]

[Logo: PACINAS]

Public Adaptation to Climate Change
# Fiscal Risk Scorecard Results EU

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<thead>
<tr>
<th>Country</th>
<th>Debt/GDP</th>
<th>SS Indicator</th>
<th>Ageing Cost</th>
<th>Climate Change Mitigation</th>
<th>Growth adjusted interest rate</th>
<th>Semi-elasticity parameter</th>
<th>AAI 2015 Relative to public expenditure</th>
<th>AAI 2030 Relative to public expenditure</th>
<th>AAI 2050 Relative to public expenditure</th>
<th>Reserve fund/budget item</th>
<th>Average insured losses</th>
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<td>Lithuania</td>
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Results

- Economic risk from climate extremes (relative to the size of economic and public finance resources) high in some countries such as Hungary, Slovenia, Latvia, Lithuania and Slovakia.
- Countries also with some need for fiscal consolidation in the medium to long-term: proactive fiscal risk management especially important.
- Many EU member states still in the stages of designing and implementing climate change adaptation strategies.
- Ample opportunities to consider iterative risk management processes, where state-of-the-art scientific information on risk (hazard, exposure and vulnerability) is mainstreamed into economic and fiscal decision-making.
Towards iterative climate risk management

- In Austria current management of extremes the entry point - climate increment not clarified
- How to co-design an inclusive process to manage contingent climate-related disaster risks in light of dynamic risk processes and others stressors?
Iterative climate risk management applied to Austria

Schinko et al., 2016

Transforming

Reframing

Reacting

(4) Implementation

Building blocks
- Risk prevention
- Risk financing
- Risk budgeting

(1) Monitoring

- Climate signal
- Hazards
- Loss database
- Instruments

(2) Climate risk analysis

Climate risk modeling:
New normal - new hazard & socio-economic thresholds

(3) Evaluation

Fiscal stress testing according to risk layers

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Projection of flood risks and catastrophe fund reserves

Losses (bn Euros 2015)

2015 2030 2050

AAL disaster fund deposits

Schinko et al., 2016
Iterative Climate Risk Management
Today's and future risk layers

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Schinko et al., 2016
Austria process

• Inclusive process with national-level institutions
  – Water and flood-risk authorities
  – EPA
  – Ministries of Finance, Environment and Interior Affairs

• Finance Ministry plans to build on analysis for qualitative 5 year budget projections of climate related risks
Beyond Austria: identifying risks, negotiating responsibilities
Next

- Evidence of risk layering at multiple levels
- Understanding usefulness of scorecard approach
- Concretise budget planning in Austria and EU
References


Iterative climate risk management
Dealing with risk and uncertainty

<table>
<thead>
<tr>
<th>Probabilities</th>
<th>Consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Known</td>
<td>Known</td>
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<tr>
<td>Unknown</td>
<td>Risk (short-term)</td>
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<td></td>
<td>Uncertainty</td>
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<td></td>
<td>Ignorance (deep uncertainty)</td>
</tr>
</tbody>
</table>

Schinko et al., 2016
Criteria and indicators

Percentile thresholds for each indicator
[1st Quartile: Green, 2nd: Yellow, 3rd: Orange, 4th: Red]

- Debt/GDP (%) [43, 72, 92, 177]
- S1 Indicator [1.1, 2.1, 3.3, 6.2]
- Increase in ageing related expenditure (% of GDP) [1.4, 4.1, 6.8, 12.6]
- Increase in climate mitigation cost (% of GDP) [0.02, 0.1, 0.2, 1]
- Growth adjusted interested rate (%) [17, 22, 37, 85]
- Budget semi-elasticity [0.44, 0.52, 0.56, 0.65]
- 100 year flood in 2015 relative to public expenditure (%) [0.4, 0.8, 2.4, 6]
- 100 year flood in 2030 relative to public expenditure (%) [0.3, 0.7, 3.7, 11]
- 100 year flood in 2050 relative to public expenditure (%) [0.3, 0.7, 7.4, 19]
- Reserve fund or budget item relative to AAL (%) [160, 360, 209, 660]
- Average insured damage (%) [2.6, 10.4, 24.8, 69]
Stochastic Debt Evaluation

\[ d_t = a^nd_{t-1} \frac{1 + i_t}{1 + g_t} + a^f d_{t-1} \frac{1 + i_t e_t}{1 + g_t e_{t-1}} - b_t + c_t + J_t + f_t \]

- \( d_t \): Debt to GDP ratio in year \( t \)
- \( a^n \): Share of total debt denominated in national currency
- \( a^f \): Share of total debt denominated in foreign currency
- \( i_t \): Nominal implicit interest rate at year \( t \)
- \( g_t \): Nominal GDP growth rate at year \( t \)
- \( e_t \): Nominal exchange rate at year \( t \)
- \( b_t \): Structural primary balance over GDP in year \( t \)
- \( c_t \): Change in age-related costs over GDP in year \( t \) relative to base year
- \( J_t \): Reconstruction needs due to disasters over GDP.
- \( f_t \): Stock flow adjustment over GDP in year \( t \)
Data and Baseline assumptions used in this study

<table>
<thead>
<tr>
<th>Item</th>
<th>Descriptions</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline GDP Growth</td>
<td>Production function approach using age and education disaggregated labors (SSP2)</td>
<td>Cuaresma (2015)</td>
</tr>
<tr>
<td>Baseline Population Growth</td>
<td>Projected population (SSP)</td>
<td>Samir and Lutz (2014)</td>
</tr>
<tr>
<td>Baseline long-run interest</td>
<td>Assumed to converge to 3% in T+10</td>
<td>European Commission (2014b)</td>
</tr>
<tr>
<td>Baseline GDP deflator</td>
<td>Assumed to converge to 2% in T+5</td>
<td>European Commission 2014b</td>
</tr>
<tr>
<td>Average maturity of debt</td>
<td>Assumed to be 8 years</td>
<td>EUROSTAT¹</td>
</tr>
<tr>
<td>Semi-elasticity parameter of budget balance</td>
<td>Assumed to remain constant at 0.58.</td>
<td>Mourre et al. (2014)</td>
</tr>
<tr>
<td>Historical macroeconomic variables</td>
<td>Quarterly data on GDP growth, interest rates, and price indices</td>
<td>EUROSTAT</td>
</tr>
<tr>
<td>Historical observations of flood losses</td>
<td>Quarterly data on insured and uninsured losses</td>
<td>NatCat Service data²</td>
</tr>
<tr>
<td>Forecasted flood risk</td>
<td>Estimated based on A1B for illustration</td>
<td>Schinko et al. forthcoming</td>
</tr>
<tr>
<td>DRM policy parameters</td>
<td>Sources and allocation of disaster fund</td>
<td>Schinko et al. forthcoming</td>
</tr>
</tbody>
</table>

¹ http://ec.europa.eu/eurostat.
Results-Austria

Mean estimates of probability of disaster fund depletion with annual DRR investment of 50 million Euro and 100 million Euro across 1000 scenarios.