Climate physical risk, transition spillovers, and fiscal stability: an application to Barbados

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Introduction

The situation of Barbados

- Exposed to climate transition risks:
  - dependent on imported oil (94% of the energy mix) [5]
  - intercontinental tourism (37% of jobs linked to it) [4]
- Highly vulnerable to physical risk (hurricanes, sea level rise) [2]
- High public debt (147% of GDP), with ongoing fiscal consolidation
- Barbados' climate action plan ongoing (e.g. Multi-hazard Disaster Management Plan)

Shortcoming of models in policy

- Acute risk often not integrating or in a backward-looking case-study fashion
- The calibration for the damage function can be highly country-dependent
- Compounding shocks are important, and their potential for **temporal addition** is still broadly unexplored
  - the probability of having two "one in a hundred years" events within 40 years is close to the probability of one "one in five hundred years" event
  - → public debt can raise in response to a first event and compromise the capacity to respond to a second one

Research approach and contribution

Question: what trade-off emerges in financing simultaneously the transition and the recovery from adverse physical and transition spillover shocks?

Aim:

- Provide a conceptual and methodological background to inform the introduction of climate risks in financial stability assessments
- Study *implications on sovereign financial stability*

Method: tailor, update and calibrate the *EIRIN* stock-flow consistent behavioral model [1]

Innovations

- Consideration of *acute* (hurricanes) physical risk
- Analysis of both climate physical and transition risks, with sector-specific effects from tourism shock
- Study of *coordination incentives*: we consider combinations of local scenarios (domestic policies) with the global one (for spillovers and physical risk)
  → Is a free-riding strategy profitable?

The EIRIN model

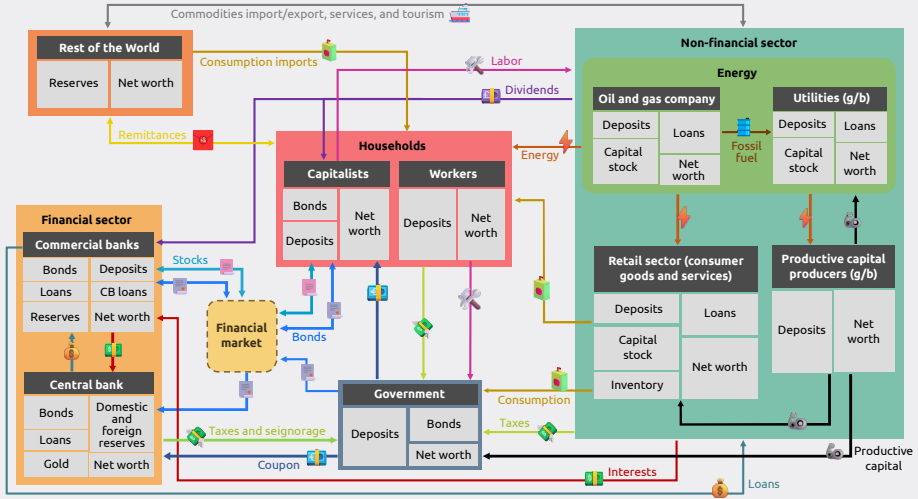

Figure 1: EIRIN balance-sheet interaction.

Main features of EIRIN

- EIRIN is a *stock-flow consistent model* where agents are endowed with specific expectations.
- Granularity of the real economy to represent the inter-industry linkages that are relevant to the low-carbon transition
- *Template for integrating financial dynamics in climate scenario analysis*: credit rationing, non-performing loans, defaults, and influence on the financing of the state
- In contrast to other SFC models, EIRIN simulates the impact of actual *defaults* happening in the system → partial bankruptcy of a sector, i.e. only a share of firms are defaulting due to insolvency
- The bank recovers part of the assets in case of defaults, and fire sales happen within sectors in trouble, for the benefit of non-defaulting firms
- Accounting consistent with endogenous money creation

Scenarios from the Network for Greening the Financial System (NGFS)

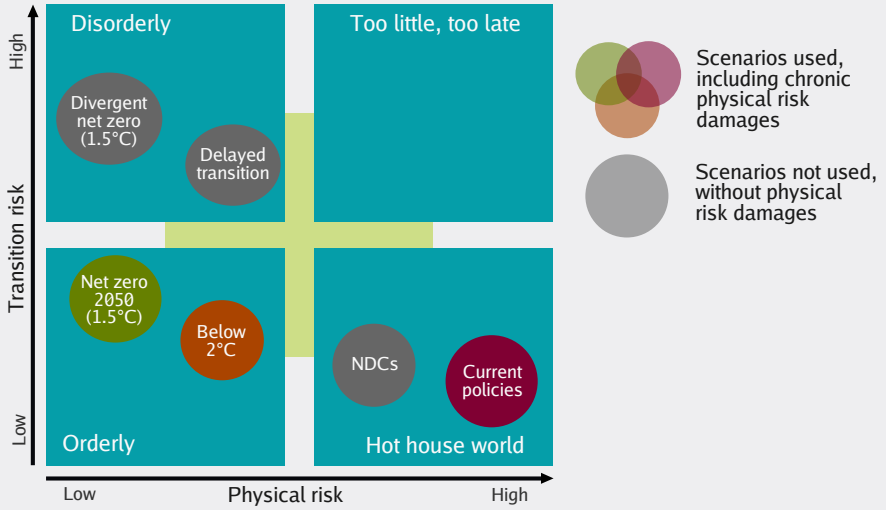

Figure 2: NGFS scenarios in the model.

NGFS scenario inputs

- *Carbon price* trajectories for the LAC region, completed by minimum green capital requirements designed in line with each scenario
- *Physical damages*
- All imported series are from the REMIND-MAgPIE 2.1-4.2 model

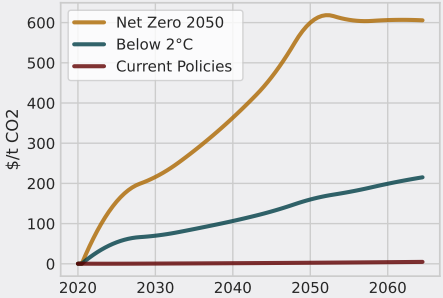

Figure 3: Carbon price path from NGFS scenarios. Values are interpolated from five years to six months periods, with geographical downscaling to Latin America and the Caribbean.

Transition policies and spillover shock

- Economy *dependent on tourists* flying in (top 3 origin countries: the UK, the US, and Canada)
- But ambitious mitigation policies would imply a *reduction in GHG emissions from air travel*
- We assume that the adjustment in tourist arrival is proportional to the decrease in total air travel GHG emissions

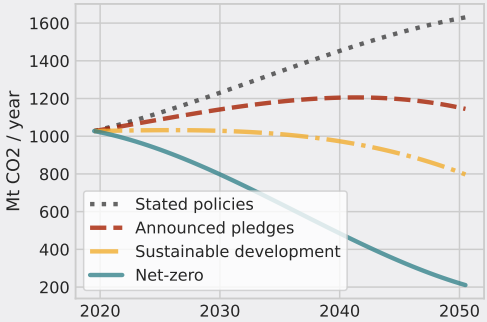

Figure 4: Evolution of total GHG emissions for the aviation sector over our simulation time frame. Source: IEA [3].

Modeling random acute physical risks with CLIMADA

1. Import data on past hurricanes and add variations of them

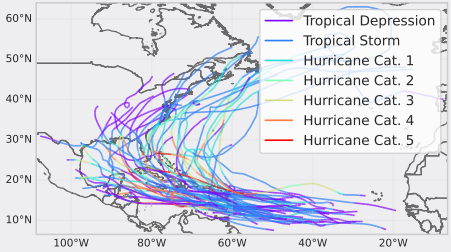

Figure 5: Visualization of the tracks of hurricanes retained. Source: Knapp et al. [7, 6] and authors' computations.

2. Assess damages on Barbados for all hurricanes with CLIMADA

2. Calculate an adjusted *hurricane probability* for a time period t in a scenario $\mathcal{S}$:

$$\mathbb{P}(\mathcal{H}_t = 1 \mid \mathcal{S}) = p_{\mathcal{H}} + (1 - p_{\mathcal{H}}) \times f_{\mathcal{H}}(\mathcal{S}, t)$$

with the baseline historical value $p_{\mathcal{H}}$, and $f_{\mathcal{H}} : \mathbb{R}_+ \to [0, 1]$.

3. Calibrate a damage distribution: models the *impact of a hurricane* impacting Barbados when one occurs

$$\mathcal{D}_t^{\mathcal{S}} \mid \{\mathcal{H}_t = 1\} \sim \mathrm{Beta}(\alpha(\mathcal{S}, t), \beta_0)\,.$$

4. The increase in expected damages follows values from the NGFS, and it is attributed equally to the frequency and intensity of hurricanes.

Results: real GDP reduced by spillovers

Domestic transition policies tend to improve the economic output in the absence of spillover, but spillover risk leads to a GDP significantly lower than the baseline.

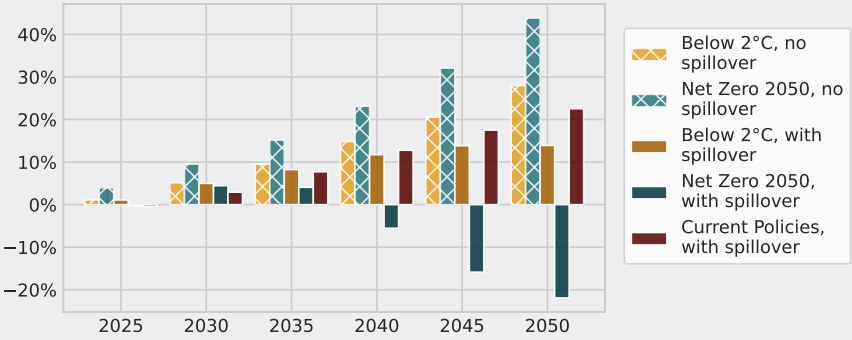

Figure 6: Effect of tourism spillover on national GDP.
Percentage deviation from the baseline case of Current Policies with no spillover.

Results: trade balance

The shock on tourism has a direct and negative impact on exports of Barbados, hence a lower balance of payment compared to the respective no-spillover baselines.

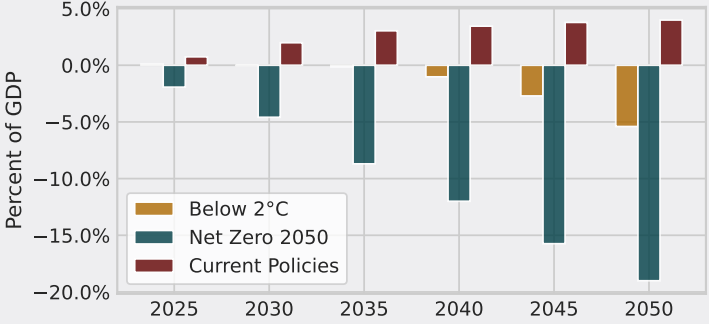

Figure 7: Effect of tourism spillover on the trade balance. Percentage deviation within each scenario with spillover from the counter-factual without spillover.

Physical damages in the 2040-2050 decade

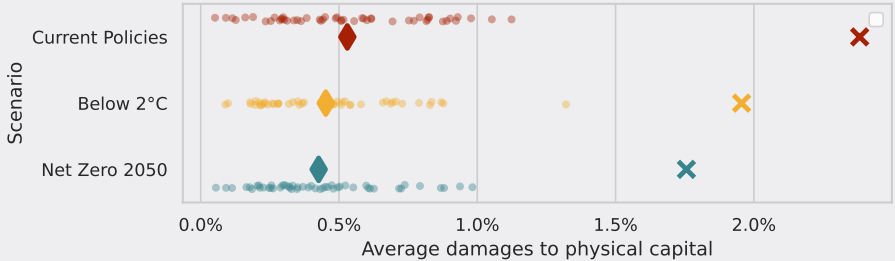

Figure 8: Markers **X** are the mean chronic impacts over the decade, i.e. the average over time of the ratio of capital that is lost to climate damages in every six-month simulation period. Markers ● represent, for one Monte Carlo simulation, the average over time of the acute physical risk destruction ratio. Markers ♦ are the average across Monte Carlo simulations of their mean acute physical risk.
Source: authors' computations.

Results: GHG emissions mostly determined by domestic policies

Mitigation policies lead to lower GHG emissions, and spillover effects have a minor effect since a lower economic activity reduces emissions.

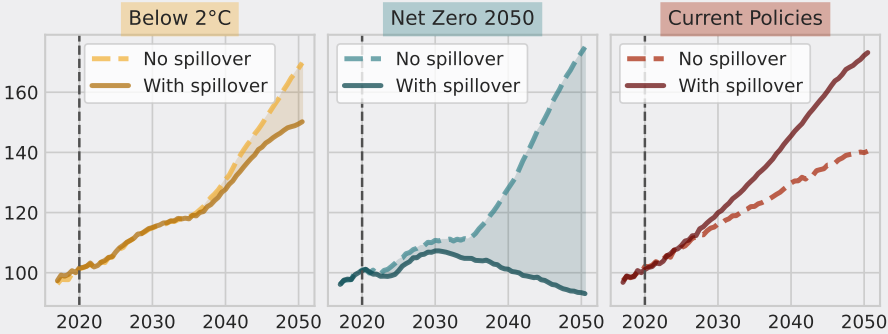

Figure 9: Effect of tourism spillover on GHG emissions. GHG emissions are given for each period and indexed with initial emissions at 100.

Findings summary and free-riding

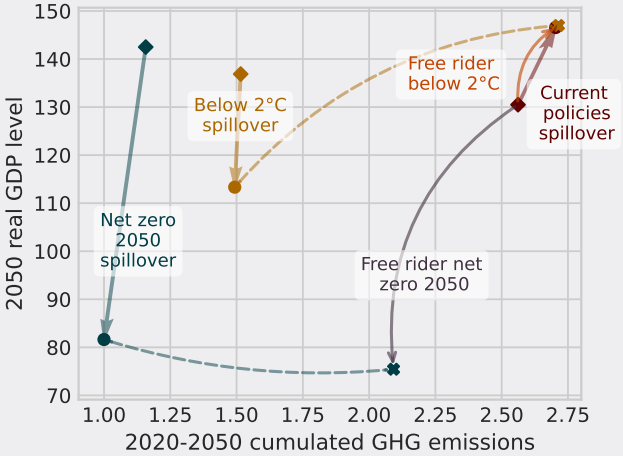

Figure 10: Summary chart of the scenarios simulated.

Legend:

♦: results with no spillovers.

●: results with spillover, Barbados and the rest of the World following the same scenarios.

x: "free rider" results → Barbadian domestic policies follow the Current Policies scenario, and the rest of the world follows a mitigation scenario, with spillover.

Conclusion

- Spillover risk mostly affects the economic output of Barbados, while the impact on GHG emissions reduction is limited to the case of the Net Zero scenario and comes as a consequence of the economic output reduction
- In the absence of any significant shock on tourism, Barbados is better off economically when implementing climate transition policies
- Spillover risks make “free-rider” policies generally unappealing, even if it benefits from less physical damages
- Barbados would benefit from diversification within the touristic industry and for the economy in general

References

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[2] Government of Barbados. ***Barbados 2021 update of the first nationally determined contribution.*** Tech. rep. 2021.

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[7] Kenneth R Knapp, Michael C Kruk, David H Levinson, Howard J Diamond, and Charles J Neumann. **"The international best track archive for climate stewardship (IBTrACS) unifying tropical cyclone data".** In: *Bulletin of the American Meteorological Society* 91.3 (2010), pp. 363–376. DOI: 10.1175/2009BAMS2755.1.