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Financial Vulnerability from Climate Shocks: Peruvian Evidence

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Research Question

- Using micro-data, we aim to provide an overview of how anomalous climate shocks impact the Peruvian financial system by altering the deposit and credit markets and how these changes are transmitted to the rest of the economy.
- More specifically, the following research questions will be addressed:

1. How do weather shocks dynamically affect financial variables? Do credit and deposits react differently to anomalous temperature and precipitation shocks?
2. What are the potential transmission mechanisms through which weather shocks affect financial activity?
3. What are the effects of climate-vulnerability risk on macro variables and the aggregate credit market?

Main Results

1. We find that financial institutions struggle to absorb temperature and precipitation shocks.
2. In the aftermath of such events, both credit issuance and deposit activity decline markedly
3. Focusing on the various forms of physical damage that climate shocks may cause, we find evidence of potential transmission mechanisms through which climate shocks translate into financial vulnerabilities.
4. Our results indicate that our aggregate measure of weather-related financial risk leads to a credit tightening, with higher aggregate lending rates and persistent reductions in credit supply across the economy. But, we find limited effects on macro variables.

Data

Climate Data

1. We use monthly grid-level ($\approx$55 km^2) of temperature and precipitation data, aggregated for each of 196 provinces of Peru. Sample 1901m1-2023m5.
2. *Climatic shocks* definition: deviations from long-term historical norms.

    - We follow Kabundi et. al. (2022) and construct province -specific z-scores to capture how much a given observation diverges from a month-province's own historical average normalized by its standard deviation, in the last 30 years.

    - The z-score for weather variable W in province i in month t is expressed as follows:

$$W_{i,t}^{z} = \frac{W_{i,t} - W_{i}^{\text{avg}}}{\sigma_{i}^{W}}.$$

    where $W = \mathcal{T}, \mathcal{P}$ are temperatures and precipitation variables, respectively.

Financial Data

- Monthly Peruvian financial firm branch-level data and bank-province data of credit and deposits. Sample 2002m1-2019m12.

Macro Data

- Control variables: log of terms of trade, log of domestic GDP, log of domestic CPI, log of total credit, the domestic interbank interest rate as the MP policy variable, log of Money (M1), a measure of lending rates, and log of nominal exchange rates.

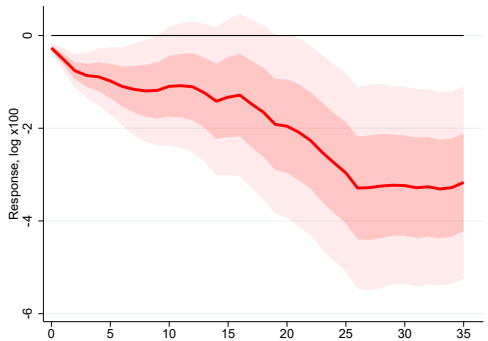
Empirical strategy: Lending and deposits after climatic shocks

We run a local projection for $h = \{0, 1, \ldots, H\}$ of the form:

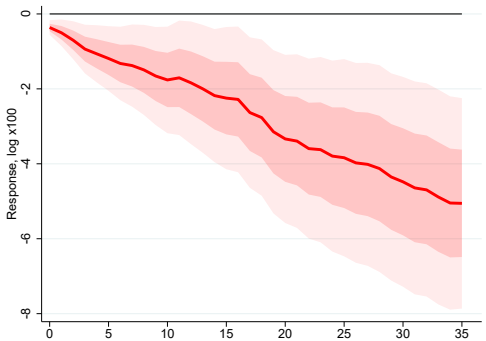
$$y_{bp,t+h} - y_{bp,t-1} = \alpha_{bp,h} + \beta_h^{\mathcal{T}} \mathcal{T}_{p,t} + \beta_h^{\mathcal{P}} \mathcal{P}_{p,t} + \sum_{k=1}^{K} \gamma_k^h X_{j,t-k} + u_{bp,t}^h$$

Temperature shocks

Panel A: Credit

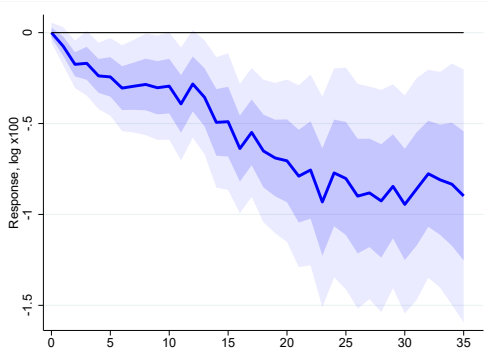


Panel B: Deposits

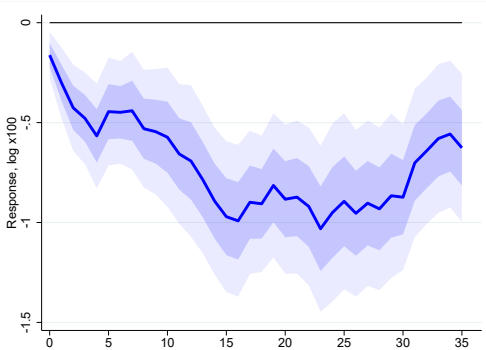


Precipitation shocks

Panel C: Credit



Panel D: Deposits



This figure shows the Micro IRF to a 1 SD shock under the LP specification.

Unveiling the Transmission Mechanism with Damage Data

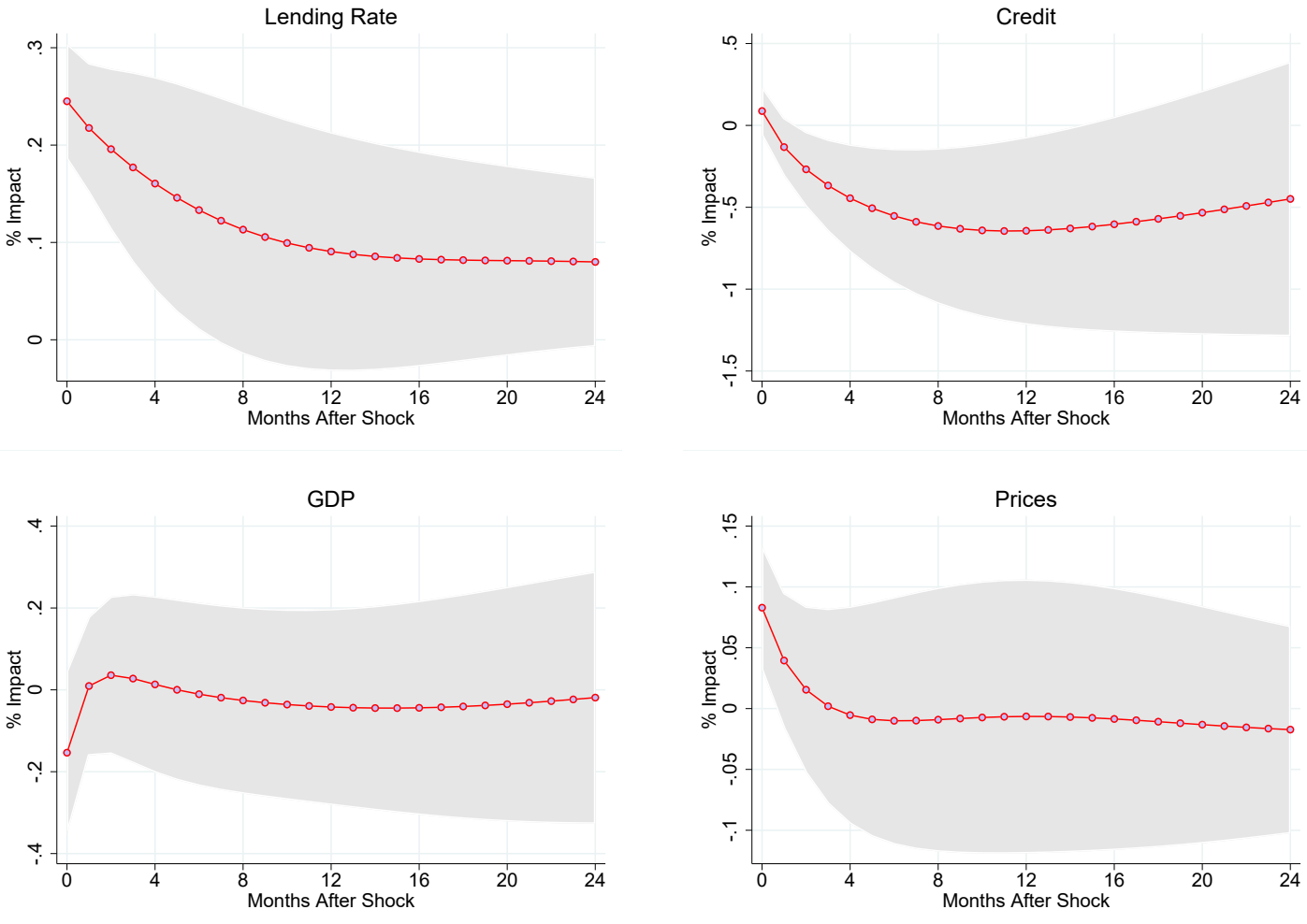
To assess the impact of the damages, due to the natural disaster, on credit activity and non-performing loan ratio, we propose the following linear model:

$$Y_{rt} = \alpha_r + \beta_0 Y_{rt-1} + \beta_1 X_{rt} + \epsilon_{rt},$$

X_{rt}	(1) Individual	(2) Housing	(3) Education	(4) Road	(5) Hectare	(6) Water	(7) Drainage	(8) Irrigation
X = Natural Event: Heavy Rain; Y = Credit Growth								
$CREG_{rt-1}$	0.124***	0.124***	0.126***	0.123***	0.124***	0.125***	0.126***	0.125***
D^X_{rt}	-0.221***	-0.198***	-0.112	-0.258***	-0.251***	-0.221**	-0.161*	-0.208***
Observations	4,513	4,513	4,513	4,513	4,513	4,513	4,513	4,513
X=Natural Event: Heavy Rain; Y = Deposit Growth								
$DEPG_{rt-1}$	-0.107***	-0.107***	-0.108***	-0.106***	-0.108***	-0.108***	-0.108***	-0.109***
D^X_{rt}	-0.301***	-0.307***	-0.699***	-0.392**	-0.554***	-0.722***	-0.734***	-0.837***
Observations	4,538	4,538	4,538	4,538	4,538	4,538	4,538	4,538
X= Natural Event: Heavy Rain - Y = Non-performing loan ratio								
NPL_{rt-1}	0.967***	0.967***	0.966***	0.967***	0.966***	0.966***	0.966***	0.966***
D^X_{rt}	0.0475***	0.0470***	0.0644***	0.0614***	0.0435***	0.0513***	0.0477***	0.0615***
Observations	3,450	3,450	3,450	3,450	3,450	3,450	3,450	3,450

*** Statistically significant at 1%, ** statistically significant at 5%, * statistically significant at 10%. All regressions include region fixed effects and month fixed effects. Clustered (at region level) standard error.

Aggregation: Weather-financial Losses Shock → Financial and Macro variables - VAR analysis



This figure shows the IRF to a 1 sd of our weather-financial losses (WFL). 2003m5 - 2019m12. We define the aggregate weather-financial losses WFL_t at time t by summing the significant contributions of weather to credit losses, which are represented by the coefficients of the weather variables $\beta_h^{\mathcal{T}}$ and $\beta_h^{\mathcal{P}}$ over the horizons and provinces: $WFL_t = \sum_h \sum_p \left(\beta_h^{\mathcal{T}} \, \mathcal{T}_{p,t-h} + \beta_h^{\mathcal{P}} \, \mathcal{P}_{p,t-h} \right) \times \omega_{p,t}$

Conclusions

- Our results underscore the importance of incorporating climate-related risks into financial and regulatory frameworks.
- After temperature and precipitation shocks, financial institutions struggle to cope with persistent losses in credit and deposit activity.
- These results indicate that as climate shocks increasingly disrupt financial intermediation, through both credit supply constraints and deposit volatility, the resilience of banking systems in climate-vulnerable economies like Peru becomes critical.
- We find empirical evidence that damages on roads, housing, educational centers, hectares of crops, and sanitation services negatively affect both financial intermediation and financial stability.
- The persistent effects on macro financial variables but the limited effects on macro variables call for further future research.