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

Serafin Martinez-Jaramillo (CEMLA and Banco de México) in collaboration with:

Alan Roncoroni (University of Zurich), Stefano Battiston (University of Zurich), Luis O. L. Escobar-Farfán (Banco de México)

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* The opinions expressed here are those of the authors and do not represent the views of Banco de México nor of CEMLA.
Outline

- Motivation
- Research questions contribution
- Model
- Results
- Conclusions
Motivation

- 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.
- 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.
Research questions

- Q1 How do we build a science-based climate stress-test of 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 stress-test?
Contributions


- 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.
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


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).
Methodology, building on:

- 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 ea. 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
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.
Exposures to CPRS by type of exposure

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

Transport
Utilities
Housing
Fossil Fuel
Energy-Intensive
Finance
Other
Exposures LIMITS by type of exposure
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

Adjustment of gain/losses distr. → Value at Risk

Value at Risk

Probability

Variation in assets (USD million)

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Disorderly transition

Example trajectories for brown sector: negative shocks on market share wrt to business-as-usual

Policy Scenario Change from "LIMITS-Base" to "LIMITS-500" at 2020
Policy Scenario change from "LIMITS-Base" to "LIMITS-450" at 2030

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

Value at Risk →
Distress propagation

The diagram illustrates the concept that entity $i$ invests in entity $j$'s obligation/security.
The financial network
Distress propagation via banks
Distress propagation via banks
Distress propagation via banks
Distress propagation via banks

Climate policy relevant sectors

A1

A2

A3

CLIMATE POLICY SHOCK

First Round Losses

Banks

B1

B2

B3

B4

External Creditors and Depositors

Ext1

Ext2
Distress propagation via banks

![Diagram showing distress propagation via banks.]

- **Climate policy relevant sectors**: A1, A2, A3
- **Banks**: B1, B2, B3, B4
- **External Creditors and Depositors**: Ext1, Ext2
- **Direct Contagion**: (interbank leverage + R<1)
- **Second Round Losses**
Distress propagation via banks
Distress propagation via funds
Distress propagation via funds

Diagram showing the interaction between climate policy relevant sectors (A1, A2, A3) and funds (F1, F2, F3, F4). Funds F1, F2, and F3 are linked to external investors (Ext1, Ext2) through loans and corporate bonds.
Distress propagation via funds

[Diagram showing interactions between climate policy relevant sectors, funds, and external investors, with labeled nodes and arrows indicating flow and shocks.]
Distress propagation via funds

Climate policy relevant sectors

A1

A2

A3

Funds

F1

F2

F3

F4

External Investors

Ext1

Loss on fund shares

Ext2

Losses for Ext. Investors
Distress propagation via banks and funds
Results, how to read them

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%].

~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
Results: policy implication I

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

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Results: policy implication II

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

If market conditions ($R$, $\sigma$) 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.

Roncoroni ea. 2019 - Climate risk and financial stability in the network of banks and investment funds
Conclusions and key messages


- **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.