Stress Testing within the Banking Industry

A Comparative Study within the G-20

By

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This book first published 2024

Ethics International Press Ltd, UK

British Library Cataloguing in Publication Data

A catalogue record for this book is available from the British Library

Print Book ISBN: 978-1-80441-758-4

eBook ISBN: 978-1-80441-759-1

Paperback ISBN: 978-1-80441-760-7

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Acknowledgement

Writing a book is always a challenge. However, writing a book on Stress-testing in the Banking Industry is a more daring intellectual exercise.

I would like to thank my astoundingly supportive friends who motivated me all along the project, knowing my dedication to the subject and thought I am more than able to complete this project: Dr. Marsha Gordon, Dr. Linda Sama, Fouad Sayegh, Dr. Lavern A. Wright, Dr. Lester Reid, Jordan Romine, Claude Lomama, Janize Hernandez, and Jerry Izouele.

Last but not least, thank you to all the original readers of this book when it was in its infancy. Without your enthusiasm and encouragement, this book may have never been ready.

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List of Acronyms

ACS	annual cyclical scenario
BCBS	Basel Committee on Banking Supervision
BHC	Bank Holding Company
BI	Bank of Indonesia
BIS	Bank for International Settlements
CAR	capital adequacy ratio
CBRT	Central Bank of the Republic of Turkey
CCAR	Comprehensive Capital Analysis and Review
CCyB	Countercyclical Capital Buffer
CDS	Credit default swap
CETI (capital)	common equity tier one (capital)
CLAR	Comprehensive Liquidity Assessment Review
CPI	Consumer Price Index
DFAST	Dodd-Frank Act Stress Tests
D-SIB	Domestic Systemically Important Bank
EAD	Exposure at Default
EBA	European Banking Authority
EBIT	Earnings before interest and taxes
ECB	European Central Bank
EDP	Expected default provision
EL	Expected Loss
EM	Emerging market
FPC (UK)	Financial Policy Committee
FRS	Federal Reserve System
FSAP	Financial Sector Assessment Programs
FSB	Financial Stability Board

FSC	Financial Stability Committee
FX	foreign exchange
GDP	gross domestic product
GFC	global financial crisis
HPI	House Price Index
HQLA	high-quality liquid asset
ICAAP	Internal Capital Adequacy Assessment Process
ICR	Interest Coverage Ratio
IF	Investment fund
IMF	International Monetary Fund
IFRS	International Financial Reporting Standard
ILAAP	internal liquidity adequacy assessment process
IRB	internal ratings-based
LCR	liquidity coverage ratio
LGD	Loss Given Default
NBFI	non-bank financial institution
NFC	Nonfinancial Corporate
NGFS	Network for Greening the Financial System
NPL	Non-Performing Loan
NSFR	Net Stable Funding Ratio
OCC	Office of the Comptroller of the Currency
OECD	Organization for Economic Co-operation and Development
PD	Probability of Default
P&L	Profit and Loss
PPI	Producer Price Index
PRA	Prudential Regulation Authority
RAM	Risk Assessment Matrix
ROA	return on assets

ROE	return on equity
RR	Required reserve
RWA	risk-weighted asset
SARB	South African Reserve Bank
SCAP	Supervisory Capital Assessment Program
SCR	Solvency Capital Requirement
SIFI	systemically important financial institution
SRB	Systemic Risk Buffers
SSM	Single Supervisory Mechanism
UK	United Kingdom
US	United States
TRY	Turkish Lira
VaR	Value-at-Risk
WEO (IMF)	World Economic Outlook

Introduction

Bank stress testing is designed to test the resilience of banks to severe but plausible shocks. Bank stress tests have moved from being an isolated risk management tool used by banks, to becoming a core part of the policy toolkit.

Before conducting stress tests, the main risk factors should be defined. These can be interest rate risk, credit risk, exchange rate risk, liquidity risk, market risk, etc. Unlike capital requirements, stress testing provides a forward-looking assessment of losses that would be suffered under adverse economic scenarios. For the banking sector, stress tests are simulation exercises conducted to assess the resilience to a hypothetical scenario of either a single bank or the system as a whole.

Stress-testing practices vary widely internationally, with several authorities still in the development stage of their stress-testing frameworks. Stress testing models differ in terms of complexity and the risks considered. Stress tests inform authorities about banks' capital needs and helped them to reassure investors and the public of the capacity of the banking sector to continue functioning throughout the crises. The type of stress testing a bank needs to undergo depends on the size of the bank and the regulations in the country in which it operates.

There are two main approaches to conducting stress tests. In bottom-up stress tests, individual banks use their internal models. In top-down stress tests, regulatory authorities apply their own models. Banks' authorities conducting stress testing must develop scenarios based on the range of risk to which banks are really exposed.

Nonetheless, the identification of relevant stress events, the application of sound modelling approaches and the appropriate use of stress testing results each require the collaboration of different senior experts such as risk controllers, economists, business managers, traders and actuaries.

Chapter 1
Stress Test and Reverse Stress Test

The stress test is a forward-looking quantitative evaluation of bank capital that demonstrates how a hypothetical macroeconomic recession scenario would affect firm capital ratios. The stress testing aims to facilitate the development of risk mitigation or contingency plans across a range of stressed conditions. Authorities running Stress testing can pursue both microprudential and macroprudential objectives at the same time. While microprudential policies are bottom up, macroprudential policies are top down. Banks' stress tests are based on at least two scenarios: (i) a baseline scenario using the World Economic Outlook (WEO) projections, and (ii) at least one adverse scenario. At the level of individual institutions, reverse stress testing is a regulatory requirement in the United Kingdom and the European Union. Reverse stress testing is ultimately a risk and strategic management framework tool that can unveil vulnerabilities to the business model, weaknesses in the identification, capturing, monitoring and management of risk and provide insight into future risks that can be proactively addressed.

1.1 General

Bank stress testing is designed to test the resilience of banks to severe but plausible shocks. Bank stress tests have moved from being an isolated risk management tool used by banks, to becoming a core part of the policy toolkit. Stress tests informed authorities about banks' capital needs and helped them to reassure investors and the public of the capacity of the banking sector to continue functioning throughout the crises. Although the stress testing has become widely used, there is no consistent definition of key terms across all jurisdictions that run such exercises, and the meaning of some commonly used terms can become ambiguous. The stress test is a forward-looking quantitative evaluation of bank capital that demonstrates how a hypothetical macroeconomic recession scenario would affect firm capital ratios.

Prior to the financial crisis, stress testing of banks was largely conducted by banks themselves for internal risk management purposes. For the first several years of stress testing, the Comprehensive Capital Analysis and Review (CCAR) was a public exercise that included a quantitative and qualitative assessment.[1] Stress tests are forward-looking exercises that aim to evaluate the impact of severe but plausible adverse scenarios on the resilience of financial firms. They involve the use of models and data at the firm or system-wide level and may rely on historical or hypothetical scenarios.[2] For the banking sector, stress tests are simulation exercises conducted to assess the resilience to a hypothetical scenario of either a single bank or the system as a whole. Stress testing incentivizes banks to implement robust risk mitigation and management practices. More, it provides transparency in the banking system through better data collection and publication. The first use of stress tests can be dated back to the early 1990s, when they were mainly run by individual banks for internal risk management purposes.[3] Since the GFC, there has been significant advancement in the implementation and use of stress testing conducted by national or regional authorities. In general, there are two types of tests: (1) system wide stress tests conducted by central banks and/or supervisory agencies; and (2) stress tests that focus on individual banks and that can be carried out by banks themselves or supervisors.[4] The International Financial Reporting Standard (IFRS) 9 has prescribed stress testing for banks and financial institutions as an exercise to determine the volatility in the expected credit loss in baseline and adverse scenarios such as significant deceleration in GDP growth or sharp increase in unemployment rates. During the Great Financial Crisis (GFC), stress testing became an important tool used by banking supervisors to identify and quantify

[1] Federal Reserve Bank (2022): Board of Governors of the Federal Reserve System, https://www.federalreserve.gov/supervisionreg/stress-tests-capital-planning.htm.
[2] BIS (2021): Stress testing- Executive Summary, pp. 1-2, https://www.bis.org/fsi/fsisummaries/stress_testing.pdf.
[3] Patrizia Baudino, Roland Goetschmann, Jérôme Henry, Ken Taniguchi and Weisha Zhu (2018): Stress-testing Banks – A Comparative Analysis, BIS, pp. 1-36, https://www.bis.org/fsi/publ/insights12.pdf.
[4] Idem.

immediate capital shortfalls in distressed banks[5]. Macroprudential stress tests are usually conducted by authorities in charge of the financial stability function in a central bank.[6] The type of stress testing a bank needs to undergo depends on the size of the bank and the regulations in the country in which it operates. The two commonly used stress tests for banks in the United States are the Comprehensive Capital Analysis and Review (CCAR) and the Dodd-Frank Act Stress Test (DFAST):

– Comprehensive Capital Analysis and Review (CCAR)

In 2011, US authorities launched the Comprehensive Capital Analysis and Review (CCAR). The CCAR incorporates concurrent stress testing as well as the capital planning process for individual banks.[7] Starting in 2013, the Federal Reserve's capital assessment of large banks consisted of two primary components: The Dodd-Frank Act Stress Test (stress test) and the Comprehensive Capital Analysis and Review (CCAR). In 2019, the Board incorporated the qualitative evaluation into the standard, confidential supervisory process. In 2020, the Federal Reserve replaced the quantitative CCAR evaluation with the stress capital buffer. The stress capital buffer requirement simplifies the Board's capital framework by integrating the Board's non-stress regulatory capital requirements with its stress-test-based capital requirements under CCAR[8]. Banks with more than $100 billion in assets are required to undergo CCAR testing. Financial institutions with more than $250 billion in assets are required to undergo more comprehensive CCAR testing, which may include additional qualitative and quantitative

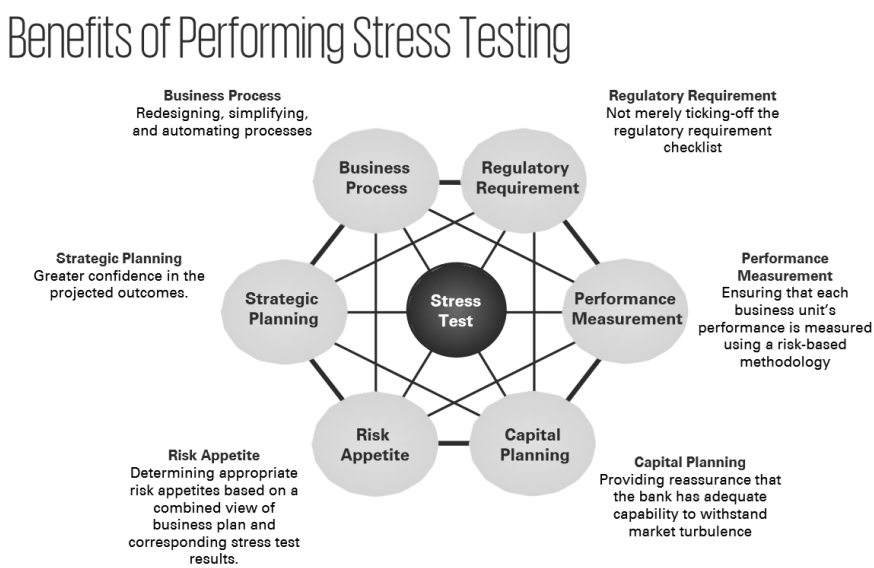
[5] Elizabeth McCaul (2021): The evolution of stress testing in banking supervision, Europa, https://www.bankingsupervision.europa.eu/press/speeches/date/2021/html/ssm.sp211210~333effaef3.en.html.
[6] Jerome Henry (2021): Banking Sector Stress test – a post-Corona landscape? ECB, pp. 1-31, https://www.centralbanking.com/media/download/44511/download.
[7] Kieran Dent and Ben Westwood (2016): Stress testing of banks: an introduction, Bank of England- Quarterly Bulletin 2016 Q3, pp. 130-142.
[8] https://www.federalreserve.gov/supervisionreg/stress-tests-capital-planning.htm.

elements than the regular CCAR. Qualitative elements of the test focus more on internal risk management frameworks and policies.

– Dodd-Frank Act Stress Test (DFAST)

The DFAST is for the largest financial institutions (with more than $250 billion in assets). All banks that fall in the category must satisfy DFAST requirements and send periodical test results to the Federal Reserve. The DFAST includes an adverse and severely adverse scenario with the results from the severely adverse scenario used for the CCAR exercise. The severely adverse scenario is calibrated using outturns for macro variables observable during severe recessions.[9]

Figure 1.1: *Benefits of performing stress testing*



Source: KPMG (2018): Integrated Stress Testing Framework

[9] Idem.

1.2 Stress testing objectives

Stress Tests are non-statistical tools where risk factors are stressed to assess their impact on the bank. In that, stress testing complements the VaR / Unexpected Loss methodologies to assess the kind of losses that may occur if the markets are very stressed and start behaving abnormally ('tail risk').[10] The stress testing aims to facilitate the development of risk mitigation or contingency plans across a range of stressed conditions. It has become an integral part of the institution's decision making process, including setting the institution's risk appetite, setting exposure limits, and evaluating strategic choices in longer term business planning. Stress tests are performed with the aim of understanding the capital situation of a bank after a prolonged period of severe macroeconomic stress.[11]

An institution's stress testing program should serve the following purposes:

- Risk identification and control

Stress testing should be included in an institution's risk management activities at various levels, for example, ranging from risk mitigation policies at a detailed or portfolio level to adjusting the institution's business strategy. In particular, it should be used to address institution-wide risks, and consider the concentrations and interactions between risks in stress environments that might otherwise be overlooked.

- Providing a complementary risk perspective to other risk management tools

Stress tests complement risk quantification methodologies that are based on complex, quantitative models using backward looking data

[10] Araceli Hector (2011): Stress Testing Presented to The Institute of Banking (IOB), https://slideplayer.com/slide/3972010/.
[11] Andreas Ita (2019): Bank stress tests - an overview of the supervisory approaches in different jurisdictions, Orbit 36, pp. 1-26, https://www.orbit36.com/wp-content/uploads/2019/09/stress_testing_whitepaper.pdf.

and estimated statistical relationships. In particular, stress testing outcomes for a particular portfolio can provide insights about the validity of statistical models at high confidence intervals, for example those used to determine VaR.

- Simulation of shocks

As stress testing allows for the simulation of shocks which have not previously occurred, it should be used to assess the robustness of models to possible changes in the economic and financial environment. Stress tests should help to detect vulnerabilities such as unidentified risk concentrations or potential interactions between types of risk that could threaten the viability of the institution, but may be concealed when relying purely on statistical risk management tools based on historical data.

- Impacting customer behavior

Stress testing can also be used to assess the impacts of customer behavior arising from options embedded in certain products – particularly where the impact is not easily modelled under extreme events.

- Supporting capital management

Stress testing should form an integral part of institutions' internal capital management where rigorous, forward-looking stress testing can identify severe events, including a series of compounding events, or changes in market conditions that could adversely impact the institution.

- Improving liquidity management

Stress testing should be a central tool in identifying, measuring and controlling funding liquidity risks, in particular for assessing the institution's liquidity profile and the adequacy of liquidity buffers in case of both institution-specific and market-wide stress events.

Figure 1.2: *Objectives of internal stress testing framework*

	Rank			
Objectives	**1**	**2**	**3**	**4**
Capital adequacy assessment	77%	13%	4%	4%
Liquidity adequacy assessment	13%	51%	15%	4%
Regulatory compliance	11%	8%	21%	23%
Risk bearing capacity determination	9%	9%	28%	17%
Risk identification	6%	13%	17%	15%
Risk exploration	6%	4%	8%	6%
Recovery planning	4%	4%	13%	19%
Assessment of strategy	2%	0%	9%	11%

Source: BCBS survey of banks. The question presented a list of possible objectives of internal stress testing frameworks and asked banks to rank the objectives in order of priority. Rows and columns do not sum to 100% because only the top 4 ranks are shown and some banks provided the same rank for multiple options.

1.3 Stress testing principles[12]

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 organizational structures should be adequate to meet the objectives of the stress testing framework

[12] Basel Committee on Banking Supervision (2018): Stress testing principles, BIS, pp. 1-15, https://www.bis.org/bcbs/publ/d450.pdf.

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

1.4 Stress testing approaches/ objectives

Authorities running Stress testing can pursue both microprudential and macroprudential objectives at the same time. While microprudential policies are bottom up, macroprudential policies are top down.

1.4.1 Microprudential approach

Microprudential stress tests have been used as a tool to assess the risk of failure of a single institution. Micro stress tests are used to assess bank-specific risks, calculate capital adequacy taking into account credit risk, operational risk, market risk, liquidity risk, interbank contagion risk.[13] It assesses banks' balance sheets with a focus on capital and regulatory ratios, and increasingly on assessments of risk management practices. Weaknesses or deficiencies observed would requires banks to consider remedial measures, including additional safety buffers in the form of bank capital or others. Put differently, the primary objective of microprudential BU stress tests is to ensure that banks, especially systemically important banks (SIB), have both adequate capital and sufficient capital buffers not only to withstand shocks under extreme but plausible market events but continue lending to households and businesses even during the worst episode of stress.

[13] Taskinsoy, John (2019): Typology of Stress Testing: Microprudential vs. Macroprudential Stress Testing of Risk Exposures (March 28, 2019). Available at SSRN: https://ssrn.com/abstract=3361528 or http://dx.doi.org/10.2139/ssrn.3361528.

1.4.2 Macroprudential approach

An important development since the global financial crisis is the increasing use of stress tests in macroprudential analysis and in calibrating macroprudential measures as well as supervisory policy changes. Macro stress-testing have become effective tools in assessing stability of the banking system, and the financial system more broadly.[14] Macroprudential stress testing is an ongoing process, and requires a strong governance framework. Macroprudential stress test can offer quantitative, forward-looking assessments of the resilience of financial systems as a whole, to particularly adverse shocks.[15] In the EU, supervisory stress tests and sensitivity analyses have been used to support the calibration of macroprudential instruments. However, the use of stress tests for calibration of macroprudential instruments raises a number of challenges such as the identification of the state of the financial cycle and choosing an appropriate level of severity for the stress test scenario; mapping stress test results to the desired instrument, etc.[16] Banks' authorities pursuing a macroprudential approach use several instruments. These instruments are designed to strengthen and complement each other by addressing the buildup of systemic risk through time. They are usually split into three groups:[17]

- Broad-based buffers/capital tools

Risks from a broad-based credit boom can be addressed through a variety of capital tools, including dynamic provisioning requirements

[14] Bo Jiang, Bruce Philp (2017): Macro Stress Testing in the Banking System of China, core.ac.uk, pp. 1-39, https://core.ac.uk/download/pdf/146503782.pdf.
[15] Ron Anderson, Jon Danielsson, Chikako Baba, &sea (2018): Macroprudential Stress Tests and Policies: Searching for Robust and Implementable Frameworks, IMFWP/18/197, pp. 1-79, https://www.imf.org/-/media/Files/Publications/WP/2018/wp18197.ashx.
[16] BCSB (2017): Supervisory and bank stress testing: range of practices, BIS, pp. 1-66, https://www.bis.org/bcbs/publ/d427.pdf.
[17] Ron Anderson, Jon Danielsson, Chikako Baba, &sea (2018): Macroprudential Stress Tests and Policies: Searching for Robust and Implementable Frameworks, IMFWP/18/197, pp. 1-79, https://www.imf.org/-/media/Files/Publications/WP/2018/wp18197.ashx.

(DPRs), countercyclical capital buffers (CCyBs), and countercyclical leverage ratio caps. These tools work to increase the resilience of institutions to aggregate shocks, and to maintain the supply of credit through periods of adverse conditions. They are usually uniformly applied to all exposures.

- Sectoral tools

When vulnerabilities from deterioration in lending standards for loans originating from specific sectors arise, sectoral tools (i.e., sectoral capital requirements, limits on loan-to-value (LTV), debt-service-to-income (DSTI), loan-to income (LTI) ratios, and caps on the share of foreign currency loans) can help maintain the resilience of lenders and/or borrowers. Although they are usually applied to mortgages (residential and commercial), they can also be used in other market segments, including consumer and some corporate credit.

- Liquidity tools

A range of prudential tools aim to contain the build-up of liquidity risks associated with credit booms. These prudential tools are meant to ensure that financial institutions avoid fire sales that are triggered by disruptions in funding markets. Tools include differentiated reserve requirements, the liquidity coverage ratio (LCR, potentially calibrated by currency), and the net stable funding ratio; caps on the loan-to-deposit ratio; and price-based tools (such as liquidity charges on non-core funding).

Figure 1.3: *Typology of stress test*

Typology	Aim & Use	Pros	Cons
Microprudential Individual banks Bottom-up (BU)	Banks own stress tests for internal risk management purposes. Sensitivity and scenario analyses are conducted to identify and gauge risk exposures.	Internally developed models measure capital adequacy and liquidity. Assess bank resilience.	Narrow focused, portfolio or a single risk factor. Risk measurement methods vary among banks.
Microprudential Supervisors Top-down (TD)	Supervisory stress testing collects data from banks to assess their soundness and to ensure that each bank meets capital minima and sufficient liquidity.	Improved governance and transparency. An integral part of bank oversight. Routinized.	Resource intensive, costly. Banks are forced to change lending/capital planning behavior. More complex.
Macroprudential Central banks Top-down (TD)	Forward-looking capital planning to ensure that banks have adequate capital and sufficient liquidity under highly unlikely market conditions.	Planned distribution of capital. System-wide, consistently applied multiple scenarios.	Qualitative objection until Jan. 2017. Predictable and routinized. Costly and time consuming, and complex.
Macroprudential IMF's FSAP BU & TD	Help countries enhance resilience to shocks, foster growth by promoting financial stability and financial sector diversity. Consistently applied.	Cost is shared by IMF and World Bank. It is voluntary, systematic and consistent.	Voluntary, and misleading results. Loss of credibility, a scuff on the unblemished reputation. Resource drain.

Source: Taskinsoy (2018b); European Banking Authority (EBA, 2014)

1.5 Stress test scenarios

The quality of a stress test depends on the definition of stress scenarios, and pondering over scenarios requires one to imagine situations that have perhaps not yet occurred but might occur in the future.[18] Banks' tress tests are based on at least two scenarios: (i) a baseline scenario using the World Economic Outlook (WEO) projections, and (ii) at least one adverse scenario.[19] Scenario design is divided in three phases: (a) selection of shocks that can exacerbate identified financial vulnerabilities; (b) assessment of sufficient severity; and (c) simulation of the complete set of macro-financial variables that are consistent with the shock.[20] Scenario severity is measured in terms of the fall in the level of real GDP below baseline or equivalently the cumulative fall in real GDP growth, and other benchmarks or drivers. These can include a fall of asset prices, a shock to interest rates, a reassessment of risk premiums

[18] Thomas Breuer, Martin Janda, Klaus Rheinberger, and Martin Summer (2009): How to Find Plausible, Severe, and Useful Stress Scenarios, International Journal of Central Banking, pp. 1-20, https://www.ijcb.org/journal/ijcb09q3a7.pdf.
[19] Tobias Adrian, James Morsink, and Liliana Schumacher (2020): Stress testing at the IMF, IMF- Monetary and Capital Markets Department, pp. 1-73, https://www.imf.org/-/media/Files/Publications/DP/2020/English/STIMFEA.ashx.
[20] Idem.

or a large depreciation to correct an external imbalance. Once the severity of the scenario is chosen, a set of consistent macro-financial variables paths (expressed as deviations from the WEO baseline) are simulated using macro-financial models and targeting the chosen severity benchmark.[21] More than one scenario is sometimes used when banks have different business models or operate internationally.

1.6 Stress test scenario analysis

The type of stress testing a bank needs to undergo depends on the size of the bank and the regulations in the country in which it operates. There are two main approaches to conducting stress tests. In bottom-up stress tests, individual banks use their internal models. In top-down stress tests, regulatory authorities apply their own models. In general, scenario analysis exercises can be grouped into two approaches: bottom-up and top-down. In bottom-up exercises, the central bank or supervisor sets out the scenario and a set of methodological rules. Financial institutions then run the scenarios against their balance sheet, using their internal data and models. Conversely, a top-down exercise is run entirely by the central bank or supervisor, without involvement of financial institutions. Balance sheet assumptions can be grouped into two broad categories: a basic balance sheet, and a dynamic balance sheet.

- A static balance sheet assumption

A static balance sheet assumption assumes that balance sheets are 'frozen' over time, allowing only balance sheet changes that result directly from risks materializing in the scenario (e.g. assets going into default). Put differently a static balance sheet assumption refers to a methodological assumption according to which the impact of the stress test scenarios is to be measured on the assumption of a 'constant balance sheet' and of an 'unchanged or stable business model' throughout the

[21] Idem.

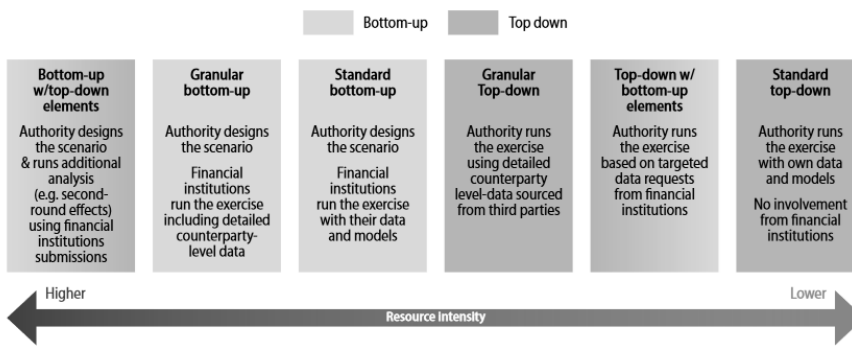
projection period, enhancing the comparability of the results across institutions.[22]

- A dynamic balance sheet assumption

Under the dynamic balance sheet assumption, the outcome of the stress test reflects a combination of the scenario imposed and the responsive actions taken by the management reducing the comparability of the results across institutions. The extent of responsive actions taken by the management may be constrained or unconstrained (e.g. interventions planned from the start and independent from the scenario and/or conditional on the stress test scenario). A dynamic balance sheet assumption allows balance sheets to change over time, either because counterparty characteristics change (they may reduce their emissions or gain market share for example), or because the financial institution divests from existing counterparties, or invests in new ones.[23]

It is also possible to adopt a hybrid approach, combining elements of both static and dynamic balance sheet assumptions.

Figure 1.4: *Bottom up and top-down approaches*

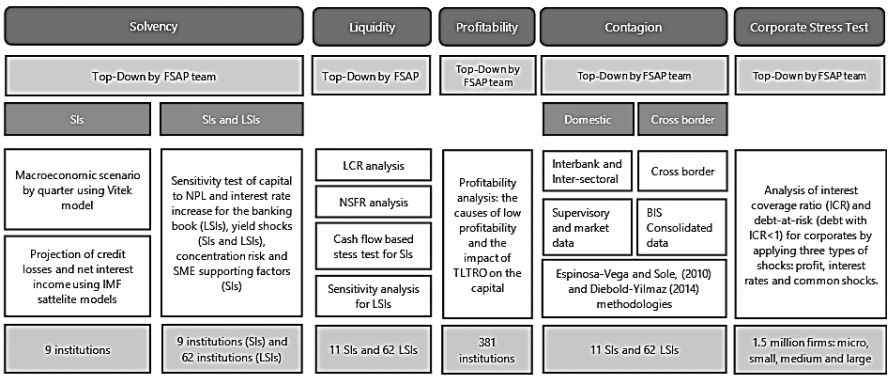


[22] European Banking Authority (2018): Guidelines on institutions' stress testing- Final Report, pp. 1-130, ttps://www.eba.europa.eu/sites/default/documents/files/documents/10180/2282644/2b604bc8-fd08-4b17-ac4a-dd5e662b802/Guidelines%20on%20institutions%20stress%20testing%20%28EBA-GL-2018-04%29.pdf?retry=1.
[23] Idem.

1.7 Risk covered

Stress tests aim to identify a wide range of risks and improve capital and liquidity management. Banks core risks consist primarily of the usual major risk categories: operational risk, counterparty/credit risk, market risk and liquidity risk.

Figure 1.5: *Risks covered*



Source: IMF staff calculations.

1.8 Reverse Stress Test

As the result of the 2007–2009 financial crisis, regulatory authorities emphasized the complementary role of Reverse Stress Test (RST), which focuses on analyzing the scenarios that have rendered a bank business model unviable.[24] Put differently a RST requires the risk team to identify and assess circumstances that would lead a firm's business model to become unviable or its counterparties to lose confidence to a critical point.[25] Reverse stress tests can be a useful tool to evaluate bank resilience to a credit shock, especially in environments where financial

[24]Claudio Albanese, Stéphane Crépey & Stefano Iabichino (2023): Quantitative reverse stress testing, bottom up, Quantitative Finance, pp. 1-14, DOI: 10.1080/14697688.2023.2187315.

[25] Metin Epozdemir (2021): Reverse Stress Testing: A critical assessment tool for risk managers and regulators, S&P Global- Market Intelligence, https://www.spglobal.com/marketintelligence/en/mi/research-analysis/reverse-stress-testing-assessment-tool-risk-managers-regulators.html.

data are limited or opaque.[26] Contrary to the classic stress test, which is designed to test the resilience of banks to severe but plausible shocks, a reverse stress test RST with defining the outcome followed by reverse-engineering scenarios that, should they unfold, lead to the specified result.[27] A reverse stress test is a targeted exercise that quantifies how much current viability conditions should change for a bank to hit a pre-determined adverse outcome.[28] Therefore, reverse stress testing conceptually challenging when many risk factors are relevant for the value of the bank's portfolio and when this portfolio is structured in a complex way with many different assets and types of financial instruments.[29] A key objective of the reverse stress testing is to overcome disaster myopia and the possibility that a false sense of security might arise from regular stress testing in which institutions identify manageable impacts.[30]

Figure 1.6: *Six steps in RST*

[26] Erik Feyen and Davide Salvatore Mare (2021): Measuring Systemic Banking Resilience- A Simple Reverse Stress Testing Approach, World Bank- Policy Research Working Paper Series, pp. 1-16.
[27] Michael Eichhorn and Philippe Mangold (2021): Reverse Stress Testing in Banking, De Gruyter 2021.
[28] Idem.
[29] Peter Grundke, Kamil Pliszka (2013): Empirical implementation of a quantitative reverse stress test for defaultable fixed-income instruments with macroeconomic factors and principal components, pp. 1-29, https://www.efmaefm.org/0efmameetings/efma%20annual%20meetings/2013-Reading/papers/Empirical_Implementation.pdf.
[30] Christian Thun, Juan M. Licari, Mark Zandi (2011): Reverse Stress Testing: Challenges & Benefits, Moody's Analytics, pp. 1-41, https://www.moodysanalytics.com/-/media/presentation/before-2011/10-23-11-Reverse-Stress-Testing.pdf.

1.8.1 Types of reverse Stress Test

There are two types of reverse stress testing: (i) the qualitative Reverse Stress Test, and (ii) the quantitative Reverse Stress Test, though RST is often treated as a predominantly quantitative exercise.

- The Qualitative reverse stress test

The qualitative approaches can vary in complexity. The qualitative approach consists of a variety of tools and techniques such as cognitive maps, error trees, iterative interviews. Conducting interviews of experts and analyzing their responses is the most used tool. Nonetheless, it requires a significant effort depending on various aspects including the size of the stakeholder group, the time taken to conduct each interview and the time taken to analyze the results.[31]

- The Quantitative reverse stress test

The quantitative approach aims to determine all risk factors that can trigger a key indicator the threshold, defined as capital ratios below the regulatory minimum. It provides a useful set of results that aids in understanding the bank's vulnerabilities and sources of risk. The quantitative reverse stress identifies forward-looking fragilities tailored to a bank's portfolio, credit and funding strategies, models, and calibration constraints[32]. The quantitative approach looks on realistic scenario inflicting the highest loss. A realistic scenario can be represented as a series of shocks on all risks factors that have been previously occurred either independently or together. The quantitative approach takes into account the specifics of the business activities as

[31] Michael Eichhorn, Tiziano Bellini, and Daniel Mayenberger (2021): Reverse Stress Testing in Banking, De Gruyter, https://doi.org/10.1515/9783110647907-202.
[32] Claudio Albanese & Stéphane Crépey & Stefano Iabichino (2022) "Quantitative Reverse Stress Testing, Bottom Up," Working Papers hal-03910136, HAL.