The Coalition
of Finance Ministers
for Climate Action

Understanding the financial stability implications of climate risks: approaches to climate risk analysis in Financial Sector Assessment Programs (FSAPs)

International Monetary Fund (IMF)

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An overview of the IMF's work on climate risk analysis

Climate change and mitigation actions present risks and opportunities for the real economies and financial sectors of the IMF's global membership. Understanding the risks is key to prepare for a successful transition to a lower carbon global economy and to foster a climate resilient financial sector. This contribution outlines the IMF staff's approach to assessing the impact of climate-related risks on financial stability, with a focus on the Financial Sector Assessment Program (FSAP). The analytical approaches described below consist of a suite of modeling and analytical tools that can be used to understand the broader implications of climate change and mitigation actions on the economy. Some of these approaches, for example, have been used in other surveillance and capacity building activities beyond FSAPs.[1]

Climate-related financial risks are generally classified into two categories: transition and physical risks. Transition risks result from changes in policies, markets, and technologies as economies shift away from fossil fuels and emissions-intensive activities and production processes; this transition can impact the valuation of financial assets and liabilities. Physical risks arise from the physical effects of climate change and environmental degradation and can be both chronic (e.g., sea-level rise and temperature increases) and acute (e.g., floods, droughts, and storms). Shifts in climate patterns can lead to damage to physical assets, disruptions in markets, and declines in productivity, thereby affecting the resilience and stability of the financial system.

Transition and physical risks can propagate through the financial system via multiple channels, potentially triggering financial risks in both the public and private sectors and affecting long-term economic growth. For example, extreme weather events may result in income losses and property damages for households, capital damages and supply disruptions for businesses, and consequently lower tax revenues and reduced fiscal space for the Government. An abrupt transition to a low-carbon economy could lead to changes in household income, costs, and property valuations as well as changes in firms' costs and revenues and potentially stranded capital. These may subsequently lower revenue streams and potentially increase borrowing costs for the Government. Beyond microeconomic impacts, climate change and mitigation actions can also generate macroeconomic effects, such as sudden price fluctuations, productivity changes, and labor market frictions (BIS, 2021; Dunz and Power, 2021; NGFS, 2020). Furthermore, when compounded with other macrofinancial shocks, climate-related risks could lead to more severe and potentially cascading effects (Hallegate et al., 2022).

Climate risk analysis plays a crucial role in understanding the potential transmission channels of climate-related risks and assessing the broader implications for economic and financial systems. It is increasingly used by jurisdictions to assess the resilience of the financial system to climate change and mitigation actions (Dunz and Power, 2021; Gardes-Landolfini et al., 2023; NGFS, 2021). It has also been piloted in several FSAPs. For example, the FSAPs of Chile, Colombia, Mexico, Norway, the United Kingdom, Kazakhstan, and Japan have assessed transition risks posed by climate change mitigation and implications for the financial sector (Grippa and Mann, 2020; IMF, 2022a,b, 2024a,b; Sever and Perez-Archila, 2021). The FSAPs of Mexico, the Philippines, the Maldives, and the Netherlands have assessed country-specific physical risks, such as typhoons in the Philippines, tropical cyclones and floods in Mexico, sea-level rise and coastal floods in the Maldives, and floods in the Netherlands (IMF, 2022a, 2024c,d; IMF and World Bank, 2022).

The challenges of assessing climate-related financial risks

The analysis of climate-related financial risks has distinct characteristics that set it apart from conventional risk analysis, introducing new data and modeling challenges. First, unlike conventional risk analysis or stress testing of financial systems, climate risk analysis involves longer time horizons, covering both medium-term (3–5 years) and long-term (30–50 years). Second, in contrast to the well-

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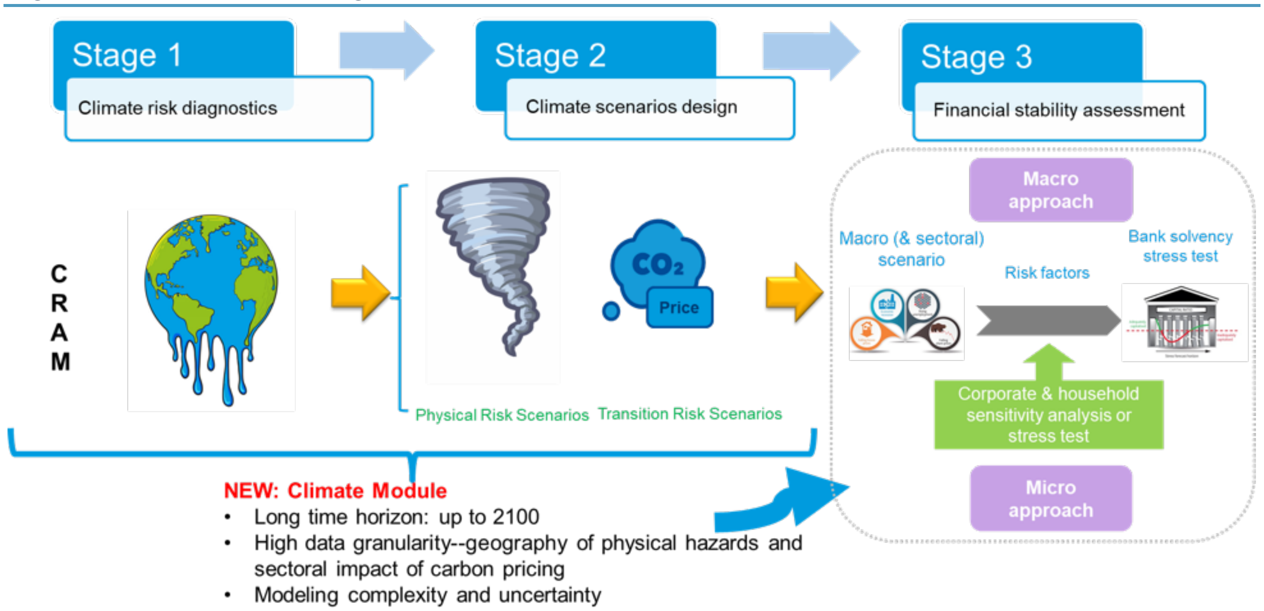
1 For example, climate risk analysis was covered in the technical assistance to Bangladesh (Carella and Urunuela, 2023) and the 2024 Article IV Consultation with France (Teodoru et al., 2024).

documented financial information available for standard stress testing, it remains rare that climate-related financial data is disclosed. Third, the assessment of climate-related financial risks extends beyond the economic and financial factors typical of conventional risk analysis to include projections about climate policy and technological advancements. Fourth, whereas conventional risk analysis often relies on historical data to estimate potential shocks, climate risk analysis is inherently forward-looking, with minimal to no guidance from historical trends. Fifth, a critical aspect of climate risk analysis is the enhanced sectoral and geographical granularity; for example, it involves a nuanced breakdown of transition risks by industry and economic sector, and physical risks by geographical location, diverging from the general approach and data used in standard financial system stress testing. Finally, climate risk analysis entails a higher level of uncertainty and model complexity due to the need for assumptions regarding the interactions between the climate, anthropogenic activities, and economic dynamics.

Approaches to assessing climate-related financial risks

The modeling framework of the IMF's climate risk analysis consists of three stages: (1) climate risk diagnostics with global and country-specific perspectives, (2) the design of country- and financial system-specific climate scenarios, and (3) a financial stability assessment (Adrian et al., 2022). These stages are relevant for both physical and transition risk analysis (Figure 1). This modeling framework and the approaches outlined below aim to provide a general overview of methodologies and tools available to assess climate-related financial risks. These insights can help Ministries of Finance, central banks, and financial regulators understand the pressure points of the financial system in relation to climate change and the transition to a low-carbon economy.

Figure 1. The IMF's modeling framework to assess climate-related financial risks



Source: IMF staff

Two general approaches can be used to assess the implications of climate-related risks for financial stability: macro and micro approaches. The macro approach aims to quantify the impact at an aggregated economic/financial level. The micro approach examines the impact using granular income and balance-sheet data of a large sample of individual firms and/or households. The two approaches are complementary. The selection of the most appropriate approach, or a combination of the two, depends on the data availability for the specific country.

Transition risk analysis

In the macro approach, climate-augmented macrofinancial scenarios are used as inputs for standard stress-testing methodologies to assess the financial system's resilience. While climate transition models, such as computable general equilibrium (CGE) models and integrated assessment models, provide detailed information on energy transition and emissions pathways, they may not generate a sufficiently wide range of macrofinancial variables that would be required for financial system stress testing. In such cases, the outputs from these models can be used as inputs to other models, such as the Global MacroFinancial Model (GFM)[2] and the Integrated Policy Framework (IPF) model,[3] which are better suited for producing a range of macrofinancial variables.

The micro approach is used when granular and reliable data on balance sheets and income statements of firms and/or the financial conditions of households are available. It is an extension of the macro approach, entailing exposure-level assessment. The integrated micro-macro modeling framework has been piloted in several FSAPs: Mexico, Kazakhstan, and Japan (IMF, 2022a, 2024a,b). This modeling framework is generally implemented in three steps: transition scenarios; firm-level variables, vulnerability indicators, and credit paths (e.g., projections of probability of defaults and loss given defaults); and bank capital and credit losses. Transition scenarios are often obtained from a CGE model, (e.g., GTAP-E, IMF-ENV, and ENVISAGE). Additional balance-sheet dynamics can be considered when applying the integrated micro-macro approach.

There is a particular focus, especially from a financial perspective, on the impact of sudden, unexpected transitions. Potential upfront shocks to carbon prices, technological breakthroughs, and changes in expectations of how future policies may impact asset valuations can generate additional pressure on the financial system. These shocks can cause a rapid collapse in asset values (the so called "climate Minsky moment"). The "climate Minsky moment" approach has been explored in the UK FSAP, where the exposure of financial institutions (banks, insurers, investment funds, and pension funds) to the potential materialization of credit and market losses within a five-year horizon was assessed (IMF, 2022b). The main source of the shocks is assumed to be a policy change, in the form of a switch in the economic agents' expectation from a low and relatively flat path to a high and steep path for carbon prices, in the United Kingdom and on a global level.

Physical risk analysis

Physical risks arise as the interaction of three components: hazard, exposure, and vulnerability. Changes in both the climate system and socioeconomic processes, including adaptation and mitigation, drive hazard, exposure, and vulnerability.

The macro approach incorporates the analysis of the impact of aggregate shocks, due to hazard damages, on macroeconomic and financial variables using macro models. Granular damages are estimated using catastrophe models (e.g., CLIMADA) and then aggregated to the country level and used as inputs in macro models (e.g., the GFM) to generate macrofinancial scenarios. Physical risk shocks can generate macroeconomic impacts through several transmission channels. These include immediate physical capital destruction, long-lasting decline in total factor productivity, reconstruction efforts, unemployment, rising housing prices, and financial market impacts, as demonstrated in the Philippines, Mexico, and the Netherlands FSAPs (IMF, 2022a, 2024d; IMF and World Bank, 2022).

The micro approach has limited application due to data constraints. This method requires granular transaction and loan-level data, which are often unavailable. However, when the data is accessible,

2 The GFM is a global dynamic stochastic general equilibrium model, disaggregated into several national economies. It was developed by the IMF to support multilaterally consistent macrofinancial policy, risk, and spillover analysis, and it is regularly used to generate scenarios for FSAP risk analysis, such as solvency stress tests. Detailed information on the GFM is available in Vitek (2018).

3 The IPF is an empirically oriented New Keynesian model developed by the IMF to analyze monetary policy and financial stability issues in open economies. As a typical New Keynesian setup, it has the following features: incomplete financial markets, imperfect exchange rate pass-through local currency pricing, micro-founded private and sovereign borrowing spreads, sticky wages, and integrated policy analysis with both interest rate and exchange rate policies. Detailed information on the IPF is available in Adrian et al. (2021).

detailed geolocation information for corporates and households, along with granular data on banks' exposures, can be used to estimate the impacts of physical damages from climate-related hazards on borrowers' financial health, including via the reassessment of their collateral values. The impacts can subsequently be translated into potential credit losses for the lenders.

Potential areas for modeling improvement

While different approaches have been explored to integrate climate models and macrofinancial models for assessing climate-related financial risks, some key challenges still remain. There are model development needs to improve the assessment of climate-related financial risks, including:

- Improving temporal resolution and refining short-term scenarios to better capture near-term shocks
- Enhancing sectoral and spatial granularity to better represent heterogeneous climate-related risks across sectors and regions
- Combining transition and physical risk considerations in an integrated modeling framework
- Developing more disorderly scenarios to capture tail risks and compounding impacts.

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