Climate transition risks in Chile's banking industry: A loan-level stress test

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This project

Motivation

- There is no previous research estimating the impact of climate transition risks on the Chilean banking industry.
- Related documented exercises assume a carbon tax increase without considering the dependence among economic sectors.

Research idea

- Examine (1) the dynamics of the banking industry exposure to transition climate risks, and (2) estimate the cost of climate transition shocks on banks' profits: stress testing via credit risk.
- Unlike previous estimations, we incorporate climate stress scenarios with consistency across sectors, agents, and policy decisions.

Institutional framework: banks' loan portfolios by sector

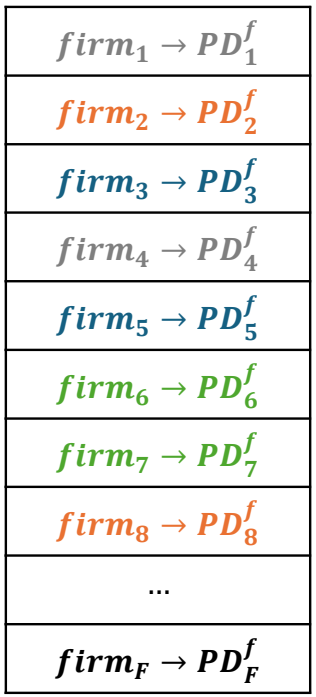


Fig. 1: Firms (f = 1, ..., F) with individual PD

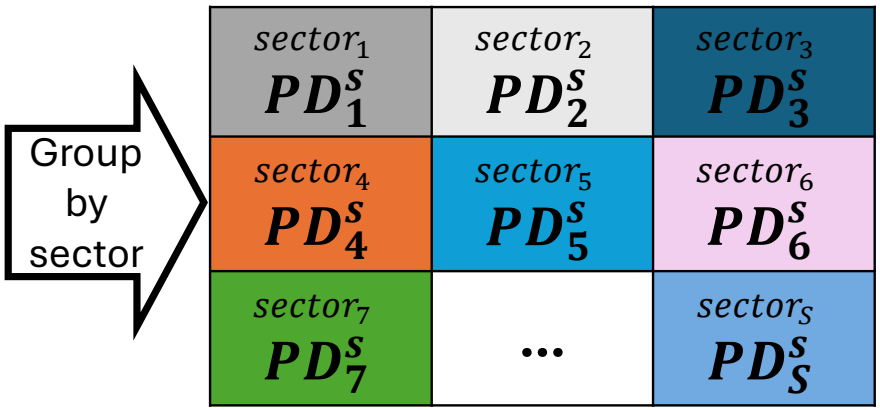


Fig. 2: Firms by sector (s = 1, ..., S)

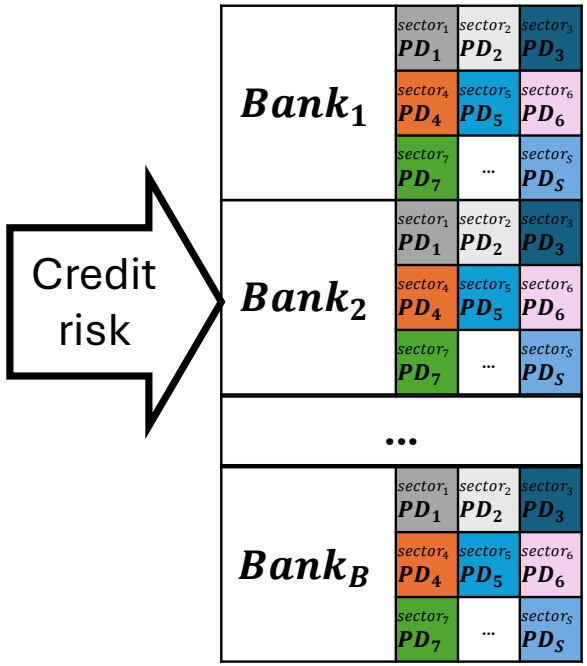


Fig. 3: Loan portfolios of bank (b = 1, ..., B) exposed to sector

Evaluating the banking system resilience to climate risks

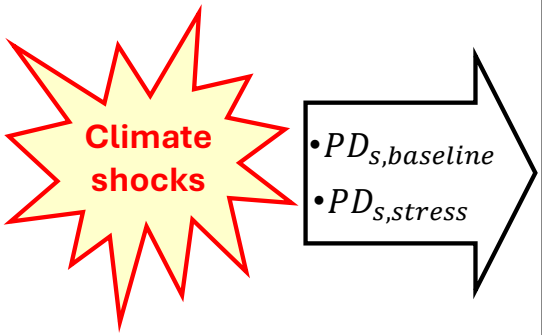


Fig. 1: 2025 ST NGFS scenarios with PDs by sector s

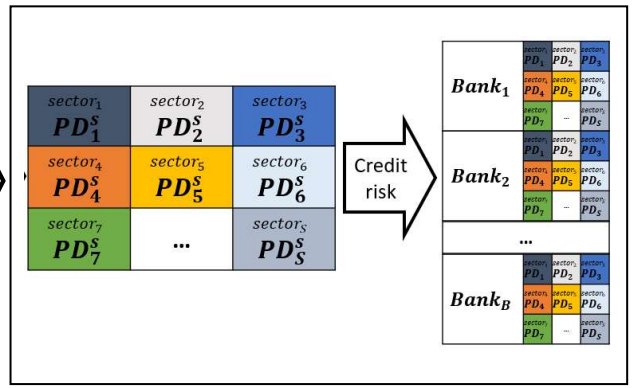


Fig. 2: Chilean banking industry exposure to climate shocks

$$IEL_b = \sum_s EAD_{b,s} \times \mathrm{LGD}_s \times \Delta PD_s$$

$\boldsymbol{IEL_b}$: Incremental Expected Loss of bank b
$\boldsymbol{EAD_{b,s}}$: Exposure (loan volume) of bank b to sector s
$\mathbf{LGD_s}$: Loss Given Default of sector s
$\boldsymbol{\Delta PD_s}$: Delta PD (i.e.: *stress* — *baseline*) of sector s

Eq. 1: Bank losses

Main results

1. Historical evolution of banks' exposure to transition risks in Chile
   - Substantial reduction in banks' exposure to economic sectors that are more sensitive to climate transition risks
   - Heterogeneity across banks

2. Climate stress testing
   - Banks' losses following climate transition shocks are comparable to those observed during the 2007-08 GFC
   - Heterogeneity across banks

Outline

1. Locating this research project in the literature
2. Data
3. Climate scenarios
4. Methodology
5. Revisiting the main results
6. Conclusion and next steps

Locating our project in the literature

Recent developments in global climate policy have amplified the importance of assessing systemic financial vulnerabilities via stress testing

- Battiston et al. (2017) introduces network-based climate stress tests: early policies reduce systemic risk, late actions cause abrupt losses
- Acharya et al. (2023) elaborate on areas for improvement: scenario design, dynamic modelling, and market-based approaches
- Reinders et al. (2020) review methods, classified scenarios and discussed limitations of current frameworks

Our findings align with recent studies on climate transition risk

- Gonzales & Rojas (2024) find 11% of bank loans in Chile exposed to severe physical risks and 20% to carbon tax impacts
- Bebczuk et al. (2025) carry out a climate stress test in Colombia: systemic risks limited, but some banks remain vulnerable
- Gross et al. (2025) quantify climate effect on German banks: heterogeneous impacts, banks face losses up to 1% of portfolios

Data collection and curation of proprietary datasets from multiple sources

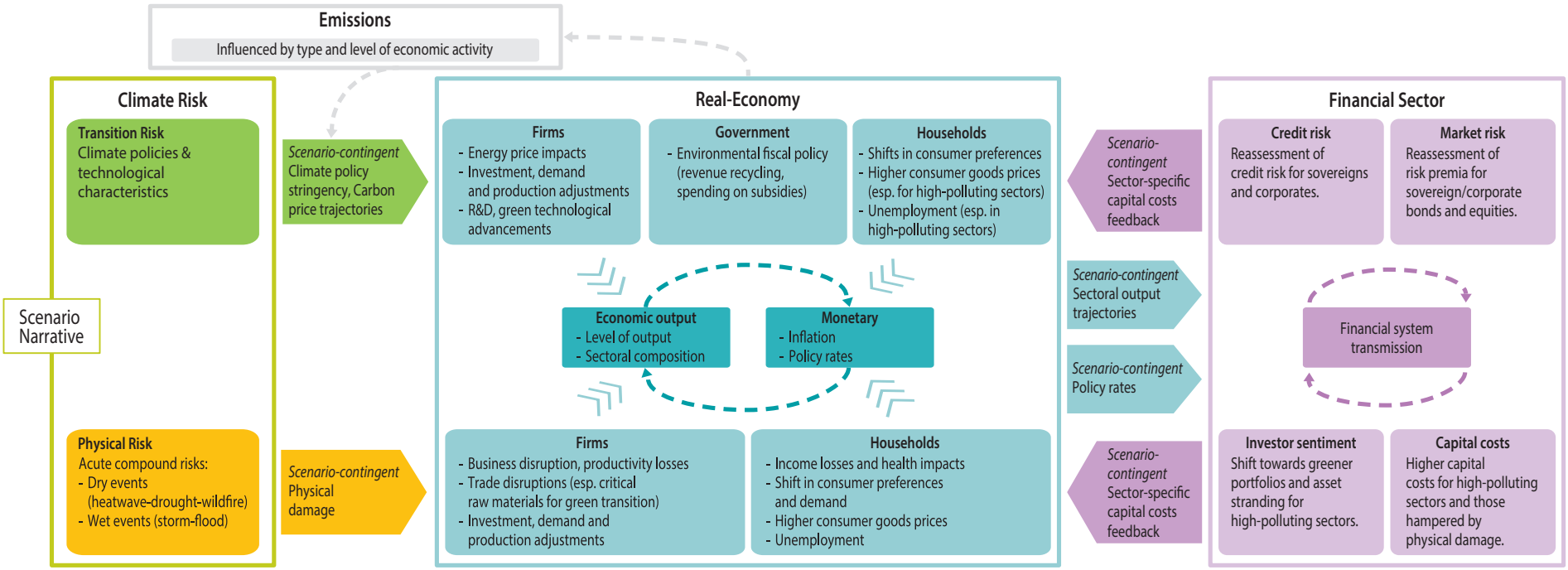
1. Credit Registry
   - Transaction-level dataset of commercial loans (40k firms, 15 banks)
   - Loan amounts, debtor credit history, credit score, among other details
   - Sample covers over 80% of loans with available credit ratings

2. Sectoral classification of firms, data provided by the Tax Authority using VAT records

3. Climate scenarios
   - Sector-level Probabilities of Default (PD) under two transition risk scenarios
   - Economically consistent scenarios

Climate scenarios built on cross-sector dynamics

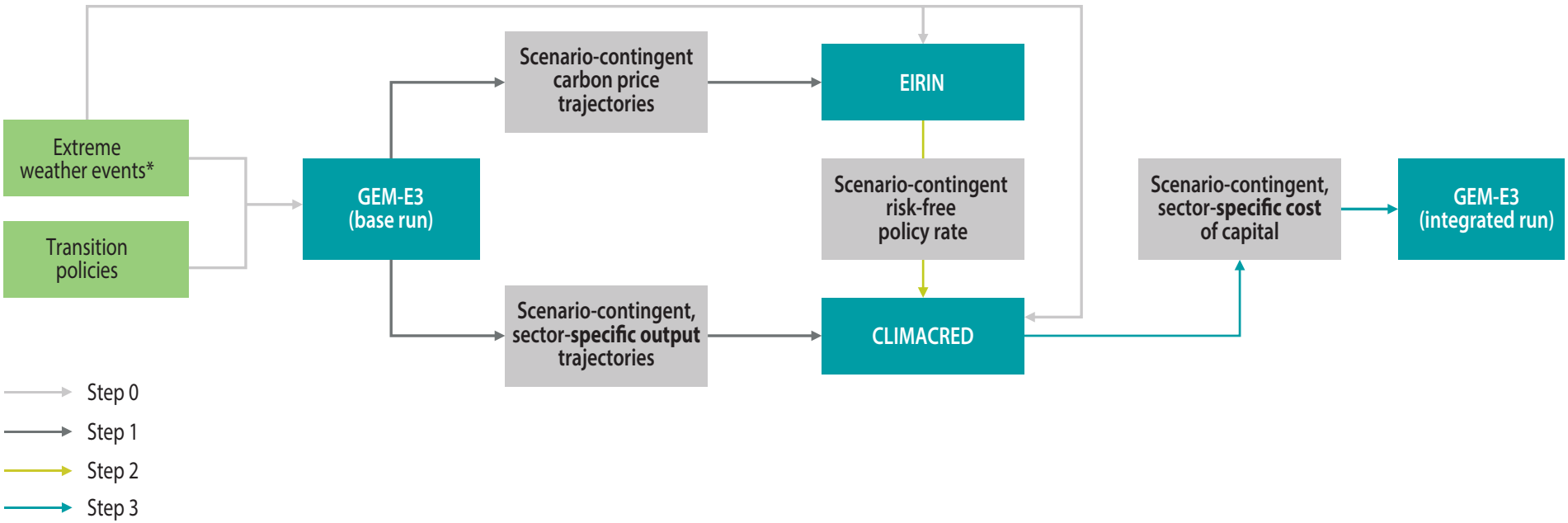
- The NGFS is a global network of central banks and supervisors promoting best practices in climate risk management(1)
- NGFS offer a climate scenarios considering interaction and feedback among sectors/agents



Source: NGFS (2025)
(1) NGFS: Network of Central Banks and Supervisors for Greening the Financial System

Modelling transmission channels and economic feedback

- Sequential estimation: Each block processes outputs from the previous stage, ensuring structured flow and dependency across steps



GEM-E3 is a Computable General Equilibrium Model for Economy-Energy-Environment used to determine the dynamics of real macro variables and climate relate variables at a high level of granularity.
EIRIN is a Stock-Flow Consistent behavioural model used to project inflation and monetary policy.
CLIMACRED is a climate credit risk model that allows for scenario-contingent valuation of bonds and equity and of the associated costs of capital.

Source: NGFS (2025)

Two transition risk scenarios

1. **Highway to Paris (HW2P, an orderly scenario)**
   - Trigger: Gradual and coordinated implementation of ambitious climate policies, aligned with the Paris Agreement
   - Policies: Progressive carbon price increase, 80% of revenues recycled into green R&D
   - Impact: Orderly transition with moderate costs, global GDP fall approx. 0.4% by 2030

2. **Sudden Wake-Up Call (SWUC, a disorderly scenario)**
   - Trigger: Initial inaction followed by abrupt policy shift in 2027 aiming to catch up with the Paris Agreement
   - Policies: Sharp and uncoordinated increase in carbon prices, low rate of investment in green R&D
   - Impact: Severe economic shock, global GDP fall approx. 1.3%, sharp unemployment increase, and enhanced financial volatility

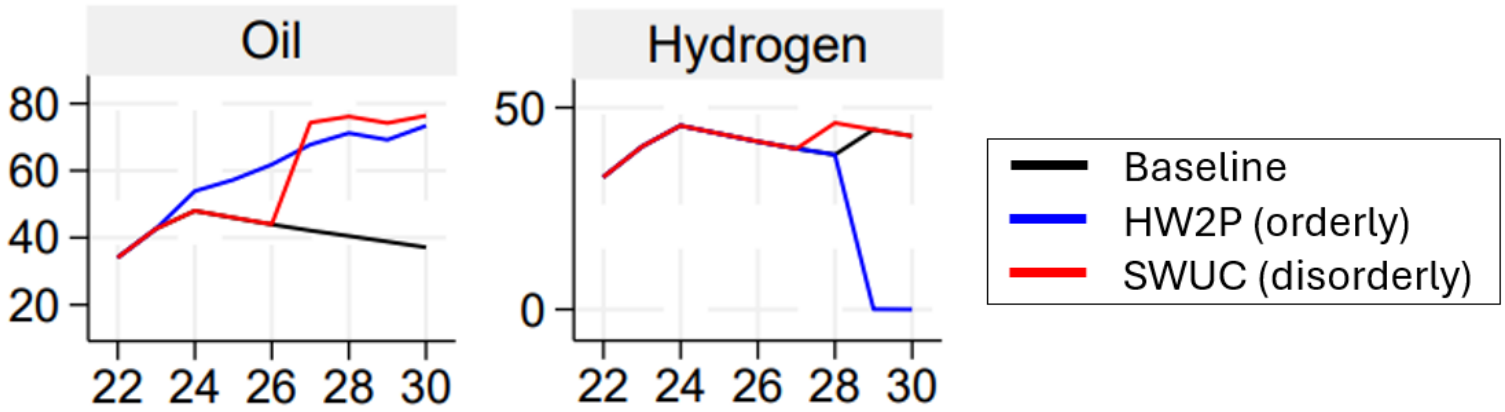
$\Rightarrow$ Delay amplifies costs and systemic risk, early action reduces disruptions

Transmission channels to the banking sector

- Transition risks toward a low-carbon economy can impair firm balance sheets through the obsolescence of carbon-intensive assets
- This leads to reduced production in climate-exposed sectors, lowering projected cash flows and weakening debt repayment capacity
- These effects reflect in increased probabilities of default of firms, making them riskier for banks under transition risk scenarios. Banks face potential losses following this increase in credit risk

PDs by sector and scenario, an example

- NGFS climate scenarios comprises 50 productive sectors, over a five year forecast sample Details
- Example of PD pathways of two sectors by scenario



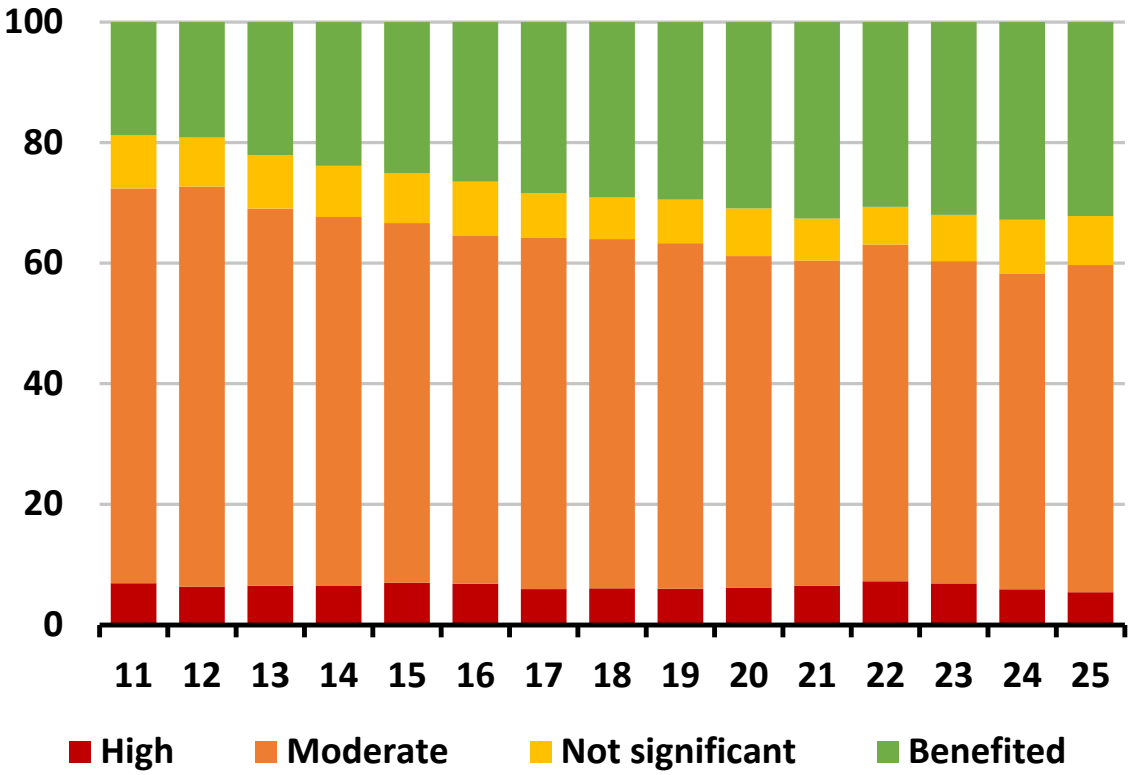
Source: NGFS (2025)

Methodology: firm category according climate sensitivity

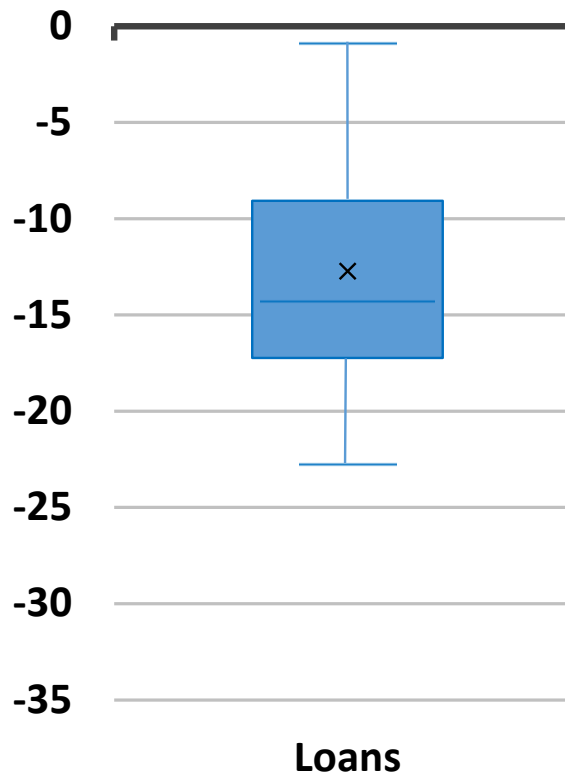
Sensitivity	Economic sector	PD change
High	Coal	64.6
	Oil	36.3
	Crude oil	31.0
	Transport equipment (excluding EV)	6.4
	Chemical products	4.8
	Agriculture	4.6
	Water transport	4.5
Moderate	Air transport	4.0
	Warehousing	3.5
	Land transport	3.2
	Consumer goods industries	2.5
	Market services	2.1
	Rubber and plastic products	1.8
Not significant	Basic pharmaceutical products	1.0
	Non-ferrous metals	0.9
	Paper products, publishing	0.7
	Non-market services	0.6
	Fabricated Metal products	0.6
	Non-metallic minerals	0.2
	Advanced electric appliances	0.0
	Computer, electronic and optical products	0.0
Benefited	Other equipment goods	-0.8
	Construction	-1.1
	Biomass solid	-3.4
	Power supply	-19.3
	R&D	-23.1

Source: Authors' calculations based on NGFS (2025)

Evolution of banks' sectoral exposure to transition risks



(a) Bank exposure: loans by sector-sensitivity from 2011 to 2025, at aggregated banking system level



(b) Change in exposure to sensitive sectors across banks, 2011 vs 2025. The x represents the banking system

Source: Authors' calculations.

Methodology: banks' losses due to enhanced credit risk

- Credit risk exercise based on climate scenarios

$$EL_{bst} = \sum_{k} PD_{kst} \times LGD_{kst} \times EAD_{bk}$$

  - EL_{bst}: Expected Loss for bank b under scenario s at time t, sourced from the NGFS scenarios.
  - PD_{kst}: Probability of Default of a firm in sector k under scenario s at time t. Based on commercial banks' credit risk assessment.
  - LGD_{kst}: Loss Given Default representing the percentage of a loan which is irrecoverable in the event of default, parameters are based on domestic regulation.
  - EAD_{bk}: Exposure at Default quantifies the value at risk at the time of default, less collateral.

- We compute EL_{bst} as the sum of expected losses across all economic sectors k at time t.

Methodology: assigning sectoral climate shocks to firms

- Climate scenarios provide PD pathways at the sector level, while our datasets are at the firm-level
- To preserve granularity, we map sector-level PD adjustments to the firm level

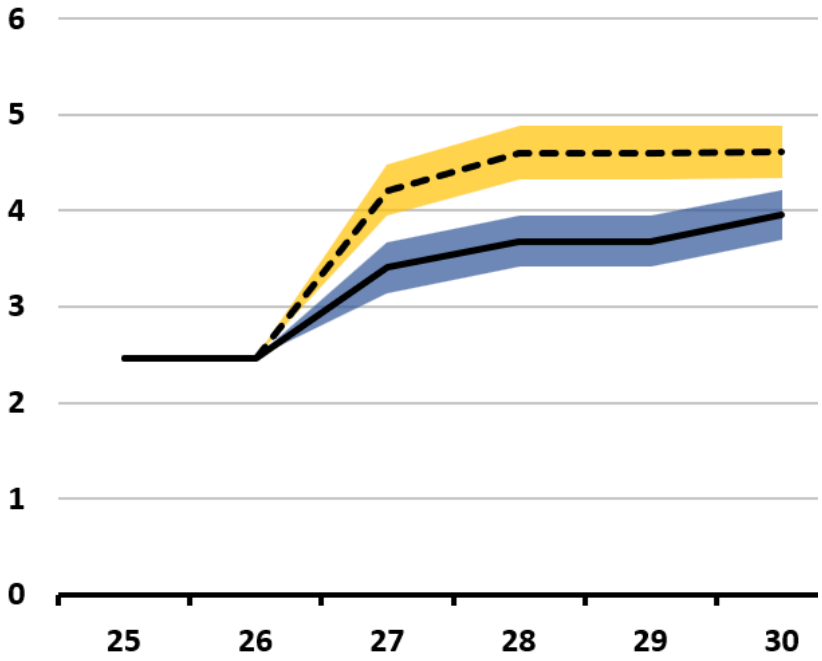
Approach 1: uniform lump-sum PD increase

- Same PD adjustment to all firms within a sector
- Strong assumption: transition risk is uniform across the sector, with no differentiated mitigation among firms

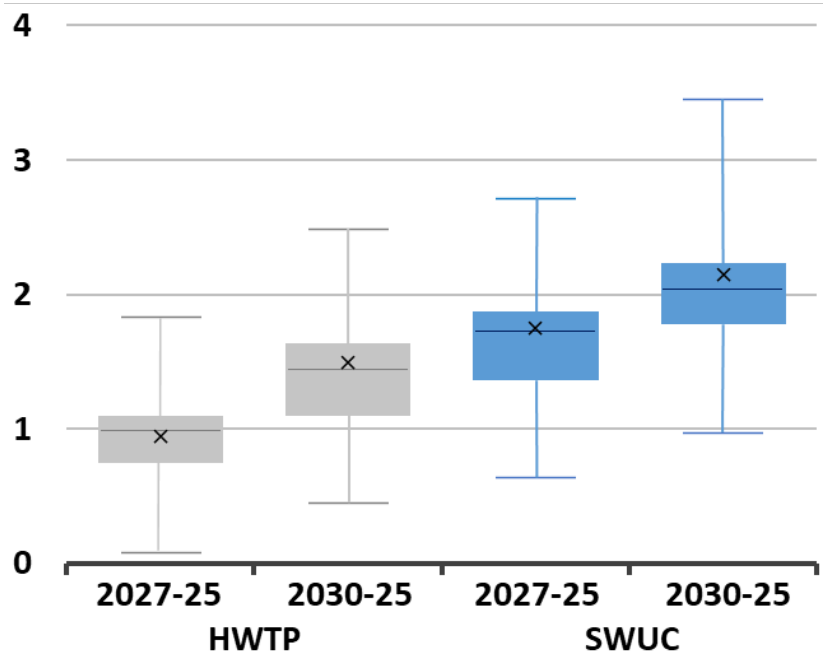
Approach 2: random allocation based on resampling

- Bootstrapping approach: randomly selects firms within each sector and adjust their PD ▸ Details
- Advantages: (1) preserves granularity of the data, (2) allows intra-sector heterogeneity capturing preventive mitigation (e.g., credit rationing)

Climate stress test: enhanced bank losses in transition risk scenarios



(a) Expected losses in the banking system, at aggregated banking system level. Solid line: HWTP, dashed line: SWUC. Shaded areas represent confidence bands.



(b) Change in *EL* across banks. Grey boxes: HWTP, blue boxes: SWUC. The x represents the banking system.

Source: Authors' calculations.

Key takeaways and next steps

- **Scope of this study:** First climate transition risk stress test in Chilean banking system, using NGFS scenarios and loan-level data.
- **Empirical approach:** Sectoral mapping to firm-level granularity, bootstrapping approach to capture uncertainty and heterogeneity.
- **Key findings:** Despite reduced exposure, potential impact remains significant: under a disorderly transition, provisions nearly double, with tail risks comparable to the Global Financial Crisis.
- **Next steps**: Integrate these elements into stress testing, capital adequacy, and macroprudential frameworks. Advance Chile-specific scenarios, dynamic models capturing credit rationing, and data and communication infrastructure.

Thanks for your attention

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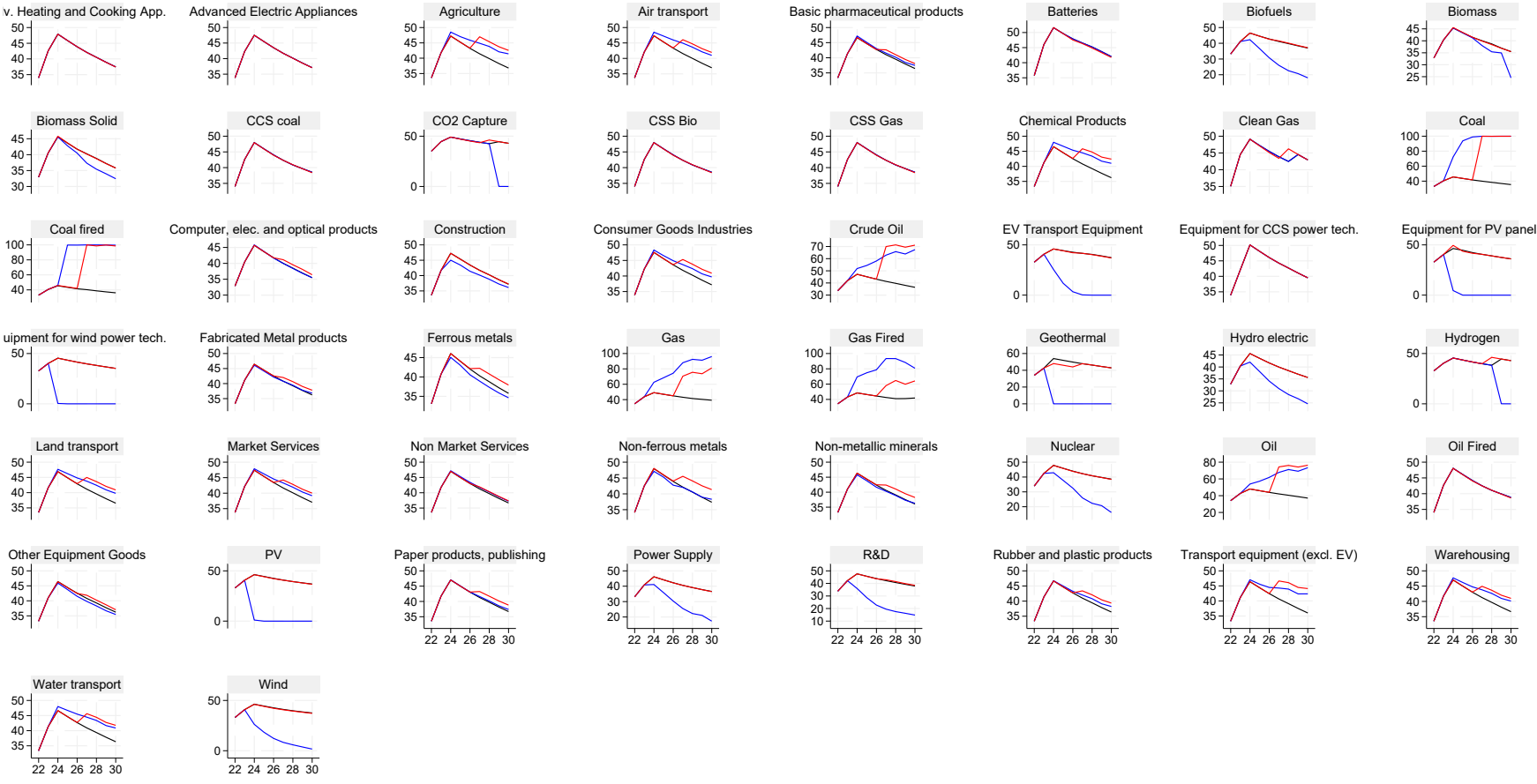
PD by sector



Black line: baseline scenario, blue line: HW2P, red line: SWUC. Source: NGFS (2025)

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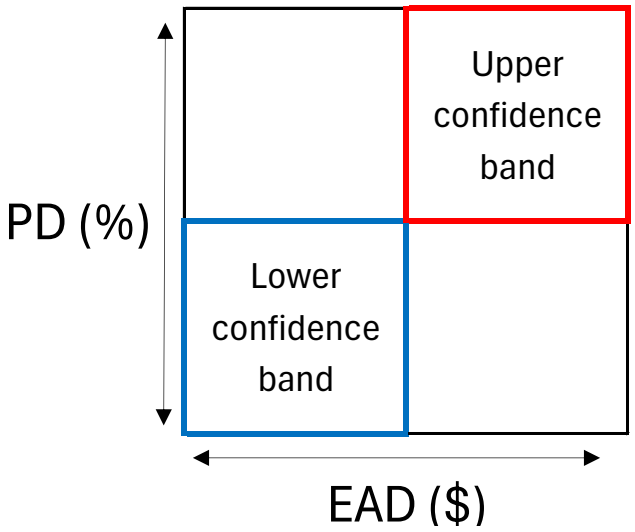
Bootsrapping

- Subsamples of 30k observations per period across the simulation horizon
- 1k replications using bootstrap resampling with replacement to compute *EL*



$$\mathrm{EL}_{bst} = \sum_k \mathrm{PD}_{kst} \times \mathrm{LGD}_{kst} \times \mathrm{EAD}_{bk}$$

- Firm PD trajectories aligned with NGFS sectoral shocks, with uncertainty quantified by confidence band based on 5th and 95th percentiles
- It allows us to incorporate more realistic assumptions, such as credit rationing to a highly sensitive sector when climate shocks take place

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