Box 4.1: Climate Risk assessment

Introduction

Financial market participants and policy makers are becoming increasingly concerned about the potential risks to economic activity, corporate performance and asset values emanating from climate change. Such concerns have motivated central banks and regulatory authorities around the world to understand and assess the financial risks of climate change, and integrate climate risk considerations into their existing financial stability and prudential supervisory activities.

Stress Tests are a core forward looking tool used by the central banks and prudential authorities to test the resilience of financial sector to adverse economic conditions and emerging risks. However, applying the existing toolkits to the analysis of climate risk requires efforts in two dimensions, i.e., design of scenarios that describe the realization pathways of climate risk and quantitative modelling of channels through which these risks lead to adverse economic outcomes that can affect banks and the stability of financial systems.

Nature of Climate related risks

Climate change affects the financial system through two channels i.e. 'Transition Risk' and 'Physical Risk'. Transition risks arise in the financial system as it adapts to a shift to low-carbon economy and changes in climate policy, technology and consumer/ investor preferences. Such changes, if unanticipated, can cause sudden revaluation of assets and reassessment of projected earnings, both in carbon-intensive sectors and in sectors connected to them through supply chains. This abrupt asset repricing could have large implications for a wide range of financial institutions that have significant exposures to these sectors, with potential consequences for financial stability. Physical risks, on the other hand, affect the economic activity and asset valuation through physical manifestation of climate change, such as rising sea levels, floods, droughts, wildfires, fall in crop and labor productivity due to rise in temperature.

Although physical and transition risks can potentially interact, they operate at different time horizons and differ substantially in terms of their implications for overall economic activity as well as the sectoral distribution of any effects. In the early stages of the transition, these risks can move together, as increasing physical damages cause authorities to implement increasingly forceful regulatory responses to ensure transition to low carbon. Over a longer time, and to the extent that regulatory interventions are effective in reducing carbon emissions and slowing the process of climate change, long-run physical risks might decline as a result of the realization of transition risks. Climate risk scenarios, therefore, need to consider a range of possible joint evolutions of both physical and transition risks.

Following paragraphs discuss the existing international practices in terms of their risk coverage, scenario design, horizon considerations, modelling approaches, assumptions on balance sheet and data used to estimate the climate change impacts for financial institutions.

- **Risk Coverage**

Recent studies by Kruger (2020)[114] and Stroebel and Wurgler (2021)[115] find that among investment professionals, finance academics, regulators and policy makers, transitional risks

[114] Krueger, P., & Sautner, Z., & Starks, L. T. (2020). The importance of climate risks for institutional investors. *The Review of Financial Studies, 33(3), 1067-1111*.

[115] Stroebel, J., & Wurgler, J. (2021). What do you think about climate finance? *Journal of Financial Economics, 142(2), 487-498*.

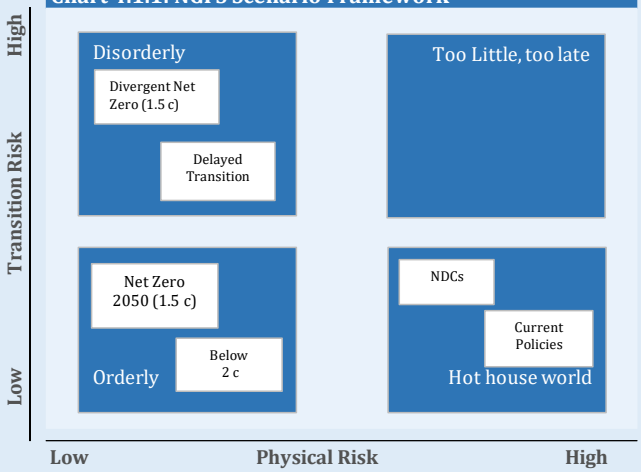
are somewhat more important today than physical risks. Physical risk, although important, are thought to become important over long-term horizons. The implied relative importance of different risks from these studies is consistent with findings from a joint review of the practice of climate scenario analyses by the Financial Stability Board and Network of Central Banks and Supervisors for Greening the Financial System (NGFS) (2022).[116] The study suggested that almost 90 percent of the central banks' exercises explored the implications of transition risk, while about 67 percent analyzed the effects of physical risks.

- **Overview of scenarios**

NGFS has played a leading role in the development of a set of climate risk scenarios to serve as a common starting point for different regulators (NGFS 2020, 2021). In June 2021, the NGFS published the second version of its scenarios, which describes six scenarios across three categories: Orderly Transition (Net Zero 2050, below 2°C), Disorderly Transition (Divergent Net Zero, Delayed Transition), and Hot House World (Nationally Determined Contributions or NDCs, Current Policies)[117] **(Chart 4.1.1)**.

In terms of transition risk, the carbon prices or taxes have been identified as a key catalyst driving the transition. In terms of physical risk, majority of the exercises conducted by authorities explored acute physical risk, such as the impact of floods and droughts, prioritizing them based on potential extent of materialization (FSB-NGFS 2022).

Chart 4.1.1: NGFS Scenario Framework



- **Projection Horizon**

The horizon for the exercises depends upon the nature of climate related risks considered. Shorter horizons are often adopted for exercises featuring acute physical risks or transition risks arising from policy changes. On the other hand, longer scenario horizons are more suited for assessing longer term physical risks, or medium-term structural shifts arising from a climate transition.

- **Modelling Approaches**

In terms of models applied, European Central Bank (ECB), France, Germany, Italy, Singapore and Japan used macroeconomic variables from NiGEM model, as these variables were part of NGFS scenario.[118] Authorities that did not use the NGFS scenarios, used alternative macroeconomic models, including in-house models.[119] Some exercises did not employ a macroeconomic model in their stress testing exercise because the scenarios chosen did not require a macroeconomic overlay.[120]

[116] Financial Stability Board and Network for Greening the Financial System. (2022). Climate Scenario Analysis by Jurisdictions: Initial findings and lessons. *November, Basel*. For details, please visit https://www.fsb.org/wp-content/uploads/P151122.pdf

[117] NGFS Climate Scenarios for central banks and supervisors – phase 2.

[118] NiGEM (National Institute Global Econometric Model) is a leading macroeconomic model designed by National Institute of Economic and Social Research, UK.

[119] For instance, Bank of Canada (MIT-EPPA), Banco de Espana (CATS general equilibrium).

[120] For example, Malta Financial Services Authority, De Nederlandsche Bank.

- **Approaches and Assumptions on Balance Sheet**

For the purpose of stress testing, in general, top-down and/or bottom-up approaches are usually employed. The former is generally employed by the regulators/ supervisors whereas the latter is applied by the individual institutions. In case of climate stress tests, a top-down exercise allows the authorities to cover a large sample of institutions, including many smaller players that might not have the expertise to perform bottom-up assessments. Furthermore, a top down approach improves the consistency and comparability of the results while minimizing the regulatory burden on the individual institutions.

On the other hand, bottom up approach enables the authorities to evaluate and develop the climate risk assessment capabilities of individual financial institutions. In addition, many bottom-up approaches involve financial institutions directly engaging their counterparties to better assess climate-related counterparty risks. This generates important data on firm-level exposures that facilitates new analyses to better understand the risks to financial firms as well as the overall financial system.

Table 4.1.1: Climate Stress Tests: Approaches and Assumptions

Approach	
Top Down	Brazil, Canada, Denmark, Egypt, Finland, Hungary, Indonesia, Italy, Korea, Norway, Portugal, Spain,
Bottom up	Australia, Colombia, ECB, France, Germany, Hong Kong, India, Japan, Singapore, UK
Balance Sheet Assumption	
Static	Brazil, Canada, Denmark, Egypt, Finland, Hong Kong, Hungary, Iceland, Indonesia, Italy, Japan
Dynamic	Australia, Colombia, ECB, France, Germany, Norway, South Africa, Spain

Source : FSB & NGFS climate scenario analysis by jurisdiction

As with regular stress testing exercise, a major requirement of climate risk scenario analysis is the assumption of static or dynamic balance sheet. A static balance sheet assumption generally assumes that financial institutions' balance sheets remain constant over the projection horizon in terms of size and composition and hence explores the vulnerability of today's business model to future shocks. On the other hand, a dynamic balance sheet assumption can incorporate future business expectations, and takes into account management actions of financial institutions in response to events over the scenario horizon. Jurisdiction-wise detail of approaches and balance sheet assumptions is provided **(Table 4.1.1)**.

- **Data Used**

Given the cross cutting nature of climate change, a wide range of financial and non-financial data are employed. In terms of non-financial data, greenhouse gas (GHG) emissions is the major variable used for analysis of transition risk. The data on GHG emissions, however, presents challenges depending on where the emissions emanate in the value chain **(Table 4.1.2).** Given data availability issues with Scope 3 emissions, many authorities have only employed Scope 1 and 2 data.

Table 4.1.2: GHG emissions across value chain

Scope 1	Direct greenhouse (GHG) emissions that occur from sources that are controlled or owned by an organization.
Scope 2	Indirect GHG emissions associated with the purchase of electricity, steam, heat, or cooling.
Scope 3	Emissions result of activities from assets not owned or controlled by the reporting organization, but that the organization indirectly affects in its value chain

Source: US Environmental Protection Agency

Some scenario analysis exercises have also used sector specific and firm specific information to supplement their analysis (e.g., ECB and UK).[121]

[121] For instance, ECB used energy performance certificates for properties, BoE used car price data for internal combustion engines and statistics relating to composition of new vehicle sales.

Projections of macroeconomic and energy variables (e.g., energy demand, price and mix) are used to inform sectoral and counter party analysis. The data for these variables is mainly sourced through NGFS climate scenarios and national authorities' databases. For assessment of physical risks, the authorities used forward-looking risk indicators that included indicators for flooding, drought, wildfire, hurricanes and sea level rise. **(Table 4.1.3)**.

For financial data, majority of the exercises have used banking asset exposures by sector and geographical location of the borrowers. In addition to the above exposure data, authorities have also employed data for insurance coverage, projected dividend pathways and IMF World Economic Outlook forecasts.

Table 4.1.3: Indicators of Physical Risk used in scenario analysis

European Central Bank	Damage rates for commercial and residential buildings for different flood depth levels, as well as estimated impacts of heat stress on labour productivity .
Banque de France	Forward-looking indicators for health risk (e.g. mortality rates) due to vector-borne diseases and air pollution at a national and regional level.
South Africa Reserve Bank	Rainfall data from its national weather service to design a historically consistent drought scenario.
Australian Prudential Regulation Authority	Postcode-level risk index projections for tropical cyclone, precipitation stress, river flood, fire weather stress, drought stress and heat stress.
Hong Kong Monetary Authority	Adopted the projection of climate pattern by the Hong Kong Observatory for banks to estimate the impact of physical risk

Source: Relevant Climate Stress Testing Exercises

Assessment of Climate Risk at the SBP – Current Approaches and Way Forward

Pakistan ranks among the top 10 countries affected by climate change and natural disasters.[122] According to the World Bank group, climate related disasters in Pakistan resulted in a total economic loss of USD 29 billion (inflation adjusted) between 1992 and 2021. Recent floods in the monsoon of 2022 served as a knockout blow to the growth as economic losses of USD 15.2 billion were inflicted.[123] Given the severity of climate change risk facing Pakistan, an assessment of physical and transition risks to the financial sector of Pakistan is crucial.

Pakistan's financial sector comprises of Banks, DFIs, MFBs, CDNS, Insurance companies and NBFIs. However, around 77 percent assets of the financial sector are concentrated in the banking sector.

Current Practices

The SBP has been including climate related stresses in its annual stress testing exercise, which is also published as part of FSR. In previous three FSRs, the exercise incorporated the impacts of floods and droughts on aggregate output and banks' soundness indicators, mainly through physical risk. FSR 2021 also outlined overall dynamics of climate-change risks and the policy initiatives to mitigate these risks.

Way Forward

SBP aims to enhance the assessments of climate related risks by incorporating granular level information on risk drivers.

Table 4.1.4: NDCs and mitigation actions

Sr. No	Actions
I	50 percent reduction of Pakistan's projected emissions by 2030 (15 percent unconditional , 35 percent conditional)
II	60 percent of the energy to be produced through renewable energy sources.
III	By 2030, 30 % of all new vehicles sold in Pakistan in various categories will be Electric Vehicles (EVs).
IV	From 2020, new coal power plants are subject to a moratorium, and no generation of power through imported coal shall be allowed,
V	2016 onwards, continued investments in NbS through the largest ever afforestation program in the history of the country—the Ten Billion Tree Tsunami Programme (TBTTP)—will sequester 148.76 MtCO2e emissions over the next 10 years.
VI	By 2023, total protected areas in the country will be enhanced from 12% to 15%.

Source: GOPs updated NDCs 2021

There are a number of ways to incorporate the climate related risks in the in-house stress testing exercises. For instance, for transition risk, SBP can rely on the scenarios provided by the NGFS. In addition, the transition risks can

[122] German Watch. (2021). Global Climate Risk Index 2021.

[123] Pakistan floods 2022: Post-Disaster Needs Assessment.

be incorporated and modelled in accordance with the Nationally Determined Contributions, committed by the government of Pakistan in compliance with Paris Agreement of 2016 **(Table 4.1.4)**.

For assessment of physical risks, scenarios can be developed by relying on data from historical damages due to floods and heavy rainfalls (as is already being done in stress testing contained in FSRs). Time horizon of the scenario may, however, vary with the nature of risk(s) considered. Shorter horizon can be adopted for acute physical risk and transition risk arising from immediate change in regulations. For instance, in the wake of recent floods, an assessment of potential credit risks over two quarters to the banking sector was conducted. Nonetheless, longer horizons are more suited for assessing medium term structural risks arising from transition or chronic physical risks.

In terms of approach, the top down approach towards climate stress testing is currently more suitable, given data limitations. This will enable SBP to evaluate the climate risk for a large number of institutions, especially smaller institutions that might not have the expertise for a bottom up assessment. In terms of balance sheet approach, SBP may adopt static balance sheet approach as it provides the advantage of analyzing the vulnerability of *current business model* and financial position of the financial institutions in response to climate change.

A more robust and reliable analysis requires data on multiple dimensions. As part of building the climate related data, SBP is in the process of gathering data on exposures from financial institutions along two dimensions. First, data on sectors vulnerable to the physical and transition risks **(Table 4.1.5)**. This data set will enable the central bank to gauge the extent of institutional exposures susceptible to climate risk. Second, a more granular district level data on exposures, which will provide an estimate of portfolio disbursed in climate vulnerable geographical units. In addition, an effort will be made to prepare vulnerability, adaptability and resilience indexes of domestic geographical units to climate related disasters.

Table 4.1.5: Sectors vulnerable to climate related risks

I	Crop and animal production, hunting and related service activities
II	Forestry and logging; Fishing and aquaculture
III	Mining and quarrying
IV	Manufacturing
V	Water supply; sewerage, waste management and remediation activities
VI	Electricity, gas, steam and air conditioning supply
VII	Construction
VIII	Transportation and storage
IX	Real estate activities

Source: FSB, ECB and Bank of Canada

Challenges Ahead

Data gaps remain key challenge in reliable assessment of climate related risks faced by the financial sector in Pakistan. In terms of data availability, lack of climate related information on sectors of the economy and counterparties is a major hurdle in their climate risk analysis. In addition, dearth of data for geographical location vulnerability to climate related risks limits the ability to assess the vulnerability of financial sector assets to physical risk.

An equally important aspect is modelling the impacts given the inter-linkages and feedback effects over heterogeneous sectors as well as uncertainties revolving around interventions. For instance, the efforts to mitigate effects of physical risks may involve considerable uncertainties given long delays in implementation and full effects: costs are incurred upfront but the benefits are materialized over time.[124] Moreover, the models typically require a wide range of variables –

[124] Brunetti, C. et al. (2021). Climate Change and Financial Stability. *FEDS Notes, Federal Reserve Board*.

quantitative and qualitative – and considerable non-linearities.

Notwithstanding the challenges of data availability and complexities involved in modelling climate risk, SBP is committed to enhance its climate risk assessment framework for effective and timely assessment of climate-related risks to financial stability.