STI IMF – Singapore Regional Training Institute

INSTITUTE FOR CAPACITY DEVELOPMENT

S3 – Financial Stability and Climate Risk Analysis

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Adolfo Barajas and Iris Claus

Agenda

Financial supervision and regulation

Climate risks

Stress tests

Case study: Bankonia

- Financial soundness indicators
- Stress testing without climate risk

Climate risk analysis

Summary

What area is most of your work in?

1) Financial supervision and regulation
2) Climate change
3) Macroeconomic policy and/or forecasting
4) Other

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Financial supervision and regulation

Financial intermediation

Investment is a key source of economic growth.

Financial systems channel funds from those who have savings, but no productive uses for them, to those who have productive investments, but insufficient funds to carry them out.

They leads to a more efficient allocation of resources.

Financial intermediaries help reduce an information asymmetry.

Borrowers generally know more about their investment projects than lenders do,

… how risky their projects are,

… how likely they are to repay a loan.

Costs of moving funds

Financial intermediaries reduce the costs of moving funds between borrowers and lenders.

They can obtain information at a lower cost than individual lenders.

There are **increasing returns to scale** to financial intermediation.

- Financial intermediaries develop special skills in evaluating prospective borrowers and investment projects.
- They can exploit across customer information.
- They can re-use information over time.

Financial supervision and regulation

Economies of scale increase with the size of a financial intermediary.

Large financial intermediaries increase **systemic risk**.

Financial intermediaries are also subject to information asymmetry problems.

Microprudential supervision seeks to safeguard financial intermediaries from idiosyncratic risks and prevent them from taking too much risk.

Macroprudential supervision seeks to safeguard the financial system as a whole.

Climate risks

Human influence is warming the atmosphere, ocean, and land

Not everyone recognizes their responsibilities towards nature and future generations. Defining obligations is difficult.

- No one can easily be excluded from the use of environmental assets (public good and common access).
- People and firms do not bear the full costs of their environmental degradation and/or receive all the benefits of their activities to preserve the environment (externalities).
- People's and firms' actions cannot be easily observed and monitored (hidden information).
- Governments are tempted to renege on earlier promises when circumstances change (time inconsistency).

Human influence is warming the atmosphere, ocean, and land (cont.)

Signals about the scarcity and value of environmental assets are inaccurate because of missing markets for environmental assets.

Firms do not capture all the benefits of their research and development (R&D) of new technology and hence underinvest in it.

R&D increases private profits but it can also have added social benefits of raising the general level of knowledge within society.

The magnitude and timing of climate risks are highly uncertain due to political and scientific uncertainty.

There is a value of waiting to invest until some of the uncertainty is resolved.

The global nature of climate change adds another level of complexity.

Climate change

Climate change is a complex problem.

A comprehensive approach that combines economic, regulatory, legal, educational, scientific, technological, and social strategies is likely to be most effective.

Transition to a net zero carbon economy will require a reallocation of scarce environmental resources to their highest valued use.

Financial systems facilitate price discovery, assess and transfer risks, and allocate capital.

Well functioning and sound financial systems and adequate financial supervision and regulation are critical for achieving an orderly transition.

In my country, the impacts of climate change are expected to be …

1) extremely severe.
2) somewhat severe.
3) neutral.
4) positive.
5) I don't know.

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Stress tests

Stress tests

Stress tests have become an important tool for financial institutions and financial supervisors and regulators.

They are forward-looking exercises to evaluate the impacts of severe but plausible adverse scenarios on the resilience of financial institutions.

Initially developed with a focus on individual banks, the IMF has been using stress tests with a financial system perspective since 1999 as part of its Financial Sector Assessment Program (FSAP).

FSAPs are mandatory (every 5 years) for countries with “systemically important” financial sectors and voluntary for all others.

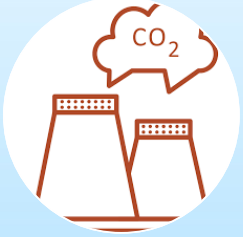
https://www.imf.org/en/News/Articles/2015/09/14/01/49/pr10357

Climate risk assessment in Financial Sector Assessment Programs (FSAPs)

PHYSICAL RISK

Chile
Philippines
South Africa
UK
Mexico
Ireland
Uruguay

TRANSITION RISK



Norway
South Africa
UK
Colombia
Chile
Mexico
Ireland

Climate risks have started to be considered as part of FSAPs.

Climate risk analysis is not a standard stress test.

Climate risks have different characteristics compared to other financial risks.

Climate risks have different characteristics compared to other financial risks because …

1) climate catastrophes may be even more serious than systemic financial crises.
2) they could pose an existential threat to humanity.
3) they have potentially long horizons of materiality.
4) they may impact countries, regions, and sectors differently.
5) they are complex to model due to chain reactions and cascade effects.
6) insufficient historical data are available to inform scenarios.

Select all that apply.

“Standard” stress testing

FSAP risk analysis typically develops scenario-based stress tests to assess bank solvency and liquidity.

Solvency stress tests help to assess banks’ capital adequacy, thereby reducing the likelihood of failure.

- A business is (in)solvent if the value of its assets is greater (less) than the value of its liabilities.

Liquidity stress tests examine if banks have enough cash inflows to withstand cash outflows in a stressed scenario.

- An entity is (il)liquid if its liquid assets and available financing are (in)sufficient to meet or roll-over its maturing liabilities.

Solvency and liquidity risks

We will focus on solvency risk (and assets).

- How much capital does the banking system have today?
- How exposed is the banking system to different risks?
- How likely and large could these risks (shocks) be?
- If the shocks materialize, could the banking system survive?

Liquidity risk deals with the banking system's ability to fund its activities.

Climate shocks are not expected to have a direct impact on funding.

But there is a possible indirect effect: Climate shocks → loss of trust in the financial system → withdrawals (runs) → impairment of funding

This indirect effect has not been explored to date.

The impacts of climate change on financial stability risks are assessed in my country.

1) Yes, they are.
2) No, they are not.
3) I don't know.

Case study: Bankonia

Case study: Bankonia

We will apply four approaches to detect the possibility of insolvency in Bankonia's banking system:

- Financial ratios
- Z-score (resilience to shocks to earnings)
- Value-at-Risk (VaR)
- **Stress testing and climate risk analysis**

Financial soundness indicators (FSIs)

Bankonia:
Financial soundness indicators

Diagnostic goal

The diagnostic goal is to detect the possibility of banking system insolvency, i.e., that bank capital could be wiped out.

Balance sheet	
Assets (A)	Liabilities (L)
	Capital (K)

$K = A - L$

Insolvency occurs when $A < L$.

How likely is this?

How close are we to this possibility?

Equity/capital is:

- the amount of capital invested or owned by the owner(s) of an entity;
- the money that would be left if an entity sold all its assets and paid off all its liabilities;
- the principal loss absorber.

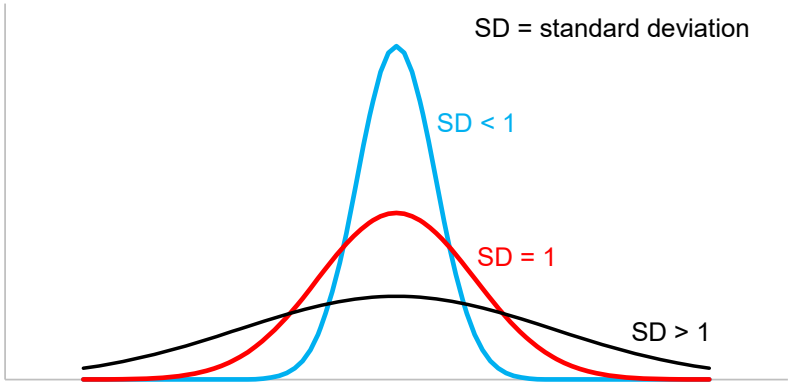
Distribution and standard deviation

A distribution gives the probability of a range of events that could happen and the probability that any one particular event could happen.

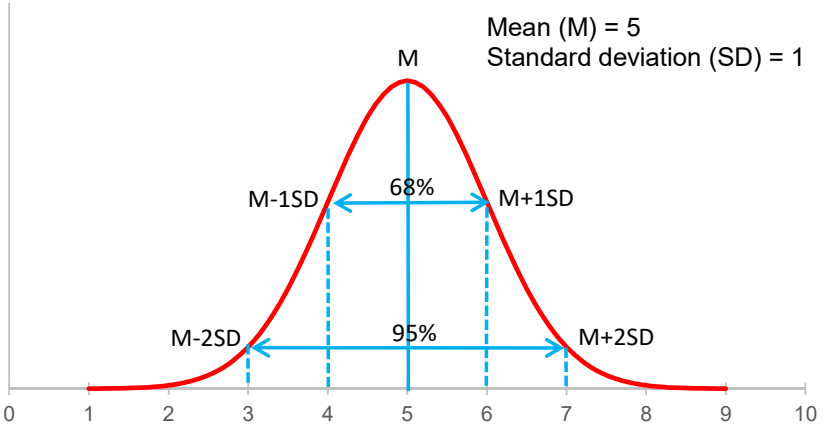
Standard deviation (SD) defines the width of the distribution.

E.g.: The probability of an outcome of 4, i.e., SD = 1 lower than the mean (M = 5) is 16%. 16% of the time we can expect an outcome below 4.

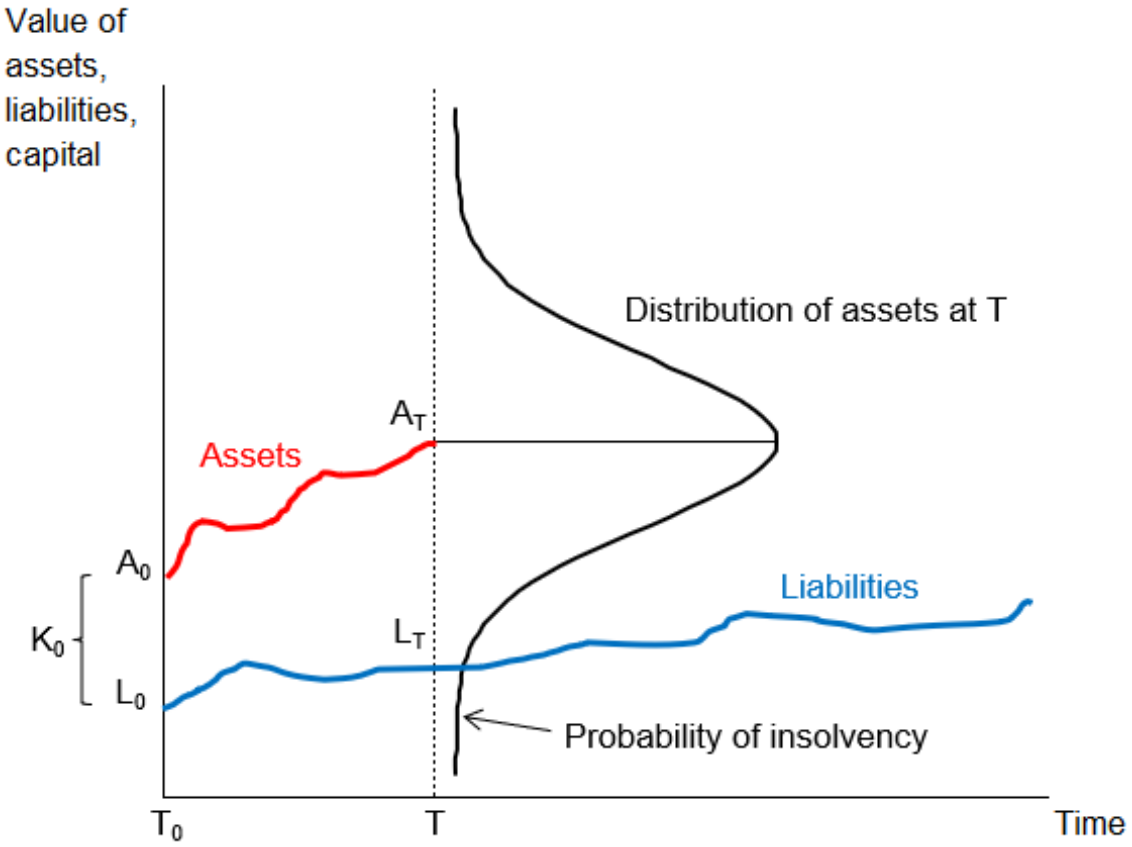
Normal distributions



Standard deviations in a standard normal distribution



A graphical representation



What determines probability of insolvency?

- Capital today: K_0
- How much A and L are expected to grow
- Volatility of A

A = assets; L = liabilities; K = capital
K = A – L

Basel III

Basel III is an internationally agreed set of measures to strengthen the regulation, supervision, and risk management of banks.

Under Basel III, the minimum capital ratio a bank must maintain is 8% of its risk-weighted assets (RWAs) with a minimum Tier 1 capital ratio of 6%.

Risk-weighted assets are the loans and other assets of a bank, weighted to reflect their risk of loss to the bank.

Tier 1 - equity and disclosed reserves

Tier 2 - supplementary capital, e.g., undisclosed reserves and unsecured subordinated debt instruments

Countercyclical capital buffers of 0% to 2.5% of a bank's RWAs can be imposed during periods of economic expansion.

Consolidated banking system balance sheet

Bankonia

Banking System Balance Sheet (B$ millions, end-2021)

Assets		Liabilities	
	4,470,880		**4,181,810**
Cash and liquid assets	582,420	Deposits	2,319,627
Securities portfolio	734,074	Demand deposits	1,646,067
Net loans	2,793,684	Term deposits	673,560
Other assets	360,703	Other liabilities	1,862,183
		Total capital (equity)	**289,070**

Financial Ratios

Capital/assets	6.5%
Regulatory capital	289,070
Risk-weighted assets (RWA)	3,180,555
Regulatory capital/RWA	9.1%

Credit risk

Market risk

Exchange rate risk

Are the ratios large?

How likely is it that capital could be wiped out?

What types of shocks could wipe out capital?

Risk-weighted assets exclude safe assets, e.g., cash.

What are examples of credit, market, and exchange rate risks?

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Exposure of the banking system to different risks

Credit risk: How large is the credit portfolio (e.g., lending products)? How large are non-performing loans (NPLs)? How much of non-performing loans are provisioned?

Market risk: How large is the securities portfolio (e.g., corporate bonds)? How sensitive is its value to changes in market conditions including interest rates?

Exchange rate risk*:* How much of the balance sheet is denominated in foreign currency? What is the net exposure / net open position?

Non-performing loans are loans that are not being paid on time.

Banks make provisions for some non-performing loans going bad in the future.

Net open position, *in each currency* = Foreign currency assets – foreign currency liabilities

Probability of insolvency

How large of a shock to **assets** would be required to exhaust bank capital?

Suppose the standard deviation (SD) of assets is 3%.

$$\frac{\text{capital}}{\text{SD of assets}} = \frac{289{,}070}{134{,}126} = 2.2$$

Bankonia

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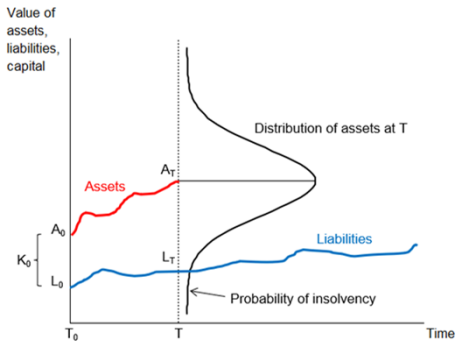


A 2.2 SD shock to assets would exhaust the banking system's capital. How likely is that?

Assuming a normal distribution, $\text{prob}_{\text{bank insolvency}}$ = **1.56%**

Z-score (resilience to shocks to earnings)

How large of a shock to **earnings** would be required to exhaust bank capital?

Suppose the standard deviation (SD) of return on assets (ROA) is 3%.

$$\text{Z-score} = \frac{\frac{\text{capital}}{\text{assets}} + \text{ROA}}{\text{SD of ROA}} = \frac{0.065 + 0.0063}{0.03} = 2.37$$

A 2.37 SD shock to earnings would exhaust the banking system's capital. How likely is that?

Assuming a normal distribution, $\text{prob}_{\text{bank insolvency}}$ = **0.9%**

Z-score is also called "distance to default".

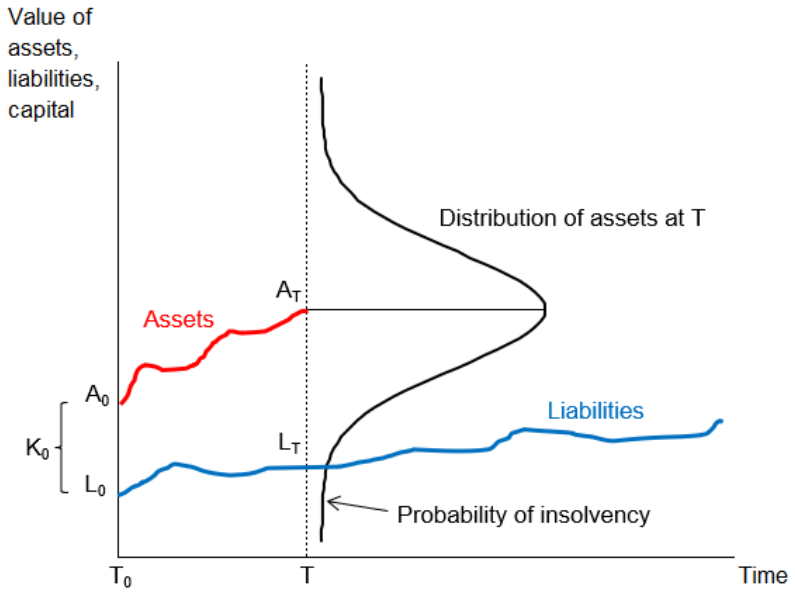
Value-at-Risk (VaR)

Value-at-Risk for earnings and capital is similar to the z-score, but the question is inverted, as we choose the probability.

What is the minimum amount of capital that the banking system could expect to lose with a 5% probability?

Given the standard deviation of assets and assuming a normal distribution, 5% VaR of capital is equivalent to ***-$220,618*** or 76% of capital.

There is a 5% probability the banking system will lose 76% of its capital or more.

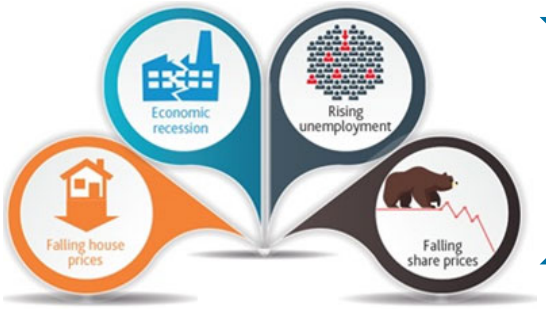


Bankonia:
Stress testing without climate risk

Stress testing

Risk assessment matrix

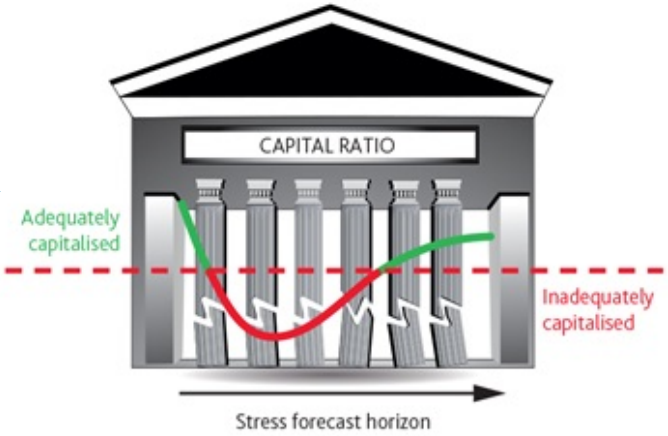
Macro scenario



Risk factors

- Credit, market, exchange rate risks
- Historical relationships
- 3-5 year horizon

Bank solvency stress test



Corporate and household sensitivity analysis or stress test

Stress tests are forward-looking exercises to evaluate the impacts of severe but plausible adverse scenarios on the resilience of financial institutions.

Stress testing: an example

The economy of Bankonia is hit by an adverse macroeconomic scenario:

- A pronounced decline in GDP
- An increase in unemployment
- A crash in house and equity prices
- A sharp depreciation of the exchange rate
- Interest rate hikes

The estimated impact of this scenario on the banking system's balance sheet is:

- Net loans decline by 0.5% (due to ↑NPLs)
- The value of securities declines by 10% (due to ↑i)
- The value of foreign currency liabilities increases by 25% (due to ↑e)

Stress testing without climate risk

- Non-performing loans increase by 25%.
- The value of the security portfolio declines by 10%.
- The exchange rate depreciates by 25%.

Bankonia

Banking System (B$ millions)

Assets	2021	2022	Liabilities	2021	2022
	4,470,880	**4,384,088**		**4,181,810**	**4,185,456**
Cash and liquid assets	582,420	582,420	Deposits	2,319,627	2,323,273
Securities porfolio	734,074	660,667	Demand deposits	1,646,067	1,646,067
Net loans	2,793,684	2,780,299	Term deposits	673,560	677,206
			Foreign currency	14,585	18,232
			Domestic currency	658,974	658,974
Gross loans	2,847,222	2,847,222			
NPLs	62,810	78,512			
Provisions	53,538	66,923			
Other assets	360,703	360,703	Other liabilities	1,862,183	1,862,183
			Total capital (equity)	**289,070**	**198,632**

K = A - L

WS 1. Simple Stress

WS 2. Conventional Stress Test

Assuming a ***static*** balance sheet:

Capital falls by 31%.

The ratio of capital to risk-weighted assets falls from 9.1% to 6.3%.

System becomes undercapitalized (<8%).

The system fails the stress test.

Climate risk analysis

Climate risk analysis

Climate risks

- **Physical risks**: Risks arising from physical impact of climate change
- **Transition risks**: Risks resulting from policy, technology, legal, and market changes that occur during the move to a low-carbon economy

Relative to conventional stress testing, including climate risk implies

- greater potential losses and damages
- larger uncertainty
- longer horizons
- need for new data and models
- increased sectoral and geographic diversity

Climate risk scenarios

For a country with climate risks, physical and transition risks are added to bank solvency stress testing using temperature and emissions scenarios from the IPCC and NGFS.

The IPCC (Intergovernmental Panel on Climate Change) is a body of the United Nations responsible for advancing knowledge on human-induced climate change.

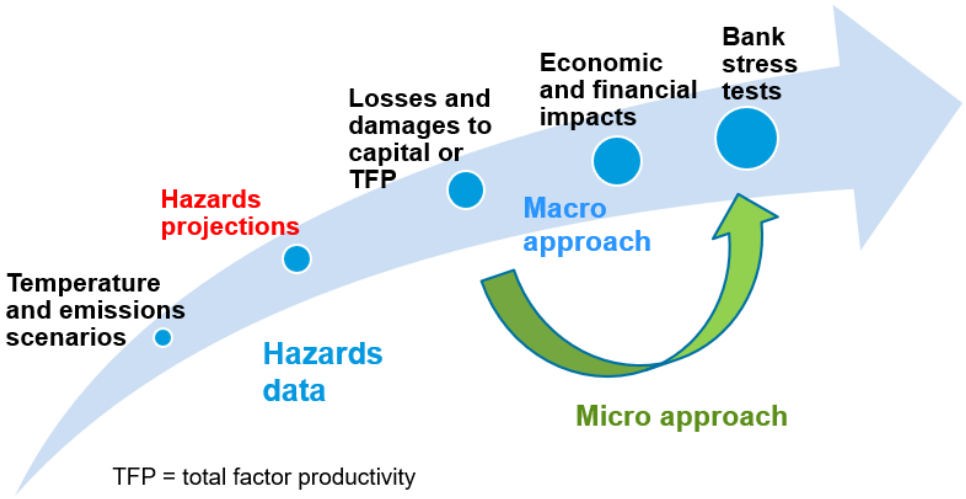
The NGFS (Network for Greening the Financial System) is a network of central banks and supervisors from advanced, emerging, and developing economies to enhance the role of financial systems to manage risks and mobilize capital for green and low-carbon investments.

Representative concentration pathways (RCPs) provide reference scenarios for the potential future paths for greenhouse gas emissions and associated changes in global temperatures.

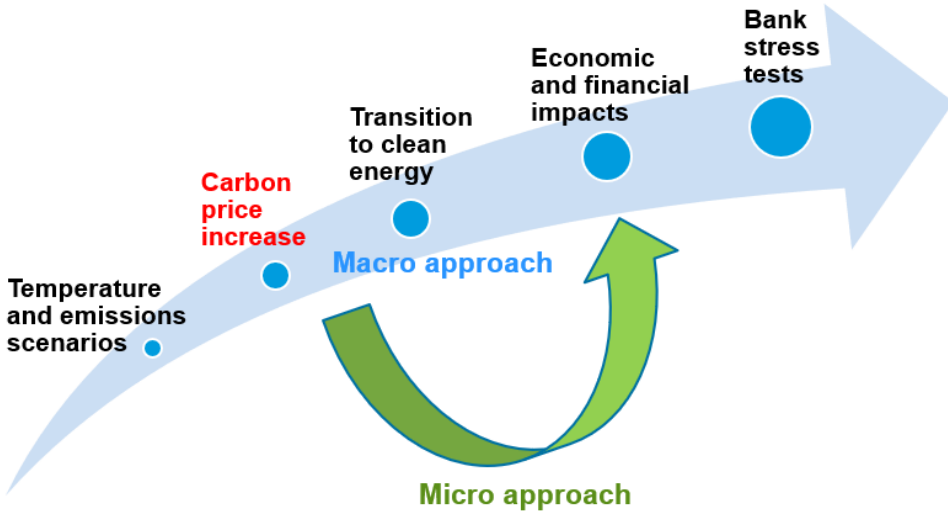
NGFS reference scenarios are used to integrate climate risks into macroeconomic and financial stability surveillance.

Physical and transition risk analysis

Physical risk analysis



Transition risk analysis



Micro approach

- Exposure-level data
- Analysis of corporate, household, and government sectors
- Institution-level resilience

Financial stability analysis with climate risk

Bankonia

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WS 3. Macro Physical Risk

WS 4. Micro Transition Risk

Physical and transition shocks have an impact on the valuation of assets and liabilities of Bankonia's banking system.

Different exposure of banks to transition risks introduces heterogeneous impacts.

Summary

Summary

Financial systems and adequate financial supervision and regulation are critical for achieving an orderly transition to a net zero carbon economy.

Financial systems facilitate price discovery, assess and transfer risks, and allocate capital.

One major aspect of financial stability risk is solvency risk. How likely is it that the financial system would lose substantial amounts of its capital?

There are several approaches to answer that question, with stress testing being particularly useful.

We focused on credit, market, and exchange rate risks.

Climate risks have different characteristics compared to other financial risks.

Climate risk analysis is not a standard stress test and work-in-progress.

In your view, how can financial regulation and supervision best support an orderly transition?

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Workshop

In your view, what are the key macroeconomic issues regarding climate change?

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