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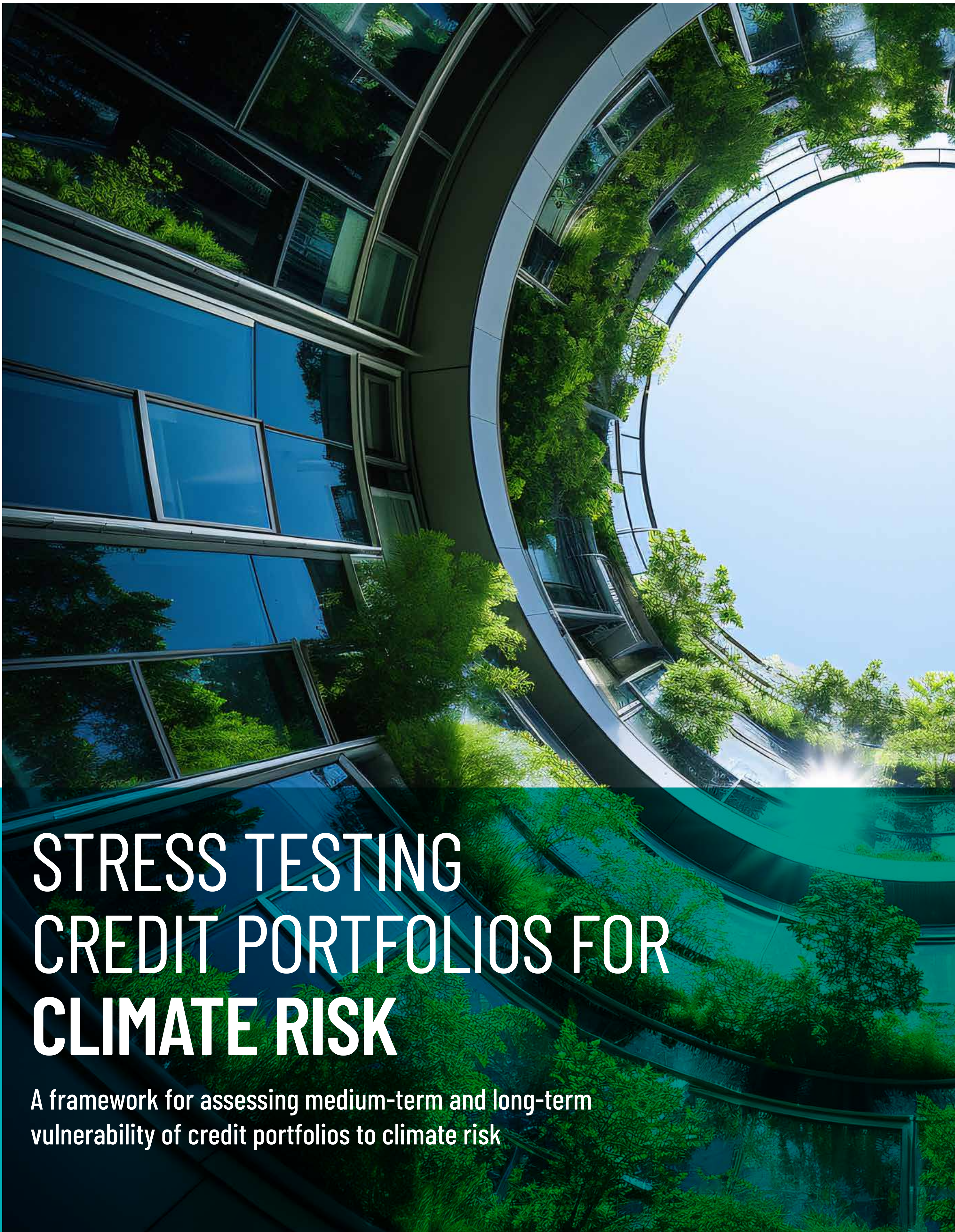


STRESS TESTING CREDIT PORTFOLIOS FOR **CLIMATE RISK**

A framework for assessing medium-term and long-term vulnerability of credit portfolios to climate risk

HIGHLIGHTS

- Climate risk, in the context of the financial sector, refers to the potential for adverse economic consequences resulting from climate change as well as human responses to climate change.
- At a systemic level, climate risk may cause widespread asset devaluation and defaults, particularly in vulnerable sectors like real estate and energy. These effects can lead to liquidity shortages, increased market volatility, and systemic credit losses, which may cascade through interconnected financial institutions and may have adverse implications on the financial stability of the broader banking system[1].
- For individual banks, climate risk drivers may impact their conventional financial risks directly or indirectly through their counterparties or financial assets. Such an impact can be transmitted through micro-economic transmission channels at both corporate and household levels and thus has the potential to affect the safety and soundness of individual banks.
- Specifically in terms of banks' credit risk, climate risk can deter their borrowers' creditworthiness through operational and supply-chain disruptions and can adversely impact collateral valuations, translating to a tangible impact on the banks' credit risk profiles.
- Such an interplay of credit and climate risks brings into focus a range of climate-related pathways that banks need to consider as part of the periodic stress testing of their credit portfolios.
- This paper explores a structured framework for banks to test the resilience of their credit portfolios to climate risk and assess its impact on their capital positions and expected credit losses under different climate scenarios of extreme severities.
- The paper also discusses how banks can update their existing stress testing frameworks to account for the additional complexities of climate risk.

1 Basel Committee on Banking Supervision

CONTENTS

WHAT IS CLIMATE RISK?

What is Climate Risk?

The Intergovernmental Panel for Climate Change (IPCC)[2] describes climate risk as *the potential for adverse consequences, of climate change as well as human responses to climate change, on lives, livelihoods, health and wellbeing, economic, social and cultural assets and investments, infrastructure, services (including ecosystem services), ecosystems and species.*

Climate risk includes physical risks related to the physical impacts of climate change and transition risks related to the adjustment to a net-zero emission economy[3].

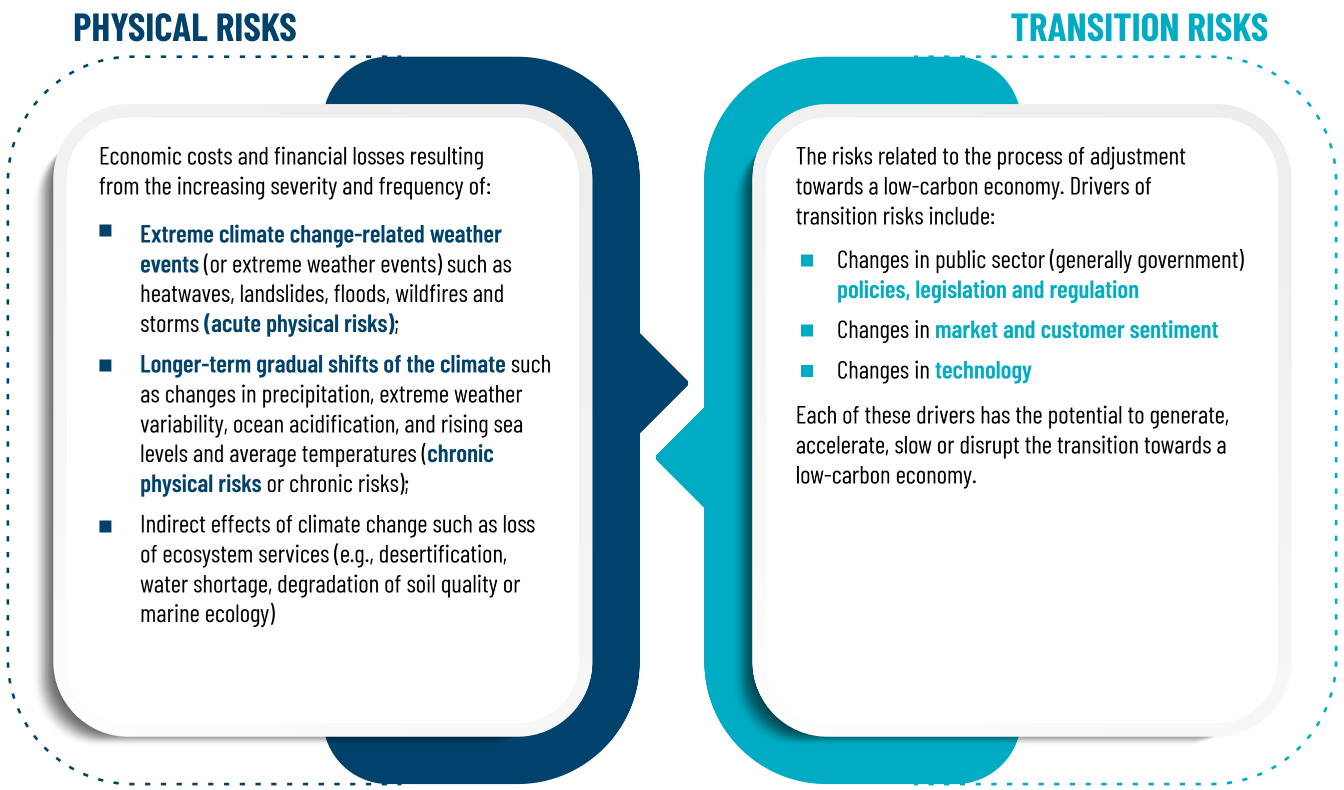
According to the Basel Committee on Banking Supervision[4] (BCBS), climate risk has the potential to affect the safety and soundness of individual banks and have adverse implications on the financial stability of the broader banking system. Some examples highlighted in the Committee's December 2023 working paper on the effects of climate change-related risks on banks are listed below[5].

- After a flood event, the probability of default (of a non-insured moderately priced property) increases by 2.6 times after two years[6].
- Firms in regions exposed to droughts pay significantly higher spreads on their bank loans: loan spreads of firms in the top quartile of climate risk exposure are about 4.4% larger than those of firms in the bottom quartile[7].
- The interest rate spread for mortgages in a zip code where all residential real estate are exposed to sea level rise (SLR) risk is approximately 7.5 bp higher than the interest rate spread for mortgages in a corresponding area where none of the properties are exposed to SLR risk[8].
- A 2021 study on potential impact of flooding on the Dutch banks estimates that a major flooding event might cause a 10% fall in the country's GDP, and a possible impact of up to 700 basis points on its banks' capital[9].

Consequently, banks should identify, monitor and manage all climate-related financial risks that could materially impair their financial condition, including their capital resources and liquidity positions.

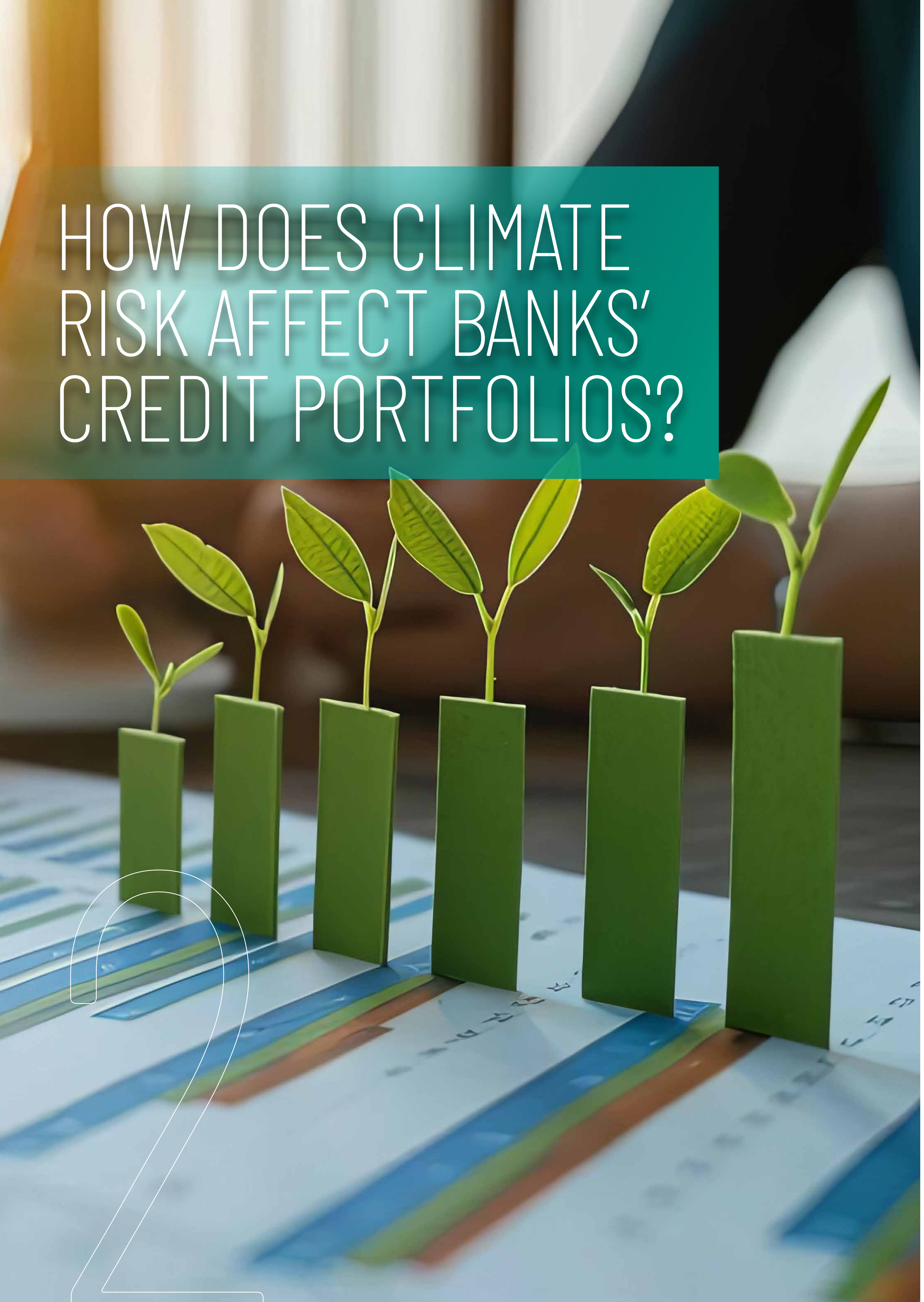
This paper explores how banks can test the resilience of their credit portfolios to climate risk and assess its impact on their capital positions and expected credit losses under different climate scenarios.

Figure 1 describes the concepts of physical and transition risks in greater detail.



2 The concept of risk in the IPCC Sixth Assessment Report: A summary of cross-Working Group discussions, Intergovernmental Panel for Climate Change – September 2020
3 Guide to climate scenario analysis for central banks and supervisors, Network for Greening the Financial System Technical document – June 2020
4 Principles for the effective management and supervision of climate-related financial risks – June 2022
5 BCBS Working Paper 40, The effects of climate change-related risks on banks: a literature review – December 2023
6 Correa, R., A. He, C. Herpfer and U. Lel (2023). "The rising tide lifts some interest rates: Climate change, natural disaters and loan pricing". (No. 889/2023) ECGI Working Papers in Finance, March 2023
7 Javadi, S., Masum, A.-A. (2021) "The impact of climate change on the cost of bank loans", Journal of Corporate Finance, Volume 69, August 2021, 102019
8 Nguyen, D. D., Ongena, S., Qi, S. and Sila, V. (2022). "Climate change risk and the cost of mortgage credit." Review of Finance, Vol. 26(6), pp. 1509–1549
9 Caloia, F. and D.J. Jansen (2021). "Flood risk and financial stability: Evidence from a stress test for the Netherlands". (No. 730m) Working Paper DNB, November 2021.

HOW DOES CLIMATE RISK AFFECT BANKS' CREDIT PORTFOLIOS?

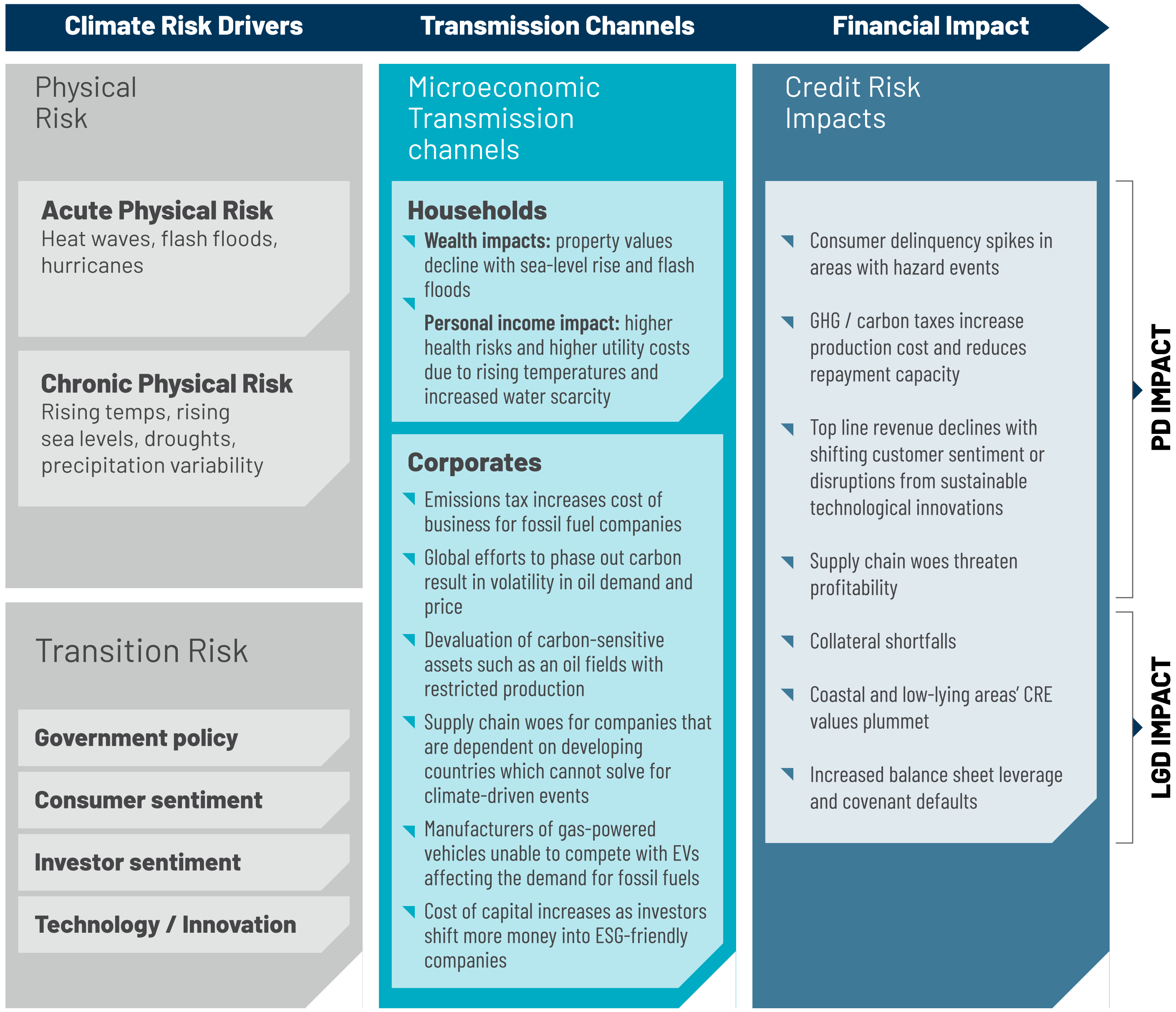


How does Climate Risk Affect Banks' Credit Portfolios?

The need for prudent risk management brings into focus the impact of climate risk on credit risk, which makes up a material component of banks' risk exposure and capital requirements in the GCC region[10]. Such a relationship is predicated on climate risks translating into tangible deterrents to their borrowers' creditworthiness or adverse impact on collateral valuations. Figure 2 highlights examples of specific physical and transition risks and the transmission channels through which they can crystallize into increased credit risks (represented in terms of a probability of default (PD) and loss-given default (LGD)).

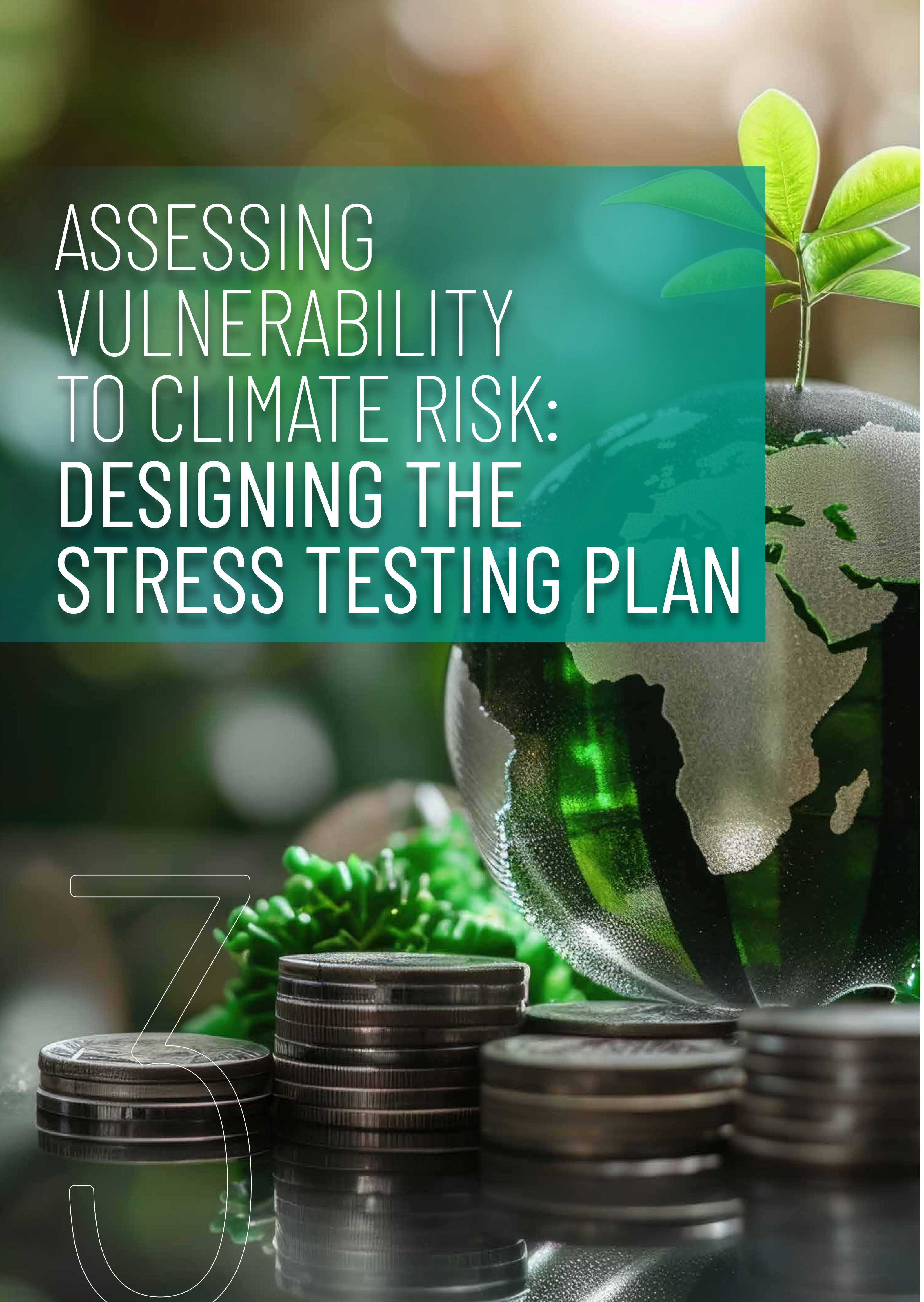
In the presence of such channels of climate risk translating into natural deterrents to their borrowers' creditworthiness, banks must assess the vulnerability of their credit portfolios under a range of climate-related scenarios.

Figure 2 Transmission Channels for Climate Risks to Credit Risks



Source: The Network of Central Banks and Supervisors for Greening the Financial System (NGFS), Protiviti

10 Credit risk accounts for more than 80% of the total risk-weighted assets based on Protiviti's analysis of the top 30 banks in the GCC region



ASSESSING VULNERABILITY TO CLIMATE RISK: DESIGNING THE STRESS TESTING PLAN

Banks and financial institutions conduct periodic stress testing of their credit portfolios to assess vulnerabilities arising from the potential impact of severe but plausible economic or financial scenarios. The introduction of climate risk brings into focus a range of additional climate-related pathways that banks may need to consider for estimating such an impact.

In achieving this objective, banks should define the critical elements of the stress testing plan, as illustrated in Figure 3: objective, approach, risk parameters, climate-related scenarios, time horizon, assumptions, outcome, and any other relevant parameters related to the exercise.

Figure 3 Elements of a Stress Testing Plan

These elements are described below in greater detail.

1. Stress Testing Objective

As per BCBS guidance, the objective of climate scenario analysis should reflect the bank's overall climate risk management objectives as set out by its board and senior management (BCBS Principle 12.44).

> In the context of assessing climate change-related impact on credit risk, one key objective can be measuring the vulnerability of the bank's credit portfolio to climate-related risks by estimating their impact on capital requirements for credit risk (credit risk capital) and expected credit losses

2. Stress Testing Approach

The approach should highlight the methodology used for conducting scenario analysis, for example, whether a bottom-up or a top-down method has been used.

> In the context of assessing climate change-related impact on credit risk, a bottom-up approach may assess the impact on the bank's top 50 non-financial corporate borrowers (based on aggregate exposure). A top-down approach, on the other hand, may leverage banks' current IFRS9 models to analyze climate change impact at a segment level (based on economic sectors or any other segmentation criteria).

At this stage, it may also help to define any additional qualifying criteria for the stress testing exercise, e.g., the definition of exposure (e.g., are investments in debt and equity included?), criteria for sectors (e.g., are only climate-sensitive sectors considered, and, if yes, how are they identified?), and borrowers (e.g., will government-related entities be included?).

3. Risk Parameters

The stress testing plan should indicate the specific risk parameters that will be stressed during the exercise.

> In the context of assessing climate change-related impact on credit risk, the typical risk parameters to be tested may include the borrowers' risk rating, probability of default, and loss-given-default estimates.

4. Climate Scenarios

As per BCBS guidance, banks should consider a range of plausible climate-related scenarios based on their potential benefits and limitations.

> In the context of assessing climate change-related impact on credit risk, and given the uncertainty related to the timing, severity, and frequency of climate-related scenarios, banks may leverage the three scenarios developed by the Central Banks and Supervisors Network for Greening the Financial System (NGFS)[11] as highlighted in Table 1.

5. Time Horizon

As per the guidance from BCBS, scenario analysis should employ a mix of short-term and long-term horizons to address different risk management objectives and levels of uncertainty. This principle is also echoed by the Monetary Authority of Singapore[12], which states in its October 2023 guidance that banks *'should take a multi-year approach, beyond the typical financing or investment time horizons, to facilitate a more comprehensive assessment of climate-related risks.'*

> In the context of assessing climate change-related impact on credit risk, banks may consider assessing climate change-related impact on credit risk capital and expected credit losses over a short-term horizon of 5-8 years (e.g., in 2030) and long-term horizon of 15-20 years (e.g., in 2040).

6. Assumptions

The stress testing exercise's assumptions and methodology should be clearly documented as part of the stress testing plan. The BCBS guidance also states that banks should consider these assumptions' potential benefits and limitations.

Table 1 Summary of NGFS Climate-related Scenarios

Sr.	Scenario Name	Scenario Description	Transition Risk	Physical Risk
01	Current Policies (+3.0°C)	In this scenario, no further climate policies or measures are introduced to arrest the impact of climate change, potentially resulting in 3 °C or more of warming. This may result in high physical risks but minimal transition risks.	Low	High
02	Net Zero 2050 (+1.5°C)	In this scenario, there is a coordinated implementation of climate policies across all sectors of the economy to reach net-zero CO_2 emissions by 2050 and limit the global temperature increase to 1.5 degrees. This may result in high transition risks from higher emissions costs and changes in business and consumer preferences, but minimal physical risks due to the arrested impact of climate change.	Moderate	Low
03	Delayed Transition (+2.0°C)	In this scenario, it is assumed that global emissions do not decrease until 2030, resulting in the need for strong climate policies to arrest warming to below 2 degrees. This leads to higher transition risks compared to the Net Zero 2050 scenario, and higher physical risks compared to the Current Policies scenarios.	High	Moderate

> In the context of assessing climate change-related impact on credit risk, assumptions such as those related to employing a static balance sheet analysis, limitations around data availability or integrity, and usage of proxy data points may be included.

7. Outcome

The stress testing plan should indicate the specific outcome/parameters that will be captured as results from the exercise. The outcome should be aligned with the stress testing objectives and other elements of the plan.

> In the context of assessing climate change-related impact on credit risk, for example, the outcome may capture the stressed values of credit risk capital and expected credit losses for the bank's top 50 non-financial corporate borrowers at two future points in time, 2030 and 2040.

Figure 4 Highlights an illustrative stress testing plan based on the elements described in this section.

Objective	Impact analysis of climate change risk on credit risk capital and expected credit losses under various climate scenarios
Approach	Bottom-up stress testing for top 20 non-financial borrowers in climate-sensitive economic sectors Only non-financial corporate borrowers considered, including GREs Exposure includes lending (both on and off-balance sheet post-CCF), investments in debt and equity
Parameters and Horizon	Impact on rating and probability of default (PD) (and on LGD if applicable) Short-term (2030) and long-term (2040)
Scenarios	Impact on PD and / or LGD under at least 3 climate scenarios (NGFS):
Assumptions	Static balance sheet analysis as on 31-Dec-2023 Only increasing transition risk scenarios considered (physical risk not stressed)
Outcome	1. Ratings and PDs for top 20 borrowers in 2030 and 2040 under different climate scenarios 2. Corresponding impact on ECL and FIRB capital (and consequently capital adequacy) in 2030 and 2040 under different climate scenarios

Scenario	Climate Change	Transition Risk	Physical Risk
Current Policies (Baseline)	3 deg. C by 2050	Low	High
Net Zero 2050	1.5 deg. C by 2050	Moderate	Low
Delayed Transition	2 deg. C by 2050	High	Moderate

The design of a clearly articulated and well-defined stress testing plan is an essential first step toward an effective assessment of climate risks on banks' credit portfolios. The following section highlights how banks can implement this plan through a structured and practical stress testing framework that combines each element and explores potential risks in various plausible future scenarios.

11 https://www.ngfs.net/ngfs-scenarios-portal/explore
12 MAS Guidelines for Financial Institutions on Transition Planning for a Net Zero Economy, October 2023

4 STRESS TESTING FOR CLIMATE RISK – AN ILLUSTRATIVE FRAMEWORK

Stress Testing for Climate Risk – An Illustrative Framework

According to the Federal Reserve Bank of New York[13], the application of stress testing for the impact analysis of climate risk *'requires important work in at least two dimensions: the design of scenarios that describe the relevant realizations of "climate risk", and quantitative modeling of the channels through which these risk realizations lead to adverse economic outcomes that can affect banks and potentially financial stability.'*

While the NGFS scenarios provide a universal set of plausible climate scenarios as a starting point for the former dimension, the latter requires banks to put in place a structured framework that factors in the practical challenges associated with the nascent stage of climate risk analysis. Figure 5 illustrates a practical stress testing framework for assessing the impact of climate risks on a bank's credit portfolio. This illustrative framework utilizes a bottom-up approach towards stress testing through which a bank evaluates the impact of climate risks on the top borrowers in its portfolio (based on aggregate exposure). It is also assumed that only the transition risks and default probabilities (PDs) are stressed as part of this scenario exercise.

Figure 5 An Illustrative Stress Testing Framework

01	Identify PD Drivers from Credit Model / Scorecard	Identify key continuous variables from credit model / scorecard as 'PD drivers'	Scorecard / Segment Level
02	Regress PD Drivers with Climate Variables	Conduct regression analysis between PD drivers and climate variables to develop models for estimating PD drivers using climate data	Scorecard / Segment Level
03	Identify Best Fit Regression Models	Identify best fit models which meet pre-defined criteria and which align with business intuition	Scorecard / Segment Level
04	Use Best Fit Models to Compute Future Values of PD Drivers	Use identified best fit models and future climate scenario data to compute future values of PD drivers	Borrower Level
05	Use Future Values of PD Drivers to Arrive at Credit Rating for Future Years	Input future values of PD drivers in credit scorecard / model to arrive at future credit ratings for individual borrowers	Borrower Level
06	Compute Borrower-level Impact and Aggregate to Portfolio Level for Future Years	Use future ratings and PDs to compute corresponding expected credit losses and credit capital at borrower-level, and aggregate at portfolio-level	Portfolio Level

Each of the above steps is described below in greater detail.

13 Climate Stress Testing, Federal Reserve Bank of New York Staff Reports No. 1059, June 2023

1. Identify PD drivers from credit models/scorecards

As a first step, banks may leverage their existing credit models/ scorecards to identify the key variables driving credit performance and form a preliminary shortlist of 'PD drivers,' for example:

- Top 3 variables with the highest normalized coefficient in case of statistical models
- Top 3 variables with the highest weights in case of heuristic (expert judgment-based) scorecards

Banks must prioritize quantitative, continuous variables, typically financial or account conduct-related parameters, as PD drivers so that they can be regressed with climate data (as explained in later steps). Figure 6A highlights an illustrative framework for identifying PD drivers within an existing credit model or scorecard..

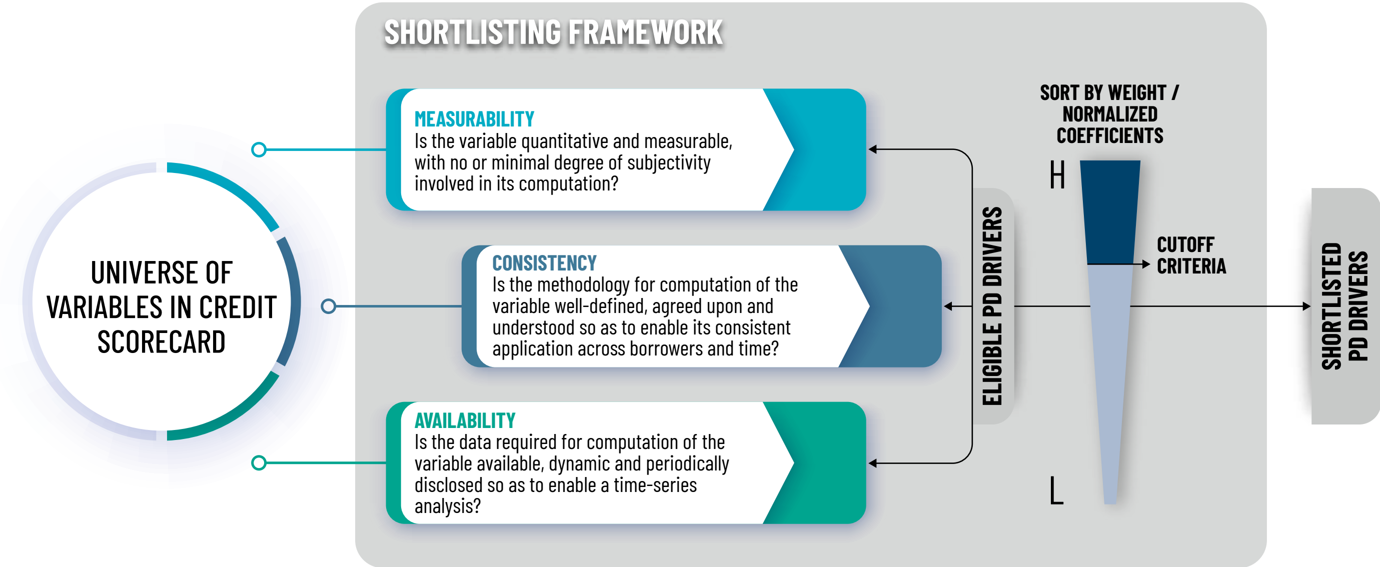


Figure 6A Illustrative framework for identification of PD drivers within a credit scorecard

Figure 6B highlights such shortlisted PD drivers for an illustrative credit scorecard for the non-financial corporate segment.

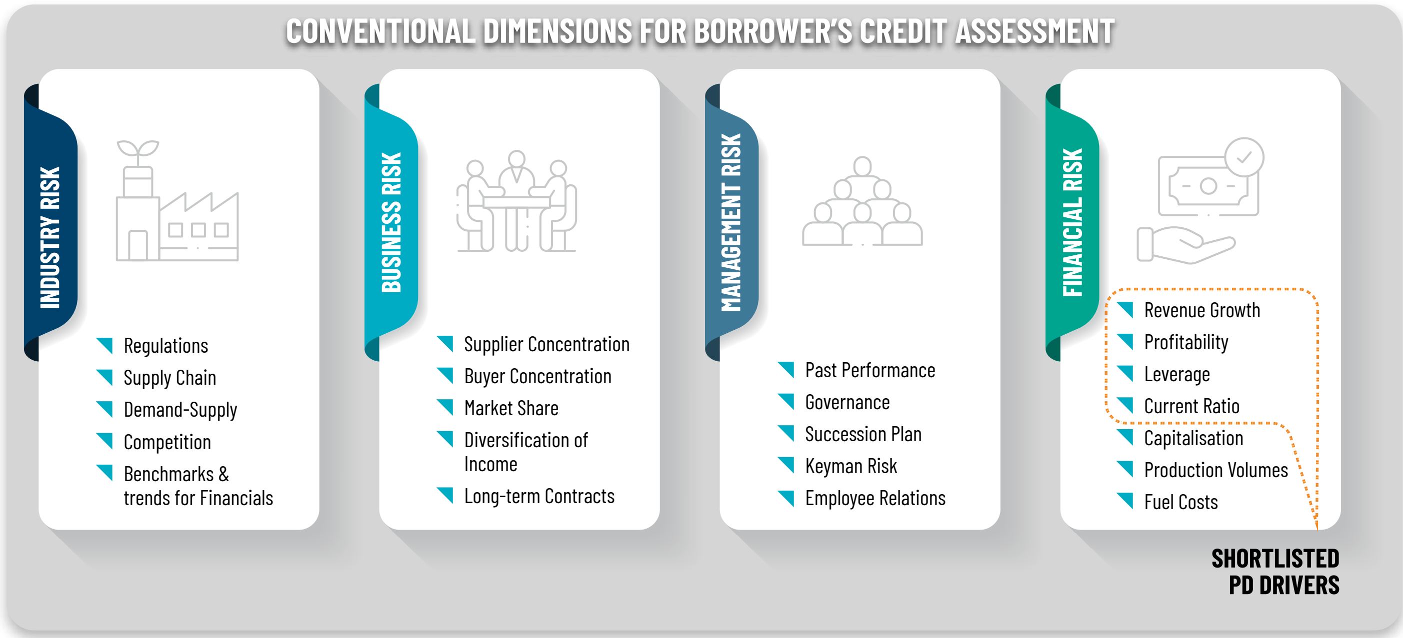


Figure 6B Example of Identification of PD Drivers for a Sample Credit Scorecard

2. Regress PD drivers with climate variables

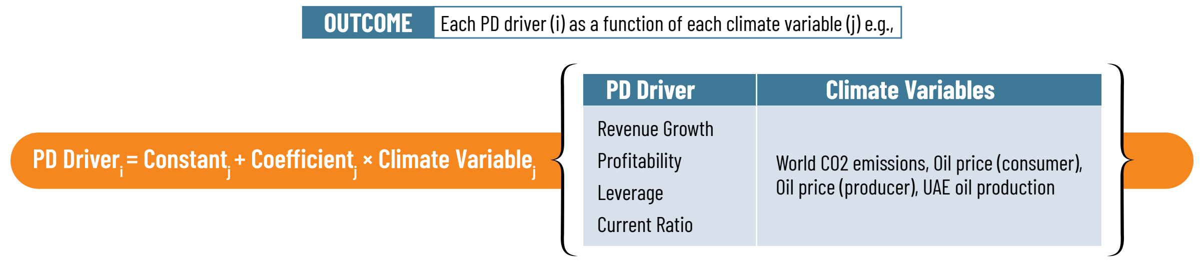
In this step, banks shall conduct a regression analysis of each PD driver from Step 1 with historical data for climate variables. The outcome of such an analysis will be to derive data-driven models that establish the PD drivers as functions of standalone climate variables.

Banks can leverage the NGFS database for historical time series data on climate variables. It may also help banks to focus on regionally relevant variables from the NGFS database. For example, variables related to oil production and CO2 emissions may be prioritized in the specific context of the GCC region.

Figure 7 illustrates regressing PD drivers with climate variables from the NGFS database.

Figure 7 Example of Regression of PD Drivers with Historical Climate Data

Name	2005	2006	2007	2008	2009	2010	2011
World CO2 emissions (Bln tonnes of CO2 per year)	34	35	37	37	37	38	39
Oil price faced by consumer (USD per barrel)	55	65	72	97	62	80	111
Oil price faced by oil producer (USD per barrel)	55	65	72	97	62	80	111
UAE oil production (Ths barrels per day)	2,580	2,555	2,489	2,567	2,238	2,305	2,518
UAE real GDP growth (% Change)	4.9%	9.8%	3.2%	3.2%	-5.2%	1.6%	6.9%
UAE CPI inflation (%)	0.0%	0.0%	0.0%	0.0%	1.6%	0.9%	0.9%
EIBOR 3-month rate (%)	0.0%	5.5%	5.2%	3.1%	2.6%	2.2%	1.7%



3. Identify best-fit regression models

In this step, banks shall subject the models establishing relationships between PD drivers and climate variables (identified in Step 2) to pre-defined quantitative and qualitative pass/fail criteria. The outcome of this step will be to identify models with relatively highest accuracy (based on quantitative criteria such as adjusted root mean square error) and which align with business intuition (based on qualitative criteria such as sign of the coefficient).

Figure 8 illustrates the shortlisting of regression models from the previous step based on a sample pass/fail criterion.

Figure 8 Example of Identifying Best Fit Models from Step 2

$$\text{PD Driver}_i = \text{Constant}_j + \text{Coefficient}_j \times \text{Climate Variable}_j$$

Regression models from Step 2

PD Driver	Climate Variables
Revenue Growth Profitability Leverage Current Ratio	World CO2 emissions, Oil price (consumer), Oil price (producer), UAE oil production

RSquare > Threshold

PD Driver	Climate Variables
Revenue Growth	Oil price (producer)
Profitability	Oil price (consumer)

Shortlisted Models

OUTCOME For example, top 2 resulting models describing PD driver (i) as a function of each climate variable (j) e.g.,

$$\text{Revenue Growth} = \text{Constant}_1 + \text{Coefficient}_1 \times \text{Oil Price Producer}$$

$$\text{Profitability} = \text{Constant}_2 + \text{Coefficient}_2 \times \text{Oil Price Consumer}$$

4. Use best-fit models to compute future values of PD drivers

In this step, banks shall run the qualified best-fit models from Step 3 for the top borrowers in their portfolio[14] (based on aggregate exposure) using future climate scenario data to compute future values of PD drivers. The outcome from this step, i.e., future values of PD drivers, shall be used as inputs to the credit scorecard to arrive at the future ratings for the top 20 borrowers in the next step.

Banks can again leverage the NGFS database for future time series data for climate variables under various climate scenarios, i.e., current policies, net-zero, and delayed transition. At this point, it may also help banks to note and emphasize that the climate scenarios used in this exercise should not be interpreted as forecasts but as a set of plausible future outcomes to explore potential manifestations of climate-related financial risks.

Figure 9 illustrates using the best-fit regression models from the previous step to arrive at future values for sample PD drivers under the three climate scenarios

Figure 9 Using Best-fit Models to Compute Future Values of PD Drivers

$$\text{Revenue Growth} = \text{Constant}_1 + \text{Coefficient}_1 \times \text{Oil Price Producer}$$

$$\text{Profitability} = \text{Constant}_2 + \text{Coefficient}_2 \times \text{Oil Price Consumer}$$

Best-fit Models From Step 3

\+ FUTURE VALUES OF CLIMATE VARIABLES UNDER EACH SCENARIO (NGFS)

Name	Scenario	2023	2024	2025	2026	2027	2028	2029	2030
Oil price faced by consumer (USD per barrel)	Current Policies	84	83	82	77	70	71	73	74
Oil price faced by consumer (USD per barrel)	Delayed Transition	84	83	82	77	70	71	73	78
Oil price faced by consumer (USD per barrel)	Net Zero 2050	124	141	161	175	187	197	208	219
Oil price faced by oil producer (USD per barrel)	Current Policies	84	83	82	77	70	71	72	73
Oil price faced by oil producer (USD per barrel)	Delayed Transition	84	83	82	77	70	71	72	78
Oil price faced by oil producer (USD per barrel)	Net Zero 2050	65	59	55	58	58	57	56	55

OUTCOME Future projected value of PD drivers under each climate change scenario

Name	Scenario	2023	...	2030	...	2040	...	2050
Revenue Growth	Current Policies							
Revenue Growth	Delayed Transition							
Revenue Growth	Net Zero 2050							
Profitability	Current Policies							
Profitability	Delayed Transition							
Profitability	Net Zero 2050							

14 Banks may prioritize climate-sensitive sectors based on internal criteria or those aligned to Task Force on Climate-related Financial Disclosures (TCFD) / United Nations Environment Programme Finance Initiative (UNEP FI) recommendations

5. Use future values of PD drivers to arrive at future credit ratings

In this step, banks shall use future values of PD drivers arrived at in Step 4 as inputs in the credit scorecard/model to arrive at future credit ratings for individual borrowers.

The outcome of this step will be the simulated, stressed credit ratings for individual borrowers at future points in time. These ratings and their corresponding PDs can then be used by banks to estimate the borrower-level (and consequently aggregated to the portfolio-level) impact on expected losses and capital requirements under each climate scenario.

Figure 10 illustrates how future values of PD drivers (arrived at in the previous step) are used to arrive at future credit ratings at a borrower level.

Figure 10 Using Future Values of PD Drivers to Arrive at Future Credit Ratings of an Individual Borrower

Name	Scenario	2023	...	2030	...	2040	...	2050
Revenue Growth	Current Policies							
Revenue Growth	Delayed Transition							
Revenue Growth	Net Zero 2050							
Profitability	Current Policies							
Profitability	Delayed Transition							
Profitability	Net Zero 2050							

Future values of PD drivers from Step 4

USE AS INPUTS IN CREDIT ASSESSMENT MODEL / SCORECARD

EXPERT JUDGMENT-BASED ADJUSTMENTS TO INPUTS FOR OTHER VARIABLES E.G., MANAGEMENT ADAPTABILITY / TRACK RECORD, CAPITAL INVESTMENTS ETC.

OUTCOME Future ratings for the borrower under each climate scenario

Borrower ABC
Current Rating A+

Scenario	2030	2040
Current Policies	A+	A
Delayed Transition	BB	BB-
Net Zero 2050	BBB-	C

Corresponding PDs

PD	2030	2040
Current Policies		
Delayed Transition		
Net Zero 2050		

6. Compute borrower-level impact on future losses and capital and aggregate to portfolio level

In this final step, banks shall use the future PD values from Step 5 as inputs to compute the corresponding expected credit losses (ECL) and credit risk capital under each climate scenario. The borrower-level impact can then be aggregated to determine the portfolio-level impact on ECL and credit risk capital under each climate scenario.

Figure 11 illustrates how future PD values (arrived at in the previous step) are used to arrive at future ECL and credit risk capital, both at borrower and portfolio levels.

Figure 11 Using Future PD Values to Arrive at Future ECL and Credit Capital (Borrower and Portfolio Levels)

Borrower-level Analysis

Borrower ABC
Current Rating A+

Scenario	2030	2040
Current Policies	A+	A
Delayed Transition	BB	BB-
Net Zero 2050	BBB-	C

Corresponding PDs

PD	2030	2040
Current Policies		
Delayed Transition		
Net Zero 2050		

Future ratings and PD values from Step 5

Corresponding ECL, Capital Charge

ECL	2030	2040
Current Policies		
Delayed Transition		
Net Zero 2050		

FIRB Credit Risk Charge	2030	2040
Current Policies		
Delayed Transition		
Net Zero 2050		

Aggregate for Top 20 Borrowers

Results for 2030

Confidence Interval	99.90%			
Z value	3.0902			
	Before Stress Amount	Stress Testing Impact: Current Policies	Net Zero 2050	Delayed Transition
Impact on Expected Loss				
Impact on FIRB Capital				

Results for 2040

Confidence Interval	99.90%			
Z value	3.0902			
	Before Stress Amount	Stress Testing Impact: Current Policies	Net Zero 2050	Delayed Transition
Impact on Expected Loss				
Impact on FIRB Capital				

The outcome of this final step indicates the levels of stressed expected credit losses and required credit capital under each climate scenario. Each of these elements can be used to compute the corresponding stressed capital adequacy ratios (CAR), contrast them against the minimum regulatory/internal risk appetite limits, and identify the need to put in place any necessary mitigation plans.

Figure 12 illustrates the results of such an impact analysis..

Figure 12 Quantifying Impact of Stress Testing Exercise on Capital Adequacy*

		Existing	Stress Testing Impact			
	Scenario name		Current Policies	Net-Zero	Delayed Transition	
	SCENARIO DESCRIPTION	Based on actuals	In this scenario, no further climate policies or measures are introduced to arrest the impact of climate change, potentially resulting in 3°C or more of warming.	In this scenario, there is a coordinated implementation of climate policies across all sectors of the economy to reach net-zero CO_2 emissions by 2050 and limit the global temperature increase to 1.5 degrees.	In this scenario, it is assumed that global emissions do not decrease until 2030, resulting in the need for strong climate policies to arrest warming to below 2 degrees.	
	CAPITAL AVAILABILITY (AMOUNTS IN MILLION)					
	A Available Capital	25	25	25	25	
Outcome of Stress Testing	B Impact on ECL	-	1	2	3	Reduces available capital
	C=A-B Impact on ECL	25	24	23	22	
	CAPITAL REQUIREMENT (AMOUNTS IN MILLION)					
	D Risk-Weighted Assets	100	100	100	100	
Outcome of Stress Testing	E Impact on FIRB Capital	-	1.2	2.4	3.6	Increases required capital
	F=E/8% Equivalent Impact on RWAs**	-	15	30	45	
	G=D+F New RWAs**	100	115	130	145	
	H=C/G Capital Adequacy Ratio	25%	20.9%	17.7%	15.2%	

*All numbers are illustrative, amounts in million
**Risk-Weighted Assets

The following section will explore how the preliminary stress testing framework defined above can be finetuned to factor in additional complexities over time and establish a roadmap for its evolution

TAKING IT FORWARD: A ROADMAP FOR EVOLVING THE STRESS TESTING FRAMEWORK

The framework highlighted in this paper provides a starting point for banks to incorporate climate risks in their larger stress testing framework. Banks shall take steps to further enhance this framework by including additional elements or introducing more complex, real-world assumptions for existing elements. Such steps include expanding the scenarios used for stress testing, incorporating the borrowers' understanding of climate risks in their assessment, introducing the effects of physical risks and industry / region-specific nuances, and assessing the impact on recovery rates due to climate risk.

Figure 13 provides details of possible enhancements to the stress testing framework for climate risk.

Figure 13 An Illustrative Roadmap for Evolving the Stress Testing Framework

	ELEMENT	BASIC STATE	ADVANCED STATE	DESCRIPTION (FOR ADVANCED)
INPUTS	Scenarios	NGFS	• NGFS • Internal scenarios (region-specific)	Banks may expand the stressed scenarios to cover more data points that help contextualize the stress testing framework to regional factors
INPUTS	Inputs from Borrowers	Quantitative (financial projections)	• Quantitative (financial projections) • Qualitative (questionnaire)	Banks may introduce a qualitative questionnaire to top borrowers to assess borrowers' understanding of ESG and climate risks to their own businesses
FRAMEWORK	Risks	Transition Risk	• Transition Risk • Physical Risk	Banks may expand the methodology to incorporate the effect of physical risks on both default risk (PD) and recovery levels through liquidation of collateral (LGD)
FRAMEWORK	Models	Industry-agnostic	• Industry-specific • Region-specific	Banks may utilize industry-specific models (for transition risk) and region-specific models (for physical risk), at least for top sectors and geographies
OUTPUT	Stressed Probability of Default	Based on financial parameters	• Based on financial and non-financial parameters	Banks may consider stressing both financial (based on projections) and non-financial (based on questionnaire) parameters to arrive at future PDs
OUTPUT	Stressed Loss Given Default	Not included / regulatory LGDs used	• Included / internal models used	Banks may incorporate stressed values for LGD based on internal models, with a focus on quantifying adverse impact on recovery levels due to physical risks

While designing the roadmap, banks shall also consider the role of tools and systems that may act as enablers for a sustainable operationalization of the stress testing framework. The assumptions and historical data used for stress testing should also be digitalized and documented for future reference and validation of results.

About Protiviti

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