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

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Outline

- Motivation

- Research questions contribution

- Model

- Results

- Conclusions

Motivation

o After the Paris agreement there is a wide consensus on the need to introduce climate related policies in order to achieve the 2°C objective.

o There are concerns that the climate policies could cause inadvertent consequences in the economy and the financial system.

o There is the risk of a disorderly transition to a low-carbon economy.

o An adequate assessment of climate-related financial risk is of great interest for policy makers around the globe

o There are no widely accepted stress testing frameworks for climate risks in the financial sector.

Research questions

o Q1 How do we build a science-based climate stress-test of the financial system?

o 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?

o Q3 What are the policy insights that we can expect from a climate stress-test?

Contributions

- C1 First combination of Climate Stress-test (Battiston ea. 2017 Nature Clim. Change) with Network Valuation of Financial Assets (Barucca ea. 2020, Math Fin.) and overlapping portfolios associated losses (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 implication I: in the face of possible disorderly transition financial institutions have incentive 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.

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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) - supervisory data

3. Second round: Network valuation of intra financial claims (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, Poledna et al. 2021).

5. Fourth round: losses too large to be absorbed by banks' capital and are transmitted to external creditors (Roncoroni ea. 2019 ECB WP).

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Methodology, building on:

o Climate stress-test (Battiston et al. 2017; Monasterolo et al. 2018):

- o disorderly transition: temporary transition between equilibria of economic trajectories consistent with different climate policies

- o shocks on financial assets: derived from shocks on GVA and revenues

o Network financial valuation of claims (NEVA, Barucca ea. 2020) and (DebtRank, Battiston et al. 2012; 2015)

- o standard finance valuation assumptions + fund contagion model

o Common assets contagion (Greenwood et al. 2015, Poledna et al. 2021)

- o Overlapping portfolios + asset fire sales

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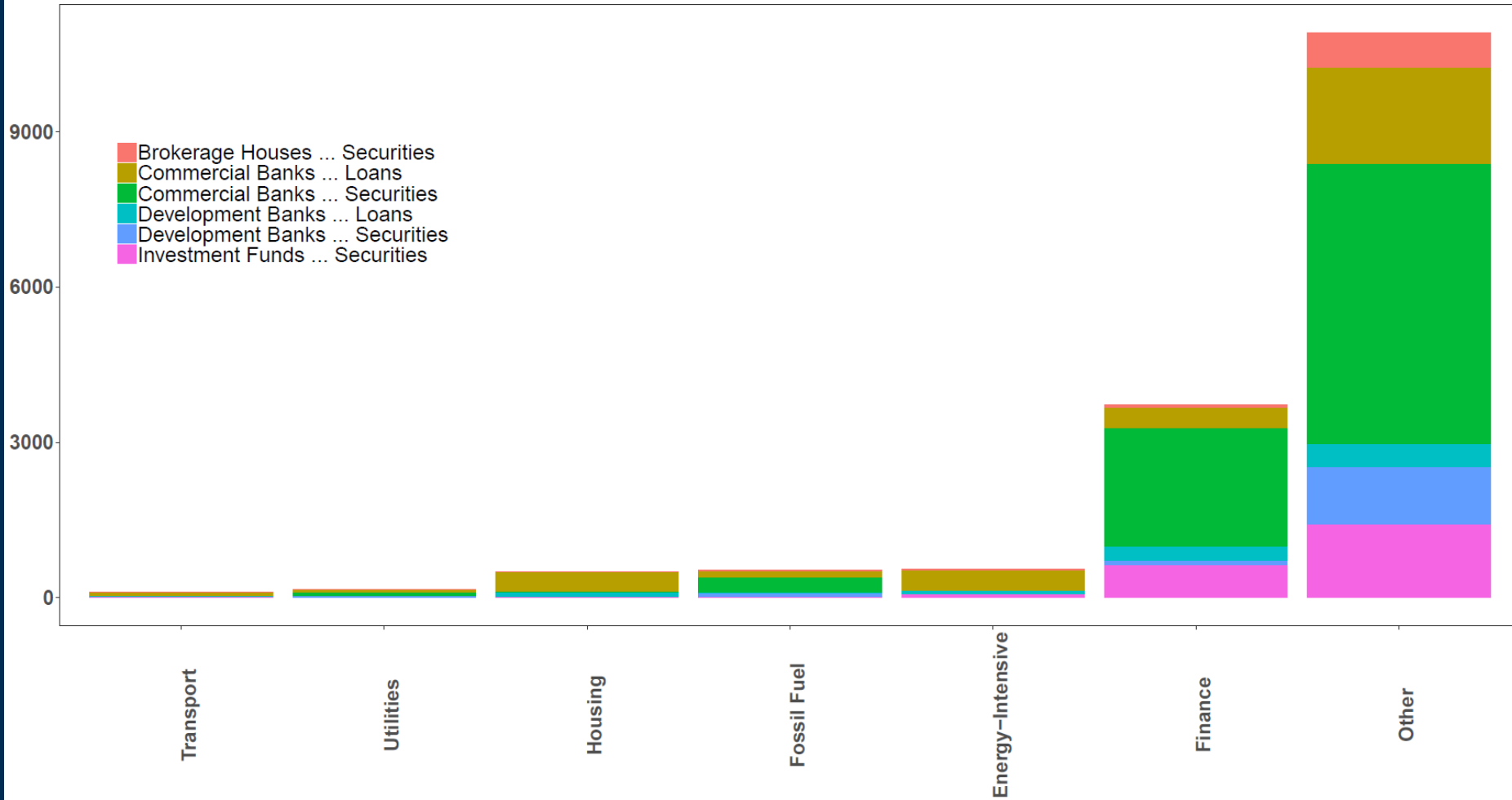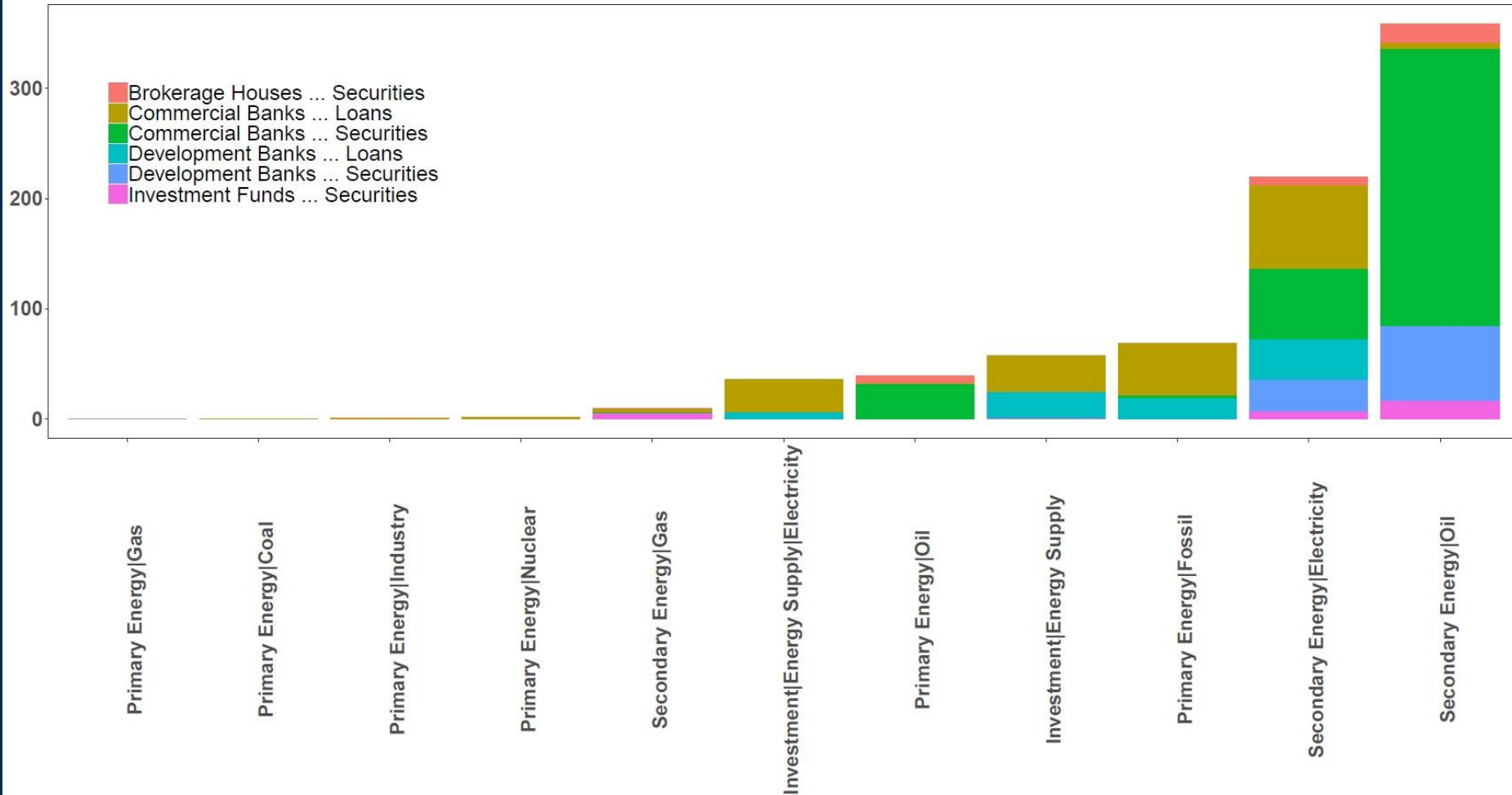# Systemic risk from overlapping portfolios
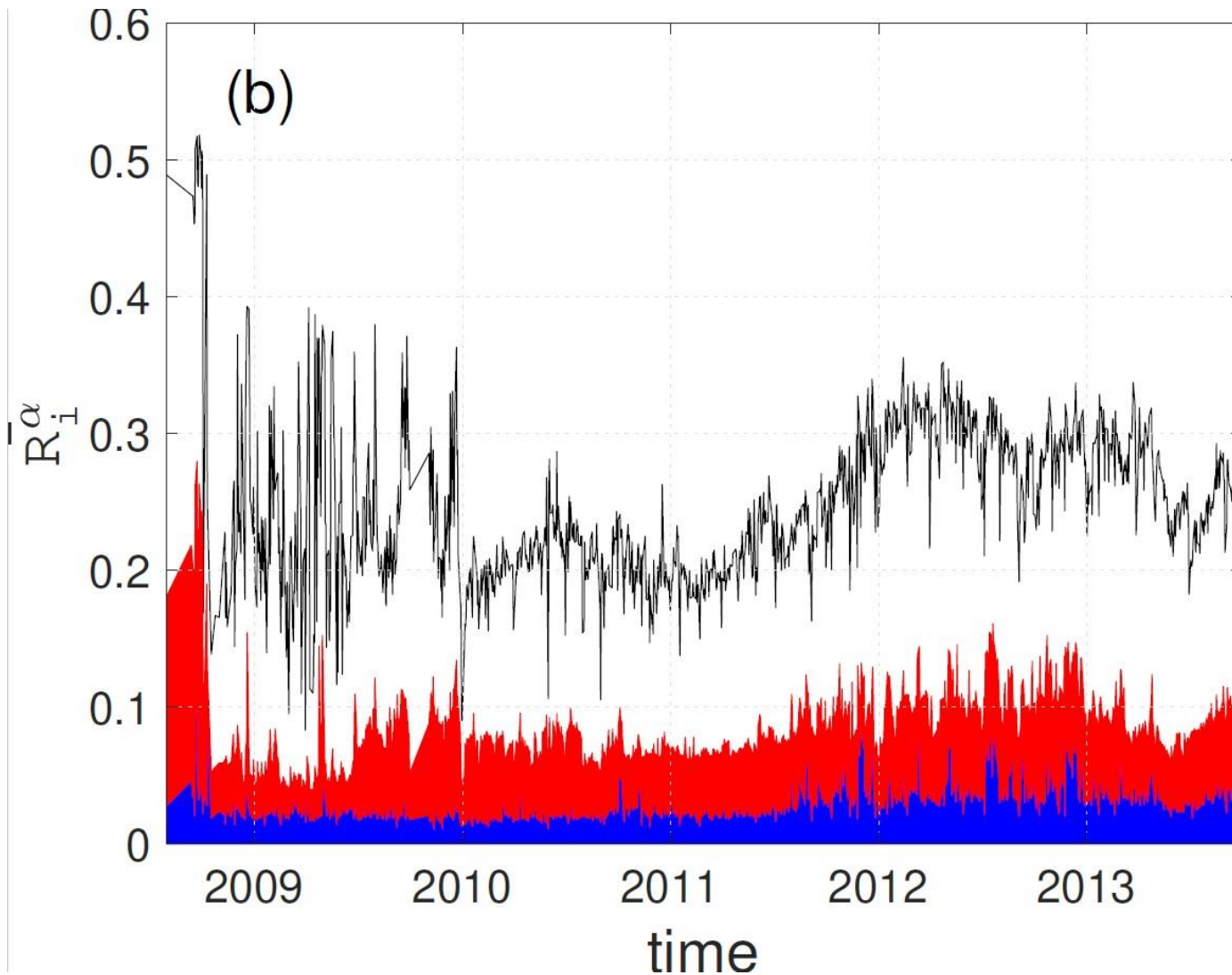
Banking system profile
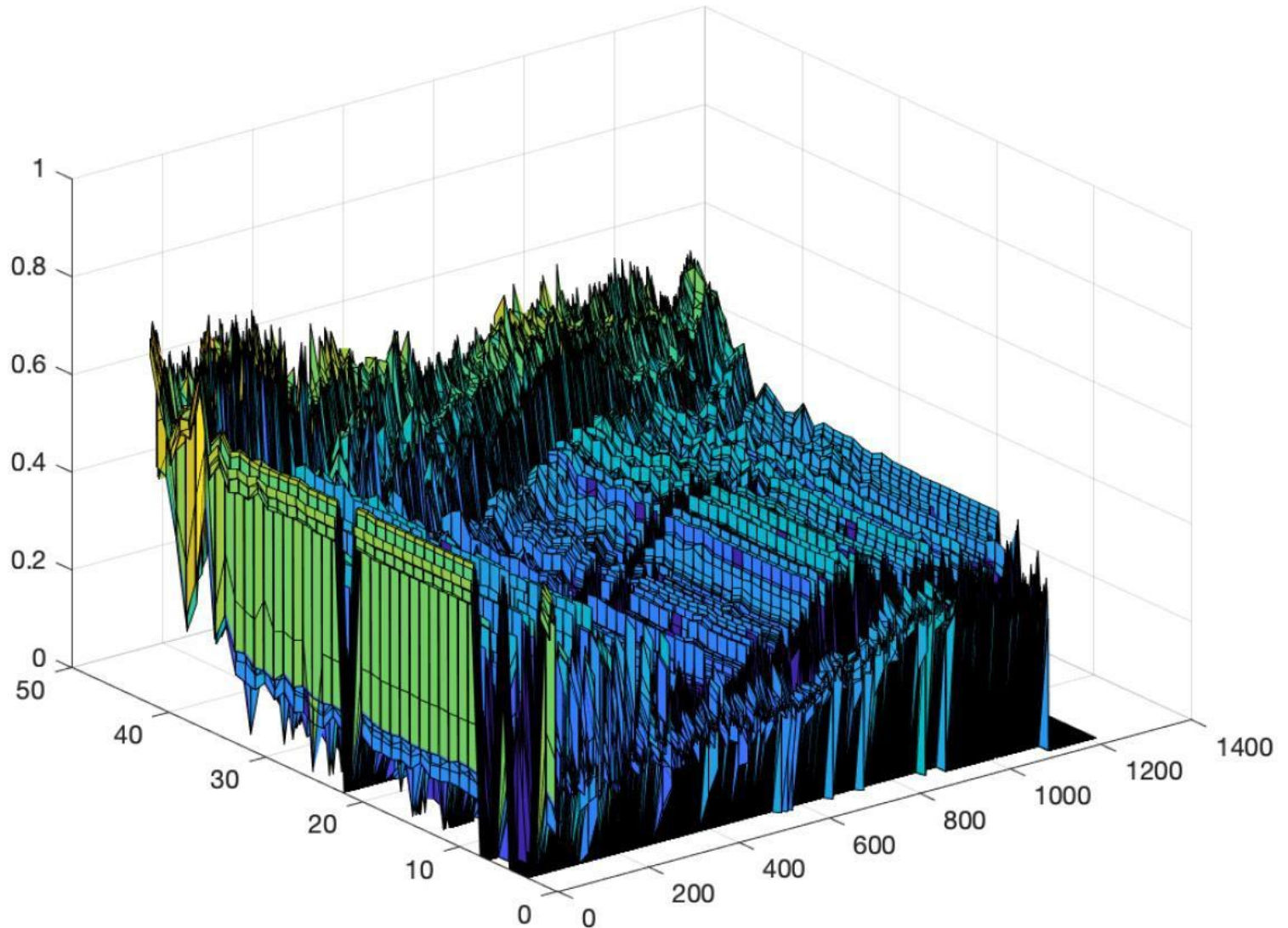
Data

- Economic trajectories from set of 6 climate economic models and 9 scenarios (IAM, LIMITS)

- 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 CPRS, interbank exposures and exposures among investment funds and banks.
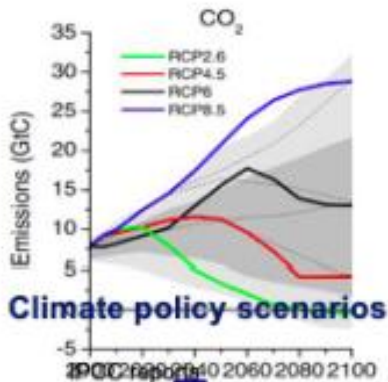
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Exposures to CPRS by type of exposure

Legend:
- Brokerage Houses ... Securities
- Commercial Banks ... Loans
- Commercial Banks ... Securities
- Development Banks ... Loans
- Development Banks ... Securities
- Investment Funds ... Securities

Categories: Transport, Utilities, Housing, Fossil Fuel, Energy-Intensive, Finance, Other

Exposures LIMITS by type of exposure

Legend:
- Brokerage Houses ... Securities
- Commercial Banks ... Loans
- Commercial Banks ... Securities
- Development Banks ... Loans
- Development Banks ... Securities
- Investment Funds ... Securities

Categories (x-axis):
- Primary Energy|Gas
- Primary Energy|Coal
- Primary Energy|Industry
- Primary Energy|Nuclear
- Secondary Energy|Gas
- Investment|Energy Supply|Electricity
- Primary Energy|Oil
- Investment|Energy Supply
- Primary Energy|Fossil
- Secondary Energy|Electricity
- Secondary Energy|Oil

Climate stress test framework

Climate policy scenarios

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)
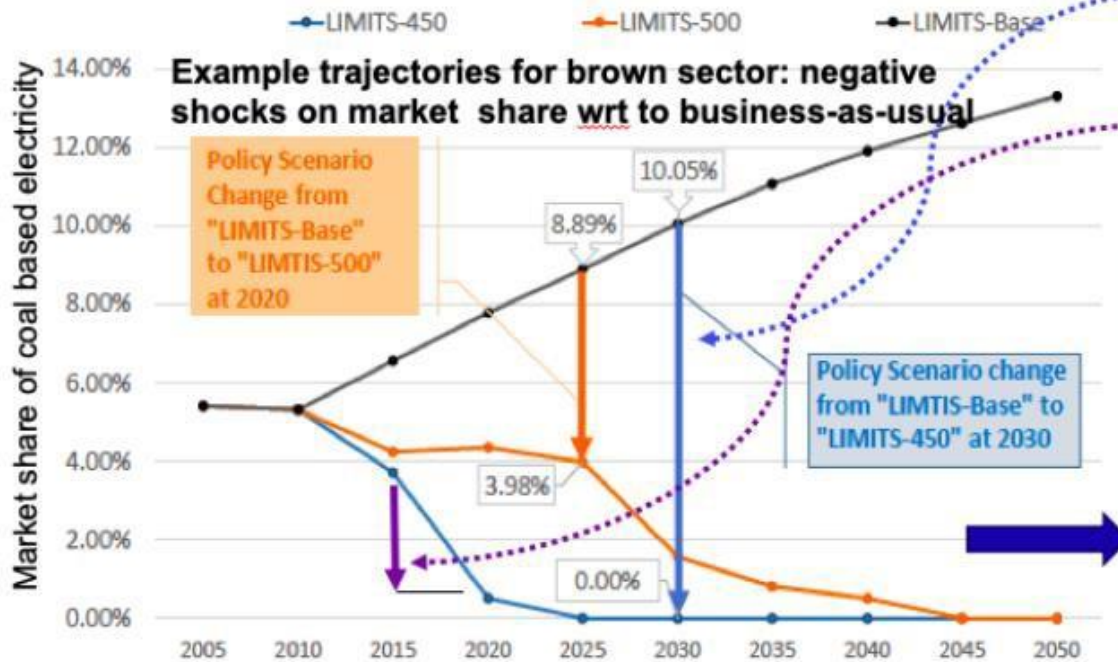→ shocks on value of financial instrument dependent on issuer firm

Output scenarios energy sectors

[source: LIMITS Kriegler ea. 2013]
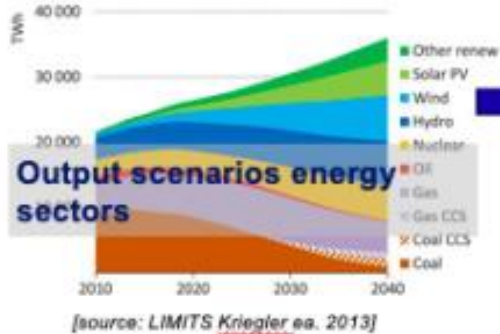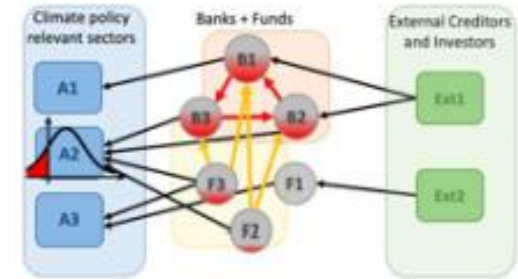
Disorderly transition
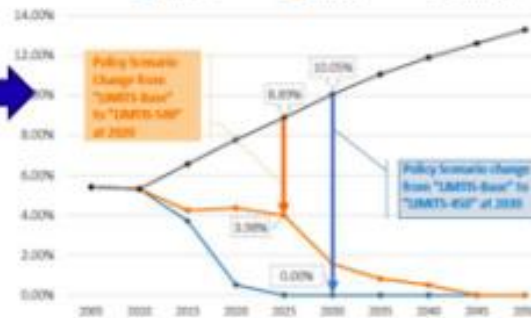
Adjustment of gain/losses distr. → Value at Risk

Value at Risk

Disorderly transition

Example trajectories for brown sector: negative shocks on market share wrt to business-as-usual
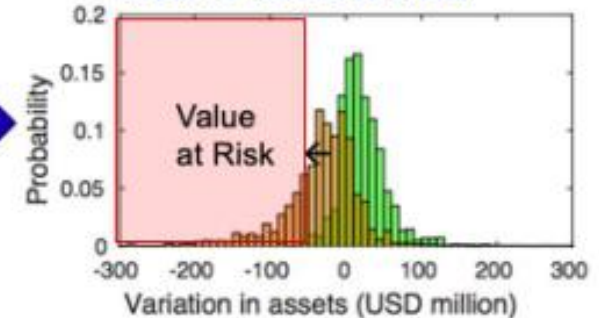
Method 2: cross-sectional: across trajectories (Monasterolo ea. 2018 JCWE; Battiston&Monasterolo 2018)

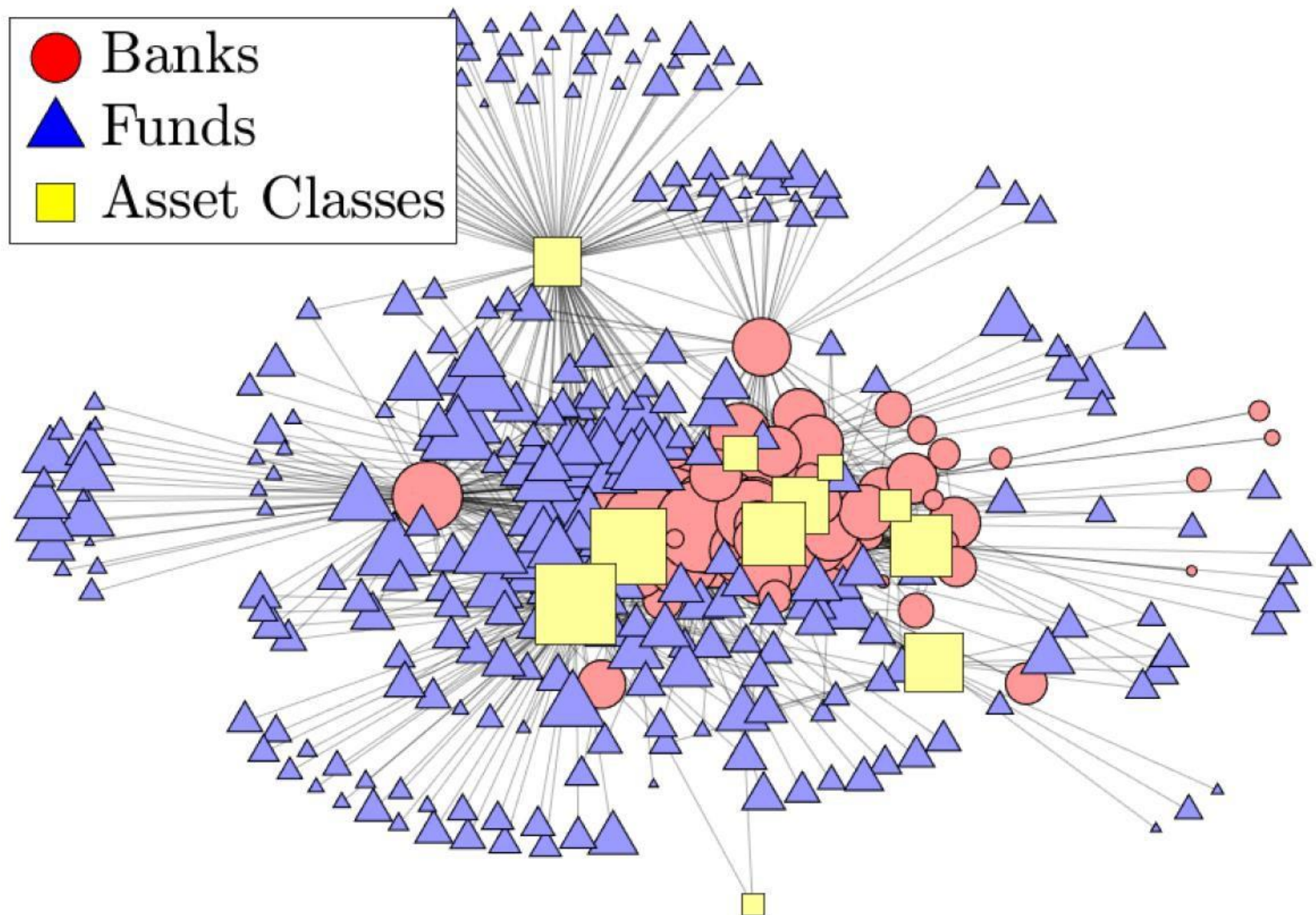Method 1: longitudinal: along trajectories (Battiston ea. 2017 NCC)
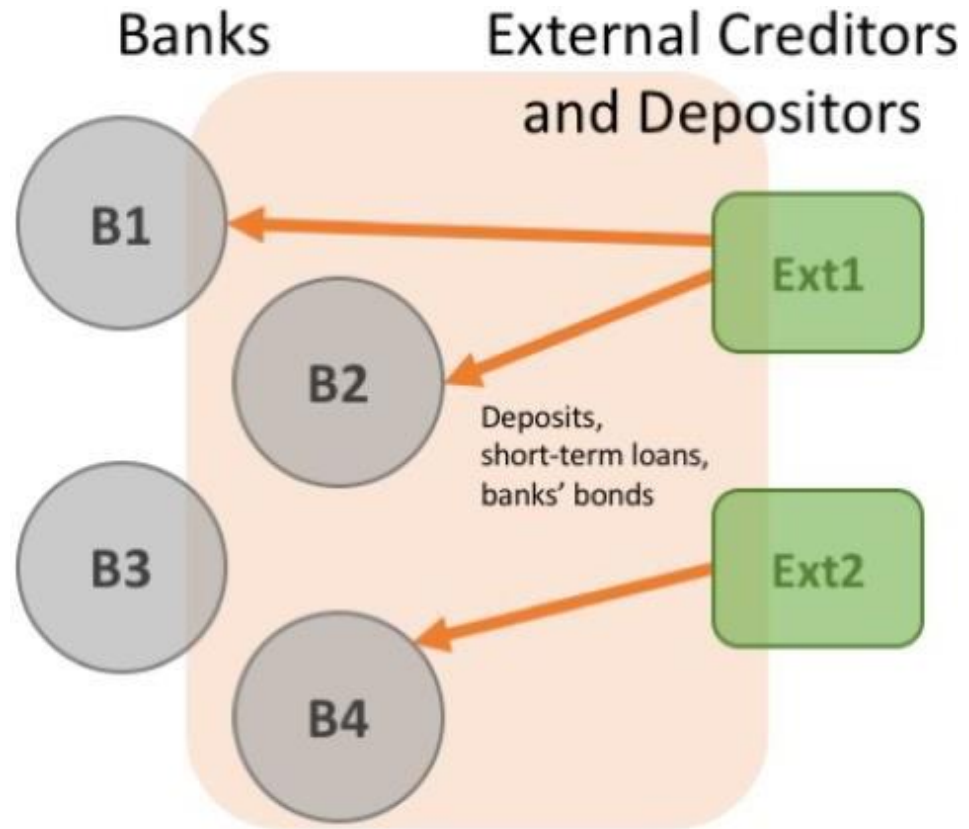
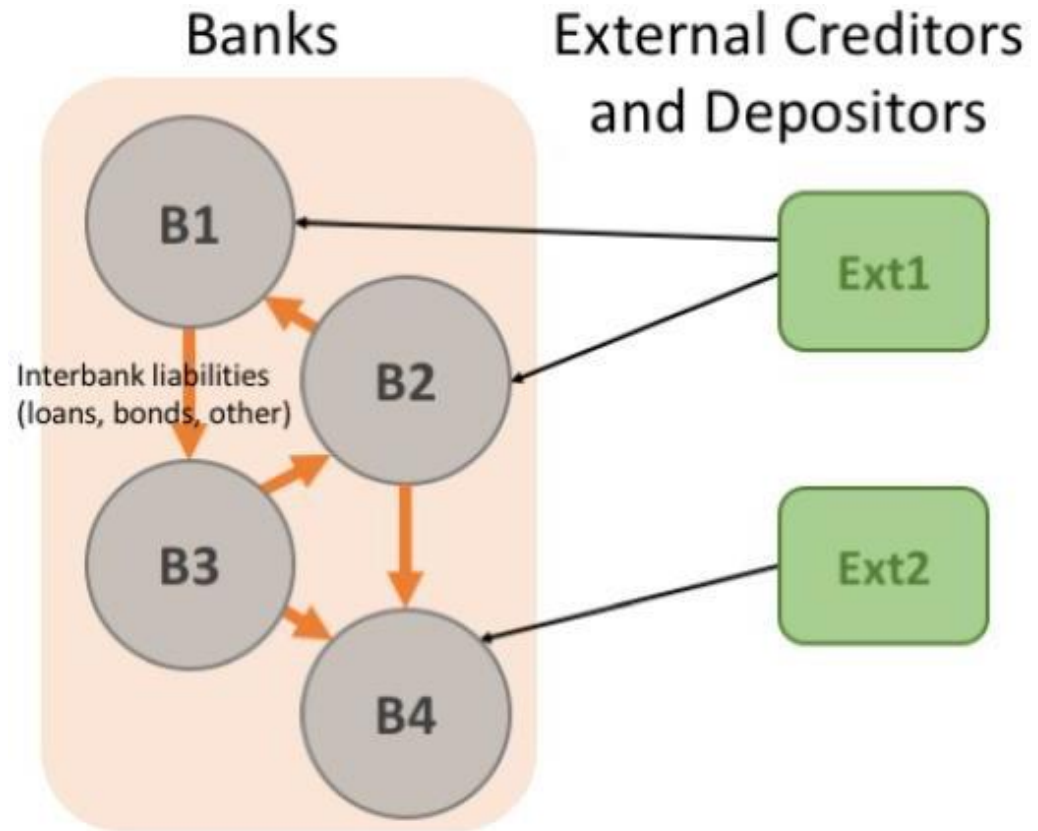Gain/losses probability distribution → Value at Risk
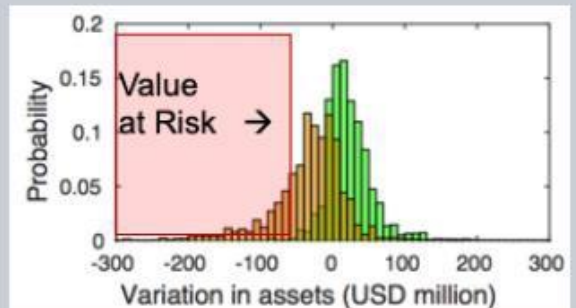
Distress propagation
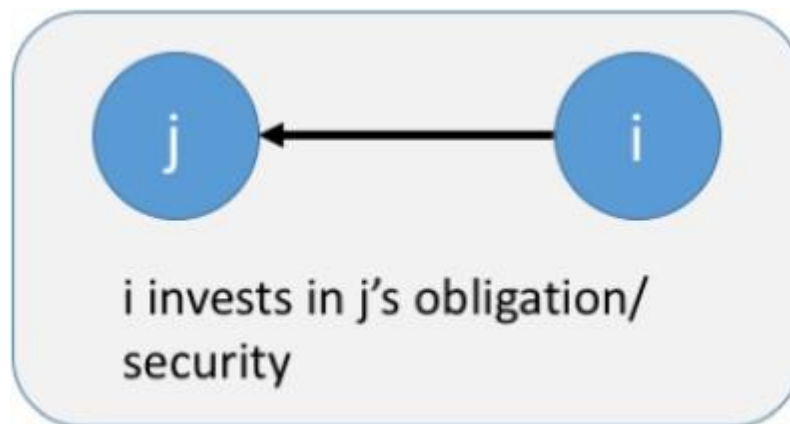
i invests in j's obligation/
security

The financial network

Legend:
- **Banks** (red circle)
- **Funds** (blue triangle)
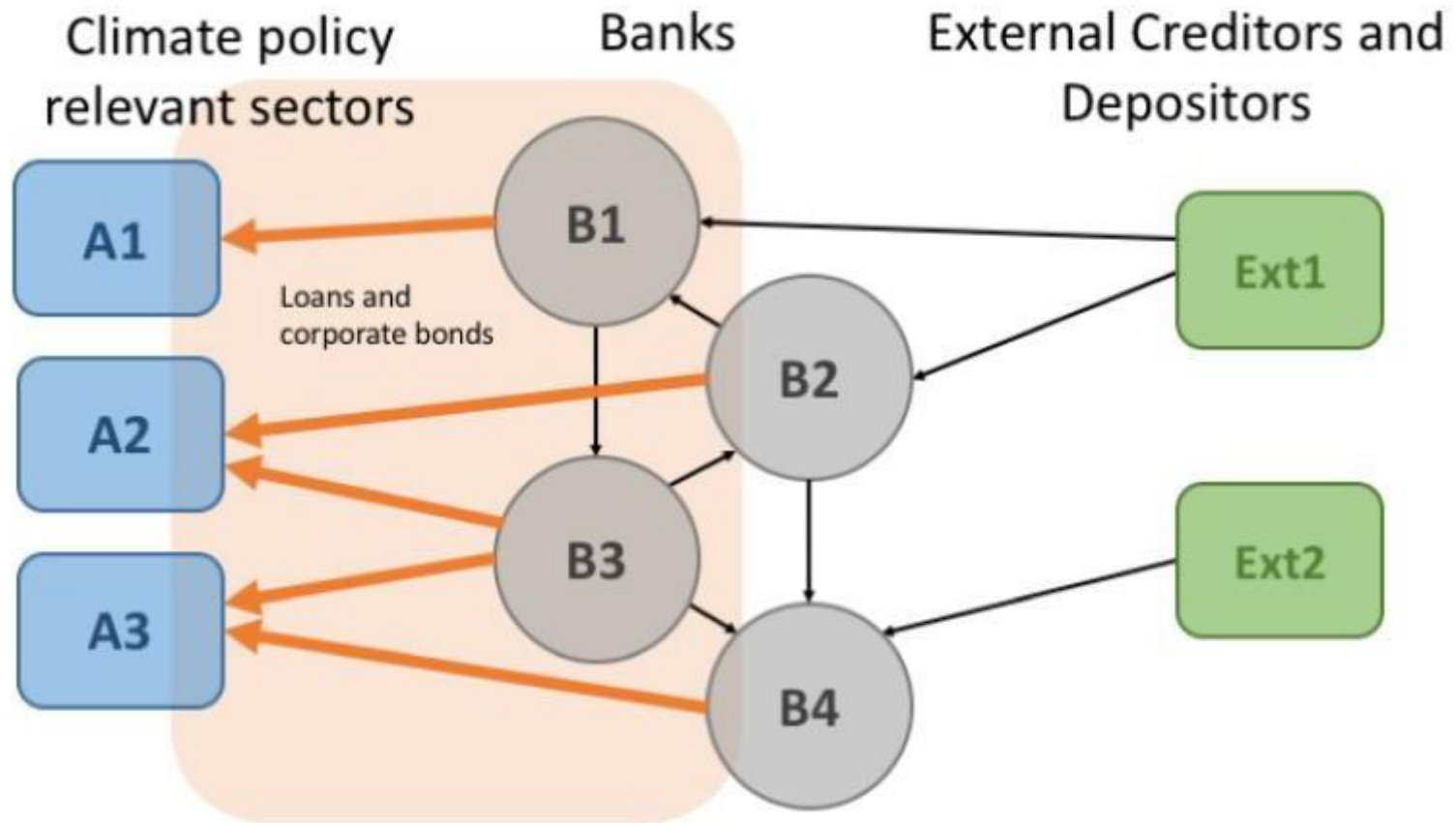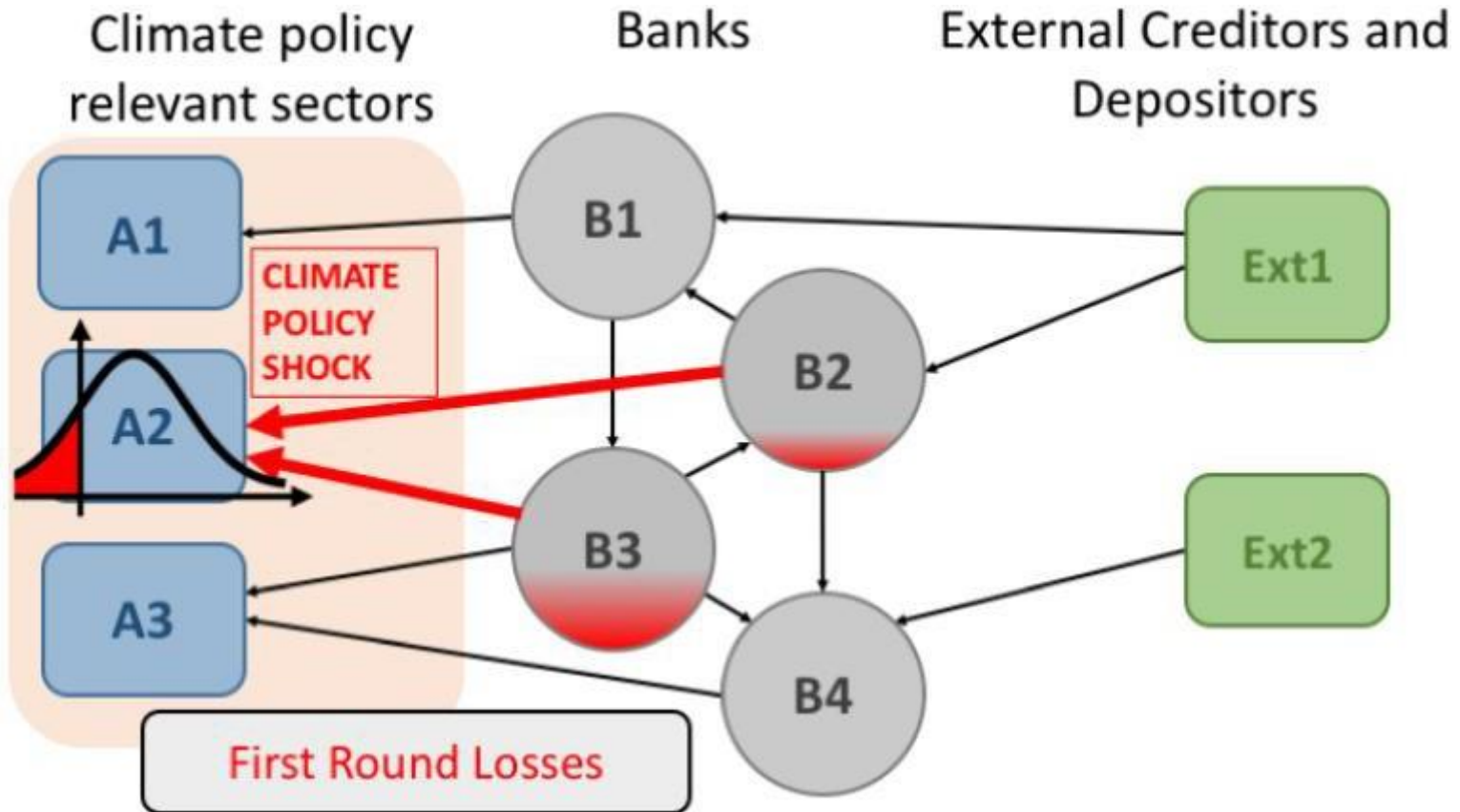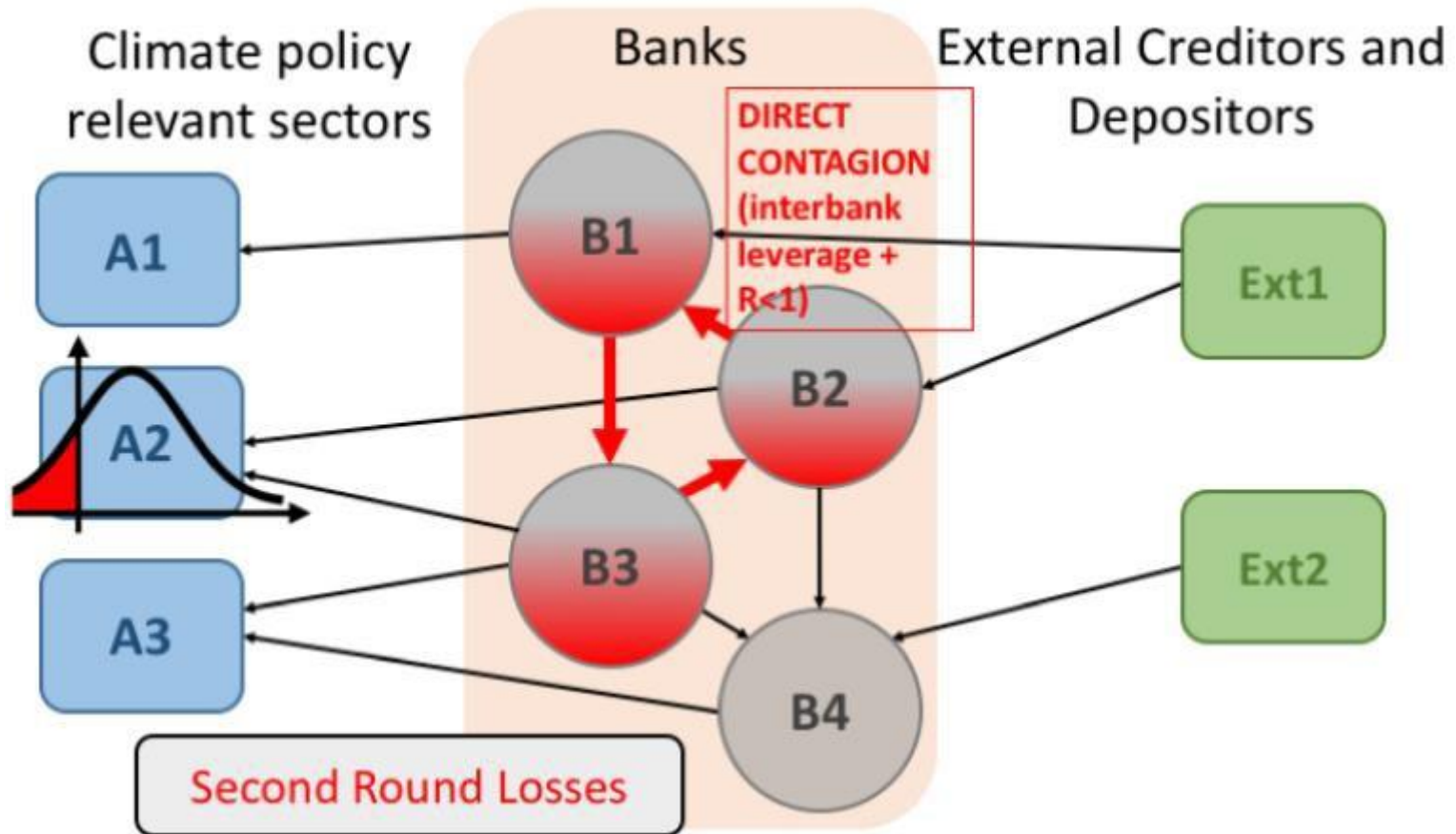- **Asset Classes** (yellow square)

Distress propagation via banks

Distress propagation via banks
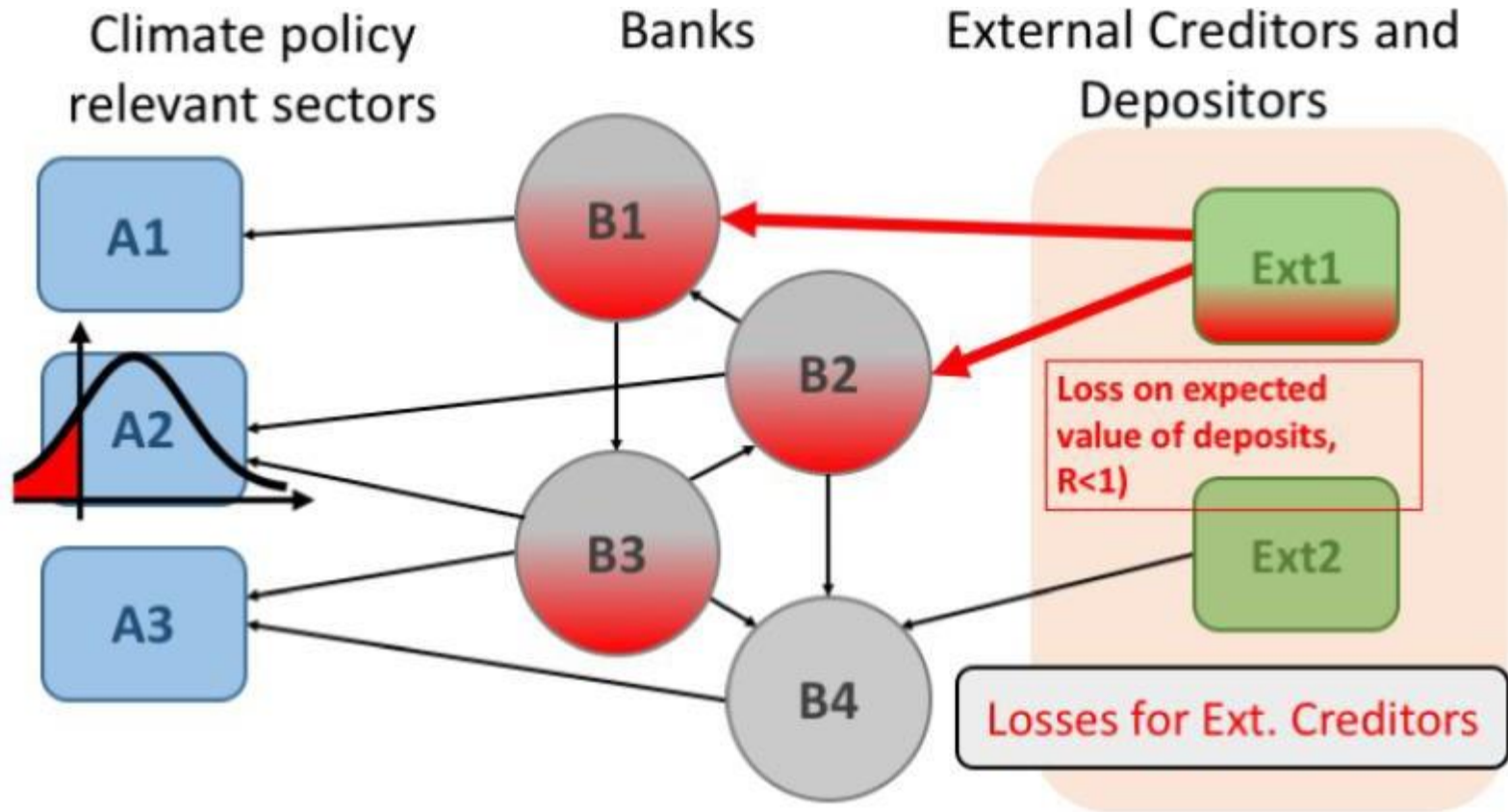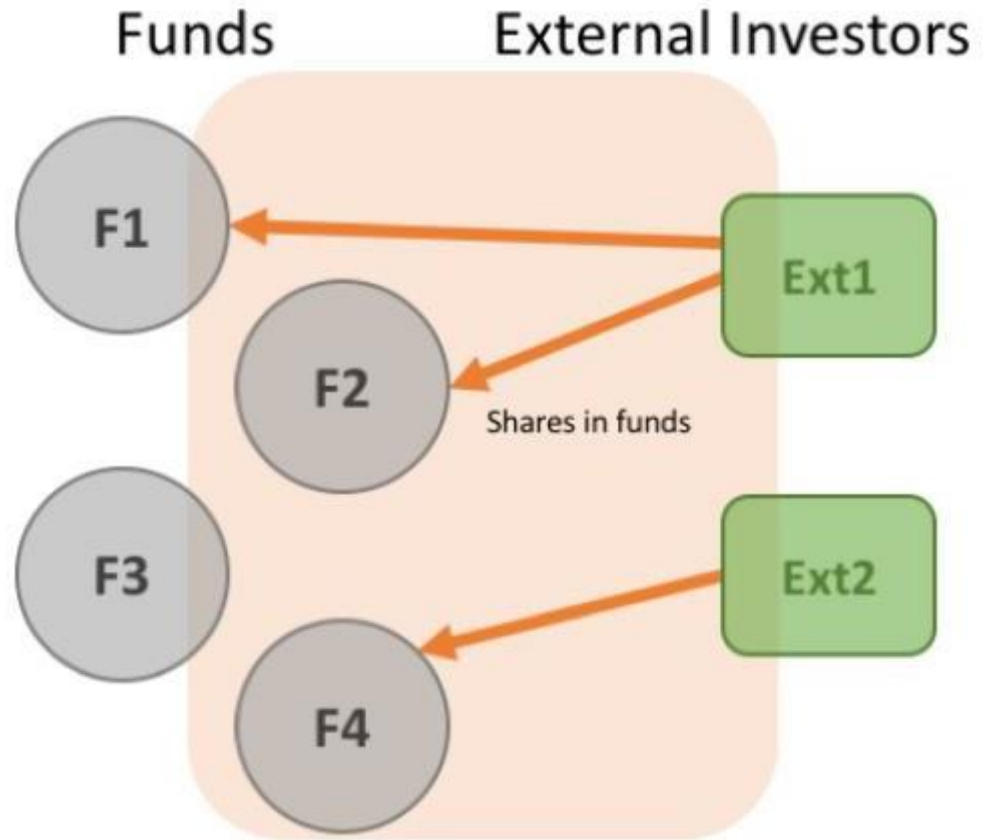
Distress propagation via banks
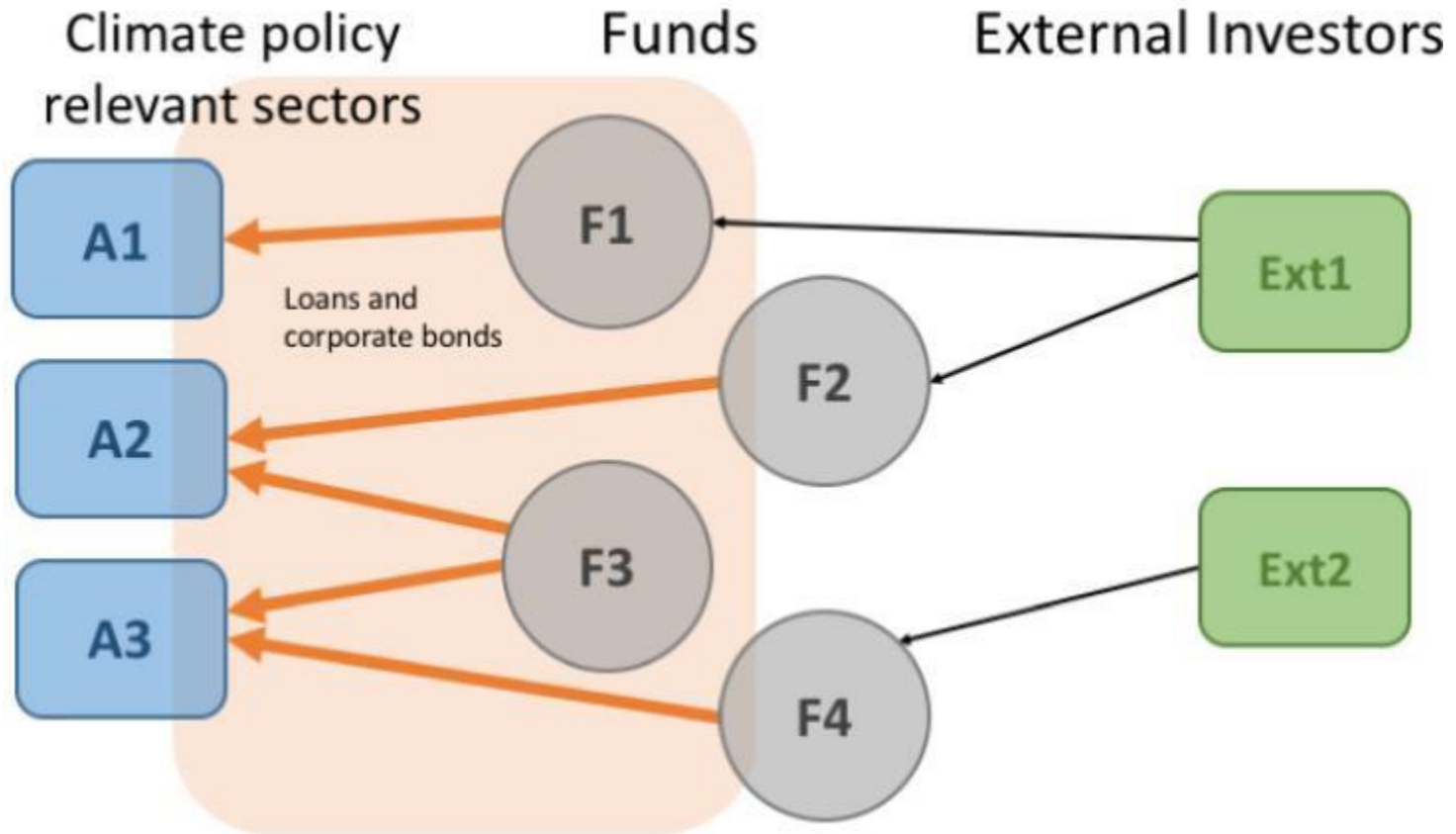
Distress propagation via banks

Distress propagation via banks

Climate policy relevant sectors — A1, A2, A3

Banks — B1, B2, B3, B4

DIRECT CONTAGION (interbank leverage + R<1)

External Creditors and Depositors — Ext1, Ext2

Second Round Losses
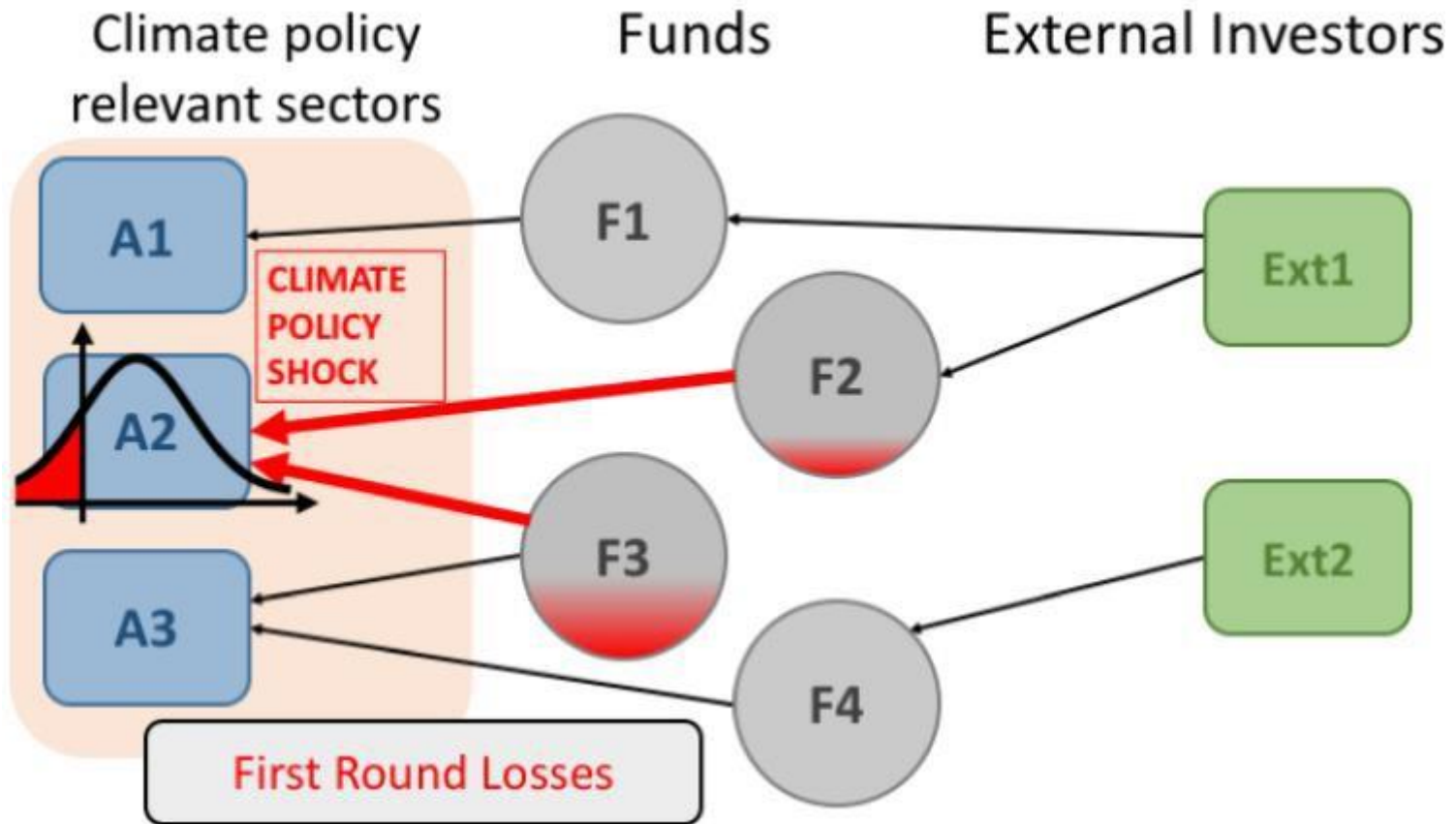
Distress propagation via banks
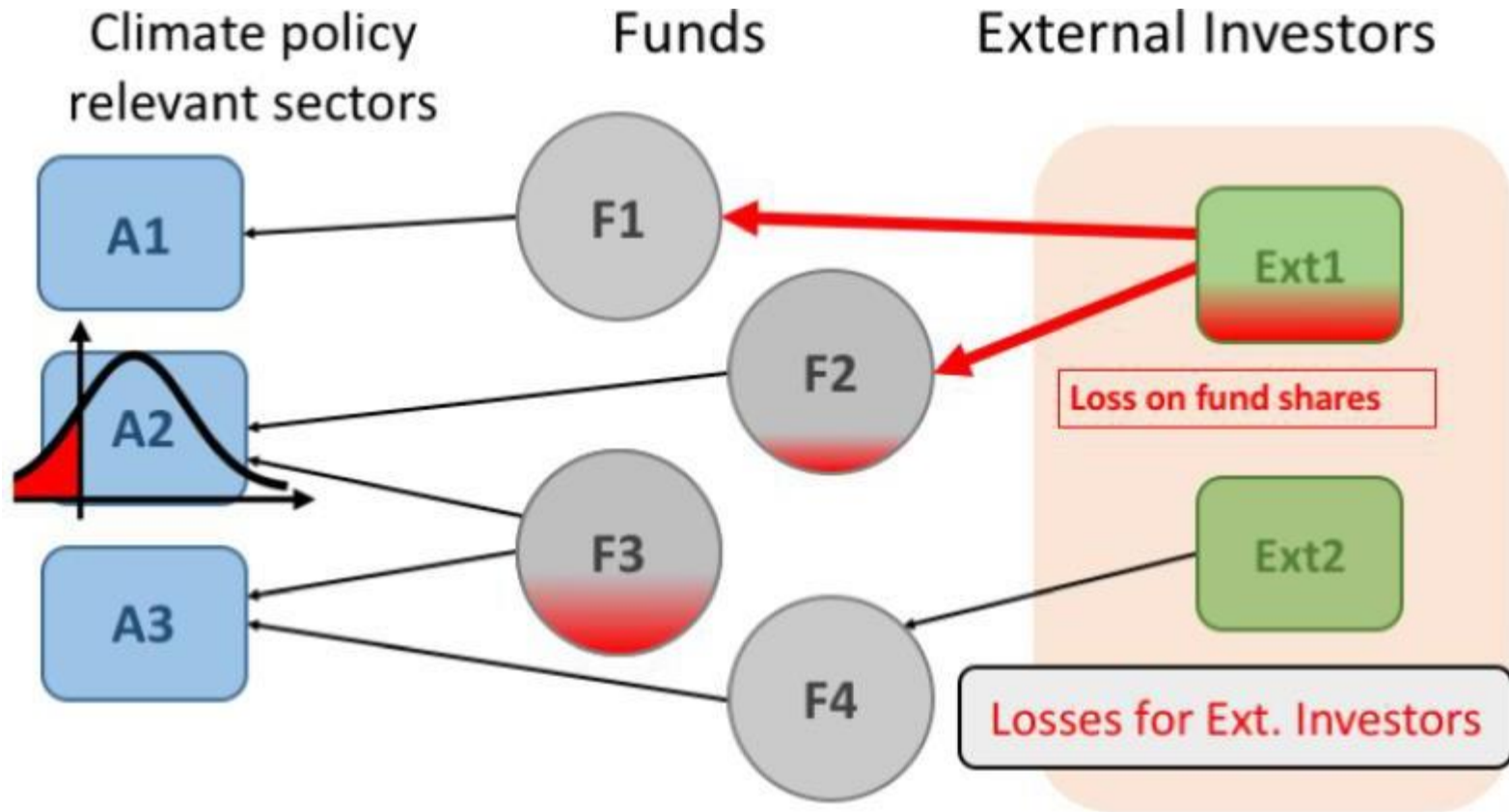
Distress propagation via funds
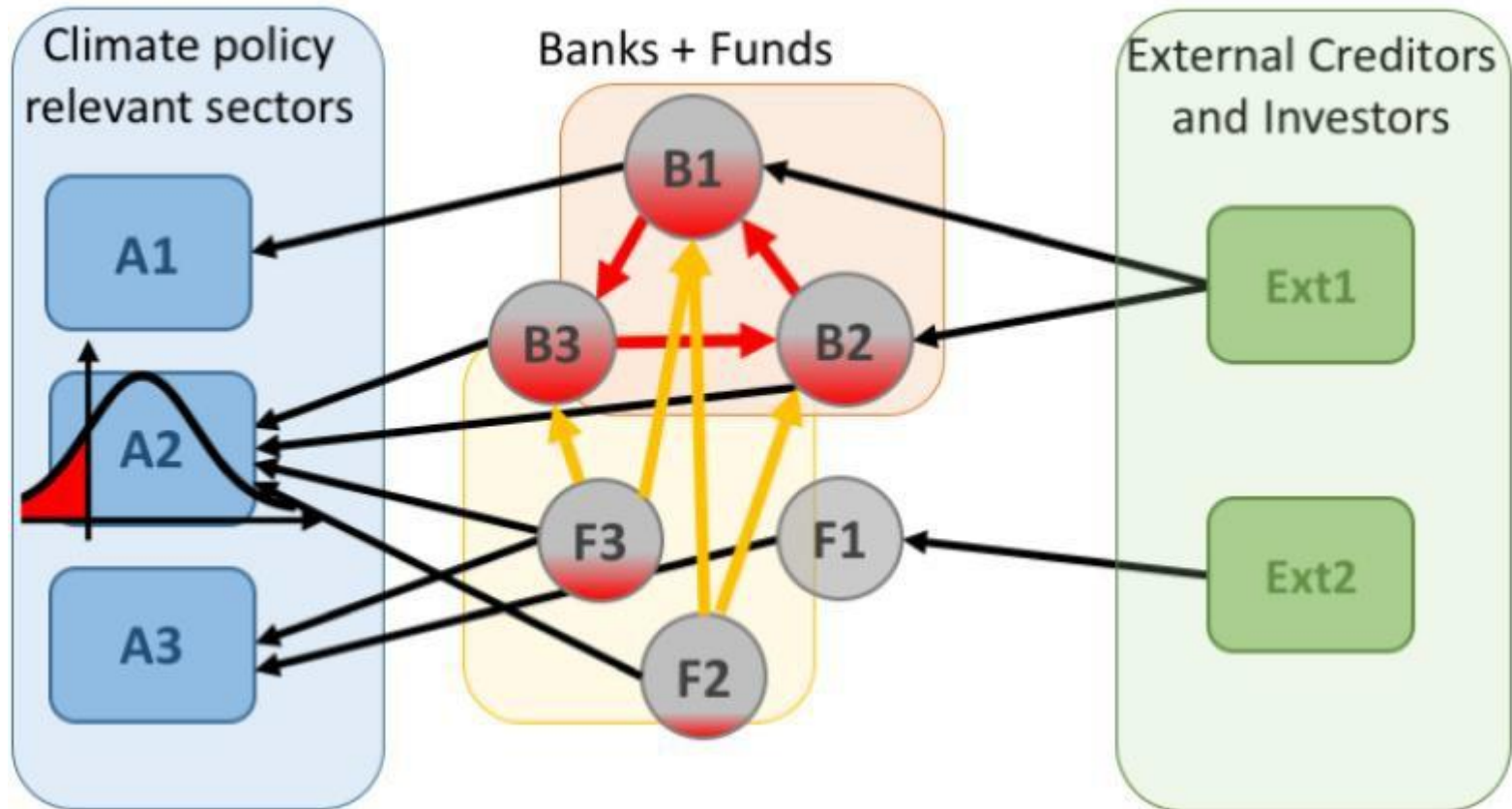
Distress propagation via funds
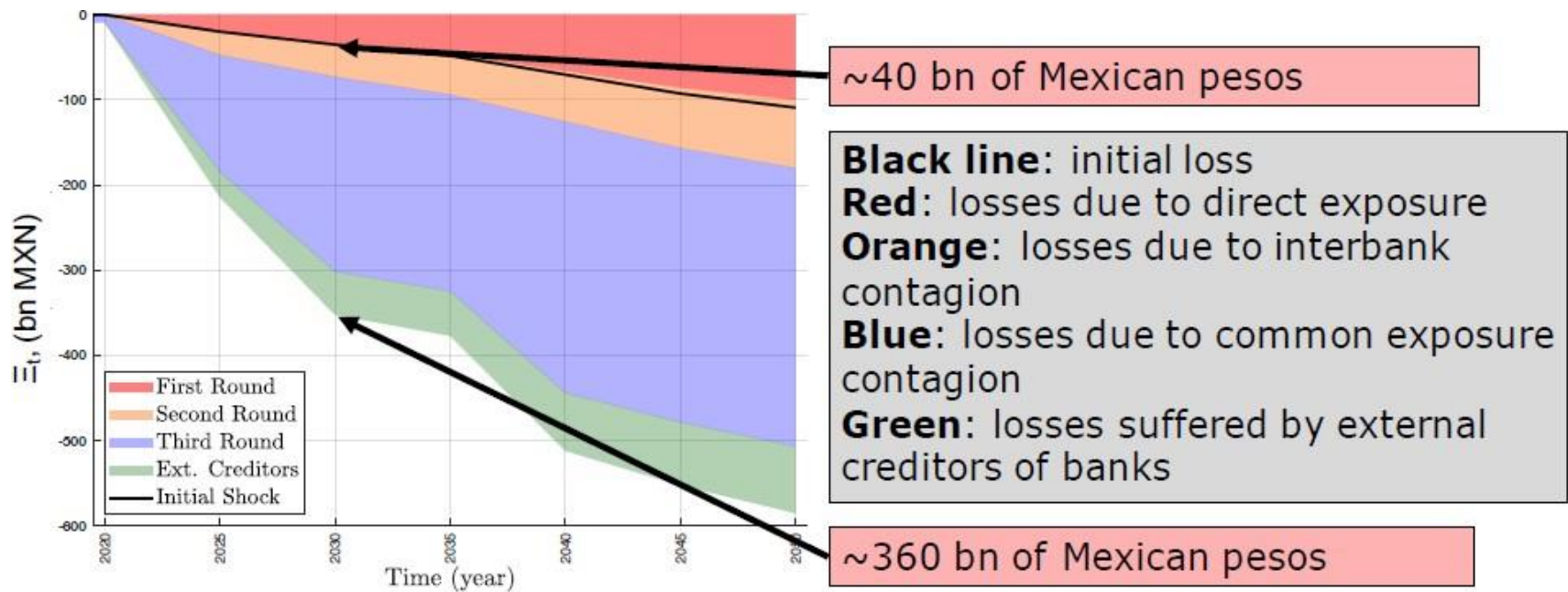
Distress propagation via funds

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, a=ln(4/3), VaR=1%].

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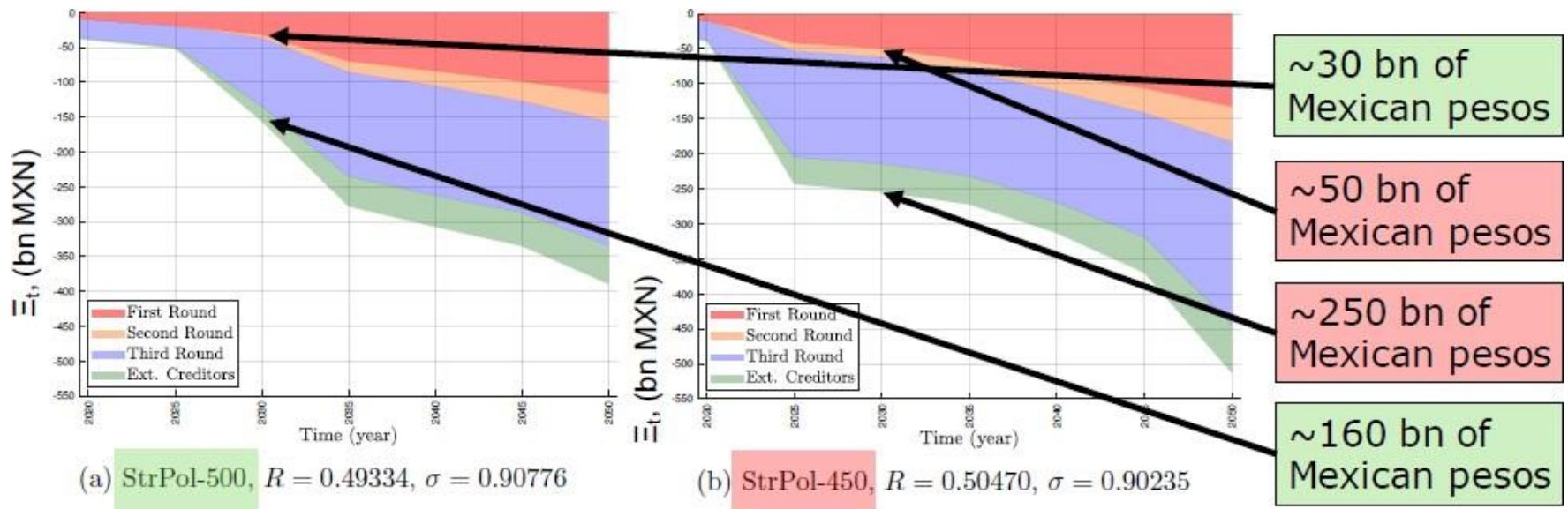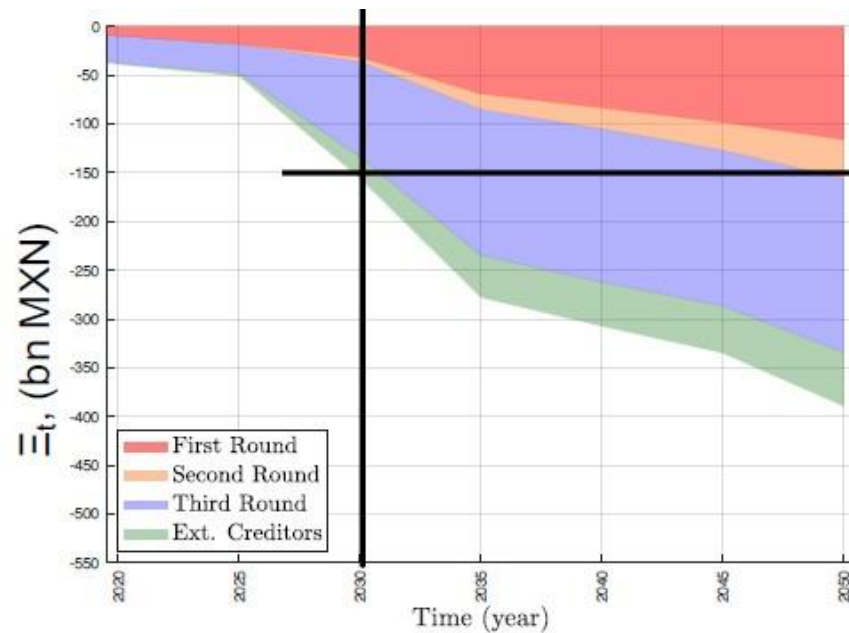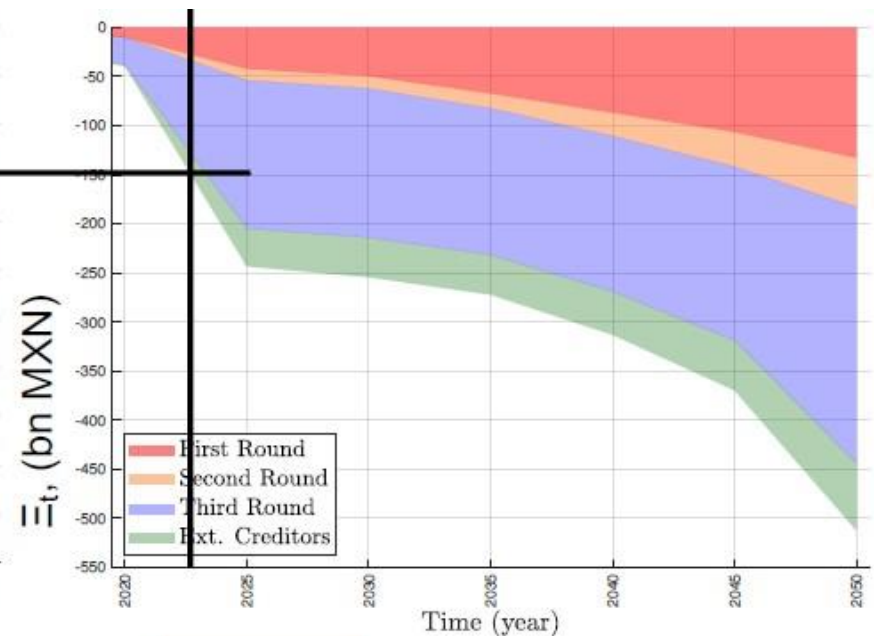
Under the same market conditions (R, σ), a stricter climate policy scenario triggers larger shocks for the financial system.

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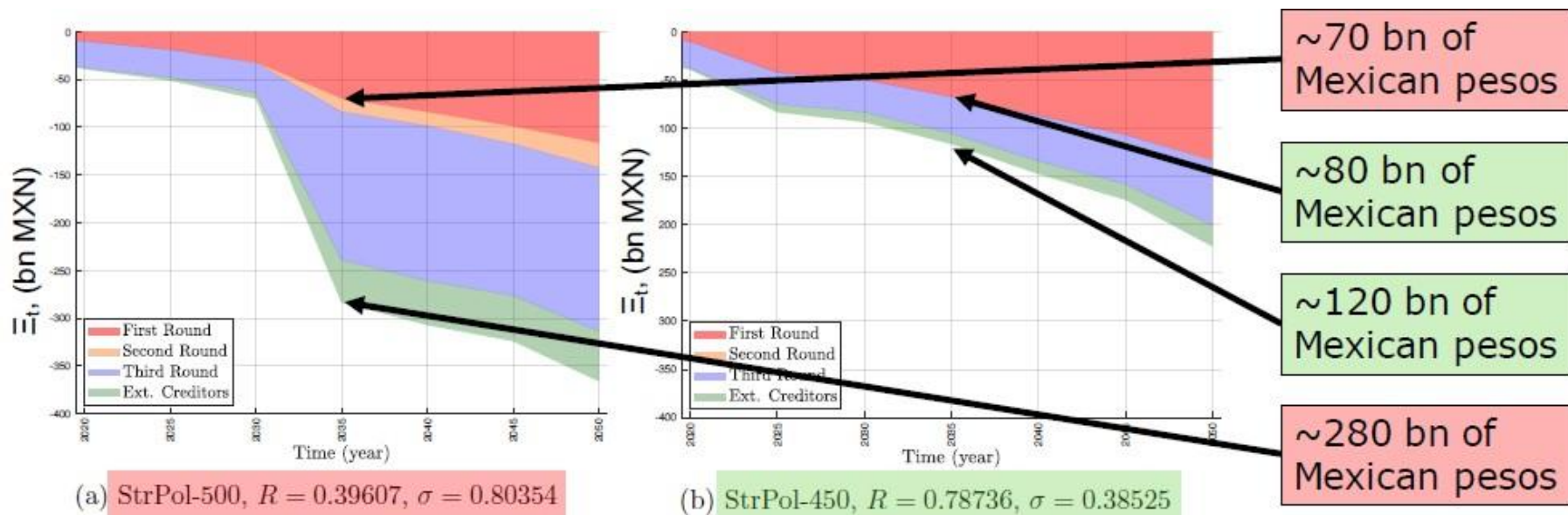
Results: policy implication II

(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, $R = 0.78736$, $\sigma = 0.38525$

~70 bn of Mexican pesos

~80 bn of Mexican pesos

~120 bn of Mexican pesos

~280 bn of Mexican pesos

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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Conclusions and key messages

- C1 First combination of Climate Stress-test (Battiston ea. Nature Clim. Change 2017) with Network Valuation of Financial Assets (Barucca ea. 2017, Math Fin., interbank claims in network of obligations).

- 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.

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