STRESS TESTING

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Prepared for the course
Financial Stability

CENTRAL BANKING

14 March 2022

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1 **Stress testing: the basics**

2 Banking stress tests: USA, EU, UK

3 Stress testing: some technical aspects

4 Capital adequacy stress tests vs climate change stress tests

Stress testing: the basics

Historical data: Set of observed economic and financial conditions

Starting point: concerns the last quarter (or last year) of observed economic and financial conditions

Baseline scenario: Set of economic and financial conditions that is consistent with the best estimate of future economic and financial conditions

Adverse scenario: Set of economic and financial conditions (significantly more negative than a baseline scenario) which is designed to stress the financial performance of a financial system and/or institution (reflecting severe but plausible conditions)

Therefore, for each institution we will have detailed **Historical data**, a **Starting point**, a **Baseline scenario** and an **Adverse scenario** with all the relevant information concerning **solvency**, **liquidity** and **profitability**.

The **Baseline (scenario) projection** of the relevant financial information is typically referred as **Funding and Capital Plan**.

1. STRESS TESTING: THE BASICS

STARTING POINT

AQR – zombie firms

AQR – illiquid assets

RWA variability

Conduct issues

IFRS9

BASELINE

Low-for-long interest rate

Implementation of Basel III

Profitability

Fintech/GAFAS challenges

STRESS TEST

Credit risk

Market risk

NII risk

Sovereign risk

Real Estate risk

Source: Neves, P.D. “An Encompassong Forward-Looking Approach to Increase Resilience in the Banking Sector: A second life for EU Stress Tests”, EBI Discussion Paper Series, 2020 – No. 1, September 2020

TAXONOMY: In terms of policy objectives, a stress test can be classified as "macroprudential" or "microprudential":

Macroprudential stress test: a stress test designed to assess the system-wide resilience to financial and economic shocks, which may include effects emerging from linkages with the broader financial system or the real economy. Interactions between individual banks can also be taken into account.

Microprudential stress test: a stress test designed to assess the resilience of an individual bank to macroeconomic and financial vulnerabilities and respective shocks. Instruments, mechanisms and measures available to the supervisor are usually applied at the bank level.

Source: "Stress-testing banks – a comparative analysis", Patrizia Baudino, Roland Goetschmann, Jérôme Henry, Ken Taniguchi and Weisha Zhu, FSI Insights, No 12, BIS, November 2018.

TAXONOMY: In terms of who performs the exercise, a stress test can be either "top-down" or "bottom-up":

Top-down stress test: a stress test performed by a public authority using its own stress test framework (data, scenarios, assumptions and models). Either bank-level or aggregated data may be used, but always in models with consistent methodology and assumptions, generally developed by the authority.

Bottom-up stress test: a stress test performed by a bank using its own stress test framework as part of a system-wide exercise, or as part of a stress test where authorities provide banks with common scenario(s) and assumptions.

Source: "Stress-testing banks – a comparative analysis", Patrizia Baudino, Roland Goetschmann, Jérôme Henry, Ken Taniguchi and Weisha Zhu, FSI Insights, No 12, BIS, November 2018.

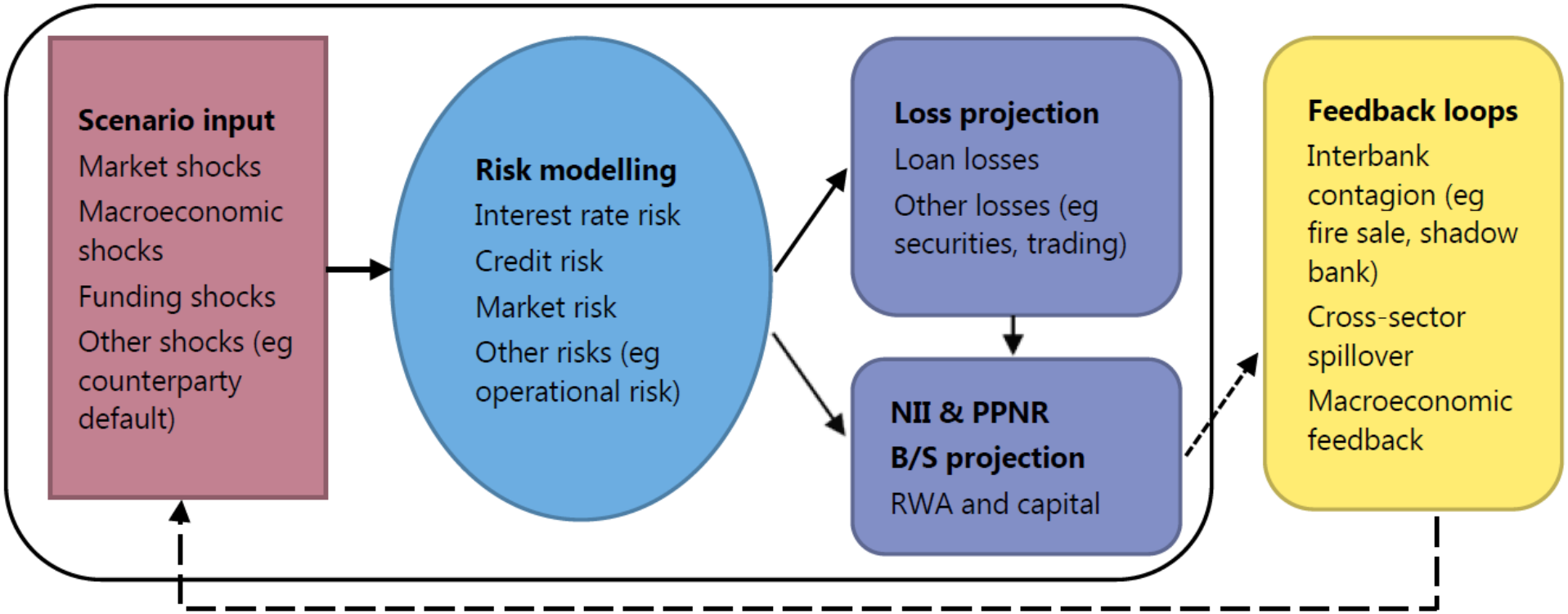
TAXONOMY: Finally, in terms of balance sheet projections, they can be described as "dynamic" or "static":

Dynamic balance sheet: an assumption that the size, composition or risk profile of a bank's balance sheet are allowed to vary over the stress test horizon.

Static balance sheet: an assumption that the size, composition and risk profile of a bank's balance sheet are invariant throughout the stress testing time horizon.

Source: "Stress-testing banks – a comparative analysis", Patrizia Baudino, Roland Goetschmann, Jérôme Henry, Ken Taniguchi and Weisha Zhu, FSI Insights, No 12, BIS, November 2018.

Figure 1: Major modelling steps in a solvency stress test



NII = net interest income; PPNR = pre-provision net revenue; B/S = balance sheet; RWA = risk-weighted asset.

Source: FSI staff.

Source: "Stress-testing banks – a comparative analysis", Patrizia Baudino, Roland Goetschmann, Jérôme Henry, Ken Taniguchi and Weisha Zhu, FSI Insights, No 12, BIS, November 2018.

1. Overview of the paper…… *Bank's (baseline) projections*

	Dynamic BS	Static BS	ICAAP	Top-down	Sensitivity
Economic scenario	Baseline	Baseline	Bank	Baseline	Sensitivity scenario
Ownership	Bank	Hybrid	Bank	Supervisor	Bank
Corporate decisions	Yes	No	Yes	Yes	Yes
Granularity	High	High	High	Medium	High

Source: Neves, P.D. "An Encompassong Forward-Looking Approach to Increase Resilience in the Banking Sector: A second life for EU Stress Tests", EBI Discussion Paper Series, 2020 – No. 1, September 2020

How to access the relevance of the stress testing exercise?

1. Realism of the exercise: is the exercise limited by (too) hard assumptions and/or methodological constraints? (static versus dynamic balance sheet)
2. Does the exercise provide a useful forward-looking perspective on how the financial institutions will address the current structural deficiencies;
3. Does the exercise provide an accountable view on the projected profitability/capital figures? (ownership, gaming)
4. Can the exercise be used in a straightforward way in the supervisory process?
5. Does the exercise bring valuable information for the markets?
6. Do these exercises have potential for improvement?

Source: Neves, P.D. “An Encompassong Forward-Looking Approach to Increase Resilience in the Banking Sector: A second life for EU Stress Tests”, EBI Discussion Paper Series, 2020 – No. 1, September 2020

1. Overview of the paper……*Bank's (baseline) projections*

	Dynamic BS	Static BS	ICAAP	Top-down	Sensitivity
Realism	H	L	H	M	M-H
Forward-looking	H	L	H	H	H
Accountability	H	L	H	H	M-H
Comparability	M	H	L	H	M
Supervisory use					
Capital adequacy	H	M	H	H	H
Business model	H	L	H	M	H

Note: H means High, M means Medium; L means Low

Source: Neves, P.D. "An Encompassong Forward-Looking Approach to Increase Resilience in the Banking Sector: A second life for EU Stress Tests", EBI Discussion Paper Series, 2020 – No. 1, September 2020

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Stress Tests in the EU, UK and USA

	EU	UK	USA
Stress Test	EBA 2018	ACS 2019	DFAST 2019
General features			
Release date	Nov 2018	Dec 2019	June 2019
Frequency	Biennial	Annual	Annual
Inclusion threshold	EUR 30 Billion	---	USD 100 Billion
Number of banks	48	7	18
Time horizon	3 years	5 years	9-quarter
Technical features			
Balance Sheet	Static	Dynamic	Dynamic
Type of stress test	Constrained bottom-up	Hybrid	Top-down
Ownership	Hybrid	Supervisor	Supervisor
Hurdle rate (CET1)	No	6.9-8.1	4.5 + specific buffers
Hurdle rate (Tier 1 leverage)	No	3.47-3.86	4.0
Transparency			
Disclosure of models	n.a.	No	No
Disclosure of bank data	Yes (extremely granular)	Yes	Yes

Source: Neves, P.D. et al (2021) "Stress-testing in banking in the EU: critical issues and new prospects" forthcoming as a chapter in "Capital and Liquidity Requirements for European Banks", editors Bart Joosen, Marco Lamandini and Tobias Tröger, to be published by Oxford University Press

EU-wide Stress Test main features (2011-2018)

	2011	2014	2016	2018
General Features				
Release Date	July 2011	Oct 2014	July 2016	Nov 2018
Number of banks	90	123	51	48
Number of countries	21	22	15	15
Starting Point	Dec 2010	Dec 2013	Dec 2015	Dec 2017
Time Horizon	2011-2012	2014-2016	2016-2018	2018-2020
Data Points per bank	3200	12.000	16.000	17.200
New features	Capital raising actions prior to the exercise	AQR 3 years horizon	Operational risk Conduct risk	IFRS9 Level2/Level3
Capital related use	Capital adequacy	Capital adequacy	P2G	P2G
Hurdle under stress	5% CT1R	5.5% CET1	No pass/fail	No pass/fail
Failures	8-20	24	n.a.	n.a.

Source: Neves, P.D. et al (2021) "Stress-testing in banking in the EU: critical issues and new prospects" forthcoming as a chapter in "Capital and Liquidity Requirements for European Banks", editors Bart Joosen, Marco Lamandini and Tobias Tröger, to be published by Oxford University Press

EU-wide Stress Test main features (2011-2018)

	2011	2014	2016	2018
Adverse stress scenario (max difference vs the baseline)				
Real GDP	-4.1%	-7.0%	-7.1%	-8.3%
Unemployment	+1.4 p.p.	+2.9 p.p.	+2.8 p.p.	+3.3. p.p.
Real Estate Prices				
- Residential	-11.6%	-21.2%	-21.3%	-27.7%
- Commercial	----	-14.7%	-22.6%	-27.1%
Equity Prices	-14.3%	-19.2%	-25.4%	-29.9%
Gov. bond yields – average	+66bp	+150bp	+80bp	+85bp
Gov. bond yields - range	0/+258 bp	+109/+316 bp	+67/+162bp	+55/+140bp

Source: Neves, P.D. et al (2021) "Stress-testing in banking in the EU: critical issues and new prospects" forthcoming as a chapter in "Capital and Liquidity Requirements for European Banks", editors Bart Joosen, Marco Lamandini and Tobias Tröger, to be published by Oxford University Press

Examples of ad hoc stress tests during the pandemic

Key features of three ad hoc stress testing exercises under Covid-19 — Table 1

Features \ Agency	Bank of England	ECB Banking Supervision	Board of Governors of the Federal Reserve System
Date of exercise	May 2020	July 2020	June 2020
New Covid-specific scenario(s)?	YES ("illustrative" scenario)	YES (central and severe)	NO; use scenario of Dodd-Frank stress test, but adjust three key variables and make targeted adjustments
Top-down / bottom-up	Top-down only	Top-down only	Top-down only
Number of downside Covid scenarios	One ("illustrative" scenario)	Two (central and severe scenarios)	Three (U/V/W-shaped)
Stress horizon	3 years (to Q1 2023)	2½ years (to Q4 2022)	3 years (to Q1 2023)
Include Covid-19 policy response?	YES (fiscal, regulatory and monetary policy support)	YES (monetary, regulatory and fiscal relief measures, to a large extent)	ONLY regulatory and bank tax relief measures
Any publication?	YES, instead of regular stress test	YES, instead of regular stress test	YES, in addition to regular stress test
Publication of bank-level results or distributions?	NO	NO bank-level, but publication of distribution of CET1 ratios, across the sample and business models	NO bank-level, but publication of distributions of CET1 ratios across the sample
Aggregate CET1 drop in the scenario	380 bp	190 bp (central scenario) and 570 bp (severe scenario)	210 bp (V-shaped), 380 bp (U-shaped) and 430 bp (W-shaped)
What happens with the ad hoc stress test results?	Authorities encourage banks to support lending, otherwise there is a risk of an even bigger economic contraction	Use the stress test to assess the impact of Covid-19 on banks, and identify potential vulnerabilities at an early stage	Use the stress test to understand the implications of downside scenarios for bank capital

Sources: ECB (2020a,b); Bank of England (2020a); Board of Governors of the Federal Reserve System (2020a,b); Quarles (2020).

Source: Stress-testing banks during the COVID-19 pandemic, Patrizia Baudino, FSI Briefs, No 11, Financial Stability Institute, BIS.

BCBS – Stress Testing Principles

1. Stress testing frameworks should have clearly articulated and formally adopted objectives
2. Stress testing frameworks should include an effective governance structure
3. Stress testing should be used as a risk management tool and to inform business decisions
4. Stress testing frameworks should capture material and relevant risks and apply stresses that are sufficiently severe
5. Resources and organisational structures should be adequate to meet the objectives of the stress testing framework
6. Stress tests should be supported by accurate and sufficiently granular data and by robust IT systems
7. Models and methodologies to assess the impacts of scenarios and sensitivities should be fit for purpose
8. Stress testing models, results and frameworks should be subject to challenge and regular review
9. Stress testing practices and findings should be communicated within and across jurisdictions

Source: Stress testing principles, Basel Committee Banking Supervision, October 2018, BIS.

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1. Overview of the paper.....*Recommended improvements*

Move to dynamic balance sheets

Move to a reinforced holistic approach to measure capital adequacy (CET1 ratio, output floor, leverage ratio) in line with the Basel III finalization

Move to top-down stress tests and full ownership of the exercise by the supervisor

Consider more than one adverse scenario; Develop sensitivity scenarios; Incorporate ICAAP in the stress testing procedure

Reintroduce binding hurdles

2. Alternative scenarios

- Why do need more than one adverse scenario?
- Option 1: Vary the relative intensity of the key components of the adverse scenario
  - 3 types of shocks: real economy; financial markets; asset prices
- Option 2: Sensitivity scenarios
- Option 3: A more balanced focus on capital adequacy - profitability

On stress testing and scenario analysis… distinguish appropriately

… **The starting point**: conduct AQRs and RWA reviews

… **The baseline**: assess profitability concerns, LIR environment, Basel III implementation

… [favor the use of dynamic balance sheets]

… **Stress testing**: assess credit risk, market risk, sovereign risk, real estate risk

… [consider more than one adverse scenario]

On stress testing and scenario analysis…

… Reinforce the role of macro-prudential stress testing

… Integrate banking, non-banking, insurance, and pension funds in stress testing

… Progress decisively on granularity of information

… Focus on profitability and business model assessment

… Complement stress testing with growth-at-risk analysis

… Revisit the (forward-looking) use of systemic risk indicators

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4. CAPITAL ADEQUACY STRESS TESTS VS CLIMATE CHANGE STRESS TESTS

FINANCIAL RISKS STEMMING FROM CLIMATE CHANGE:

Physical risk

Transition risk

Litigation risk

TRANSMISSION AND AMPLIFICATION MECHANISMS

Changes in the pricing and management of financial risks

Potential for pro-cyclical behavior by market participants

Self-reinforcing reductions in bank lending and insurance provision

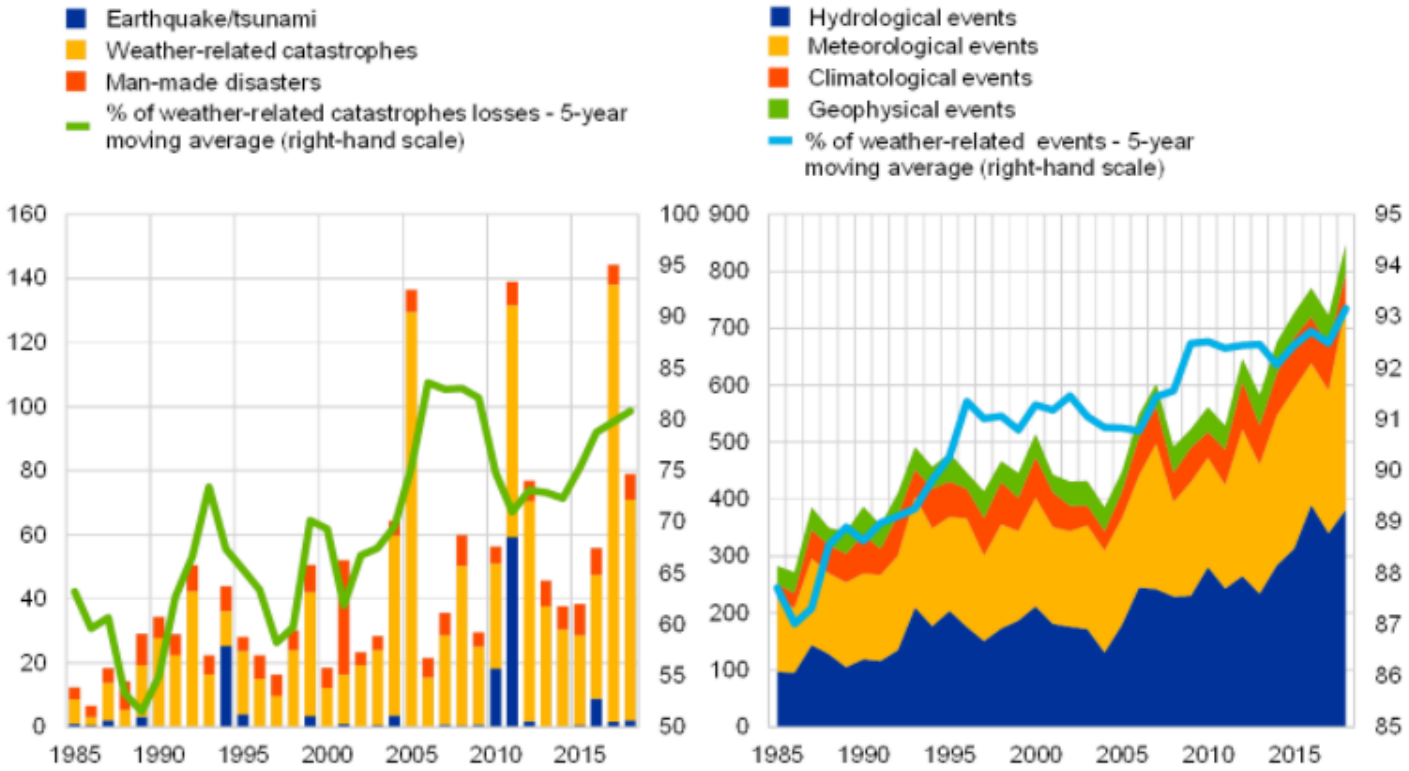
Source: *The Implications of Climate Change for Financial Stability,* Financial Stability Board, 23 November 2020

4. CAPITAL ADEQUACY STRESS TESTS VS CLIMATE CHANGE STRESS TESTS

Physical risk: weather-related insured losses and the number of natural loss events are increasing

Global insured catastrophe losses (left panel) and number of relevant natural loss events worldwide (right panel)

(1985-2018; left panel: left-hand scale: USD billions; right-hand scale: percentages; right panel: left-hand scale: number of events; right-hand scale: percentages)



Sources: Swiss Re Institute, Munich Re NatCatService and ECB calculations.

Source: *Climate change and financial stability*, Giuzio, M. et al (2019), Financial Stability Review, ECB, May 2019

4. CAPITAL ADEQUACY STRESS TESTS VS CLIMATE CHANGE STRESS TESTS

KEY FEATURES

- Multiple climate scenarios

- Broader inclusion of participants (both banks and insurers)

- Extended modelling horizon (30-years)

- Integrated climate and macrofinancial variables

- Counterparty-level modelling expectations

[- Detailed sectorial and geographic granularity]

Source: The 2021 biennial exploratory scenario on the financial risks from climate change, Bank of England, December 2019

4. CAPITAL ADEQUACY STRESS TESTS VS CLIMATE CHANGE STRESS TESTS

KEY DIFFERENCES

- Lack of historical data challenges the modeling of the interactions between climate, the real economy and the financial sector
- Lack of historical data on the relationship between credit risk and credit losses
- Climate stress testing has a much longer tome horizon (30 to 50 years)
- Climate stress testing require much more granular data (sectorial and geographic expositions)
- Much larger uncertainty associated with market participants' actions on equilibrium prices and aggregate outcomes

Source: "Challenges in Stress testing and Climate Change", Covas, F., Bank Policy Institute, October 2020

4. CAPITAL ADEQUACY STRESS TESTS VS CLIMATE CHANGE STRESS TESTS

Design	Supervisory U.S. Stress Tests	Climate Change Stress Testing
Planning horizon	Nine quarters. • Tradeoff between capturing the full extent of losses that might be incurred on assets originated when underwriting standards were looser, and a reasonable ability to project with some degree of confidence the losses and resources at more distant future points.	Varies; most common is between 30 and 50 years. • Climate risks and the policies to mitigate them have long time horizons. • Longer horizons increase the materiality of climate change risks, but also lead to more uncertainty in loss projections.
Number and granularity of scenarios	One severely adverse stress scenario combined with a global market shock for banks with significant trading exposures. • The stress scenario has typically mimicked the behavior of series in the 2007–2009 financial crisis. • Macroeconomic scenarios (16 domestic macro series, 9 foreign series). • Global market shock (+20K factor shocks).	Between 3 and 5 scenarios. Climate change variables: • Physical risks • Transition risks Macrofinancial variables: • Standard series embedded in stress tests. • Scenarios revolve around policies to mitigate greenhouse gas emissions and the pace of technological breakthroughs. • Very challenging to model the interactions between and among climate, the macroeconomy, and the financial sector. • Much less historical data to rely on to assess the severity of the scenario.

Source: "Challenges in Stress testing and Climate Change", Covas, F., Bank Policy Institute, October 2020

4. CAPITAL ADEQUACY STRESS TESTS VS CLIMATE CHANGE STRESS TESTS

Design	Supervisory U.S. Stress Tests	Climate Change Stress Testing
Data and Models	• Large amounts of historical data on losses and revenues. • Projections use a mix of bottom-up and top-down models. • Loan losses: PD/LGD/EAD models. • Trading losses: applies risk-factor shocks to exposures. • Operational risk: models that relate operational risk losses with economic conditions. • Pre-provision net revenue: models that relate specific profit components with firm characteristics and macroeconomic variables.	• Large data gaps; lack of historical data. • Most promising approaches are focused on the adjustment of probability of default and loss given default using the PD/LGD/EAD framework. • Long horizon requires large amount of information about counterparty behavior to model PD and LGD. Data on small firms are typically not available. • Lack of data is addressed using less reliable models or overlays. • The data on climate change scenarios need to be highly granular so that banks can effectively assess borrower-level risks. • Potential double counting the impact of climate change on asset prices and credit losses.
Bank Behavior over the Stress Horizon	• Bank balance sheets remain constant over the stress horizon. • It is a conservative assumption, because loan demand falls in recessions, but this is ameliorated due to the relatively short time horizon.	• Bank balance sheets remain constant over the stress horizon. • Given the long horizon, it is highly unrealistic to assume a static balance sheet over the stress horizon. • The ACPR pilot climate exercise includes a dynamic balance sheet between 2025 and 2050.

Source: "Challenges in Stress testing and Climate Change", Covas, F., Bank Policy Institute, October 2020

ANNEX

Insurance stress testing

Source: Macroprudential policy toolkit for the banking sector, Kristina Grigaitė, Cristina Dias, Marcel Magnus Directorate-General for Internal Policies PE 645.702 - September 2020, European Parliament, Briefing, Economic Governance Support Unit (EGOV)

CASE STUDY: EIOPA

Table 1-2 Overview of main transmission channels for climate change-related risks

Type of risk	Transmission channel	Balance sheet impact	Example	Covered in this paper?
Physical risk	Underwriting risk	Liabilities	Higher than expected insurance claims on damaged insured assets (non-life) or higher than expected mortality or morbidity rates (life/health)	Yes
	Market risk	Assets	Impairing of asset values due to financial losses affecting profitability of firms, due to for instance business interruptions, or damage to real estate. Specific example: equity price shocks	Yes
	Credit risk	Assets	Deteriorating creditworthiness of borrowers/bonds/counterparties/reinsurers due to financial losses stemming from climate change Specific example: bond price/yield shock	Yes
	Operational risk	Assets	Disruption of own insurance activities and/or assets, such as damage to own property	No
	Liquidity risk[9]	Assets / Liabilities	Unexpected higher payouts and/or lapses as broader economic environment deteriorates	No (not as part of climate ST)

Source: *Second discussion paper on methodological principles of insurance stress testing*, EIOPA, 02 June 2020

CASE STUDY: EIOPA

Table 1-2 Overview of main transmission channels for climate change-related risks

Type of risk	Transmission channel	Balance sheet impact	Example	Covered in this paper?
Transition risk	Market risk	Assets	Impairment of financial asset values due to low-carbon transition, for instance stranded assets, 'brown' real estate and/or decrease in value of carbon/GHG intensive sectors. Specific example: equity price shock	Yes
	Credit risk	Assets	Deteriorating creditworthiness of borrowers/bonds/counterparties as entities that fail to properly address transition risk may suffer losses Specific example: bond price/yield shock	Yes
	Underwriting risk	Liabilities	Decrease of underwriting business due to increase of insurance prices in response to higher than expected insurance claims (non-life) or changes in policyholders' expectations and behavior related to sustainability factors (e.g. green reputation) (life)	No
Legal liability risk	Underwriting risk	Liabilities	Higher than expected claims on professional indemnity cover, as parties are held accountable for losses related to environmental damages caused by their activities	No
	Legal/reputational risk	Assets/ Liabilities	Insurers could be held responsible for climate change and/or not doing enough to mitigate/adapt	No

Source: *Second discussion paper on methodological principles of insurance stress testing*, EIOPA, 02 June 2020

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