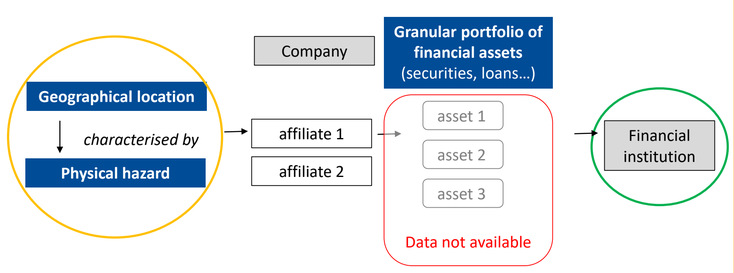
Local Banks and flood risk: the case of Germany

Research question

What is the magnitude of climate physical risk on bank's balance sheet?

- Pilot on Germany regions (NUTS2) to investigate the effect of river flooding events under different climate scenarios – 677 entities (40% total assets)
- Focus in on cooperative bank as their exposure is much more strongly geographically concentrated



Modelling framework
inputs

ECB db

Share of portfolio exposed to river floods (Normalized Exposure At Risk)

⇩

Estimation of the **total amount of assets exposed to floods** and held by non-financial institutions

JRC Risk Data Hub

Share of population exposed at NUTS2 over 1 year: (exposure weighted by the probability of occurrence)

⇩

Distribution of **assets at risk** (NPLs) across different **NUTS2 regions**

JRC PESETA

Increase in economic losses under different climate warming scenarios (delta increase in losses)

⇩

Projection of assets at risks (NPLs) under **1.5℃** and **3℃** increase in temperature

Modelling framework
simulation model (1/2)

A micro-simulation portfolio model (SYMBOL) based on individual bank balance sheet data is used to design crisis scenarios and derive the distribution of losses that cannot be absorbed by capital:

- Extract implied average riskiness of bank portfolio (IOPD)
- Use the Basel II/III FIRB formula to shape the loss distribution
- Capital provides a buffer against unexpected losses at a specific statistical confidence (99.9%**)**
- Each banks fail, depending on their level of capital, the IOPD, as well as on the severity of the negative shock

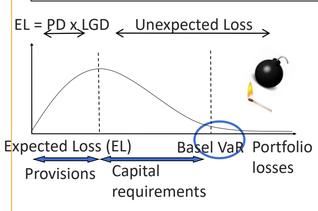
Compute each bank's portfolio average probability of default associated with the various scenarios → Generate crisis scenarios by using a micro-simulation portfolio model (SYMBOL) → Summing up unexpected losses, recapitalization needs (and climate related NPLs) → Derive the aggregated loss distribution (with and without flood-related NPL)

This is done by inverting the Basel formula for the minimum capital requirement

This is done by varying the parameter linked to the severity of the external environment

Modelling framework
simulation model (2/2)

- With all parameters known or estimated, we can use the Basel II/III FIRB formula as the exact shape of the loss distribution for each bank j …
- … and use it to simulate samples of gross losses (h = 1, …, H) by extracting random numbers representing the intensity of the shocks
- In each set of extractions h the numbers are correlated, to represent the exposure of all banks to common economic shocks **(**common factor**)**
- After millions of simulations, this data can be used to estimate aggregate distributions of losses



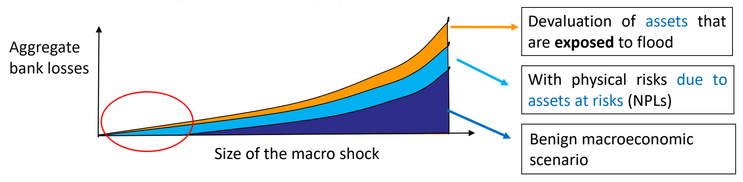
$$L_{h,j} = N\left[\frac{\sqrt{R}N^{-1}(\alpha_{h_j}) + N^{-1}(IOPD)}{\sqrt{1-R}}\right]$$

- Known
- Randomly generated
- Common factor

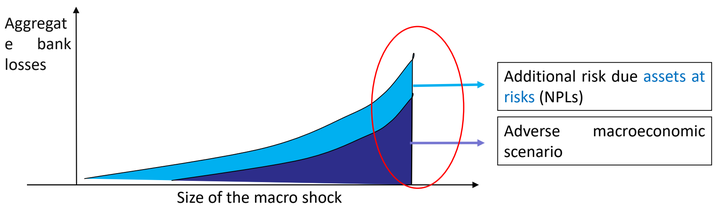
$$N^{-1}(\alpha_{h_j}) = l \times Z_h + \sqrt{1-l^2} \times W_{h,j}$$

Modelling framework
output

- Scenario #1: a *stable economic* situation where the stress on banks is only due to the physical risk

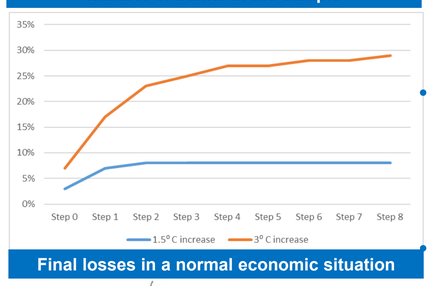


- Scenario #2: a *systemic crisis* type situation where the impact of physical risk is on top of existing financial /economic crisis

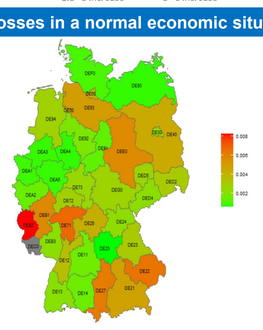


Results (1/2)

Number of banks defaulted over the total number of banks in the sample



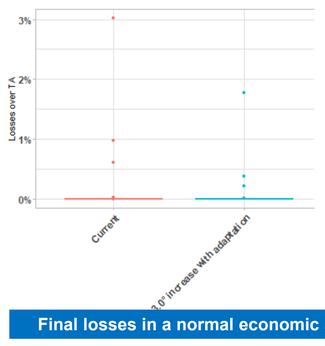
Final losses in a normal economic situation



- Assets exposed to river floods are assumed to turn into Non Performing Loans
- A micro-simulation portfolio model (SYMBOL) based on individual bank balance sheet data is used to generate crisis scenarios
- In a stable economic situation, few banks default because of physical risk but these trigger devaluation of assets exposed:
  - ✓ Losses range from 0.2% to 1.1% of total assets for the 1.5°C and 3°C scenario
  - ✓ Variability of losses across NUTS2 regions is quite large, with some regions reaching 10% of total assets

Results (2/2)

Losses' distribution for Current and 3.0℃ increase with adaptation



Final losses in a normal economic situation

- The implementation of effective adaptation strategies plays a crucial role in mitigating economic losses and enhancing the resilience of firms to climate risks
- JRC PESETA estimates point to a 80% reduction of the impact of climate-related events under a 3°C, when adaptation measures are implemented
- Results show that the financial sector would benefit significantly, as the likelihood of either sudden asset devaluations and final losses driven by climate-related events diminishes to a point where they are comparable to the present circumstances

Conclusions

- We propose a methodology to assess the effect of river-flood events occurring within Germany on regional banks
- In a normal economic situation, there are few banks defaulting because of climate risk
- Subsequent dynamics would be negligible under the actual warming conditions, however, could lead to significant losses for the German regional banking system up to 1% of total assets under a 3°C temperature rise
- This negative impact can be effectively tackled with the implementation of adaptation strategies
- Our findings support the idea that banks operating in regions prone to such geographic risks should take measures to safeguard themselves:
  - ✓ implement additional bank specific capital add-ons
  - ✓ banks can contribute to the adaptation efforts, such as investing in climate-resilient infrastructure

Joint Research Centre

Bellia M., Di Girolamo F.E., Pagano A., Papadopoulos, G., JRC Working Papers in Economics and Finance, 2023/13