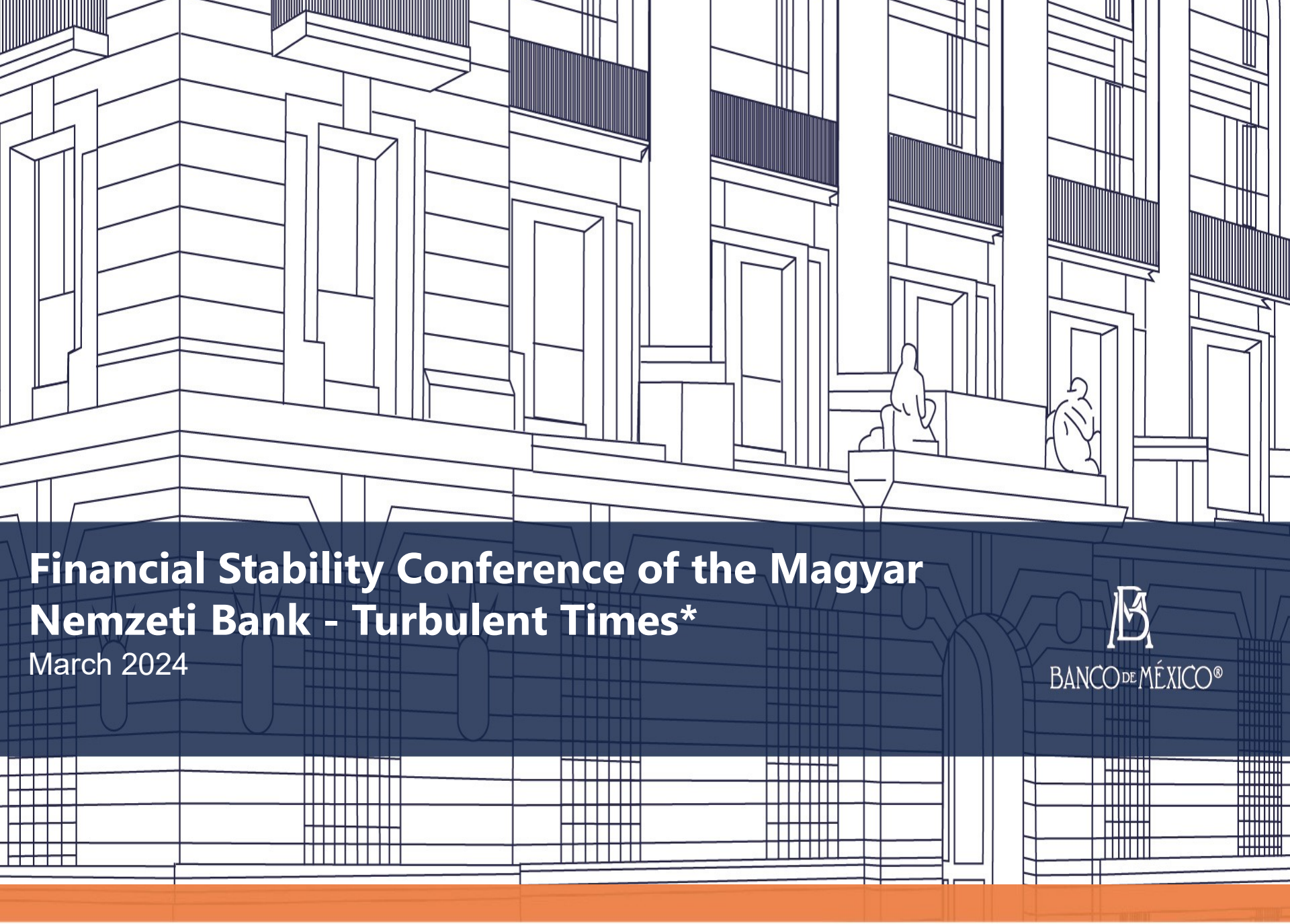

Financial Stability Conference of the Magyar Nemzeti Bank - Turbulent Times*

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Climate risk and financial stability in the network of banks and investment funds ☆

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Summary of the presentation

- Climate risk analysis should be forward looking.
- Climate scenarios are an intrinsic element of this analysis.
- Current asset valuation models do not incorporate climate risk.
- The sudden awareness of this risk can cause abrupt price adjustments.
- Model focuses on transition risk and uses high granularity data from Banco de México.
- Price adjustment have direct and indirect effects, including contagion.
- Impact on financial institutions and financial stability.
- Delivers an operational framework for climate stress-testing for the network of banks and investment funds.

Outline

- Motivation
- Key questions
- Model
- Results
- Conclusions

Motivation

- There are concerns that the climate policies could cause inadvertent consequences in the economy and the financial system.
- There is the risk of a disorderly transition to a low-carbon economy.
- An adequate assessment of climate-related financial risk is of great interest for policy makers around the globe
- There are no widely accepted stress testing frameworks for climate risks in the financial sector.
- Climate scenario analysis has been gaining prominence more recently, thanks to the NGFS.

Motivation

- Due to its geographical location, Mexico is highly exposed to climate change related physical risks, both from extreme climate events (acute risks such as floods from heavy rain, hurricanes), and chronic risks (high temperatures).
- From the transition risks perspective, Mexico could be highly exposed given the reliance on fossil fuels and non-renewable electricity generation.
- The current energy matrix composition could generate significant risks: reputational, crossborder adjustment taxes, investment loss, even possible contagion to sovereign risk.

Key questions

Q1 How do we build a science-based climate scenario analysis for the financial system?

Q2 How do we translate forward-looking knowledge from climate science and climate economics into metrics of financial risk at the level of individual institutions and at system level?

Q3 What are the policy insights that we can expect from a climate scenario analysis?

Contribution

C1 First combination of Climate Stress-test (Battiston et al. 2017) with Network Valuation of Financial Assets (Barucca et al. 2020) and common assets contagion (Greenwod et al. 2015, Battiston et al. 2016, Poledna et al. 2021).

C2 Analytical and empirical relations on impact on financial stability from the interplay btw 1) climate policy shocks and 2) financial market conditions including banks and funds.

F1 Policy implication I: in the face of possible disorderly transition, financial institutions have incentives to engage earlier, under the same market conditions.

F2 Policy implication II: possible to reach tighter climate policy target, at same level of risk if market conditions are strengthened enough.

The methodology

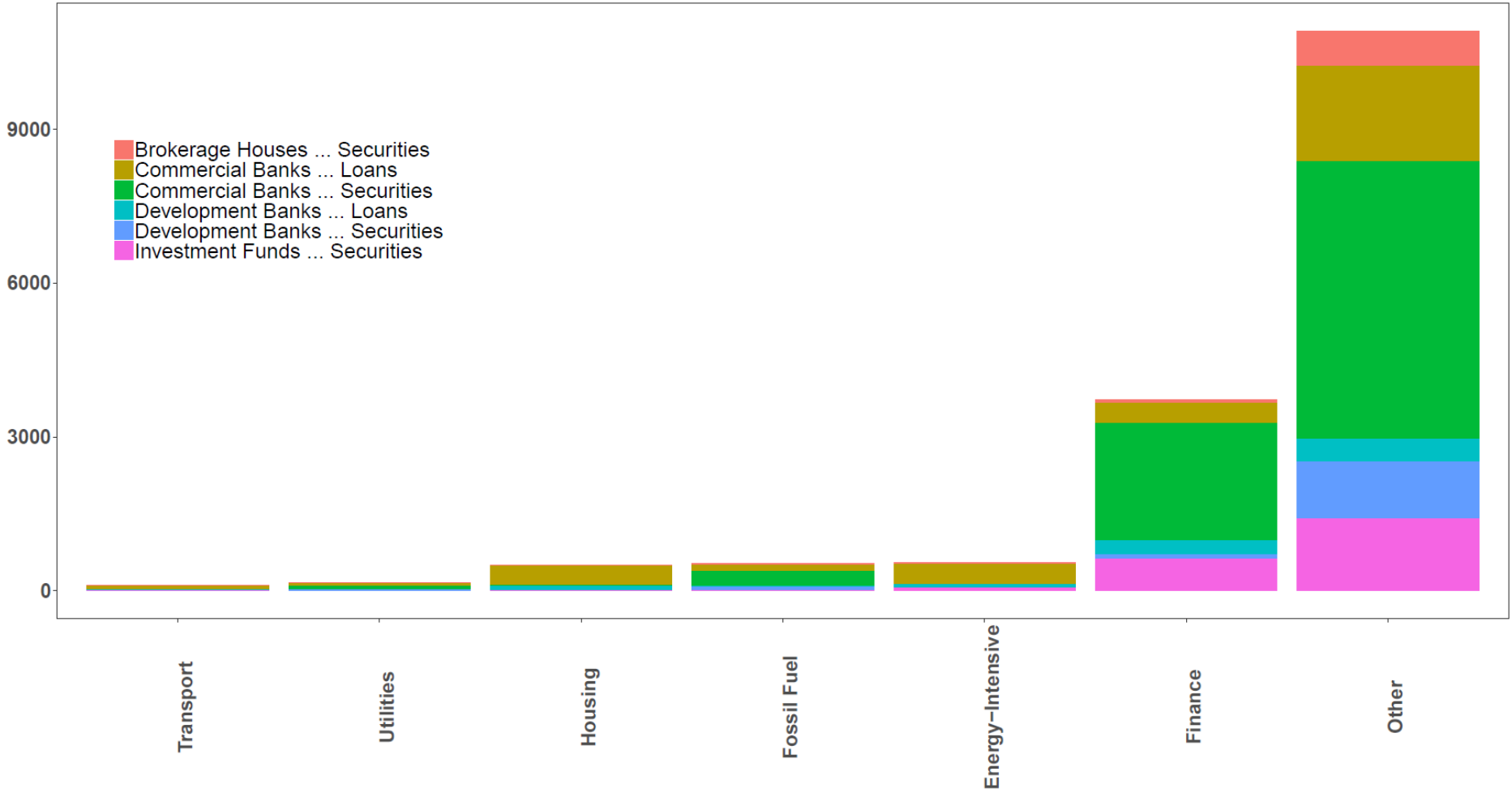
- Climate stress-test (Battiston et al. 2017; Monasterolo et al. 2018):
  - disorderly transition: temporary transition between equilibria of economic trajectories consistent with different climate policies
  - shocks on financial assets: derived from shocks on GVA and revenues
- Network financial valuation of claims (NEVA, Barucca et al. 2020) and (DebtRank, Battiston et al. 2012; 2015)
  - standard finance valuation assumptions + fund contagion model
- Common assets contagion (Greenwood et al. 2015, Poledna et al. 2021)
  - Overlapping portfolios + asset fire sales

Data

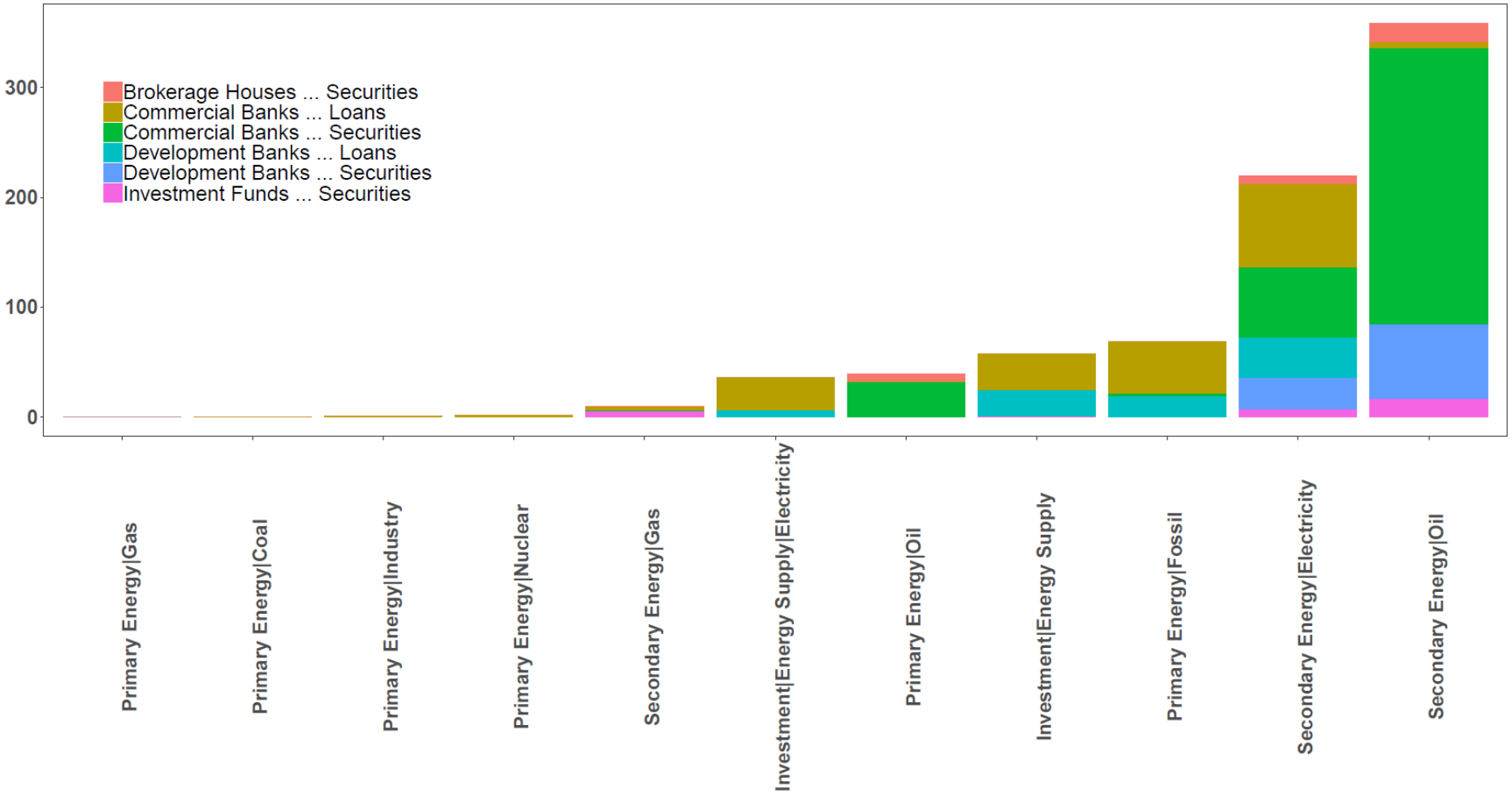
- Economic trajectories from set of 6 climate economic models and 9 scenarios Integrated Assessment Models (IAM) LIMITS database

- Supervisory data of Banco de Mexico on bank and funds exposures to the real economy
  - Banco de México has collected over time high granularity financial data which can be used to perform sophisticated climate risks stress-tests.
  - The data used to perform this exercise includes exposures of banks and investment funds to Climate Policy Relevant Sectors (CPRS), interbank exposures and exposures among investment funds and banks.

Exposures to CPRS by type of exposure



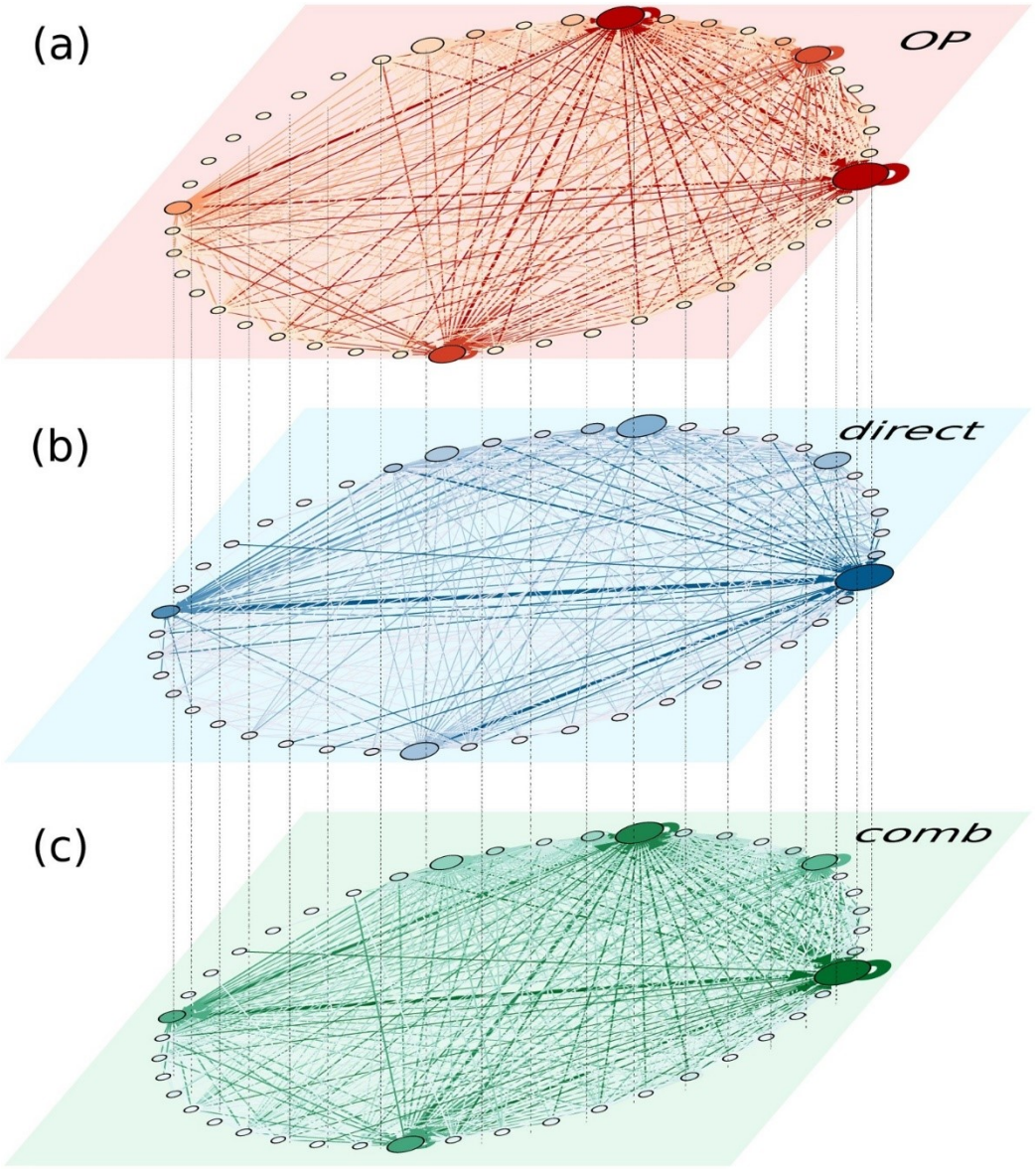
Exposures LIMITS by type of exposure



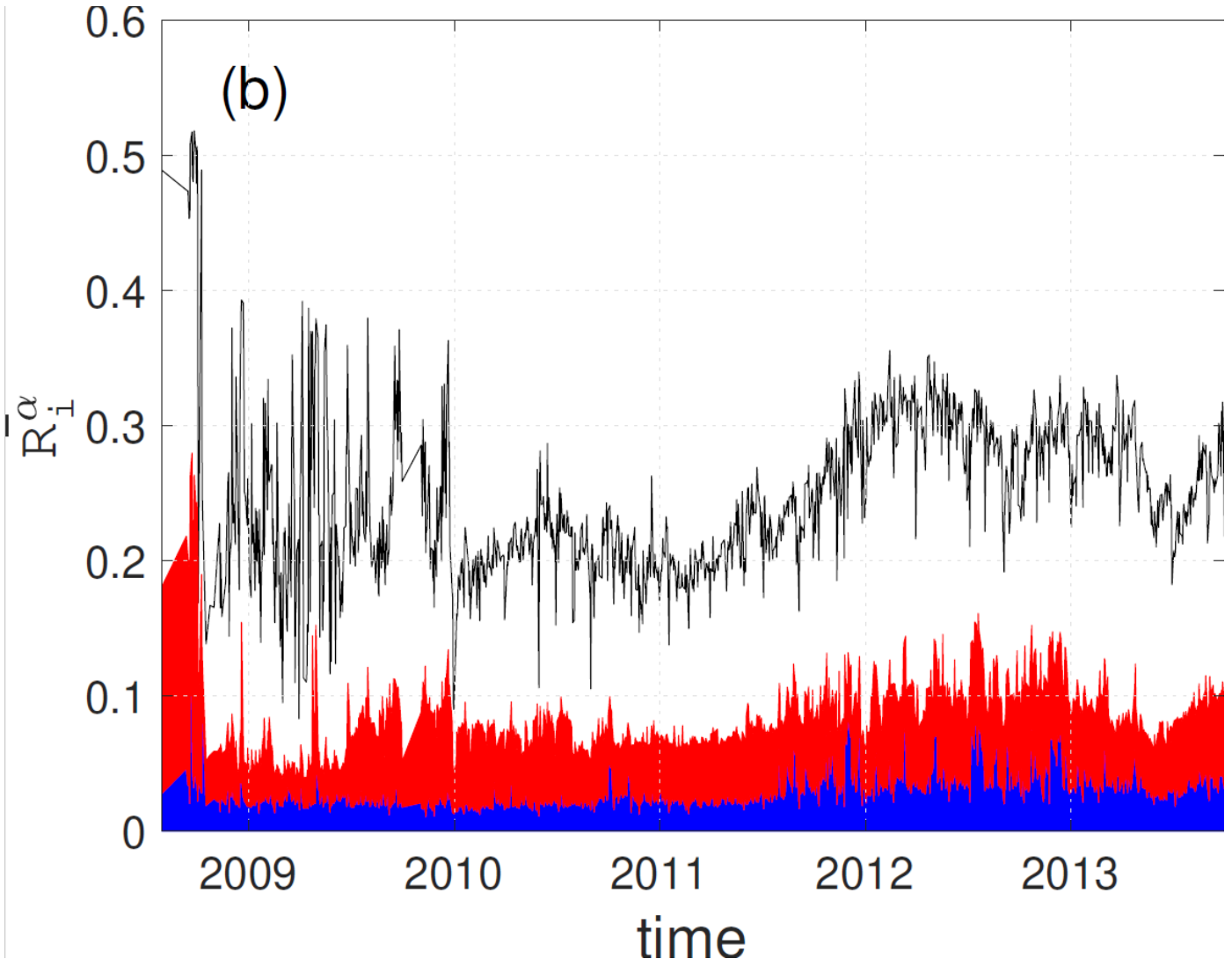
Financial contagion

Literature reference	Model features				
	Endogenous Recovery Rate	Ex-Ante Valuation	Firesales Contagion	Investment Funds	Climate Module
Systemic Risk Eisenberg and Noe, 2001	■				
DebtRank Battiston ea., 2012		■			
Leveraging the Network Battiston ea., 2016		■	■		
Pathways Bardoscia ea., 2017		■			
NEtwork VAluation Barucca ea., 2016	■	■			
Interconnected Banks Roncoroni ea., 2018	■	■			
Climate Stress Test Battiston ea., 2017		■			■
Our work Roncoroni ea., 2019	■	■	■	■	■

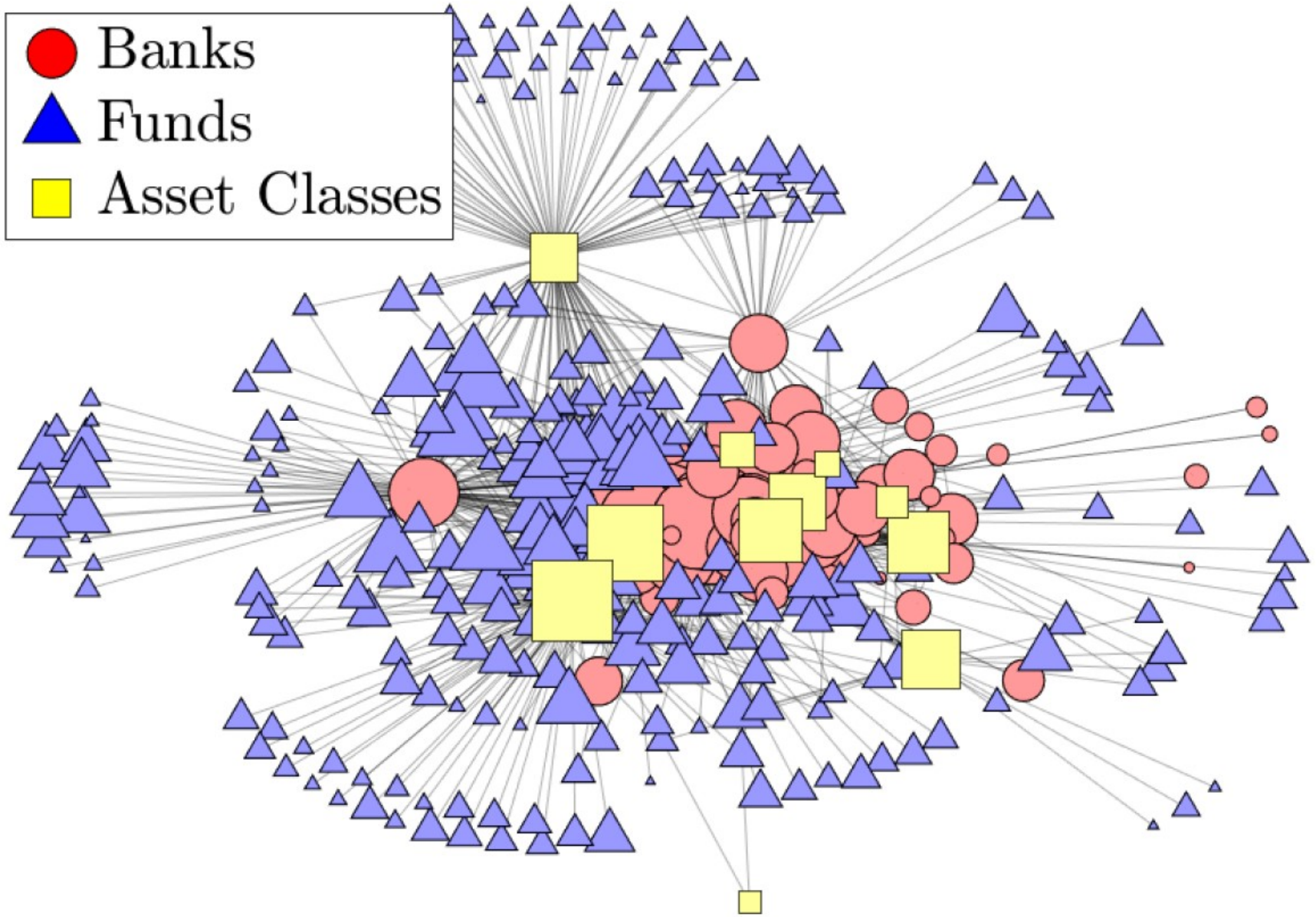
Interbank direct and indirect exposures



Systemic risk from overlapping portfolios



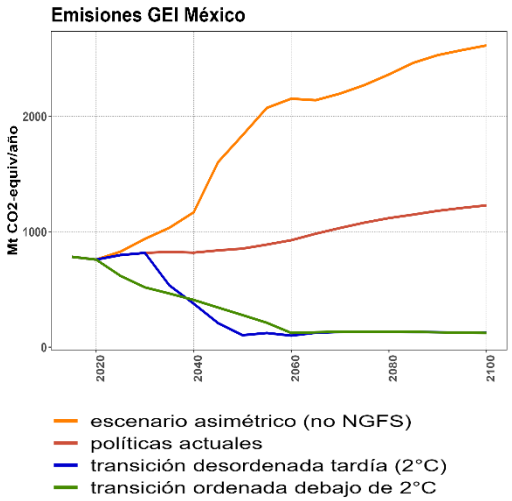
The financial network



The framework

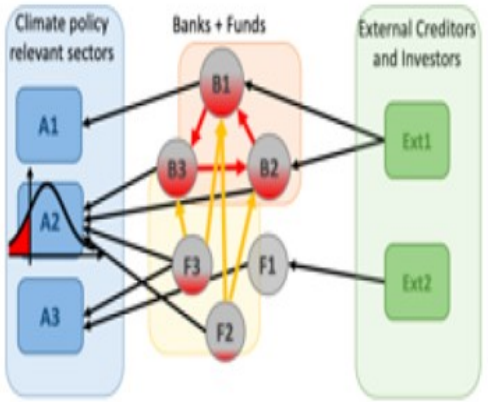
1. **Climate policy shocks:** Impact of a late and disorderly alignment to a climate policy scenario designed to meet a set of climate targets. Building on climate economics (e.g. LIMITS, CD-LINK)
2. **First round**: Losses suffered by banks and funds due to direct exposures to Climate Policy Relevant Sectors (CPRS)
3. **Second round**: NEVA Barucca ea. 2020, accounting for market volatility.
4. **Third round**: Banks' and funds' reaction to shock to get to initial risk management level which add further pressure on prices (Greenwood et al 2015, Battiston et al. 2016, Poledna et al. 2021).
5. **Fourth round**: losses too large to be absorbed by banks' capital and are transmitted to external creditors (Roncoroni et al. 2019 ECB WP).

Climate stress test framework

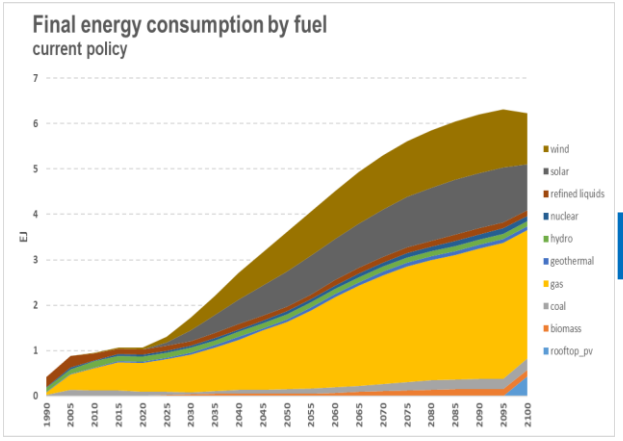


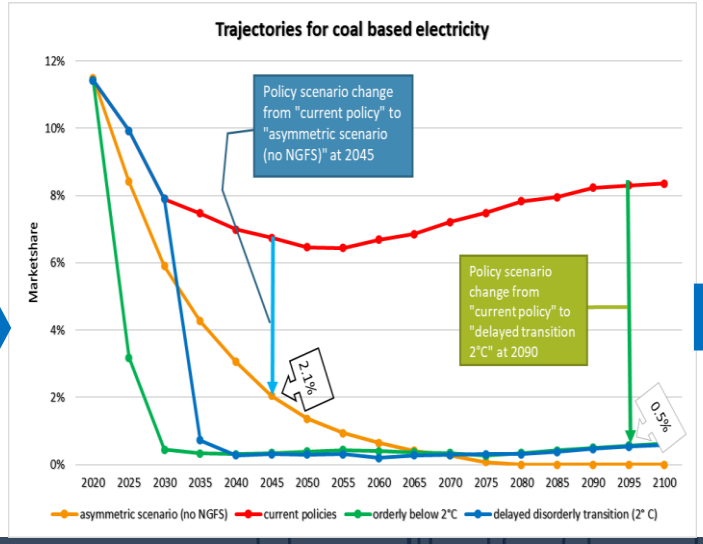
Disorderly transition: late-sudden alignment to climate targets

- → shocks on revenue streams of securities issuers/borrowers
- → adjustment of issuers' default prob., bond spread, credit risk (CVA)
- → shocks on value of financial instrument dependent on issuer firm

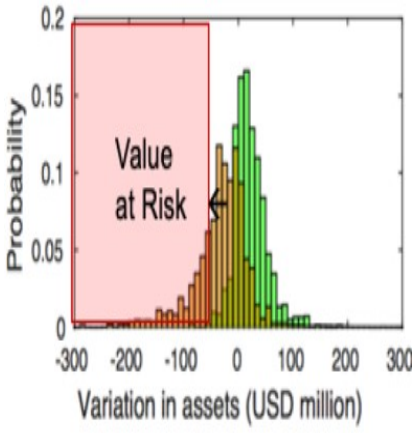


Output scenarios final energy consumption sectors

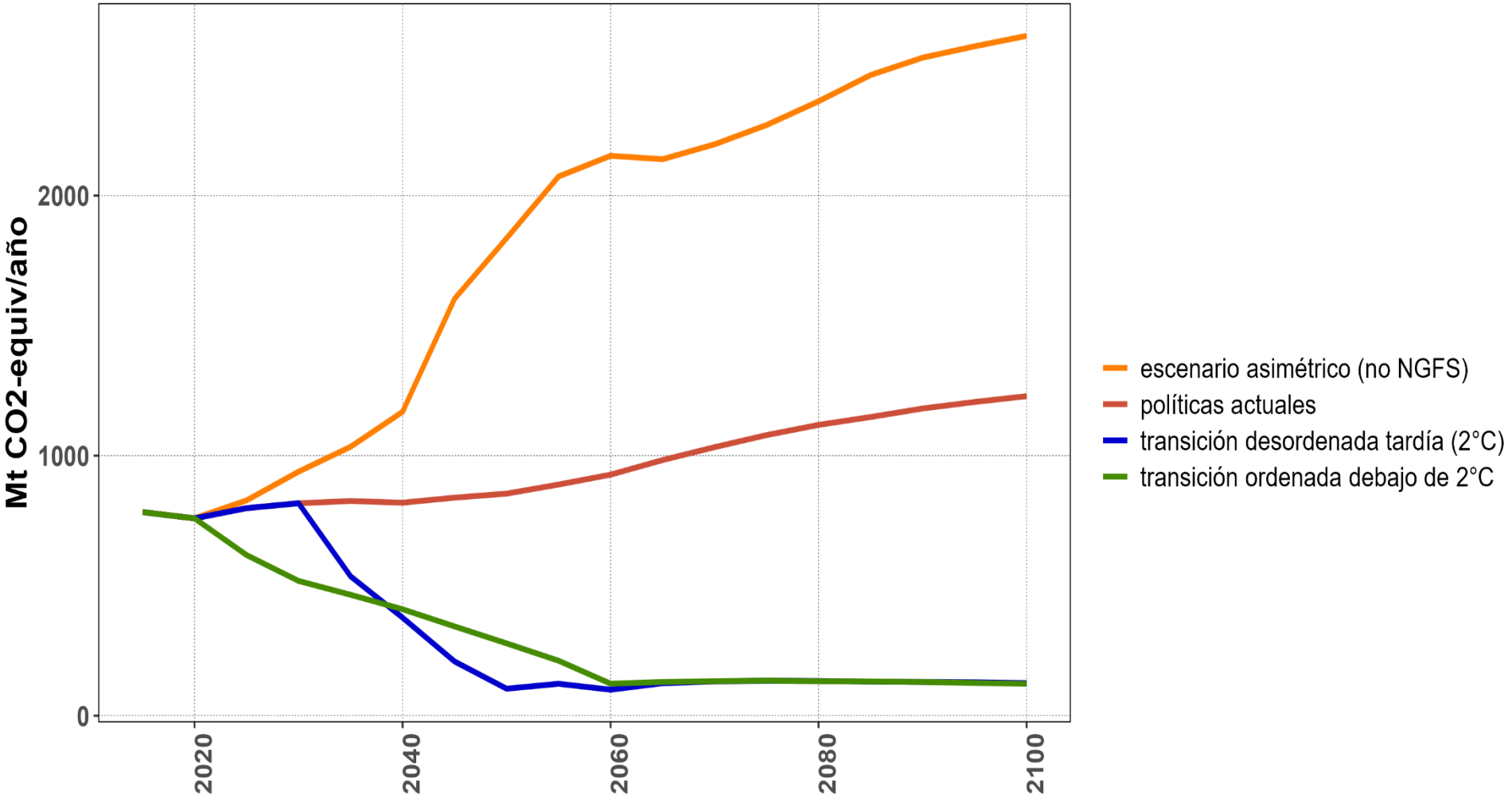




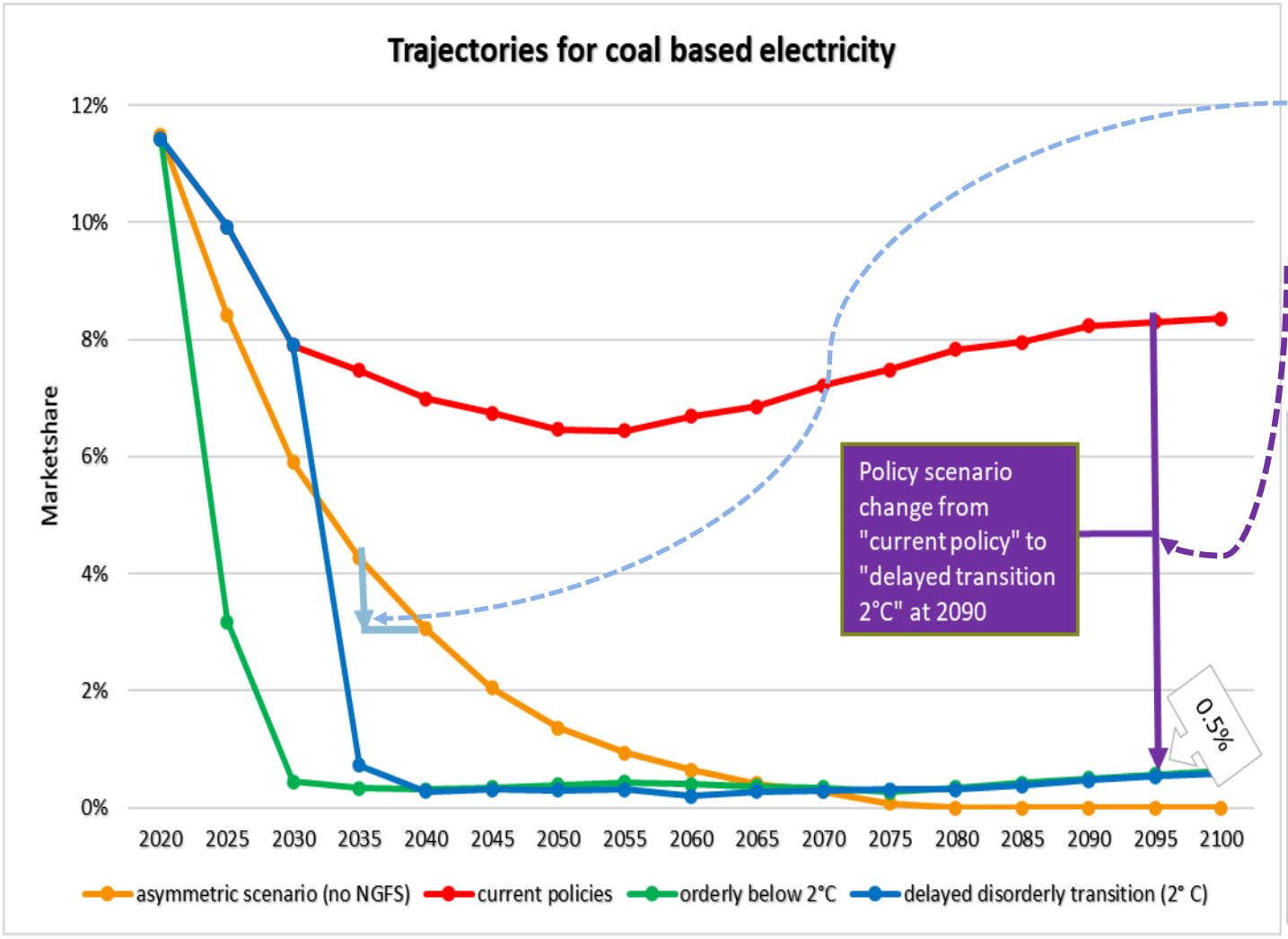
Adjustment of gain/losses distr. -> Value at Risk



Emisiones GEI México



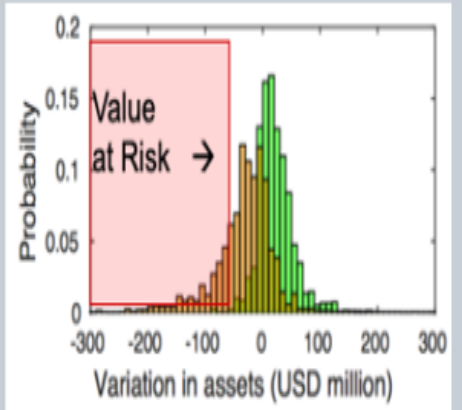
Current policies

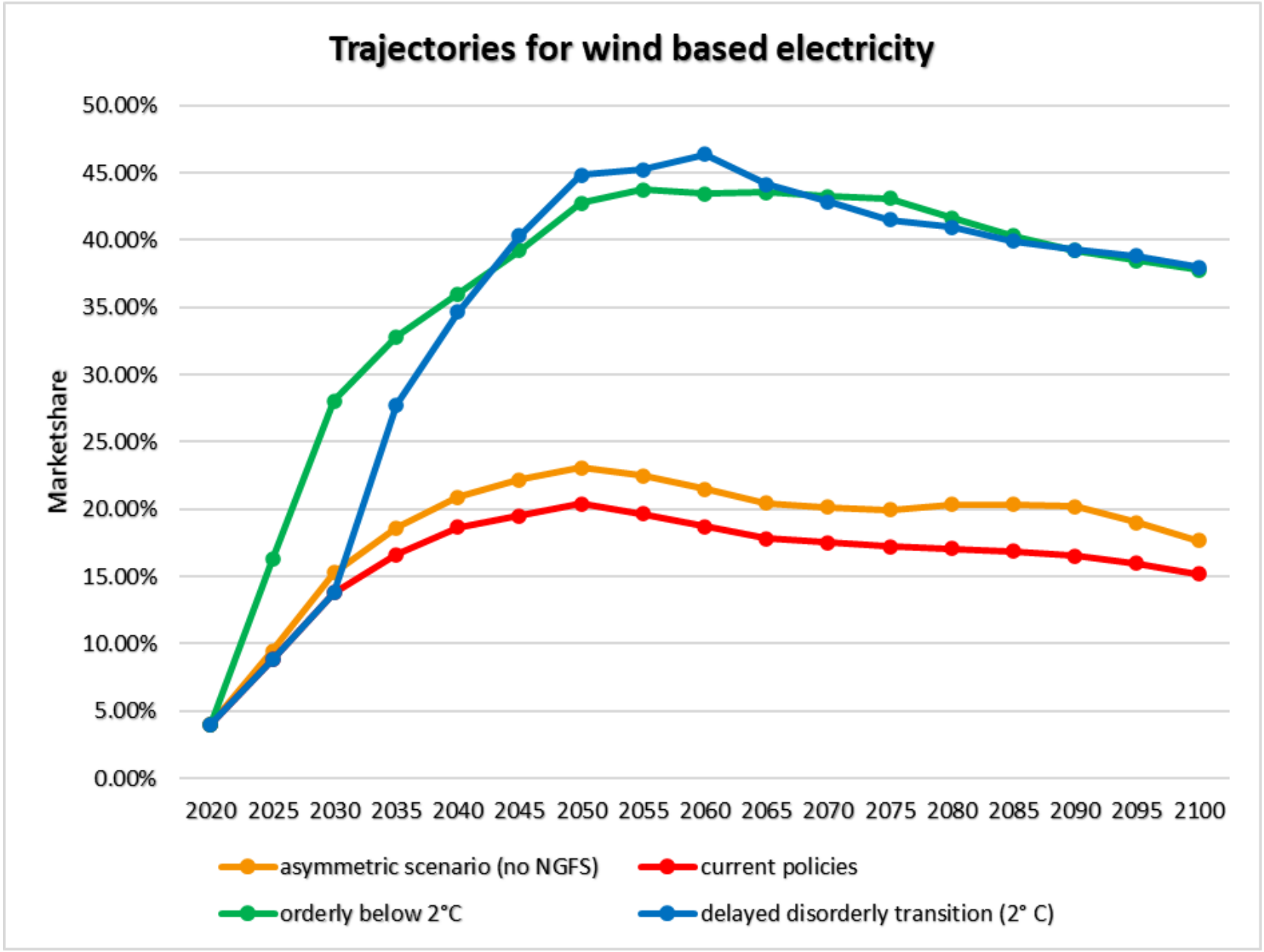


Method 2: cross-sectional: across trajectories (Monasterolo ea. 2018 JCWE; Battiston&Monasterolo 2018)

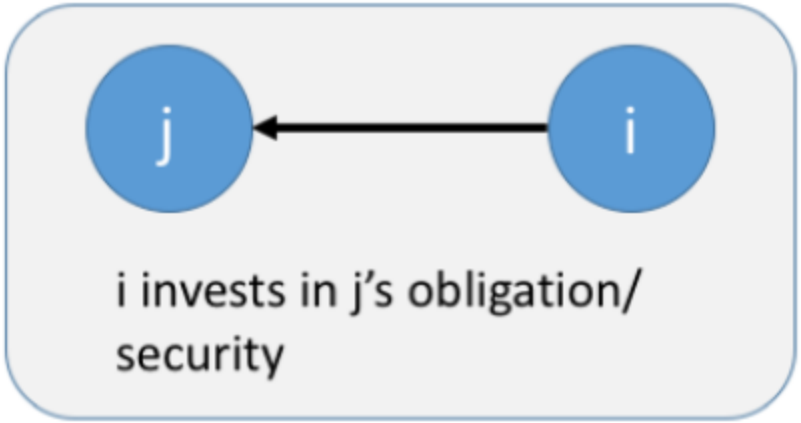
Method 1: longitudinal: along trajectories (Battiston ea. 2017 NCC)

Gain/losses probability distribution
→ Value at Risk

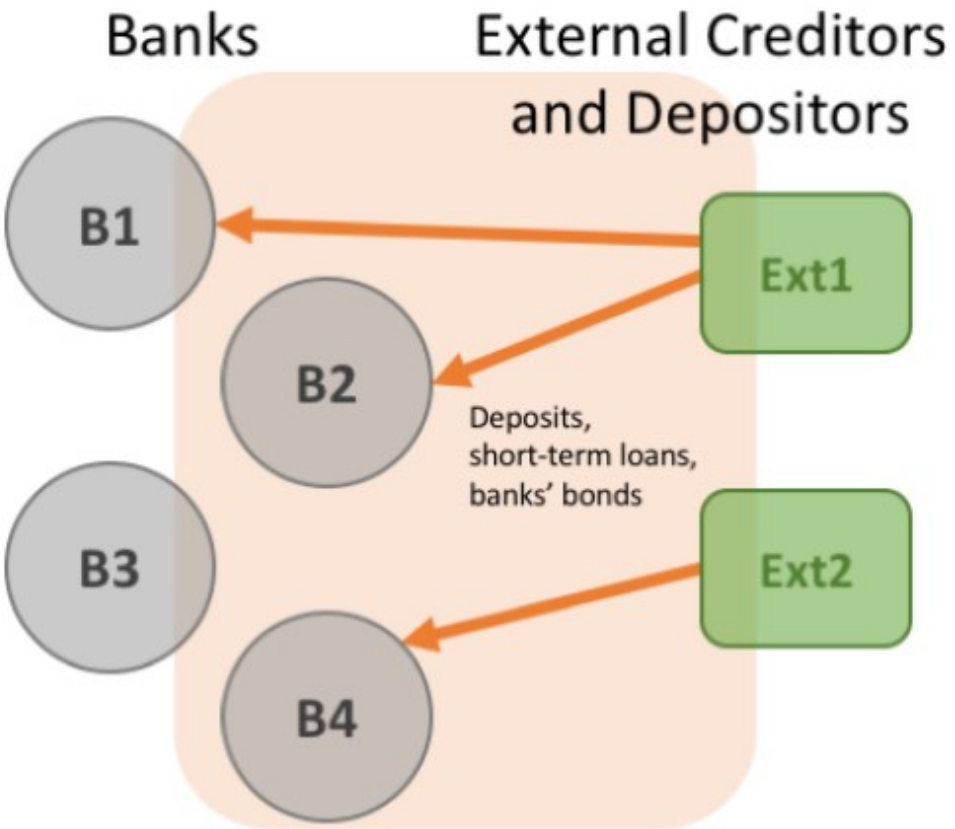



Trajectories for wind based electricity
50.00%
45.00%
40.00%
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
Marketshare
2020 2025 2030 2035 2040 2045 2050 2055 2060 2065 2070 2075 2080 2085 2090 2095 2100
asymmetric scenario (no NGFS)
current policies
orderly below 2°C
delayed disorderly transition (2° C)

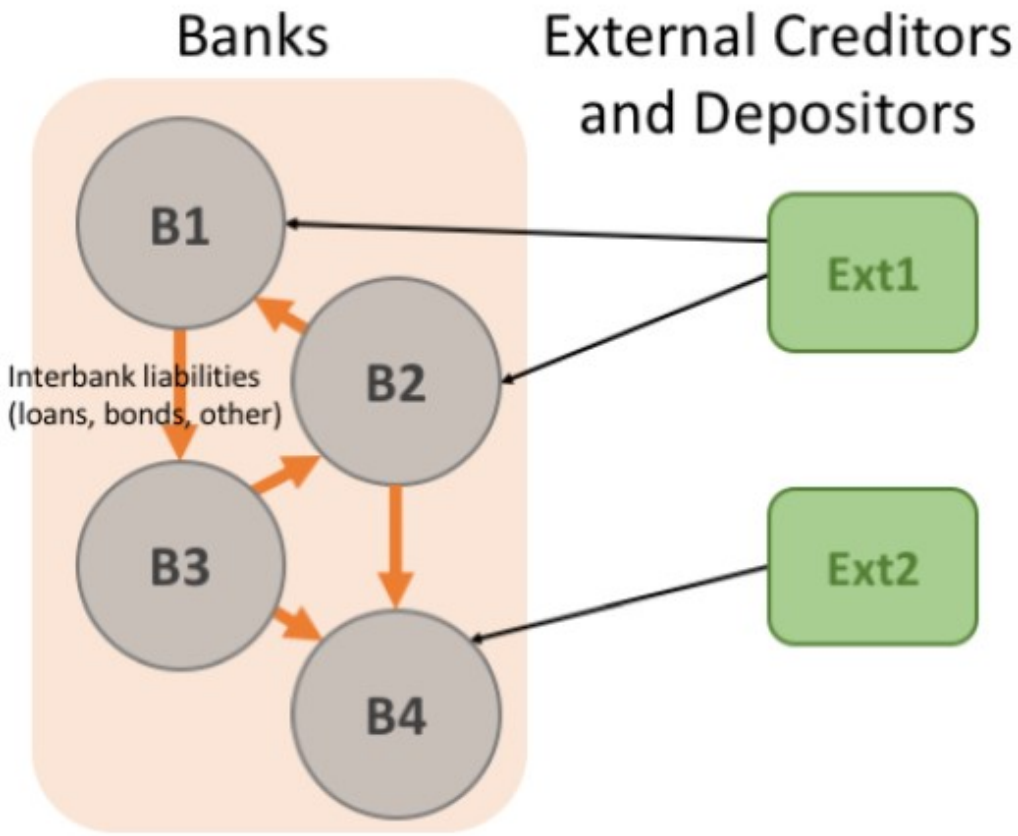
Distress propagation



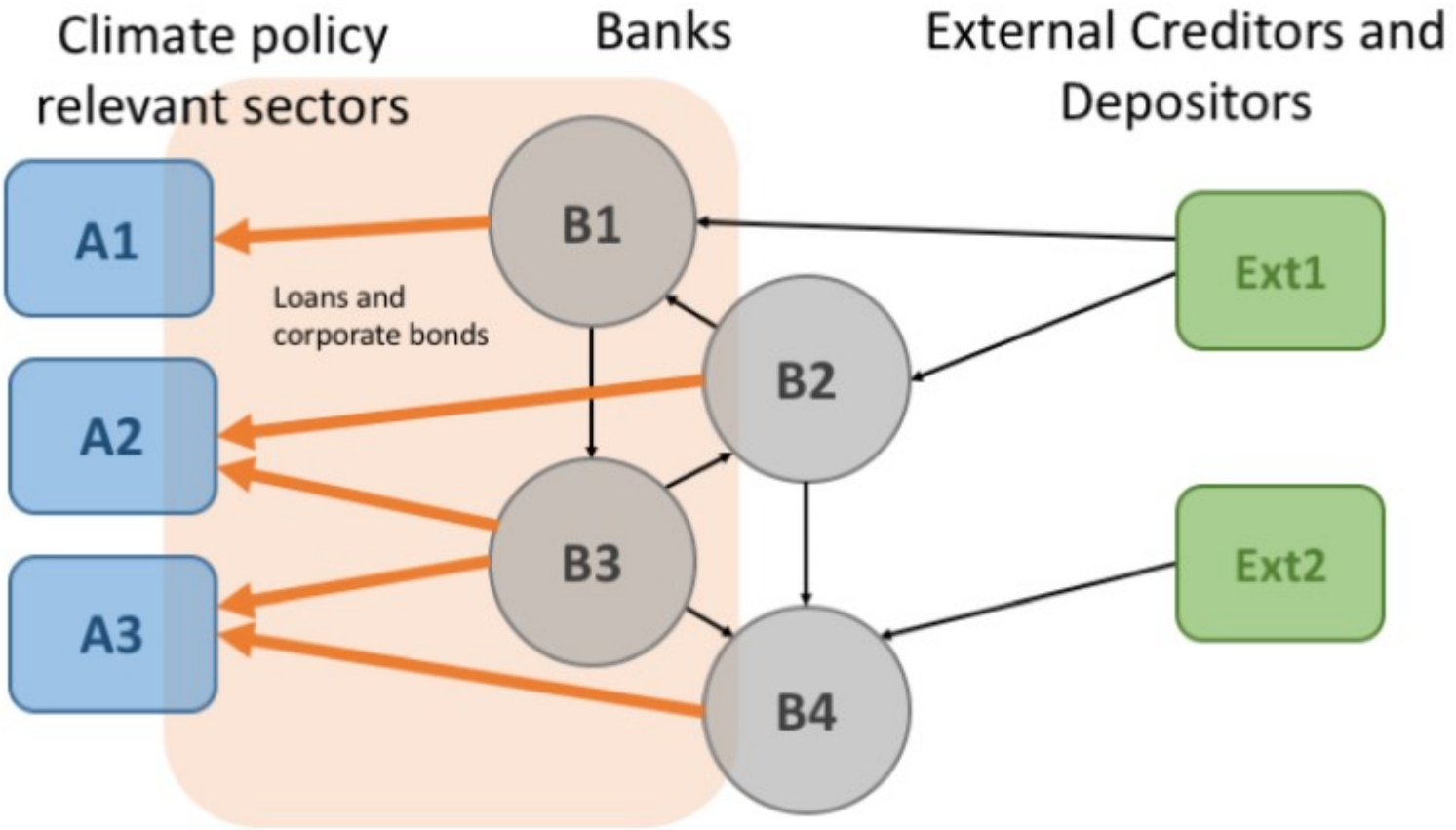
Distress propagation via banks



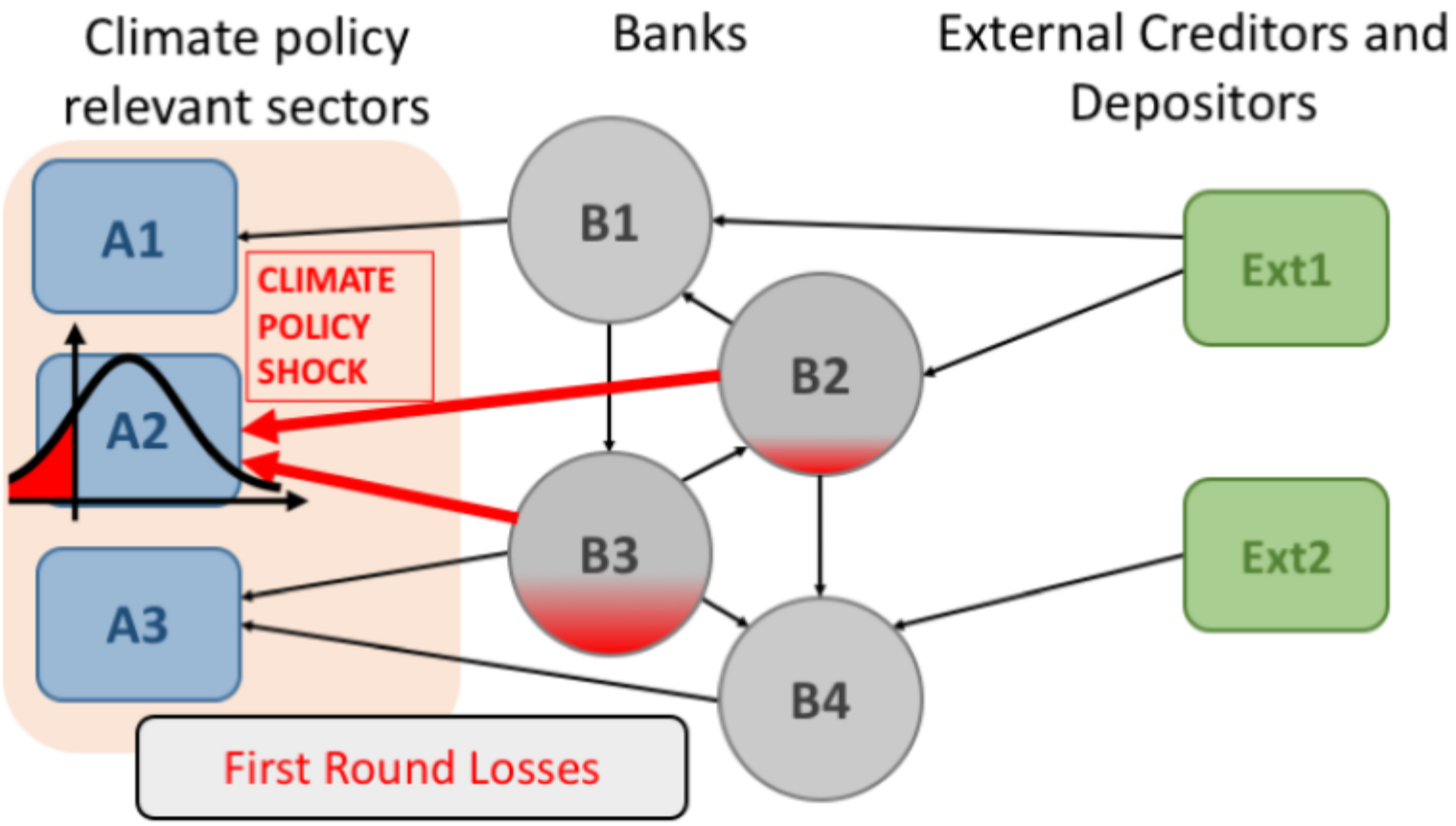
Distress propagation via banks



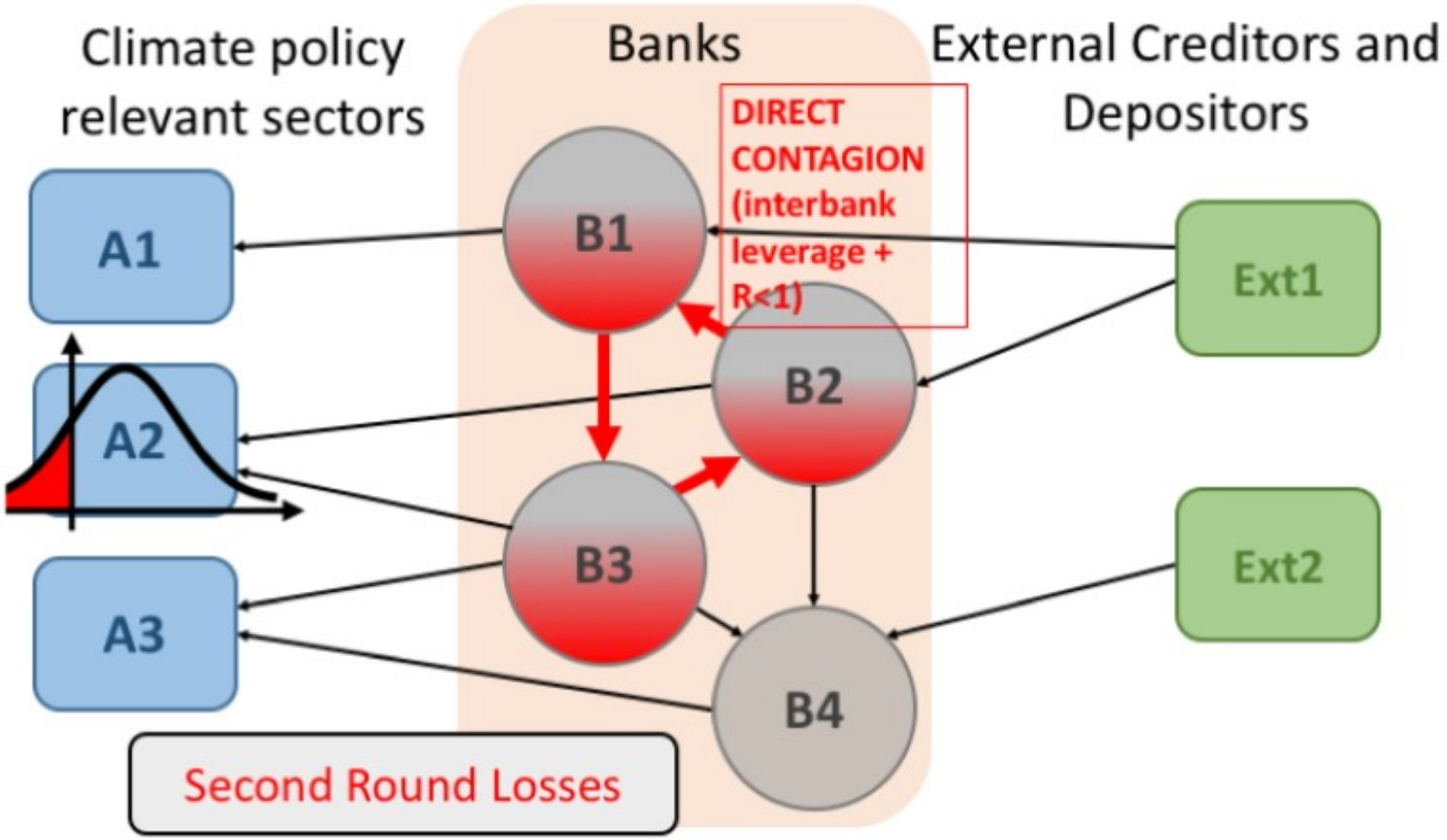
Distress propagation via banks



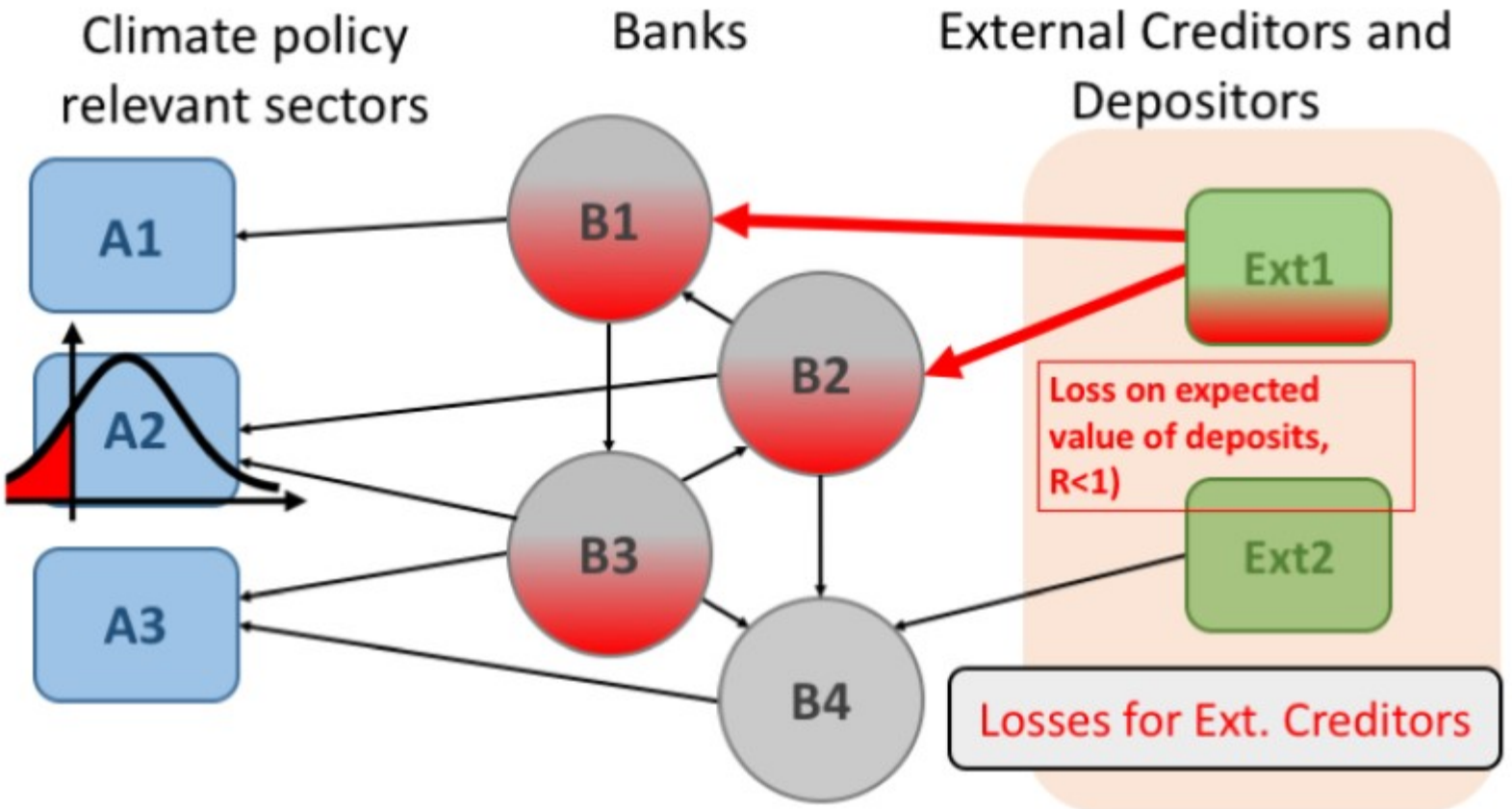
Distress propagation via banks



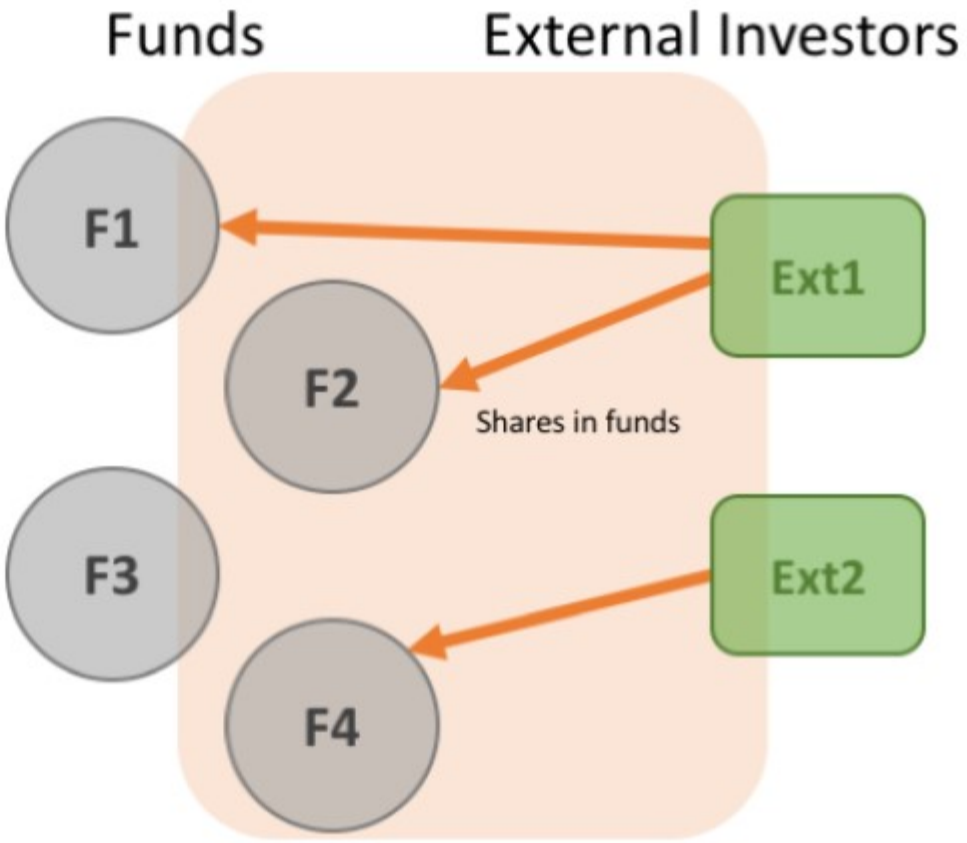
Distress propagation via banks



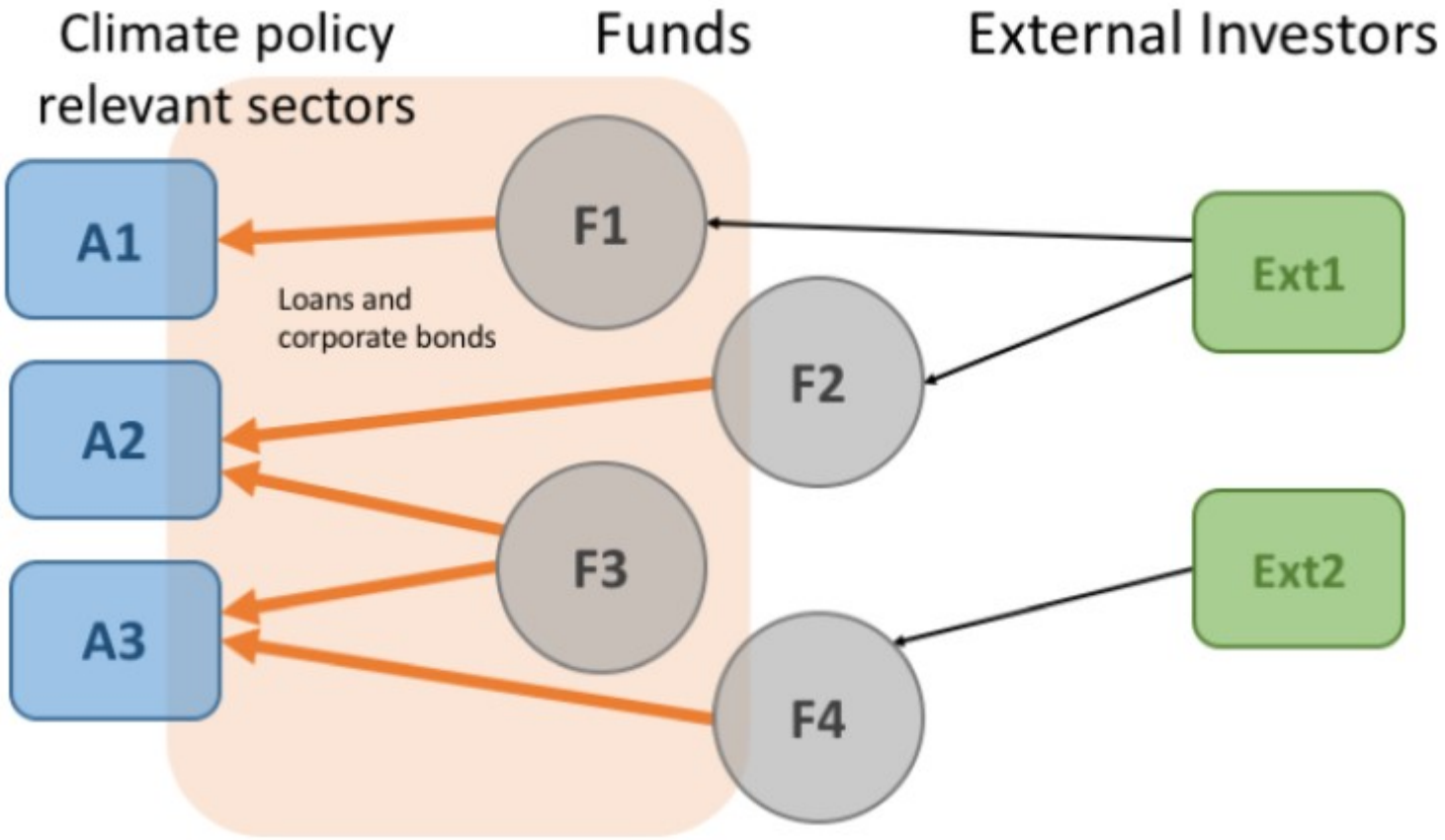
Distress propagation via banks



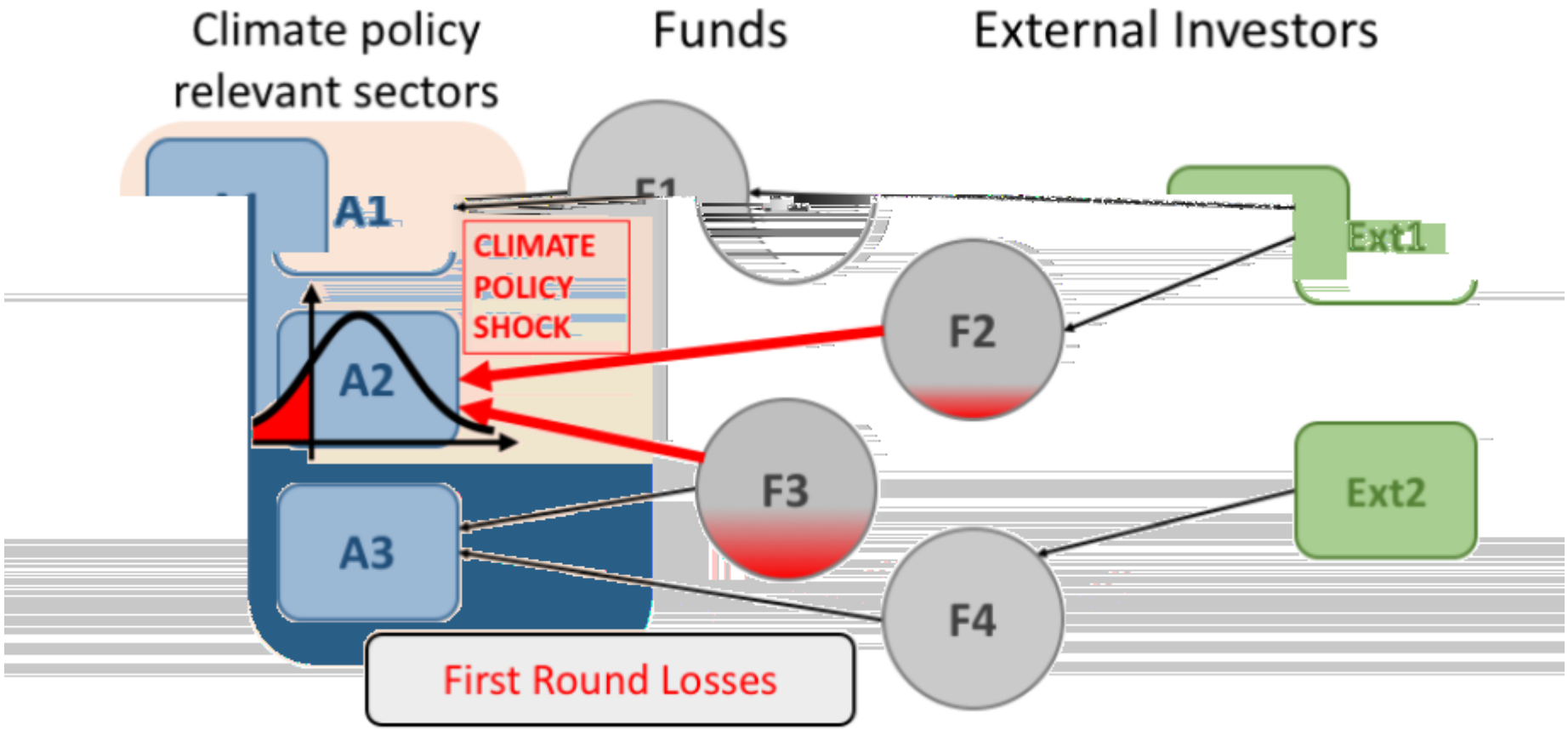
Distress propagation via funds



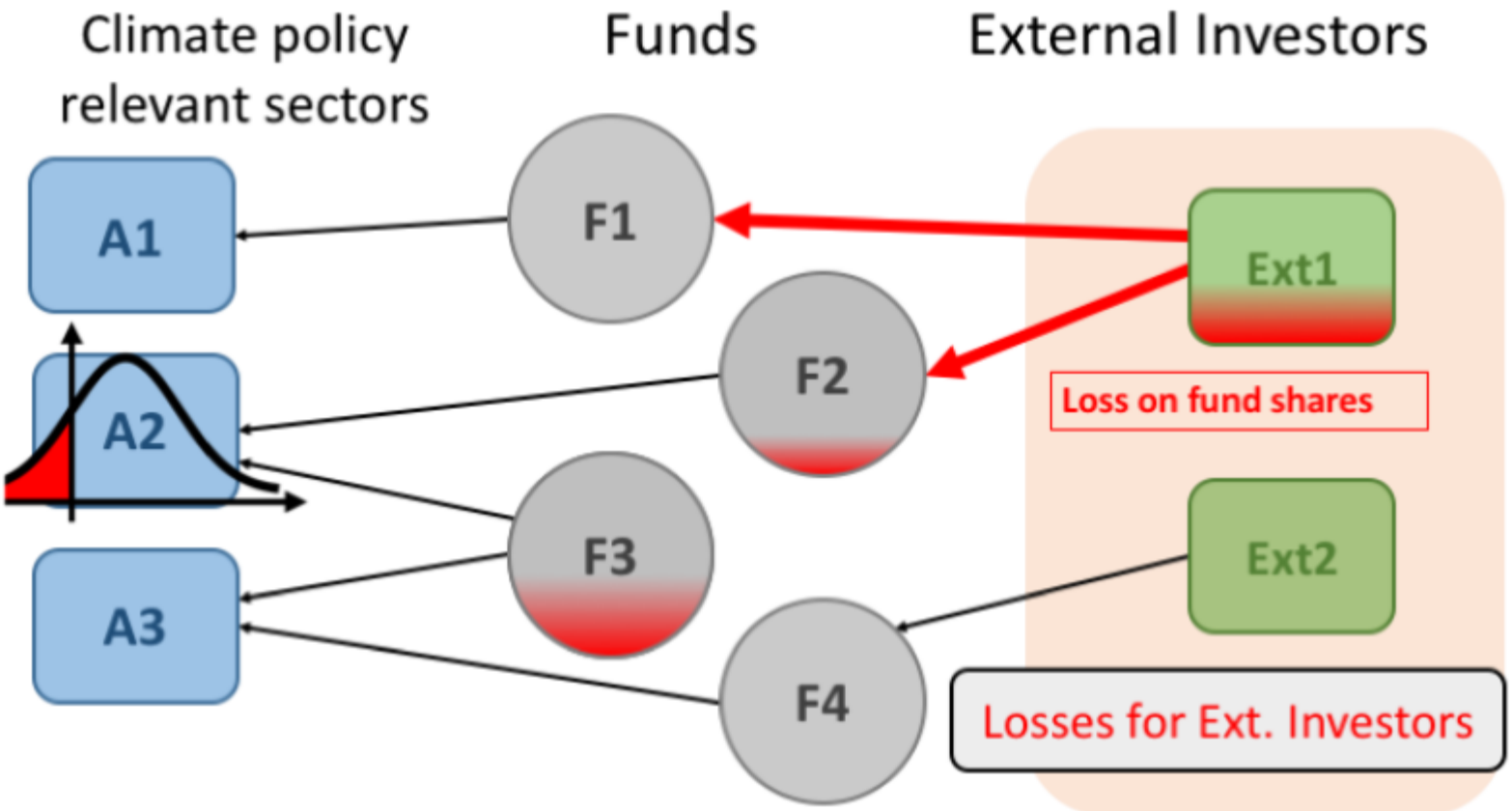
Distress propagation via funds



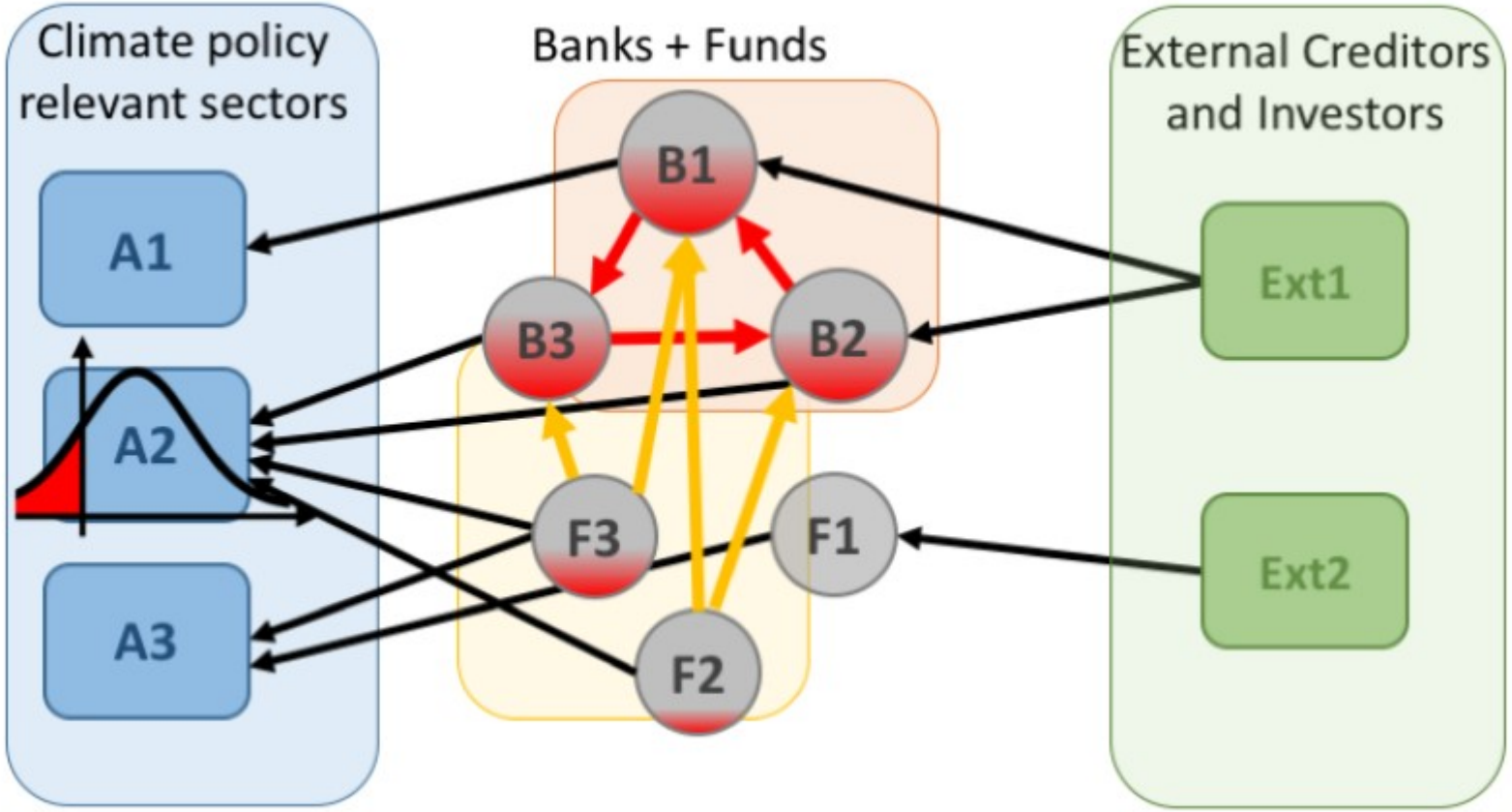
Distress propagation via funds



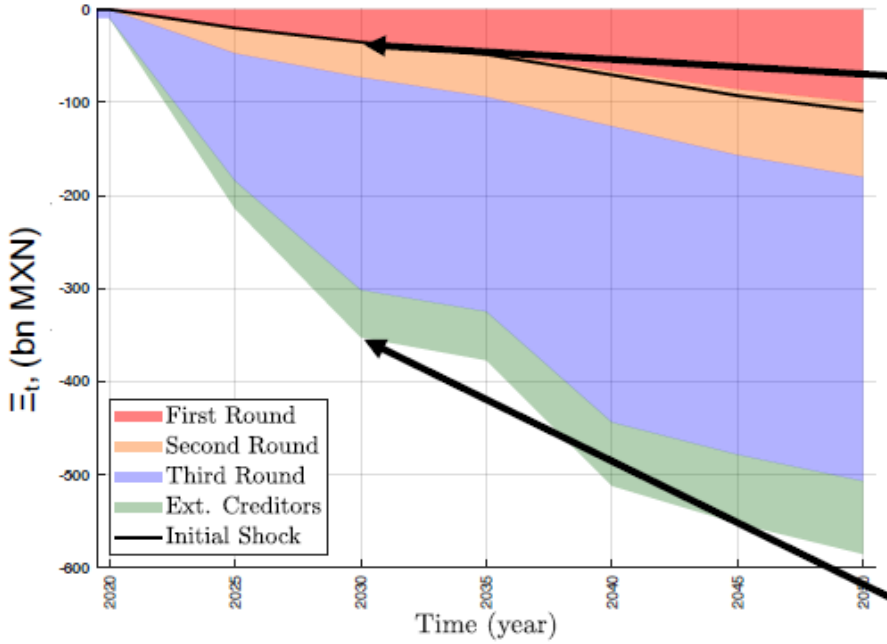
Distress propagation via funds



Distress propagation via banks and funds



Results, how to read them



~40 bn of Mexican pesos

Black line: initial loss
Red: losses due to direct exposure
Orange: losses due to interbank contagion
Blue: losses due to common exposure contagion
Green: losses suffered by external creditors of banks

~360 bn of Mexican pesos

Shock (in mln of Mex. pesos) under a mild policy scenario [RefPol-500, GCAM, R=0.5, σ=1.0, α=ln(4/3), VaR=1%].

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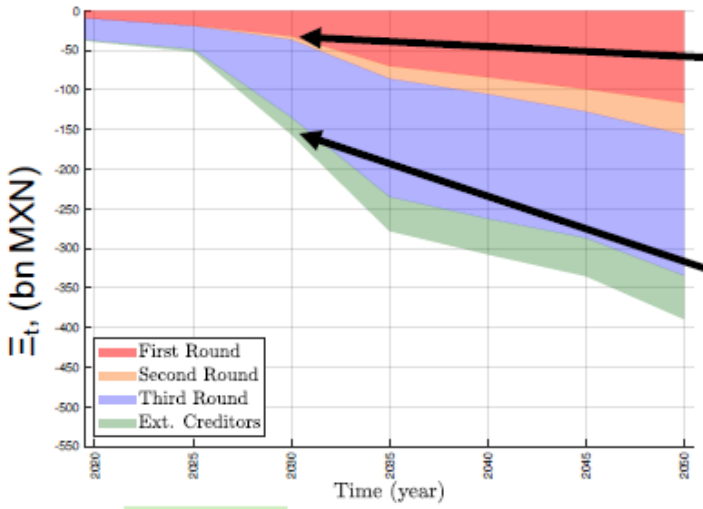
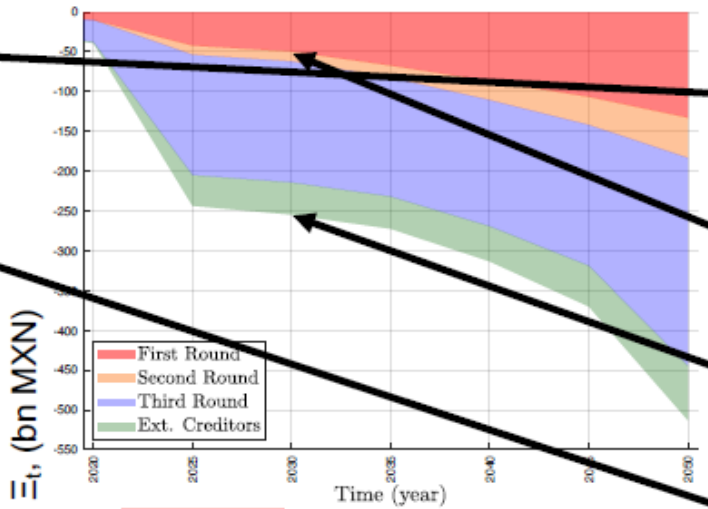
Scenarios are identified by StrPol, RefPol and 450, 500. The number refers to part per million of CO2-equivalent concentrations in 2100.

Results: policy implication I



(a) StrPol-500, $R = 0.49334$, $\sigma = 0.90776$



(b) StrPol-450, $R = 0.50470$, $\sigma = 0.90235$

~30 bn of Mexican pesos

~50 bn of Mexican pesos

~250 bn of Mexican pesos

~160 bn of Mexican pesos

Under the same market conditions (R, σ), a stricter climate policy scenario triggers larger shocks for the financial system.

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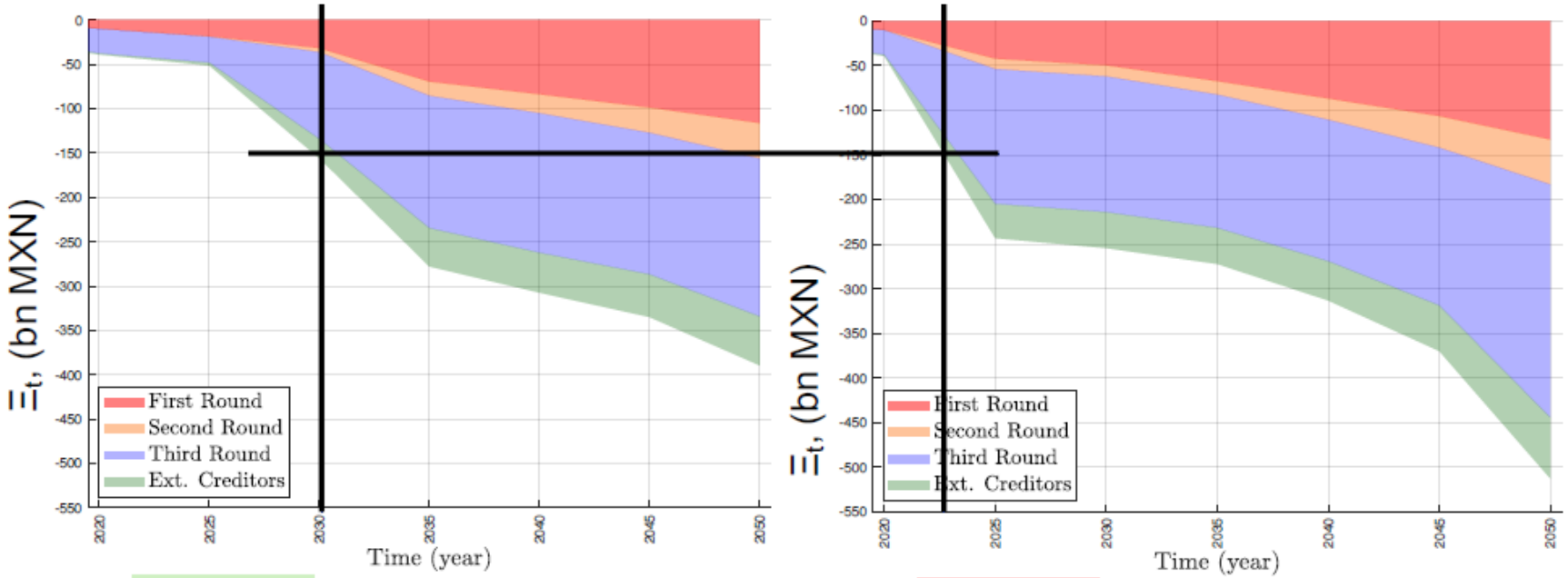
Results: policy implication II



(a) StrPol-500, $R = 0.49334$, $\sigma = 0.90776$

(b) StrPol-450, $R = 0.50470$, $\sigma = 0.90235$

Under the same market conditions, the disorderly transition to a stricter scenario may lead to the same level of losses if the alignment occurs earlier.

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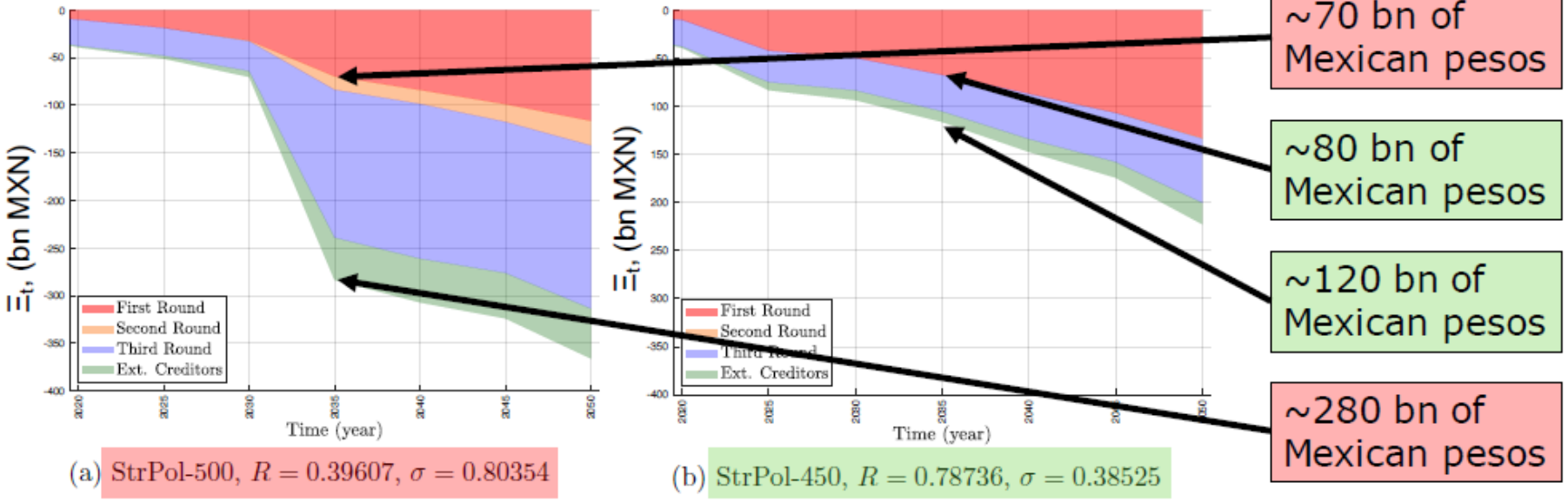
Results: policy implication III



(a) StrPol-500, $R = 0.39607$, $\sigma = 0.80354$

(b) StrPol-450, $R = 0.78736$, $\sigma = 0.38525$

If market conditions (R, σ) are less risky, aligning to a more stringent climate policy scenario might lead to lower losses than aligning to a less stringent climate policy scenario.

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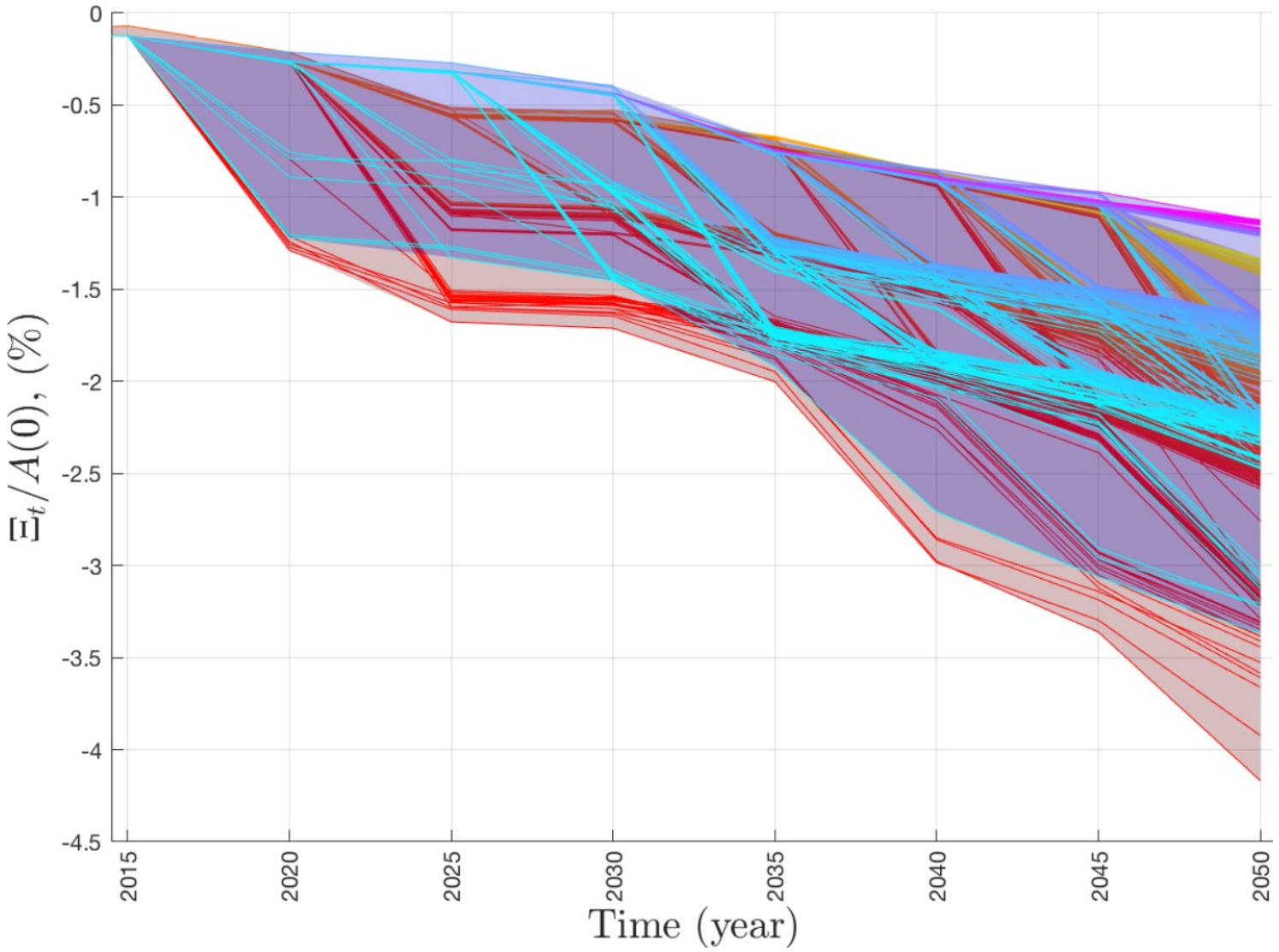
All trajectories for different parameters



Conclusions and key messages

C1 First combination of Climate Stress-test (Battiston et al. 2017) with Network Valuation of Financial Assets (Barucca et al. 2017) and common assets contagion (Greenwod et al. 2015, Poledna et al. 2021).

C2 Analytical and empirical relations on impact on financial stability from interplay btw 1) climate policy shocks and 2) financial market conditions including banks and funds.

F1 Policy insight I: in the face of possible disorderly transition, incentives of financial institutions to engage earlier, under the same market conditions.

F2 Policy implication II: possible to reach tighter climate policy target, at same level of risk if market conditions are strengthened enough.

Next steps

- The methodology is being adapted to the climate analysis scenarios NGFS and a suit of models: GCAM, Climrisk and GEMMES
- Two exercises will be performed:
  - Top-Down (by the financial authorities)
  - Bottom-Up (by individual financial authorities)
- The analysis includes physical risk by using an IAM which is focused on physical risk (Climrisk)
- There is an additional scenario being developed in which the world moves to a Net Zero Transition by 2050 but México continues with its current policies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CPRS

- The assessment of transition risk of a financial portfolio requires to classify the economic activities underlying the assets in the portfolio (e.g. the production of the firms that are financial counterparties of the securities in the portfolio) and to match them to the trajectories of the NGFS scenarios.
- To this end, the classification known as Climate Policy Relevant Sectors (CPRS), was introduced in Battiston et al. (2017) and it has been applied by financial authorities in several studies on transition risk including the ECB (EIOPA, 2019), and ESMA (ESMA, 2020). The CPRS classification allows also for identifying the portion of a financial portfolio exposed to transition risk.