Approaches to Climate Risk Analysis

METAC

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The views expressed in these slides are those of the author(s), although they do not necessarily represent the views of the IMF, or its Executive Board, or its management.

Objective

Objective of the webinar

- Introduce financial stability policy makers and national prudential supervisors to climate risk analysis
- First the webinar will introduce the key technical terms and concepts used in climate risk analysis: emissions and temperature scenarios, physical and transitions risk definitions
- Second, the presentation will lay out approaches to climate risk analysis, based on the IMF framework to climate risk analysis in FSAPs.
- The approach is not a standard stress test and seeks to:
  - Illustrate potential pressure points for the financial system due to physical climate shocks and in the transition to a low-carbon economy
  - Raise awareness of the risk and adaptation needs in the financial sector

Climate Risk Analysis

Key Concepts

Physical risk

- Physical risk refers to the physical impact of climate change. These risks represent losses due to **increasing frequency and severity of climate-related events, also called "hazards."**
- These include **acute** risks (such as storms, floods, heat waves) and so called "**chronic**" risks reflecting the effect of long-term changes in climate patterns, such as rising sea levels or changes to precipitation.
- The **losses** include adverse impacts on assets and resulting financial sector losses to the extent it is exposed to the affected assets, as well as negative effects on the economy due to second-round effects.

Transition risk

- Transition risk results from changes in climate policy, technological advances, and consumer and market sentiment during the adjustment to a lower carbon economy.
- The IMF staff's approach focuses on **carbon taxes**, both domestic and external, as the main source of transition risk.
- The adverse effects on the financial sector pertain to losses of carbon-intensive industries affected by the carbon tax as well as second-round effect of carbon taxes on the economy.
- Physical and transition risks are inter-twined:
  - The faster the transition, the lesser the temperature increase and thus the smaller the physical effects of climate change.
  - Delays in transition or large divergences across countries could lead to higher economic and financial costs from both physical and transition risk.

Climate risk indicators

Physical risk

Chronic hazards
- Global temperature
- Sea level rise

Acute hazards
- Cyclones
- Floods
- Wildfires
- Droughts
- Heatwaves

Exposure of
- Business sectors
- Population
- GDP

Transition risk

GHG emissions
- Size of carbon intense sectors
- Reduction targets
- Fossil fuel reserves

Fossil fuel production

Carbon pricing
- Taxation
- Carbon pricing gap

Renewables
- Production
- Consumption
- Energy mix

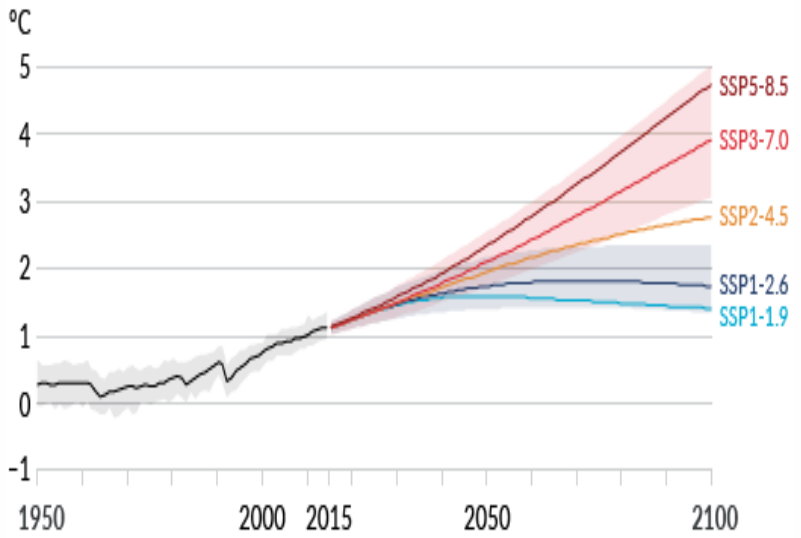
Emissions and temperature scenarios

Commonly used reference scenarios for future paths of emissions and temperatures are those developed by the Intergovernmental Panel on Climate Change (IPCC).

Scenarios combine:

- Representative Concentration Pathways (**RCPs**) that describe paths for future levels of greenhouse gases
- and Shared Socioeconomic pathways (**SSPs**), which look at five different scenarios for how socioeconomic systems around the world might evolve in the absence of policy changes to mitigate climate change.

Figure: IPCC emissions and temperature scenarios



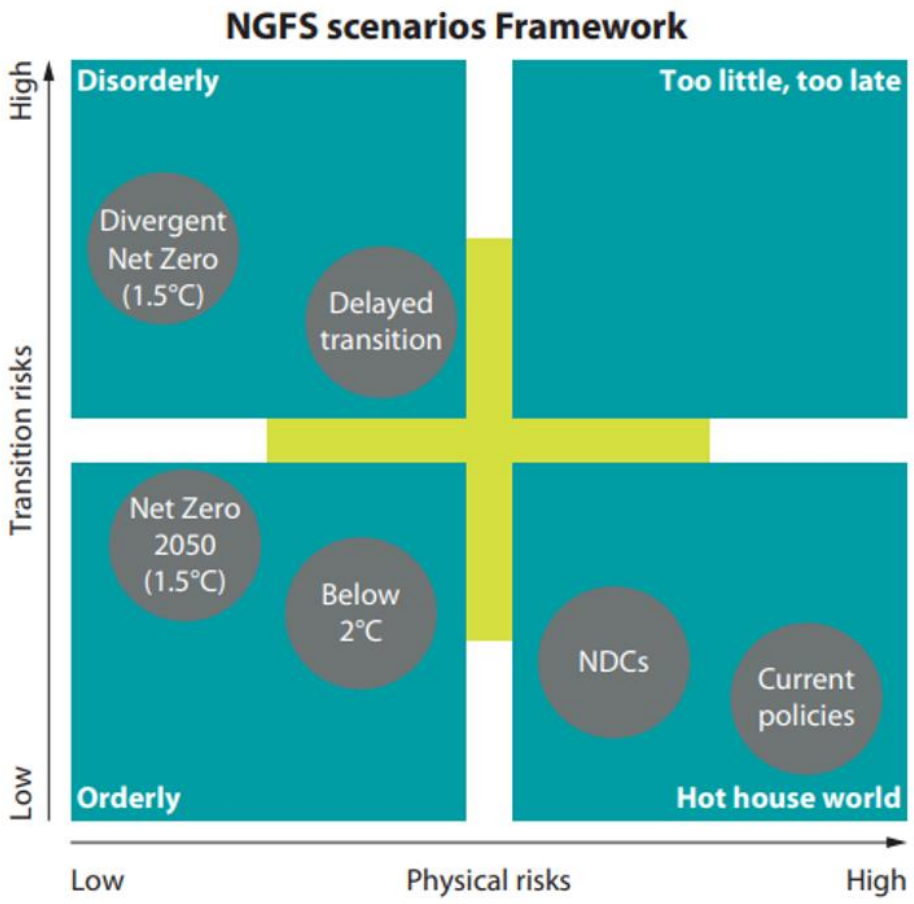
Source: IPCC, 2021 Summary for Policymakers.
1 Global surface temperature change; increase relative to the period

NGFS

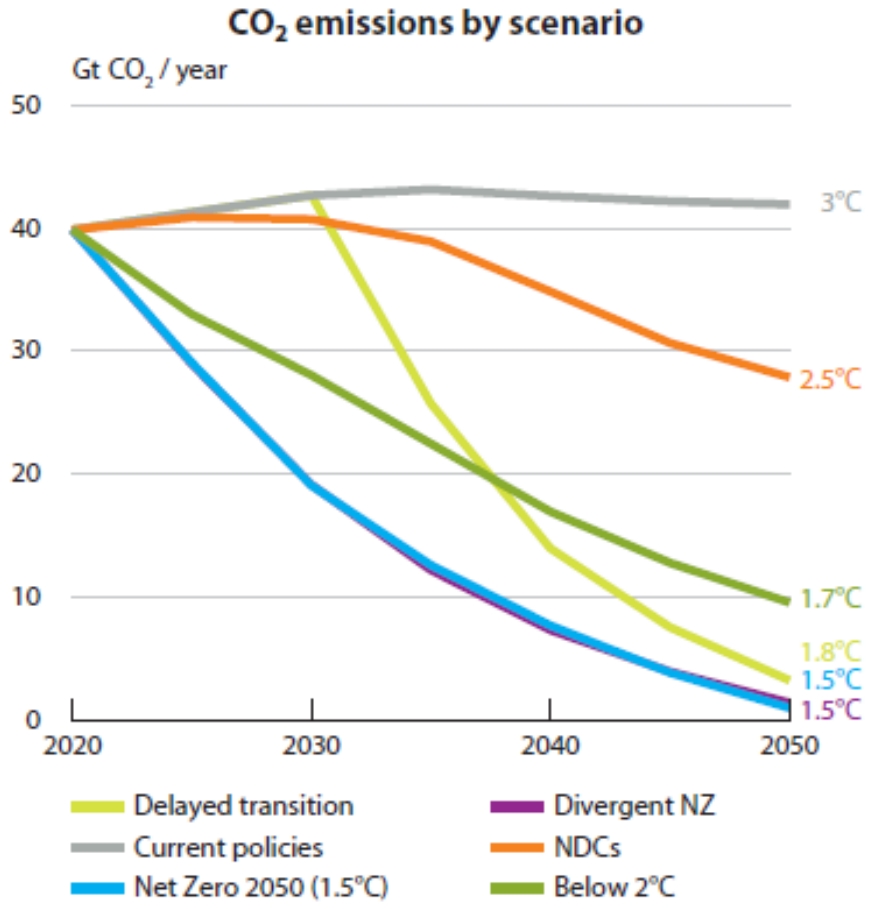
Network for Greening the Financial System (NGFS) focuses on the need for:

- common and improved disclosure of climate risks,
- **widely available scenarios based on comparable and easily accessible scenarios**,
- adapting supervisory and regulatory frameworks to address financial sector risks posed by climate change,
- broader collection of climate risk data.

NGFS scenarios



Positioning of scenarios is approximate, based on an assessment of physical and transition risks out to 2100.



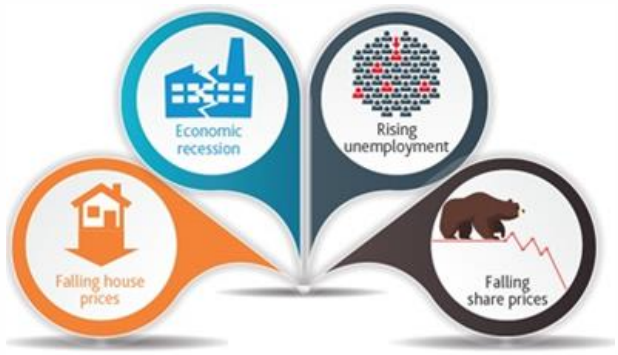
Source: IIASA NGFS Climate Scenarios Database, REMIND model.
End of century warming outcomes shown.

Approach to Climate Risk Analysis in FSAPs

Standard FSAP Risk Analysis—Scenario-Based Stress Testing of Financial Institutions

R
A
M

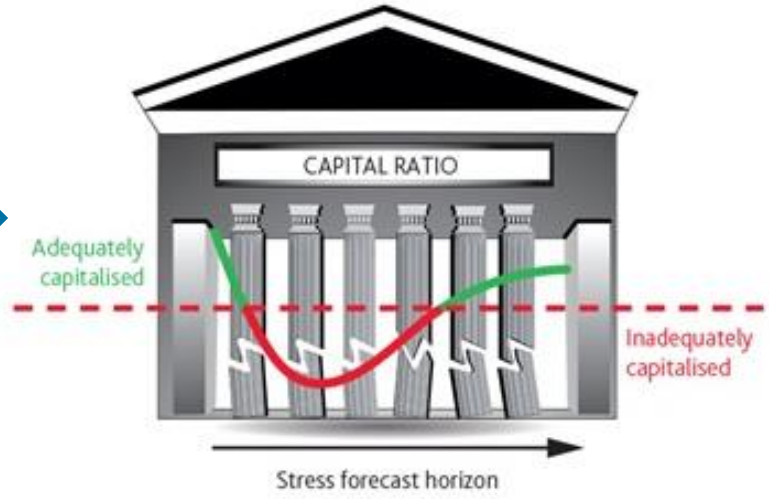
Macro scenario



Risk factors

- Credit, market, interest, FX
- Historical relationships
- 3-5 year horizon

Bank solvency stress test



Corporate & household sensitivity analysis or stress test

Adapting FSAP Risk Analysis to Incorporate Climate Risk

Stage 1
Climate risk diagnostics

Stage 2
Climate scenarios design

Stage 3
Bank stability assessment

C
R
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Physical Risk Scenarios

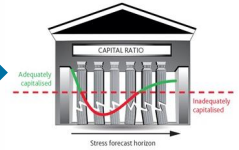
Transition Risk Scenarios

Macro approach

Macro (& sectoral) scenario

Risk factors

Bank solvency stress test



Corporate & household sensitivity analysis or stress test

Micro approach

NEW: Climate Module

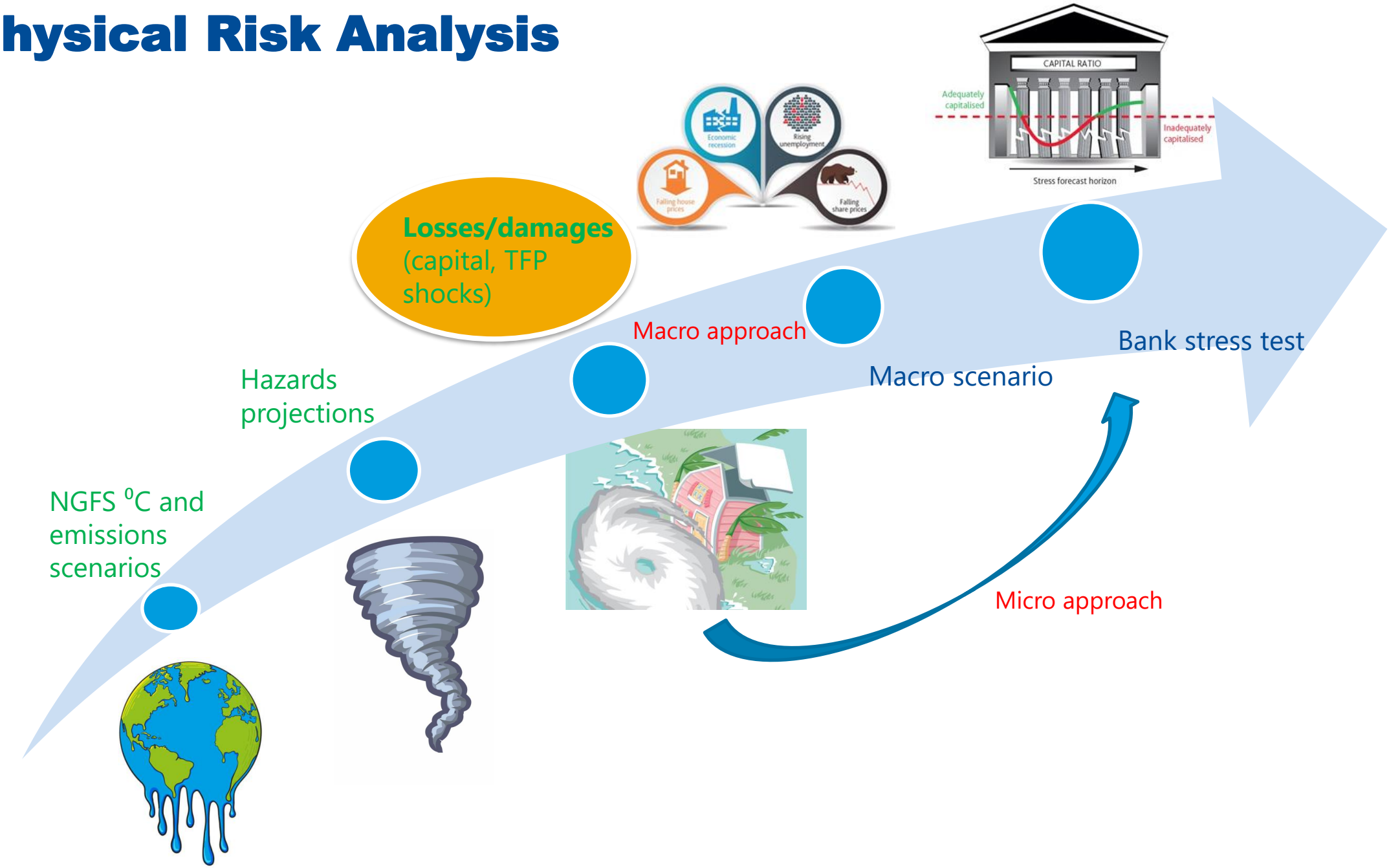
- Horizon: up to 2100
- High data granularity--geography of physical hazards and sectoral impact of carbon tax

Main Challenges

- **Long time horizon**
- **Uncertainty**
- **Modelling Complexity**
- **Data**

Physical Risk Analysis

Physical Risk Analysis

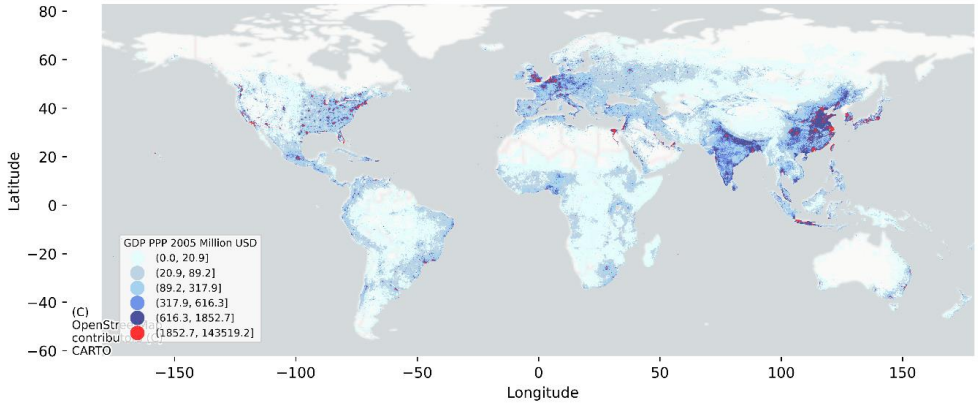


Physical Risk Analysis: Estimating Damages

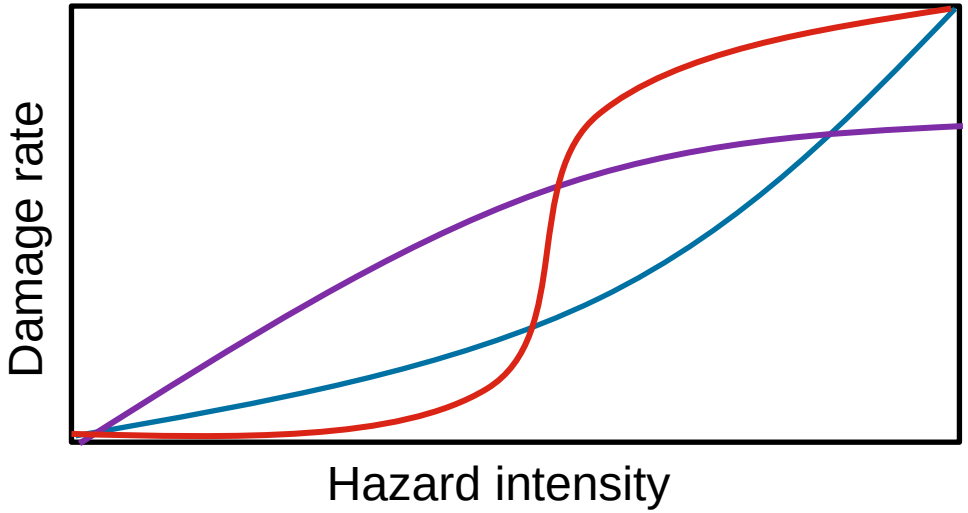
Hazard projections → Exposures → Vulnerability → Damages

Gridded GDP: projections of GDP in 2040 under SSP2 downscaled at grid level.

Drawing from the literature on damage functions.



Source: Murakami D, Yoshida T and Yamagata Y (2021) "Gridded GDP Projections Compatible With the Five SSPs (Shared Socioeconomic Pathways)".



Bank Stability Assessment

Macro approach

- Analysis of physical shocks on macro and financial variables using macro models
  - Single/Multi-country DSGE model
  - Shocks to physical capital and TFP based on damages of hazards
- Standard stress testing methods based on macrofinancial scenarios

Micro approach

- Analysis of corporates (and households)
  - Micro models to estimate impact of physical risk (and its impact on macro variables) on individual balance sheets
- Stress testing methods based on direct exposure of banks

Physical Risk Pilot: Philippines FSAP

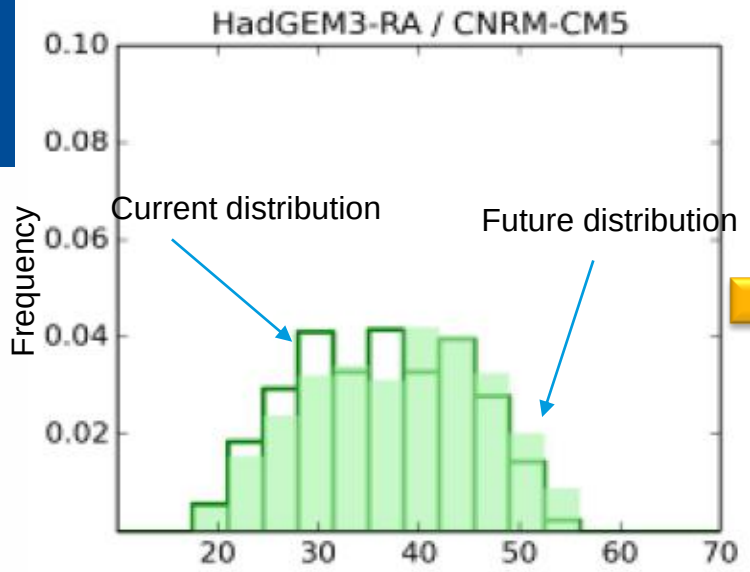
Macro approach to physical risk: Typhoon intensity and frequency in Hot house world scenario

CAT risk model: lost capital due to typhoons with various likelihood—once in 10-500 years

WB and PHL government: unique data of exposures and vulnerabilities

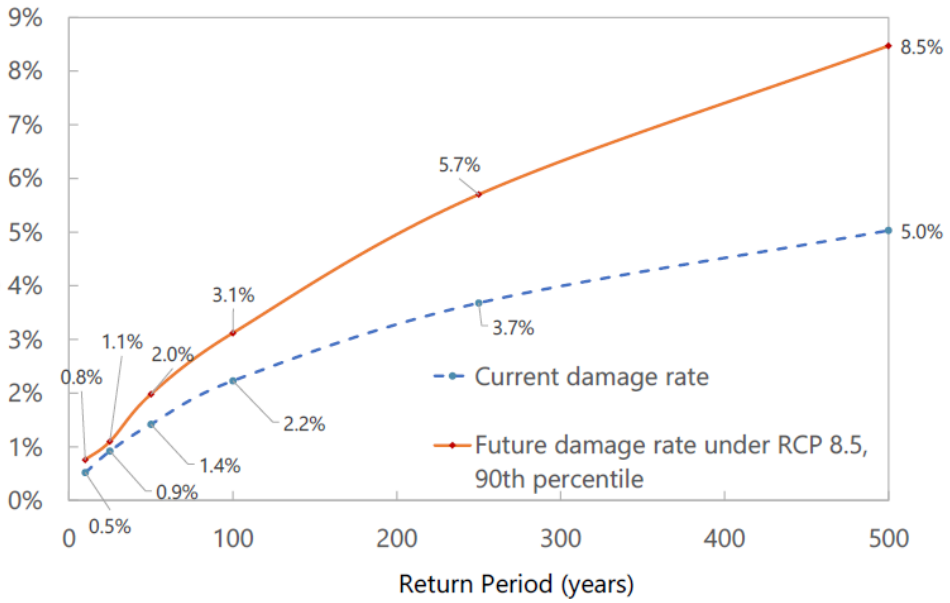
DSGE model calibrated for PHL (capital depreciation & productivity shocks): damage rate increase by 20-70 percent (depending on severity) due to climate change

Distribution of Windspeed Intensity

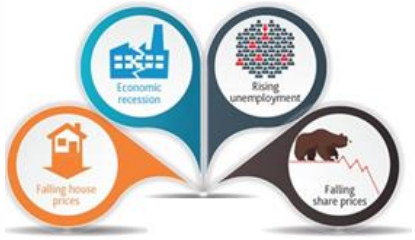


Physical Capital Damage Rate for the Philippines

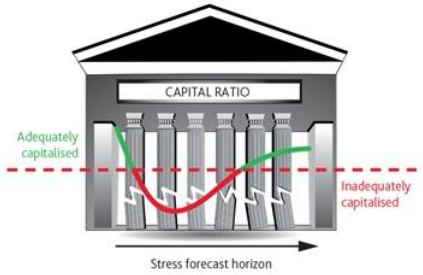
(In percent)



Macro Scenarios

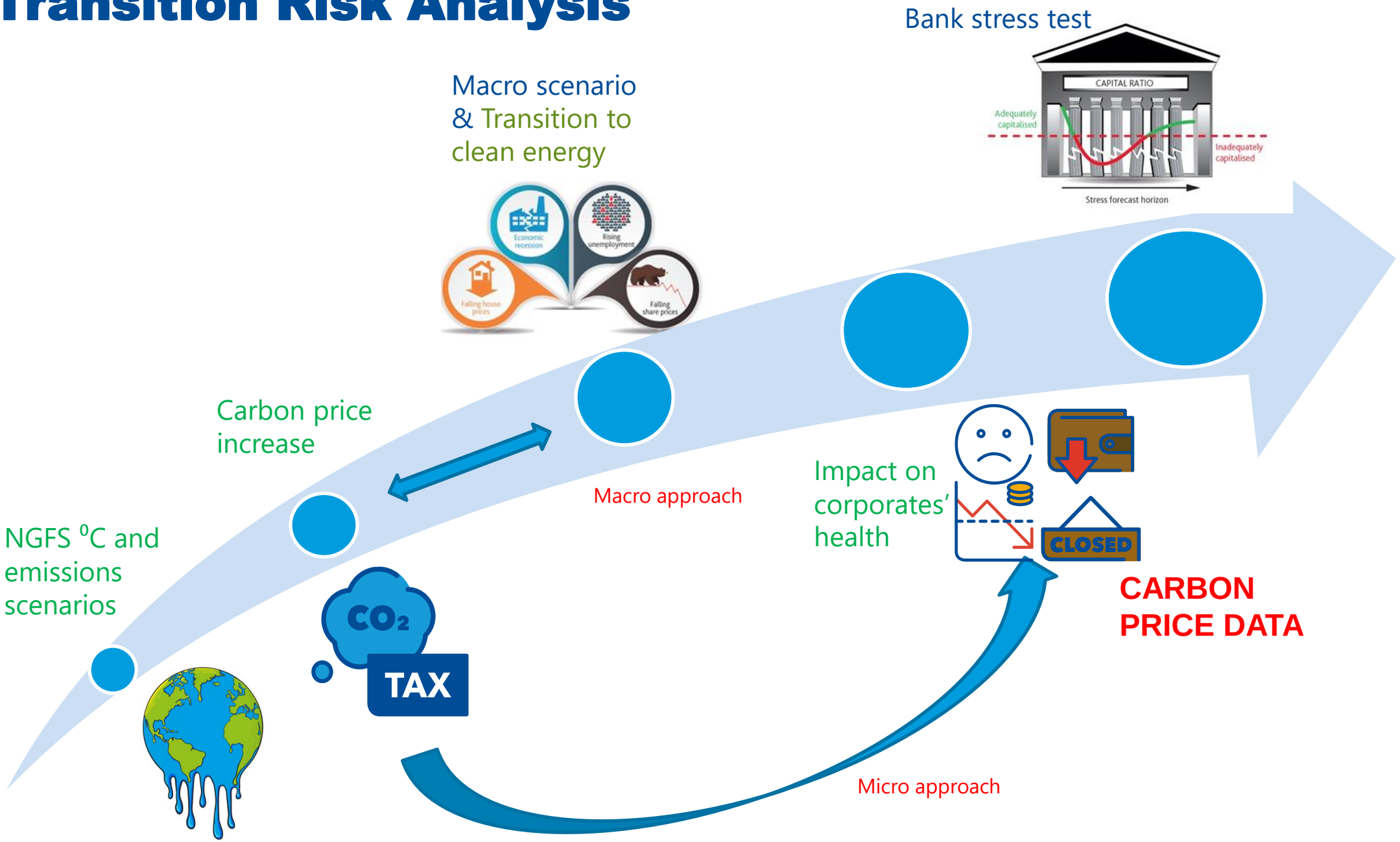


Bank Stress Test



Transition Risk Analysis

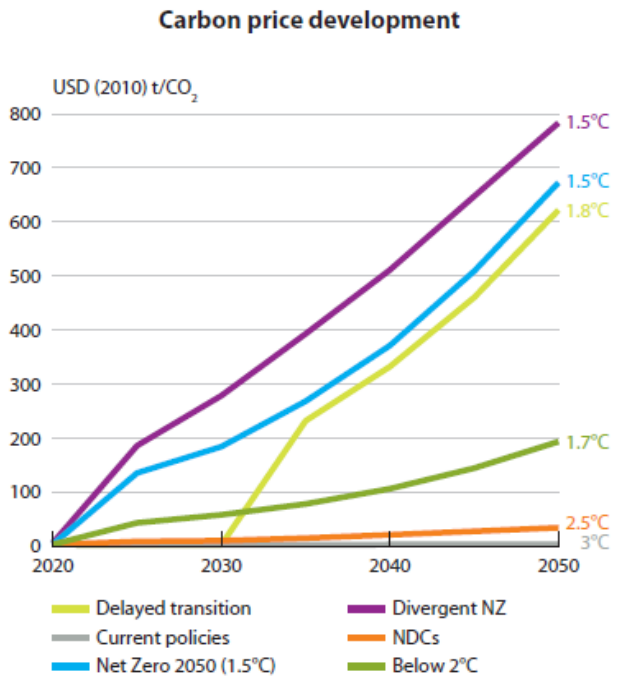
Transition Risk Analysis



Scenario Design: Where do Carbon Tax Paths (And Other Variables) Come From?

NGFS

- Carbon taxes derived via Integrated Assessments Models for a given GDP



IMF

- Option 1: Carbon taxes and GDP taken from NGFS
- Option 2: Fully endogenous carbon taxes and GDP-derived using CGE model for a given NGFS ºC and emissions scenarios
  - Further sectoral analysis
  - Could result in different carbon taxes and (larger) GDP losses over the near term

Bank Stability Assessment

Macro approach

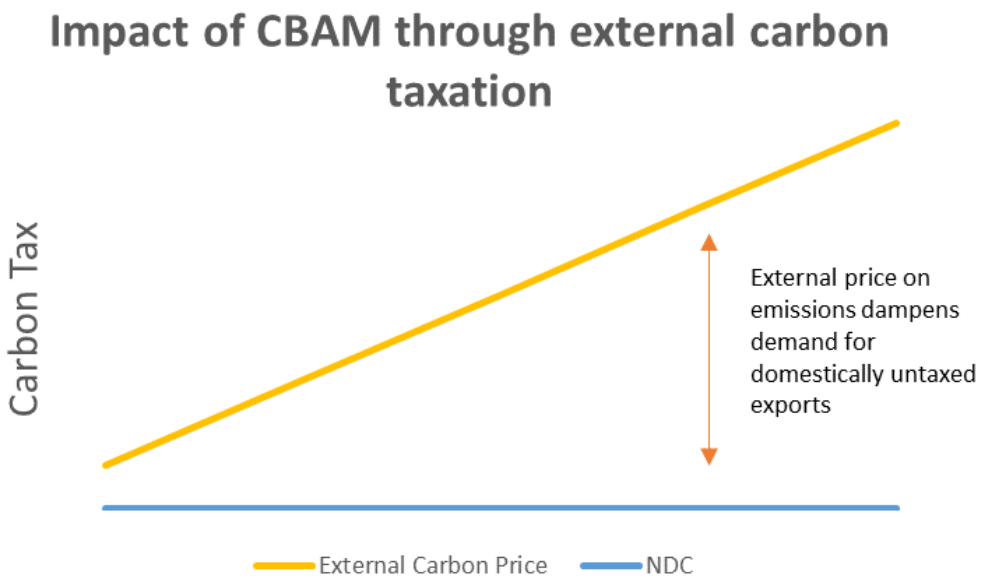
- Analysis of carbon tax shocks on macro and financial scenarios using macro and sectoral models
  - Single/Multi- country climate DSGE model **with sectors**
  - **Computable General Equilibrium (CGE)** models
- Standard stress testing methods based on macrofinancial scenarios

Micro approach

- Analysis of corporates: micro-models to estimate impact of carbon tax (and its impact on macro and sectoral variables) on individual balance sheets
- Stress testing methods based on direct exposure of banks

Transition Risk Scenarios Design: EMs and External Carbon Taxes

- A structural micro simulation for firms and banks connected to a climate-macro CGE model



Global CGE model

Obtain impacts on domestic economies and trade

Firms

Firms, account for their exports vs. domestic sales Output: PDs, LGDs, and credit spreads for all firms

Banks

Impact from firms on banks

What Has Been Done so Far in FSAPs

PHYSICAL RISK

Chile*
Philippines*
South Africa*
UK*
Mexico
Ireland

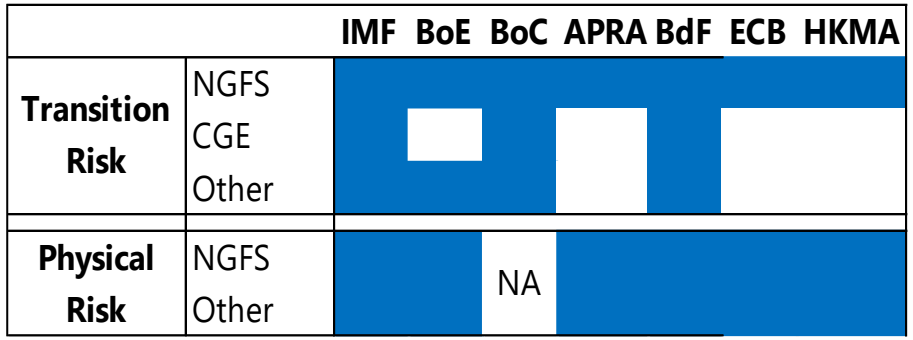
TRANSITION RISK

Norway*
South Africa*
UK*
Colombia
Chile*
Mexico
Ireland

* Completed FSAPs

What central banks and supervisors are doing

CLIMATE SCENARIO DESIGN APPROACHES



BoE: Bank of England
BoC: Bank of Canada
APRA: Australian Prudential Regulation Authority
BdF: Banque de France
ECB: European Central Bank
HKMA: Hong Kong Monetary Authority

NGFS Member Institutions Currently Conducting Climate Risk Analysis

Asia and Pacific	Middle East and Central Asia	Europe	Africa	Western Hemisphere
Australian Prudential Regulation Authority	Bank Al-Maghrib	Autorité de contrôle prudentiel et de resolution (ACPR)/ Banque de France	South African Reserve Bank	Banco Central de Chile
Bangko Sentral ng Pilipinas		Banca d'Italia		Superintendencia Financiera de Colombia/Banco de la República
Bank of Korea		Banco de España		Banco de México
Hong Kong Monetary Authority		Bank of England		Bank of Canada
Japan Financial Services Agency/ Bank of Japan		Bundesbank		
Monetary Authority of Singapore		De Nederlandsche Bank		
People's Bank of China		European Banking Authority		
Reserve Bank of New Zealand		European Central Bank		
		Malta Financial Services Authority		
		Oesterreichische Nationalbank		
		Seðlabanki Íslands		
		Suomen Pankki		
		Sveriges Riksbank		
		Swiss National Bank / FINMA		

Source: NGFS (2021): Scenarios in Action, NGFS Technical Document, October 2021

Climate risk analysis and Financial Policy

- Climate risk analysis can inform policy considerations by **evaluating the magnitude of risk and potential pressure points** for the financial system due to physical climate shocks and in the transition to a low-carbon economy.
- The resulting analysis can **raise awareness of the risk**, and adaptation needs and opportunities.
- These includes the need for banks to develop tools to manage climate risks and for financial sector supervisory authorities to adequately supervise this risk.
- This would potentially drive gradual early adjustment and help inform policies needed to enhance risk management and the resilience of the financial system.
- However, the use of climate risk analysis for regulatory purposes will require significant further work given methodological and data challenges.

Next Steps

Operationalization of the framework in FSAPs

- Taking stock based on the pilots
- Use and assessment of climate data
- Skills, technical capabilities
- Resources

Collaboration

- World Bank
- NGFS
- National authorities
- AIV team
- RES & other functional depts

Beyond banks

- Insurance firms
- Mutual funds

Beyond FSAPs

- TA
- Article IV

Survey results

Key climate risks:

- Physical risks: acute physical risks or not analyzed.
- Transition risks: risks stemming from the evolution of domestic and/or global climate mitigation policies, risks from stemming from changes in consumers' preferences, or not analyzed.

Climate risk analysis plans:

- Two authorities already require financial institutions to undertake both physical and transition risk analyses, and four authorities are planning to require them to do so in the next future.
- Three authorities plan to develop a framework and conduct regular climate risk stress tests in the near future, while three authorities are not planning to do so.

Questions?

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