MEKETA
INVESTMENT GROUP

Climate Scenario Frameworks

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Modeling climate risk is becoming increasingly common among institutional investors, particularly in using climate scenarios which analyze the impact to portfolios from a broad range of changes to the Earth's climate over time. In this paper we discuss popular scenario frameworks, ways to compare their different modeling approaches, as well as pros and cons of the various frameworks for institutional investors.

Ultimately the use of these frameworks aids the evaluation of the impact of various climate-related proposals and potentially aids the comparability of impacts across different groups of stakeholders conducting similar analyses.

Forward-looking scenario analysis, when combined with assessment of the current climate positioning of a portfolio, makes it possible to better understand the costs of various climate objectives for an investment portfolio and determine a more optimal plan for helping attain both investment as well as pre-existing financial goals.

What is a scenario framework?

Scenario frameworks can be thought of as the "ground rules" for measuring climate risk. They provide an underlying set of assumptions and priorities for building and evaluating climate change scenarios. Frameworks vary in their complexity and level of detail, ranging from broad statements of principles to suites of pre-specified scenarios with detailed forecast data. Below we review the current state of some popular modeling frameworks, discuss their suitability for different groups of investors as well as their general benefits and drawbacks.

Task force of climate-related financial disclosures ("TCFD")

The TCFD, a task force established by the Financial Stability Board[1], develops recommendations for climate-related disclosures that are intended to enable better investment, credit, and insurance underwriting decisions while simultaneously aiding transparency of carbon-related assets in the financial system. TCFD's recommendations are not targeted directly at asset owners, instead encouraging other organizations to use scenario analysis to identify and assess the potential implications of a range of plausible future states under conditions of uncertainty and to make that information available to investors and stakeholders to inform their decision making.

[1] The Financial Stability Board is an international body that monitors and makes recommendations about the global financial system which is hosted and funded by the Bank for International Settlements.

The TCFD approach to climate scenario analysis is flexible, acknowledging that quantitative as well as written qualitative assessments can be helpful for assessing risks across a number of areas including transition risks, physical risks, policy & legal risk, and reputational risk. They emphasize that to be most useful, organizations should consider multiple scenarios that cover a reasonable variety of future outcomes, at least one of which is aligned with a 2°C scenario.[2] Other helpful scenarios may include scenarios informed or mandated by national actors, or physical and transition risks that are particularly suited to the organization's operations. More recently, TCFD has provided clarifying details about its positions on scenario analysis, provided case studies for use, and solicited additional commentary integrating climate into risk management processes and determining useful financial sector metrics.

A drawback for investors is that TCFD's framework is targeted at organizations, particularly companies, and not necessarily investors. However, companies implementing the TCFD framework and reporting their findings may create inputs for asset owners' analyses of climate issues. Additionally, TCFD's considerations for assessing design decisions in scenario analysis are also applicable in a portfolio context regardless of framework:

- → Consideration of which parameters to use, the degree of certainty associated with those parameters, and the sensitivity of output to changes in those parameters
- → Assumptions made regarding policy changes, technology development/ deployment, energy mix, price of key commodities or inputs, geographical tailoring of transitional and physical impacts
- → Evaluation of analytical choices, including selection of scenarios, time horizons evaluated, and selection of supporting data and models.

In addition to its work on scenario analysis, the TCFD also advocates for increased financial transparency regarding climate exposures. This information can then be integrated into multiple scenario frameworks.

Network of central banks and supervisors for greening the financial system ("NGFS")

NGFS is a group of central banks and financial regulatory supervisors collaborating to contribute to the development of environmental and climate risk in the financial sector and sharing of best practices among the group. Given the economy-spanning responsibilities of its member institutions, the NGFS scenario framework focuses on macroeconomic impacts across a number of scenarios and their impact on the global financial system and the wider global economy. Recognizing the difficulty of determining detailed, plausible scenarios given the inherent uncertainty of climate modeling, NGFS has focused its efforts on developing and providing background data on six scenarios spanning a number of emissions/temperature scenarios and a spectrum of policy responses ranging from organized to disorganized. These scenarios are periodically updated to reflect shifts in climate policy, changes in IMF growth projections, and impacts from disruptive events (e.g., COVID-19). The particular scenarios cover a broad range of possible situations and also demonstrate varying levels of exposure to physical and transition risks. These exposures tend to be inversely correlated (i.e., transition steps

[2] Scenarios associated with a quantified change in temperature (e.g., a 2.0°C scenario) refer to modeling a rise in global temperature above the pre-industrial (1850) baseline global temperature by the end of the current century.

taken will tend to increase transition risks for economic actors but simultaneously decrease physical warming and its attendant risks), though they do interact to some degree in portions of the model ensemble.

Long-term Climate Policy	Climate Change Mitigation Policy Implementation	CO^2 Sequestration Availability	Climate Change Mitigation Policy Variation Among Regions
Net Zero	Immediate & Smooth	Medium	Medium
Below 2°C	Immediate & Smooth	Medium	Low
Delayed Transition	Delayed	Low	High
Divergent Net Zero	Immediate & Divergent	Low	Medium
Nationally Determined Contributions	Varies	Low	Low
Current Policies	No Change	Low	Low

FIGURE 1
Sample NGFS Scenario Characteristics

Source: For more information on the development, characteristics, and use of the NGFS scenarios, see the NGFS "Guide to Climate Scenario Analysis for central banks and supervisors" (https://www.ngfs.net/sites/default/files/medias/documents/ngfs_guide_scenario_analysis_final.pdf).

While the NGFS approach lacks some flexibility due to its use of pre-determined scenarios, the scenarios are based on an ensemble of models and provide well specified data, both in terms of outputs as well as documented linkages throughout. Its assessments of aspects of physical and transmission risk are broadly defined and provide high-level data suitable for reviewing portfolio risk exposures in a top-down manner. Given the position of the NGFS' sponsors and specificity of their scenarios, they seem likely to be readily adopted as a set of scenarios that allow investors to benchmark their climate exposures versus peers.

Institutional Investors Group on Climate Change ("IIGCC")

The IIGCC is a group formed to foster investor collaboration on climate change and is primarily composed of European asset owners and investment managers. The group seeks to support and help define the public policies, investment practices and corporate behaviors that they believe will result in progress towards a net zero climate goal by 2030.

While generally aligned with the TCFD, the IIGCC recognizes that climate scenario analysis presents unique challenges to financial and investment practitioners: climate impacts have great breadth and magnitude, highly uncertain and long time horizons, foreseeable wide scale outcomes but little detail certainty, and long-term consequences being impacted by short-term actions. The framework also recognizes that asset owners may seek to use scenarios to assess both financial (e.g., liability/solvency impacts, investment selection) and climate outcomes (e.g., net zero alignment, stakeholder engagement) simultaneously.

Given the different starting points and different needs of various investors, the IIGCC discusses a variety of approaches to formulating and using scenario analysis, noting that simplified scenario approaches can be appropriate to have a better initial understanding of the impact of certain policies, but it also provides perspective on the use and selection of more sophisticated integrated modelling techniques. The IIGCC

also specifically addresses the issue of translating the output of climate models into relevant financial metrics. Their approach allows for both top-down analyses that focus on macroeconomic implications of climate change and their impacts on strategic asset allocation and liabilities, and bottom-up analyses that model impacts at the asset, sector, and portfolio levels that can be aggregated in a holistic whole-portfolio analysis.

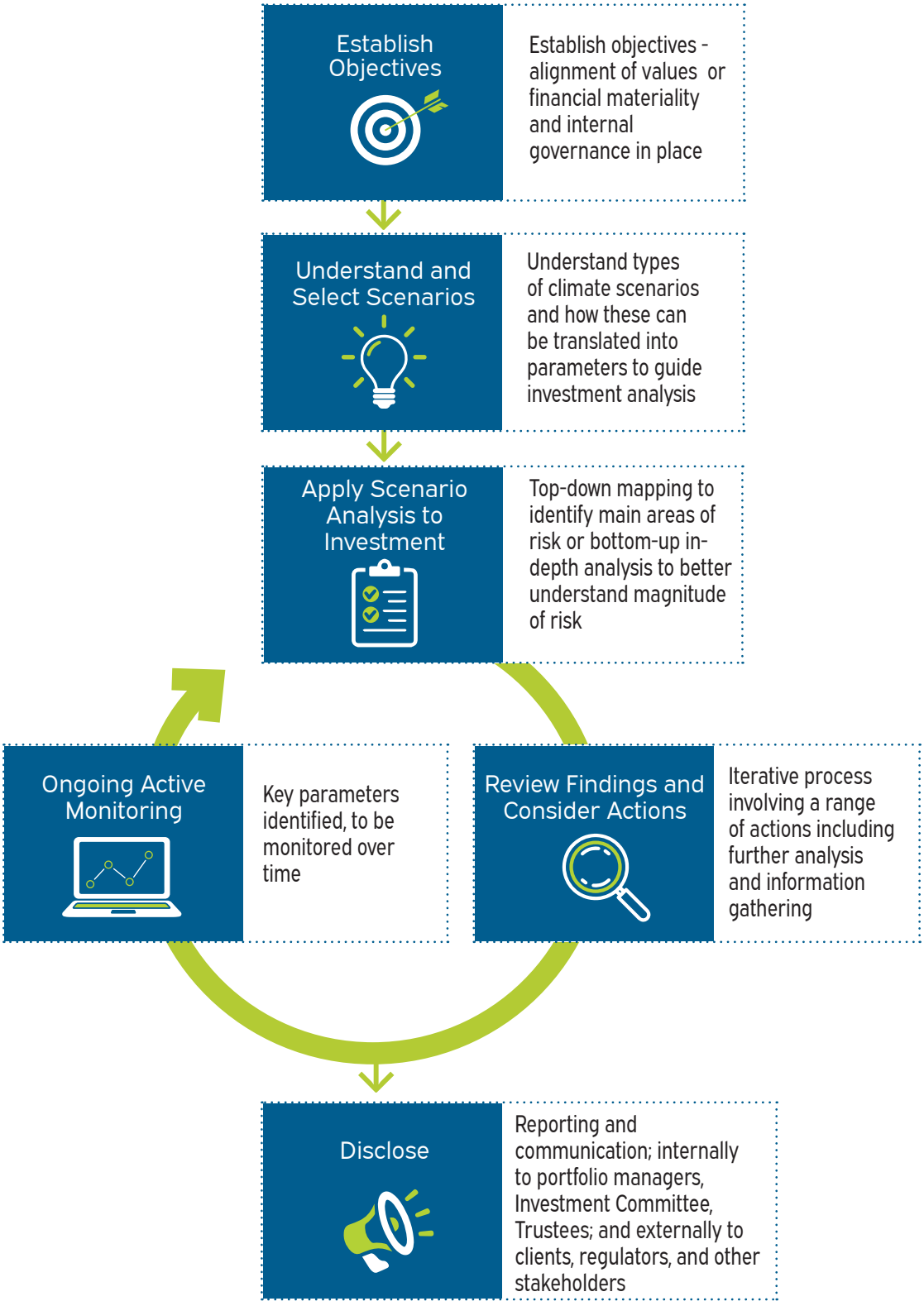

FIGURE 2
Investor Framework for Climate Scenario Analysis

Source: IIGCC, "Navigating Climate Scenario Analysis: A Guide for Institutional Investors," April 2019. https://www.iigcc.org/resource/navigating-climate-scenario-analysis-a-guide-for-institutional-investors/

	Pros for Investors	Cons for Investors
TCFD	· Encourages reporting of climate data from portfolio companies · Provides principles for evaluating scenario analyses	· Most recommendations applicable to companies, not asset owners
NGFS	· Highly comparable to other portfolios · Provides specific inputs	· Scenarios and input data are pre-ordained
IIGCC	· Highly flexible set of principles geared toward investors specifically	· Investors with different objectives and constraints may have difficulty comparing analyses despite using the same framework due to its flexibility

FIGURE 3
Comparison of the Three Policy Frameworks

Source: Meketa Investment Group, 2023.

Modeling approaches – top-down versus bottom-up

As can be seen from these frameworks, there are a variety of ways to consider using climate scenarios in addition to a variety of options within those scenarios. Another way to think about how to structure climate scenario analysis is by their modeling approach. A modeling approach describes the structure of a scenario analysis, principally what data is assumed to be used as inputs for the model, how those inputs are used to generate a forecast, and what data outputs are expected and what conclusions can be drawn from those outputs. When evaluating approaches, climate scenario methods generally fall into either "top-down" or "bottom-up" analyses, though there is considerable scope for combined or aggregated models.

Bottom-up models generally take detailed information about individual companies and industries, and then apply and aggregate that data across an entire portfolio. Starting with the outputs of climate models, investors determine what linkages between climate variables and traditional financial valuation and risk variables seem plausible. These linkages can integrate climate considerations into traditional investment processes to provide climate-aware insights. Additionally, the impact of potential climate mitigation policies can also be incorporated, allowing the measurement of both physical and transition risks. The ability to integrate into existing approaches, measure risk, or assess underlying security performance, is a key benefit of a bottom-up approach. As transparency and disclosure requirements, like those advocated by the TCFD, become more mainstream, the ability to adjust individual asset and sector models to account for climate variables should improve. Such security- and sector-specific approaches would in principle be helpful for assessing investors' underlying portfolios.

While these methods are very granular, they provide insights about current practices and exposures and can yield results that do not necessarily easily translate to long-term,

strategic decision making. Though climate models can provide long-term forecasts of environmental and associated variables, the linkages between this data and financial variables, as well as asset-level and sector-specific models, are not necessarily built to forecast future values over long time periods. Additionally, aggregation can reduce the usefulness of the analysis (e.g., a bottom-up analysis that forecasts shifts within asset classes but little change in returns among asset classes would have limited usefulness for strategic asset allocation). Fiduciaries typically consider investment decisions, particularly regarding strategic asset allocation and liability management, across longer, multi-decade timespans. Companies, business practices, and consumers' tastes all change. Though analysts can make assumptions about trends going forward, any long-term analysis will be dependent on the accuracy of those assumptions.

A key area of concern for any scenario modeling exercise, whether bottom-up or top-down, is assessing scenario output sensitivity to different scenario inputs. Particularly for longer duration (i.e., multi-decade) analysis associated with asset allocation and liability management, changes in starting dates and assumptions about the timing of various policy responses can meaningfully impact results over the periods of analysis.

Input sensitivity does not invalidate a model, but sensitivities should be understood and mitigated where possible by using a variety of different scenarios with varying inputs to help derive a meaningful set of results.

Top-down models generally begin with climate model outputs and climate scenario considerations, and then attempt to link these outputs with forecast changes in macroeconomic and broad financial trends over an extended period of time. While less useful to forecast performance for particular portions of an investor's portfolio, these broader variables typically integrate well with whole-portfolio measures of risk exposure and asset class risk and return forecasting. Scenarios like those of the NGFS can use econometric methods to estimate the impact to GDP from physical climate risk, the socioeconomic impact of climate change on GDP, and the future behavior of interest rates from climate shocks, among other variables. However, such models are only as strong as their linkages. To the extent that climate models are incorrect versus reality or that the estimated linkages between climate data and targeted variables vary, the top-down estimate will necessarily suffer. Though broader macroeconomic variables can have more stable relationships over time than company-specific measures of valuation, they can still change and would potentially become less stable in more extreme climate scenarios.

Fortunately, top-down and bottom-up approaches are not mutually exclusive.

Given the tradeoffs associated with both bottom-up and top-down approaches, combining the two can offer the strengths of both while helping to mitigate their weaknesses.

One way to combine the methods is to use them sequentially, using a top-down approach to identify riskier areas of portfolios (whether they be asset classes, sectors, or companies), and then engage in detailed bottom-up analyses for those areas to better understand and manage the particular climate risks. An investor could also conduct both simultaneously, using the output of each analysis to inform insights about the other. Additionally, an investor could use both types simultaneously but prioritize different areas of inquiry. For example, bottom-up analysis could be used for judging alignment with an investor's climate goals throughout the portfolio, while the top-down approach would focus on long-term financial impacts.

Conclusion

Ascertaining the impacts of climate change, particularly over a long time horizon, is a challenging endeavor. Differences in the character, magnitude, or timing of various climate risk factors can radically impact the outcome of the analysis. Climate change impacts are not obvious, simple to estimate, or to counteract, and their linkages to traditional financial and economic measures is neither straightforward nor static through time.

As a result, multiple stakeholders have (and continue to) work on providing guidance and resources to support scenario analysis efforts among asset owners and other investors. Different analytical approaches, whether bottom-up, top-down, or hybrid approaches, have varying strengths and weaknesses that should be acknowledged and accounted for. It is likely that sustained effort will be required at the strategic asset allocation level as well as within asset class portfolios and potentially within individual investment mandates to achieve climate alignment goals alongside financial ones.

While the sheer scale of climate risk is intimidating, disruption can provide opportunity. As the shape of future climate effects and policies becomes clearer, we anticipate the perceived importance of climate risk to investors to increase markedly. It is likely that investors who are most attentive to these risks will be best positioned to capitalize on their evolution.

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