

September 6, 2021

Scenario analysis as a valuable tool for analyzing climate change risks

Keywords: climate change risks and opportunities, scenario analysis, TCFD

Research Institute for Policies on Pension & Aging (RIPPA)

Specially Appointed Researcher: Ryujiro Miki*, CFA

Abstract

When we think about climate change, it is important to consider both the risks and opportunities that climate change brings, but the situation concerning climate change is moving rapidly and the contents are diverse. Therefore, in this paper, I attempt to organize the scenario analysis in particular in considering what risks and opportunities climate change poses to companies held in pension fund portfolios. First, it looks at what companies are required to do in terms of disclosure in line with the TCFD (Task Force on Climate-related Financial Disclosures¹) recommendations, and then summarizes scenario analysis as a valuable tool to climate change risk, focusing on the work of the Network of Central Banks & Financial Supervisors for Governing the Financial System (NGFS). As institutional investors are expected to consider how to incorporate ESG factors, including climate change (E), when appointing asset managers (AMs) and selecting investment products, this paper summarizes information that asset owners (AOs) should keep in mind. It was written mainly for Japanese corporate pensions, however, I hope it is valuable for related parties in APAC as well.

**The opinions and assessments expressed in the text are those of the author and not those of the institution the author belongs to.*

Contents

1. Introduction
2. Climate Change and Investment Analysis
3. TCFD's 2017 Recommendations on Climate Change Risks and Opportunities
4. Climate Change Scenario Analysis
5. Afterword

1. Introduction

In the past, there were no legal provisions referring to "ESG" in private pensions in Japan, and the prevailing view was that ESG investment was rather a breach of fiduciary responsibility. However, the situation has changed in recent years, and the DB Guidelines² were revised in 2017, clearly stating that when selecting an asset manager (AM), it is desirable to consider the AM's acceptance of the

¹ TCFD was established by the Financial Stability Board (FSB) at the request of G20.

² Ministry of Health, Labour and Welfare, "Guidelines on the Roles and Responsibilities of Parties Involved in Asset Management for Defined Benefit Corporate Pensions (Notice)" (2017)

Stewardship Code and its stance on ESG as qualitative evaluation items.

In March 2020, the Stewardship Code was revised to include a provision to consider sustainability (medium- to long-term sustainability, including ESG factors). AOs' awareness of ESG investment has been steadily increasing.

Among ESG issues, addressing climate change risks and opportunities is becoming an urgent theme for institutional investors, including pension funds and other AOs, as Japanese government's commitment to "net zero by 2050" in October 2020 has turned the tide toward corporate decarbonization.

In principle, corporate pension funds do not manage their own assets, but as asset owners, they are increasingly calling on AMs to take responsibility for ensuring that the companies they invest in emit virtually no greenhouse gases. However, corporate pension funds in Japan, which until recently were expected to perform as one of the welfare department under the jurisdiction of the Human Resources Department, are now being forced to be aware of themselves as asset owners which are regarded as one of the institutional investors. In particular, climate change risks and opportunities are moving so fast that a mountain of information is pouring in, and it was previously thought that it was up to the asset managers to respond. However, legislation passed in the U.K. in February 2021 will require major corporate pension plans to address and disclose climate change based on the TCFD recommendations³.

Just as the UK version of the stewardship code was introduced to Japan and the Japanese version of the stewardship code was created in 2014, this may eventually affect pensions in APAC region including Japan as well. Therefore, this paper summarizes the information about climate change risks and opportunities that corporate pensions need to know, and especially discusses "scenario analysis", which is said to be the most difficult part of climate change countermeasures and disclosure based on TCFD recommendations.

2. Climate change and investment analysis

Why do asset owners need to pay more attention to climate change risk than ever before? The reason is that climate change risk is increasingly likely to have a greater impact on the value of securities and real estate portfolios held by pension funds than ever before. A consensus is already forming that climate change risk, if left unchecked, will have a negative impact on corporate activities, as scientific

³ Dept. for Work & Pensions, "Taking action on climate risk: improving governance and reporting by occupational pension schemes" (Updated 21 July, 2021)

evidence shows that the Earth's Environmental Capacity will exceed its capacity. In other words, there is an increasing possibility that ESG environmental factors will affect corporate management, resulting in significant fluctuations in corporate value.

“Currently, about 40% of all survey respondents incorporate climate change information into the investment process. A separate question to a select group of C-level executives found about 75% feel that climate change is an important issue. The gap between these percentages seems to come from a lack of data and disclosure on climate risks from issuers.⁴”

In other words, although there is a vast amount of data on the environment, only a limited amount of this data is useful for incorporating into the investment management process, and the information that analysts and other investment professionals seek from companies is not sufficiently disclosed. In addition, even if disclosure is provided, it is unclear what kind of “scenario analysis” companies are doing.

So what analytical tools do investment professionals use to incorporate climate change risk into portfolio management? This will require tools that have never been used before.

The first tool is "carbon pricing". The term "carbon pricing" was included in the Japanese government's statement on the realization of a decarbonized society by 2050 as one of the means to achieve this goal, but it may not be familiar to the readers yet. In Japan, the Ministry of the Environment has been studying the issue for some time, and both “carbon tax” and “emissions trading system”, which are representative of carbon pricing, exist in Japan. However, the tax revenue from the former is relatively small, and the latter has only been introduced by the Tokyo Metropolitan Government and Saitama Prefecture. This is because the Ministry of Economy, Trade and Industry (METI) has been reluctant to study the issue because of the negative attitude of the industrial sector, which does not like the increased burden on businesses. However, with the Suga administration's declaration of carbon neutrality, the industrial sector has been forced to back off, and the Keidanren⁵, which has finally become more positive about the issue. Carbon pricing is a way to encourage companies and households to reduce carbon dioxide emissions by (1) reducing energy demand and (2) encouraging fuel switching.

The reason why carbon pricing is important to analysts is that carbon is priced through a market-based

⁴ CFA Institute “Climate Change Analysis in the Investment Process” (2020.9)

⁵ The Japan Business Federation (Keidanren) is one of the most important and influential business groups in the country.

mechanism. This will allow them to properly assess the negative externalities of greenhouse gases (GHG). In other words, companies have been able to turn a blind eye to the negative impacts of their GHG emissions and pursue profits for their shareholders, regardless of how much GHG they emit. In the past, companies have not borne the costs of GHG emissions. However, if carbon were priced at market value, the costs to be borne by the company could be properly quantified, and the value of the portfolio as a whole would be appropriately adjusted as a result of the negative impact on corporate value. In fact, Nomura Asset Management considers the value of GHG emissions multiplied by carbon pricing to be an expense for the companies in its portfolio and uses it in portfolio management. One company participating in the TCFD refers to the European carbon pricing market, which is currently €50 per ton of CO₂, but is expected to rise to €100 in the future. However, how to set up carbon pricing market, that is compatible with the global carbon pricing market, in Japan as a national system and what to use for its market value, are urgently required issues to be resolved soon.

The second tool is "engagement on climate change risk": AMs need to encourage the companies they manage to decarbonize toward 2050 net zero. It is said that climate change risks include "physical risks" and "transition risks," and we need to make sure that our business strategies appropriately reflect these risks in the mid- to long-term planning of corporate management. If not, AM, as an investor, needs to encourage companies to be more committed to decarbonization. Collaborative engagement is more effective than stand-alone engagement for investors to reach out to companies. In this sense, the Net Zero Asset Owner Alliance and the Net Zero Asset Managers Initiative are noteworthy organizations.

The goal of the Net Zero Asset Owner Alliance is to achieve the Paris Agreement goal of limiting temperature rise to below 1.5 degrees Celsius, and it is an initiative of asset owners who are committed to making their investment portfolios carbon neutral by 2050. It was established in December 2019 at the initiative of the United Nations Environment Programme and Finance Initiative (UNEP-FI) and the United Nations Principles for Responsible Investment (PRI). 40 organizations, including global insurance companies and pension funds such as Allianz of Germany, AXA of France, and CalPERS of the United States, are members, in which Dai-ichi Life has been the only member from Japan to participate since its inception. According to the organization's website, the total assets under management of the member institutions is approximately 6.6 trillion dollars.

The Net Zero Asset Managers Initiative was created in December 2020 by 30 of the world's largest asset managers in a \$9 trillion scale with the goal of "achieving virtually zero GHG emissions from their portfolio companies. It has established a group of investors to encourage companies to decarbonize. According to the organization's website, 128 companies are currently members with total

assets under management of \$43 trillion. Asset Management One is participating from Japan. In the past, major global AOs have been leading the movement to achieve zero GHG emissions from their investment portfolio, but now it is expected that pressure on companies will increase further in cooperation with AOs, regulators, exchanges, and rating agencies..

An organization called the Net Zero Banking Alliance was formed in April 2021 to commit to net zero lending by 2050. According to the organization's website, there are 53 banks in 27 countries that are members, and the amount of lending assets has reached 37 trillion dollars. which is nearly a quarter of the world's total lending. At the time of its founding, there were no Japanese banks participating, but Mitsubishi UFJ became a member in May 2021, and in July it became the only Japanese bank to be elected as a member of the steering committee.

The member banks have made the following commitments

- Aligning greenhouse gas emissions from their investments and loans with the progress needed to achieve carbon neutrality by 2050 (the goal is to limit temperature increase to 1.5 degrees Celsius)
- Based on credible transition scenarios (using Intergovernmental Panel on Climate Change (IPCC) and International Energy Agency (IEA) scenarios).
- Focus on the sectors that emit the most greenhouse gases and play a central role in the transition to a carbon-neutral economy.
- Set interim targets (to be implemented by 2030).
- Publish progress and action plans annually.

The third tool is the "disclosure standard". In order for companies to disclose climate change risks more transparently, it is more convenient for them if there are not too many conflicting disclosure standards. For example, the CFA Institute states that SASB and TCFD recommendations are the most commonly used and concise disclosure standards for materiality of climate change risks.

In September 2020, five standard-setting bodies - CDP, CDSB, GRI, IIRC and SASB - issued a statement of intent to work together towards corporate reporting that relates financial and non-financial information to meet the information needs of investors as well as other stakeholders. This is because non-financial sustainability reporting, including environmental reporting, has to be more complex than financial reporting, and many standards and frameworks for sustainability reporting have been developed, causing confusion for both preparers and users of reports.

Japan's Financial Services Agency (FSA) has also begun to position the issue of climate change as an important supervisory issue, and in its Corporate Governance Code revised in 2021, it states that

"companies listed on the Prime Market shall collect and analyze necessary data on the impact of climate change-related risks and opportunities on their business activities and earnings, and enhance the quality and quantity of their disclosures based on TCFD, an internationally established disclosure framework, or an equivalent framework.

The fourth is "scenario analysis": a law passed in the U.K. in February 2021 requires major corporate pension plans (over 1.5 billion pound) to commit to their TCFD based disclosure, and the cost of conducting scenario analysis is said to be the largest cost for pension plans to comply with this disclosure, with an average cost of over 15,000 pound per plan. So why does the UK law require scenario analysis?

Scenario analysis is a thought exercise for analysts to consider how a company will be affected by a future climate change path of 1.5, 2, or 4 degrees Celsius. Scenario analysis is also particularly useful in analyzing climate change risk because historical models are useless. However, the problem for analysts is that in many cases, scenarios are not disclosed in corporate disclosures or are not sufficiently analyzed, although it would be nice if the companies they are analyzing had solid scenario analysis and made business strategy decisions based on the results. Therefore, investors must engage companies and ask them to conduct scenario analysis, but companies resist describing and disclosing the worst-case scenarios. While it is not necessary to disclose every scenario analysis considered by a company internally, companies should disclose to investors what scenarios were considered and what led to the business strategy decision. Otherwise, investors will not be able to evaluate the resilience of the medium- to long-term business and financial strategies developed by the company. It is also difficult to understand how the company is strategically responding to risk management and, conversely, how it views climate change as an opportunity.

3. TCFD's 2017 Recommendations on Climate Change Risks and Opportunities

The TCFD was originally established by the Financial Stability Board (FSB) when the G20 requested the FSB to consider climate risks in 2015, based on the awareness that "climate change poses a risk to the financial system as great as the Global Financial Crisis. The final recommendation was submitted in 2017. Among the new risks that threaten financial stability, the report identifies and urges disclosure of the financial impacts of "transition risks," "physical risks," and "opportunities" as impacts of climate change on the financial industry.

Transition risk refers to the risks arising from the wide range of changes that are expected to occur in the transition to a low-carbon society, including changes in policies, laws, technological innovations and markets. For example, on July 15, 2021, it was reported that the EU has announced a policy to

effectively ban the sale of new internal combustion engine vehicles such as gasoline vehicles, including hybrid vehicles, by 2035. If hybrid vehicles are also regulated, it is expected to be a major opportunity loss for Japanese automakers. The tax burden and asset depreciation caused by such regulations are included in this transition risk.

Physical risk is the risk arising from weather events related to climate change risk. Damage to factories caused by typhoons or floods is considered an "acute risk" because it is temporary, while sea level rise is classified as a "chronic risk". There are two types of physical risks: direct damage, such as damage to buildings and facilities, and indirect financial impacts, such as disruptions to supply chains.

Climate change does not only bring risks, it can also bring business opportunities. For example, improving production and logistics to reduce GHGs could reduce costs and improve competitiveness. Similarly, a shift to renewable energy or the development of new low-carbon products may help seize new business opportunities if they can capture changes in consumer preferences.

While the 2017 TCFD recommendations helped investors and companies understand what to evaluate, it became necessary for companies to translate the recommendations into indicators that could be evaluated. Therefore, CDP developed a questionnaire to categorize the content of the TCFD recommendations into accessible and actionable data through responses from companies. CDP also developed CDP guidance on how to provide complete and comparable information related to each question, as well as a resource for taking action on each piece of data. CDP also created a "CDP scoring system" to help companies understand what best practices are for each piece of data, so that CDP data is comparable, standardized, and useful for decision-making. Chronologically, the TCFD recommendations were released in 2017, the TCFD-compliant CDP questionnaire was prepared in 2018, and the TCFD compliance for all sectors was completed with the CDP questionnaire in 2020.

4. Climate change scenario analysis

(1) Climate change scenario analysis of TCFD

From the standpoint of Japanese corporate pension funds, rather than conducting climate change scenario analysis on their own, they would rather hear how their investment managers are engaging with the companies they manage in their portfolios. Therefore, let's take a look at the 2017 TCFD report on climate change risk scenario analysis as information that AOs need to know in order to monitor what kind of analysis AMs do.

The difficulty for companies is that even if they know that climate change risks will have a significant impact on their business activities in the medium to long term, they do not know "when and to what

extent" the impact could be. Scenario analysis is a tool to overcome this difficulty, according to TCFD. Clearly, the key to scenario analysis is "which scenario to use. At this point in the process, TCFD recommends using at least two scenarios: 2°C scenario and a scenario that is closely related to the industry to which the company belongs. However, with the release of the IPCC 1.5°C Special Report in 2018 and the PRI's call for enhanced action in the same year, it is now considered common sense to use the 1.5°C scenario instead of the 2°C scenario agreed to in the Paris Agreement.

Scenarios do not describe all the events that will occur in the future, but only highlight the core elements. Therefore, it is not a forecast or sensitivity analysis, but rather a way to refine strategic thinking and challenge the traditional wisdom about the future. In a world of uncertainty, scenarios are used to force significant changes in the foundations of "business as usual" and to explore alternatives.

The scenarios considered by TCFD are as follows:

- i) Plausibility. The scenario must be feasible.
- ii) Distinctive. By using multiple scenarios, it should be possible to examine how different developments of the same key factors can produce different results.
- iii) Consistency. A logical explanation of the change as an internal logic must be a central part of the scenario.
- iv) Relevance. The set of scenarios should contribute to future insights into the strategic and economic implications of climate change risks and opportunities.
- v) Challenging. Conventional knowledge and simple assumptions about the future need to be challenged. It should seek to explore alternatives that substantially change the basis of assumptions about what would normally be the case.

This paper from TCFD is a bit dated, published in June 2017, but it is helpful to have links to case studies of what scenarios are used by issuing entities (BHP Billiton, Statoil, ConocoPhillips, and Glencore). It also includes case studies of AO and AM (CalSTRS, New York State Common Retirement Fund (NYSCRF), and the Environment Agency Pension Fund (EAPF), PGGM, and ICBC).

The TCFD, however, says that scenario analysis is not an easy task, and recommends starting with "qualitative" scenario analysis in the early stages. On the other hand, organizations that are more proficient in scenario analysis will conduct "quantitative" scenario analysis, using external data and models. While quantitative scenario analysis is essential, especially for companies that are exposed to physical and transition risks due to climate change, TCFD's stance was to leave the scenario development itself to each company.

IEA scenarios and IPCC scenarios were introduced as representative examples in the TCFD's 2017 recommendations.

The World Energy Outlook (WEO), published annually by the International Energy Agency (IEA), is the "world's most trusted energy outlook" that shows the latest trends and future prospects of energy supply and demand in the world and each region. It is a framework that covers energy demand fluctuations and power supply composition. The type of scenario deals with "transition risk," and it assumes the degree of impact of the transition to a low-carbon society in the future in categories such as "2 degrees scenario," "2.6 degrees scenario," "4 degrees scenario," and "6 degrees scenario.

However, TCFD warns that such climate-related scenarios do not always provide the ideal level of transparency, data coverage, and tool functionality that would facilitate their use in business and investment settings. Most transition scenarios, for example, provide outputs such as the energy mix under certain future conditions, but not sectoral outputs.

The IPCC, on the other hand, is a United Nations organization whose mission is to bring together scientists from various countries to conduct scientific and social assessments of global warming and publish the results. Each scenario shows the consequences of climate change, such as future GHG concentrations in the atmosphere and the risk of flooding. One of the IPCC's four published scenarios presented in the TCFD recommendations shows an ambitious pathway for reducing GHG emissions, peaking around 2020 and then declining in a linear fashion to a net reduction before 2100. It is expected to peak around 2020 and then decline in a linear pathway to a net negative result before 2100.

However, like the IEA, the TCFD states that the IPCC scenarios do not have easy access to the climate model outputs for the majority of organizations as they are currently within the IPCC framework, and there are also constraints with data availability and data granularity.

Thus, it has become quite difficult for companies to foresee the impact of climate change on their mid-to long-term business strategies, as can be seen from the two leading climate change scenario-building organizations introduced in the 2017 TCFD recommendations. TCFD says the percentage of companies disclosing in accordance with the TCFD recommendations, is gradually increasing in almost every category, but "scenario analysis" remains that only a very small part of the companies devote themselves to disclose the result. This means that even if TCFD publishes supplementary materials for technical advice, many companies still have no way to do it.

To capture the latest developments, after the 2017 TCFD recommendations, in 2020, TCFD issued

risk management guidance and scenario analysis guidance, and is currently preparing “draft guidance on climate-related indicators, targets and transition planning”, which will provide guidance on cross-industry climate-related indicators, linking climate-related financial impacts, updating indicators for the financial sector, setting and disclosing targets, and transition planning. The final version is expected to be released in mid-October 2021.

(2) Climate change scenario analysis by Japanese companies

In Japan, the Corporate Governance Code was re-revised in June 2021, and an increasing number of companies are disclosing their scenario analysis. The following are the new supplementary principles of the Code:

"The board should recognize that dealing with sustainability issues, such as taking care of climate change and other global environmental issues, respect of human rights, fair and appropriate treatment of the workforce including caring for their health and working environment, fair and reasonable transactions with suppliers, and crisis management for natural disasters, are important management issues that can lead to earning opportunities as well as risk mitigation, and should further consider addressing these matters positively and proactively in terms of increasing corporate value over the mid-to long-term.⁶"

“In particular, companies listed on the Prime Market should collect and analyze the necessary data on the impact of climate change-related risks and earning opportunities on their business activities and profits, and enhance the quality and quantity of disclosure based on the TCFD recommendations, which are an internationally well-established disclosure framework, or an equivalent framework.⁷”

As you can see from the TCFD website, Japan has the largest number of TCFD endorsing companies, ahead of the UK and the US, but the number of non-financial institutions dominates other countries, partly due to the efforts of METI.

Also the number of companies that have announced their policies and strategies for carbon neutrality by 2050 is also high. The following are some of the many companies that have announced their target year for achieving carbon neutrality ahead of schedule:

| | |
|------|----------------|
| 2021 | Recruit Co. |
| 2022 | DMG Mori Seiki |

⁶ Corporate Governance Code in 2021, Supplementary Principle 2-3-1

⁷ Corporate Governance Code in 2021, Supplementary Principle 3-1-3

| | |
|------|--|
| 2026 | Shiseido |
| 2030 | Nishimatsu Construction, Olympus, Konica Minolta, Panasonic, Hitachi, Fujitsu General, Hitachi High-Tech, Softbank, Sumitomo Mitsui Financial Group, Mitsubishi UFJ Financial Group, Resona HD |
| 2035 | Denso Corporation |
| 2040 | Kao, Eisai, Takeda Pharmaceutical Company Limited, Yokogawa Electric Corporation, Dai-ichi Life Insurance Co. |

Source: Mari Yoshitaka, Mitsubishi UFJ Research and Consulting, CFA Japan, "Domestic and International Trends in Climate Change Related Disclosures," July 12, 2021, p. 8.

Asahi Group Holdings conducted scenario analysis for its beer business in 2019, and for its beverage and non-beer alcoholic beverage businesses in 2020, with plans to conduct scenario analysis for all major businesses, including its food business, in 2021. The scenarios refer to the IPCC's RCP scenario RCP2.6 (<2°C scenario), RCP8.5 (4°C scenario), and the IEA's scenario.

The Marui Group also disclosed "Transition Risks" and "Opportunities" to the 2019 Annual Securities Report, adding "Physical Risks" in August 2020 and updating the details of "Opportunities". A key point of the report is that it uses only one scenario, 1.5 degrees Celsius, in order to "express our strong will to achieve a world below 1.5 degrees Celsius.

Nomura Asset Management uses the three scenarios presented by the International Energy Agency (IEA) in its World Energy Outlook 2019 for its scenario analysis. Given the risk characteristics of industries, only Scope 1 (direct emissions) is used for electricity, only Scope 3 (supply chain emissions) is used for fossil fuel production, and Scope 1 and Scope 2 (direct & indirect emissions) are used for other industries. In addition to analyzing power supply composition and stranded assets, the transition risk analysis uses ISS's carbon risk rating, while the physical risk analysis measures the value-at-risk of the portfolio in addition to physical risk analysis by industry and region, according to the report.

Hitachi's annual report states, "In order to contribute to the realization of a sustainable society, we have established a new, advanced goal of 'carbon neutrality in our own production in fiscal 2030' and are working to transform our society into one that leads in the creation of environmental value. The declaration, "We will not only reduce our own carbon dioxide emissions by reviewing our product designs and making our product facilities more energy-efficient, but we will also support our customers and procurement partners in their environmental efforts, and accelerate our efforts to realize environmental value throughout our corporate activities," is eye-catching.

As a transition risk, JR East estimates the financial impact of future population changes in its business areas, and estimates the amount of decrease in passenger revenue in 2050 using the second and fourth socioeconomic scenarios that take into account population decline and GDP. In addition, by using the IPCC's 2°C and 4°C scenarios for physical risks, the report says that the 2°C scenario will have less negative financial impact and that the goal is to achieve zero carbon 2050.

Sekisui House has also conducted analysis using the 1.5°C scenario and the 4°C scenario to identify risks and opportunities that will have a significant impact on the group's business. The company analyzed not only the physical risks and transition risks, but also the level of financial impact as a business opportunity. As a result, the company found that there are no major risks at present, and on the contrary, there is a potential for major opportunities as the shift to decarbonized products progresses.

(3) GPIF's Climate Change Risk Scenario Analysis

Up to this point, I have been looking at climate change responses by issuer companies, and I will now introduce the efforts of the GPIF (Government Pension Investment Fund) as one of the largest pensions in the world as an example of AO. So far in 2018, it has started passive equity management based on environmental equity indices, and in bonds, it has also invested in green bonds. Then, in October 2018, it joined Climate Action 100+, an investor-led initiative to address climate change, as a supporter. It also expressed its support for the TCFD in December 2018. As for GPIF's own disclosure, it discloses information in line with the TCFD in its "FY2018 ESG Activity Report" in August 2019, and publishes a separate "GPIF Portfolio Climate Change Risk and Opportunity Analysis" (hereinafter referred to as the GPIF Climate Change Report) in its "FY2019 ESG Activity Report" in 2020. The GPIF Climate Change Report uses the Climate Value-at-Risk (CVaR) methodology, which GPIF has introduced under contract with MSCI, to disclose climate-related financial statements that are significantly more comprehensive than those of the previous year. CVaR calculates the present value of costs and benefits arising from climate change according to assumed scenarios, and analyzes how corporate value will change in the future due to climate change. The special feature of the GPIF Climate Change Report is that, by using CVaR, in addition to the "transition risk", the "technological opportunity" and "physical risk" assessed by the patent information on environment-related technologies can be analyzed in the same scale. In addition to the "transition risk," the CVaR assesses the "technological opportunity" and "physical risk" in the form of the impact on corporate value in an integrated manner.

In the scenario analysis of the GPIF climate change report, under the "2 degree scenario," "3 degree

scenario," and "1.5 degree scenario," the CVaR analysis shows that for stocks, the 1.5 degree scenario, which has the highest transition risk, has the most positive impact on stock value. Rather, as the constraint becomes looser in the second and third degree scenarios, the impact on equity value turns negative, a noteworthy conclusion. On the other hand, the results for bonds are the opposite of those for stocks, with the negative impact on bond values decreasing as the transition risk becomes smaller, from 1.5 degrees to 2 degrees to 3 degrees. This is due to the fact that for stocks, the upside such as technological opportunities increase the value of stocks through the discounted present value of future dividends and cash flows, whereas for bonds, there is no upside. In the case of the GPIF's overall portfolio, which has a large share of equities, the findings show that the 3-degree scenario is negative, while the 2-degree and 1.5-degree scenarios gradually become more positive.

However, the use of patents for technical assessment in the GPIF climate change report is controversial. This is because there are many manufacturing companies that have many patents related to climate change in their portfolios, and under the 1.5 degree scenario with high transition risk, the portfolio value tends to increase because the relative corporate value increases and the value as a security also increases. Therefore, it is important to note that a different valuation may be derived if the measurement is done using a method that does not use patents.

(4) Climate change risk scenarios in NGFS

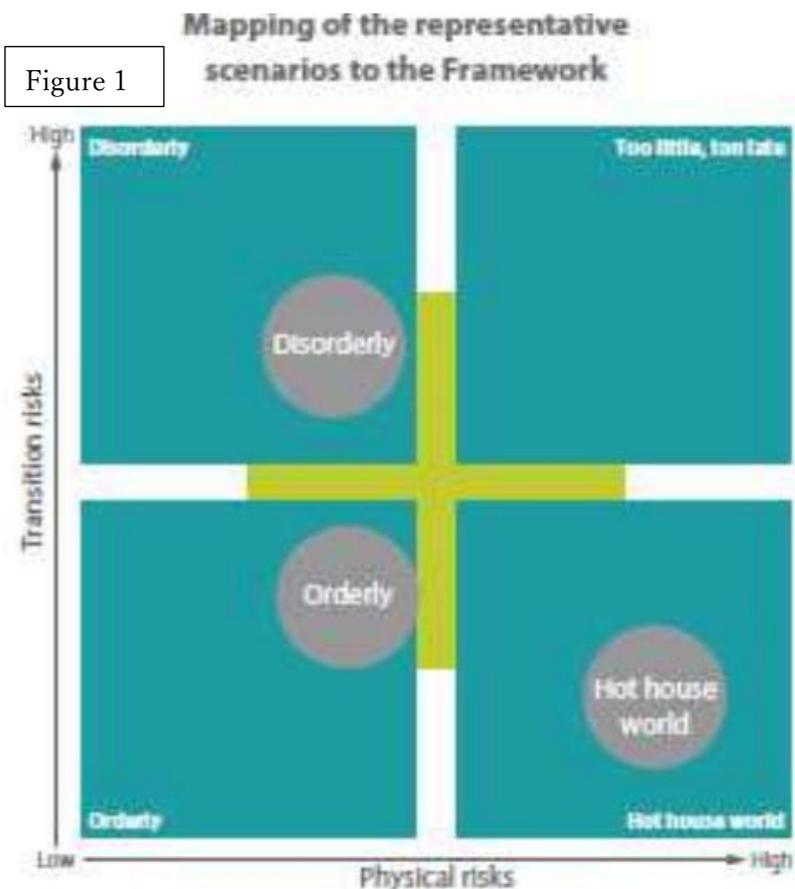
As the name, NGFS (The Network of Central Banks and Supervisors for Governing the Financial System) suggests, it is a group of financial supervisors and central banks formed in December 2017 to network and discuss how to address climate change risk in financial supervision. Japan's Financial Services Agency (FSA), which was not a founding member, joined the steering committee in November 2020.

So why did NGFS decide to promote climate change risk scenario analysis? Traditionally, financial supervisors have monitored financial institutions based on historical data, such as verifying the correctness of business risk measurements based on historical price fluctuation models. However, when it came to climate change risk, it was necessary to look at how to supplement the changes in corporate value caused by future climate change and how this would affect individual financial institutions. However, the problem arose that if it was left to each financial institution to draw up scenarios for future climate change, it would not be possible to compare financial institutions with each other, with Japan as a whole, or, more importantly, with foreign countries.

With regard to the IEA and IPCC scenarios mentioned earlier in the TCFD report, in addition to the problems mentioned in the TCFD, such as the lack of sectoral outputs, the lack of easy access to data,

and the coarse granularity of data, the lack of information on what kind of socio-economy existed at that time and what the GDP was within that socio-economy became a major problem. Therefore, financial supervisors and central banks pooled their knowledge to develop a scenario analysis tool that incorporates basic economic statistics into the overall scenario, which led to the creation of the NGFS climate change scenarios. As a common socio-economic scenario, the NGFS is based on GDP and population trends based on the IPCC's SSP2, which is an intermediate case commonly referred to as a medium scenario. By introducing this concept, NGFS could also keep a connection with the IPCC.

The basic framework of the scenarios is the four-quadrant world shown in the following Figure 1, with "transition risk" on the vertical axis and "physical risk" on the horizontal axis. The upper left of the four quadrants is an Disorderly Case where GHG emissions do not progress until a certain point in time, but at a certain point the movement toward decarbonization starts rapidly and the transition risk is very high. The bottom left is a Orderly Case where GHG emissions are steadily reduced and the physical risk of transition is very high, as the Paris Agreement aims to achieve. The bottom right shows a Hot House World in which GHG emissions continue to increase after 2020 and a hot world awaits.



First Source: NGFS (2020), NGFS Climate Scenarios for Central Banks and Supervisors

Second Source: CFA Japan, a speech in Japanese by S. Ikeda, CSFO of Japan FSA, Mar. 8, 2021

Three representative scenarios, excluding the upper right quadrant, have already been developed because the existing academic accumulation cannot produce a scenario for the upper right quadrant and is now under consideration.

Figure 2 Three representative & five sub scenarios by NGFS

| | |
|--|--|
| <p style="text-align: center;">Disorderly</p> <p style="text-align: center;">2°C scenario with limited CDR (delayed)</p> <p style="text-align: center;">2°C scenario with CDR (delayed)</p> <p style="text-align: center;">1.5°C scenario with limited CDR (immediate)</p> | |
| <p style="text-align: center;">Orderly</p> <p style="text-align: center;">2°C scenario with CDR (immediate)</p> <p style="text-align: center;">2°C scenario with limited CDR (immediate)</p> <p style="text-align: center;">1.5°C scenario with CDR (immediate)</p> | <p style="text-align: center;">Hot-house world</p> <p style="text-align: center;">Current Policies</p> <p style="text-align: center;">Nationally determined contributions (NDCs)</p> |

[Disorderly] Upper Left

Main: 2 degrees scenario, CDR introduction is marginal and delayed

Sub: 2 degree scenario, CDR introduction delayed

Sub: 1.5 degree scenario, CDR introduction is marginal but immediate Nightmare scenario

[Orderly] Bottom Left

Main: 2 degree scenario, immediate introduction of CDR

Sub: 2-degree scenario, CDR introduction marginal but immediate

Sub: 1.5 degree scenario, immediate introduction of CDR

[Hot-house] Bottom Right

Main: 4 degrees scenario. Contribution determined by the government (NDC) with current policy

Sub: 4 degrees scenario. Nationally determined contributions

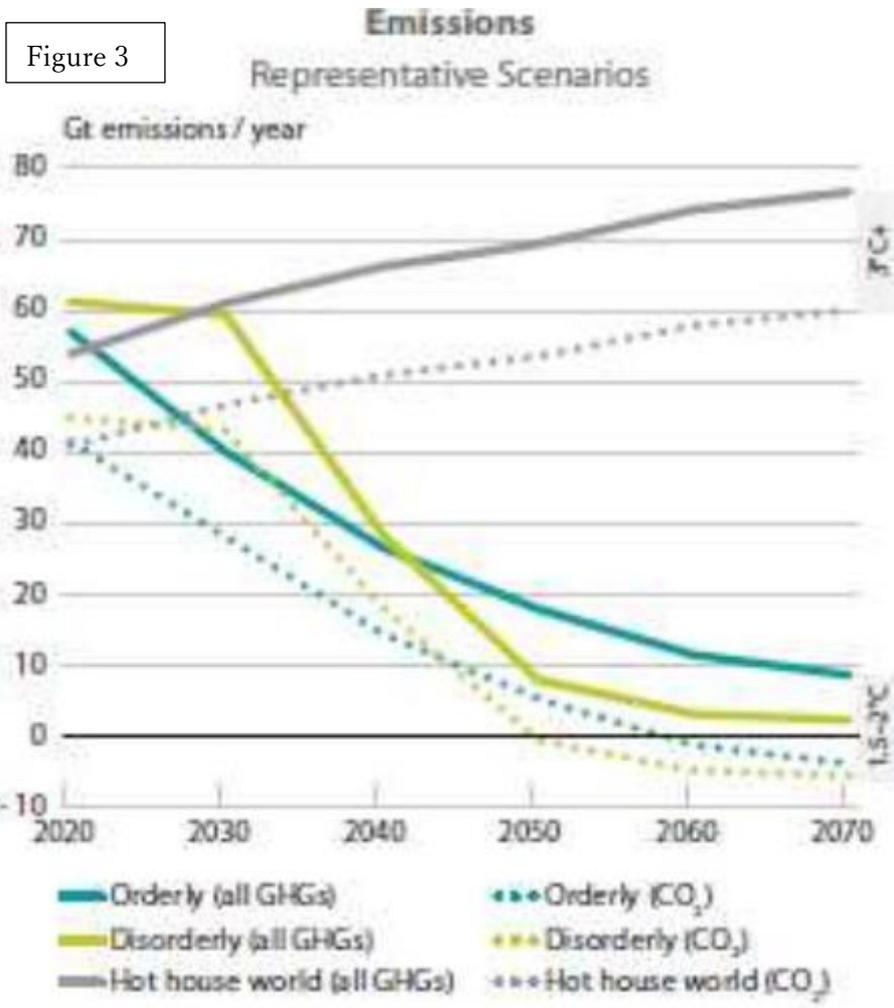
First Source: NGFS (2020), NGFS Climate Scenarios for Central Banks and Supervisors

Second Source: CFA Japan, a speech in Japanese by S. Ikeda, CSFO of Japan FSA, Mar. 8, 2021

What is important in deciphering this Figure 2 is how many degrees each scenario is associated with,

how widespread the CDR (Carbon Dioxide Removal) technology will be effective, and how strong the regulations represented by carbon pricing will be.

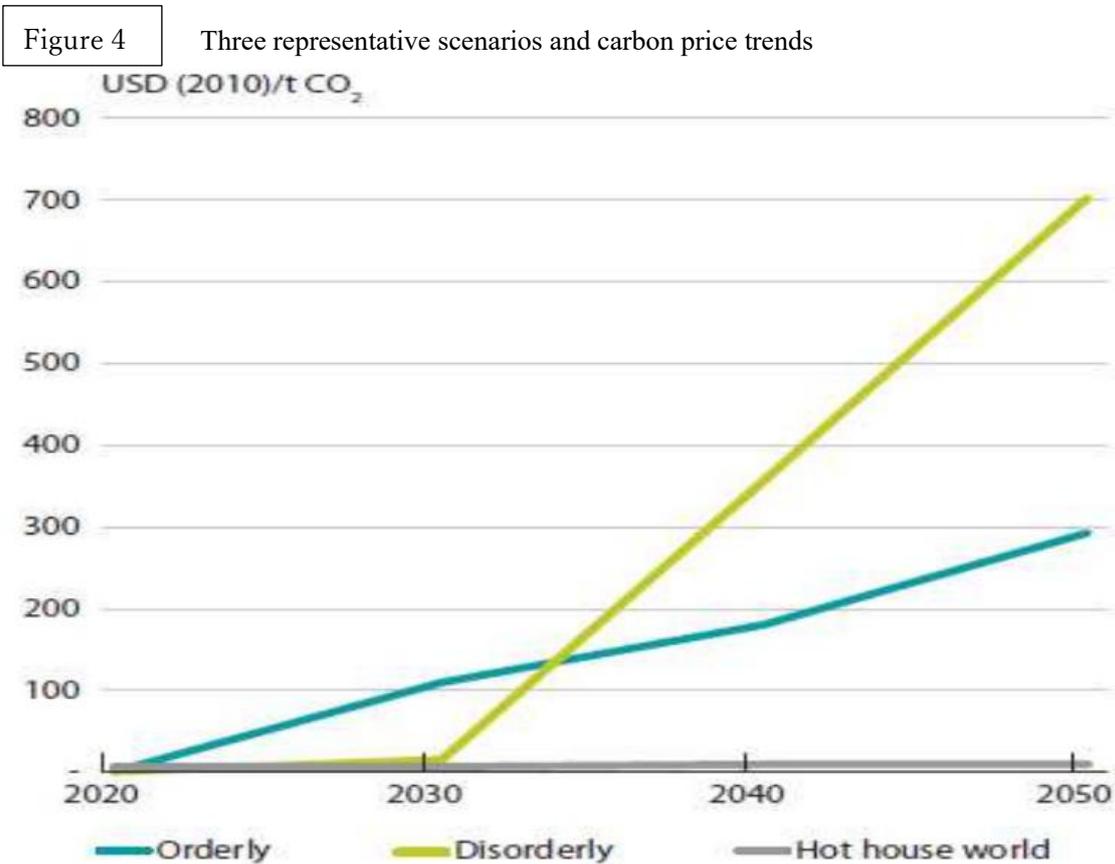
The orderly and disorderly scenarios are mainly assuming two-degree scenarios. CDR will play a major role in the orderly scenario, but only a very limited role in the disorderly scenario. As for the carbon price, the disorderly scenario assumes a delay in the strengthening of regulations, as represented by the carbon price. On the other hand, in the orderly scenario, it is assumed that such things will come in from the feet up now. In the hot-house scenario, the world is assumed to be such that such a thing cannot be assumed at all.



Source: IASA NGFS Climate Scenarios Database, using marker models.

Second Source: CFA Japan, a speech in Japanese by S. Ikeda, CSFO of Japan FSA, Mar. 8, 2021

Figure 3 shows the GHG and CO₂ emission trends of these three main scenarios, which are the assumptions for the transition risk. The heat scenario is based on a 4 degree scenario, and the orderly and Disorderly Scenarios are based on a 2 degree scenario. However, the path of the Orderly and Disorderly Scenarios is different. The Disorderly Scenario shows a rapid decrease in GHG emissions from 2030, and the reason for this is thought to be that CDR technology will lead to a rapid decrease in GHG emissions. However, it is expected that this assumption itself will be re-examined to see if it is realistic. The Orderly Scenario has higher GHG emissions than the Disorderly Scenario in 2070, but in terms of GDP, the Orderly Scenario has a negative impact of -4% by 2100, while the Disorderly Scenario has a negative impact of nearly 10%.



Source: NGFS (2020), Guide to Climate Scenario Analysis for Central Banks and Supervisors
 Second Source: CFA Japan, a speech in Japanese by S. Ikeda, CSFO of Japan FSA, Mar. 8, 2021

Figure 4 shows the carbon price trends of three representative scenarios. Because of the effectiveness of CDR, in case of Disorderly Scenario the price remains very low till 2030 and start rapidly rising afterwards.

In terms of physical risk, the Orderly Scenario assumes an increase in the area under cereal cultivation but a decrease in the area under cattle grazing, and the impact of changes in the maximum flow of rivers, especially in tropical regions, is incorporated into the model because it is expected to lead to disasters. It should be noted, however, that the model does not incorporate the effects of typhoons and sea level rise.

To summarize the features of the NGFS scenario that we have seen above, first, the scenario is based on common socioeconomic pathways such as GDP trends and population trends, not just on what the energy mix will be. Secondly, it is unique in that it covers the impact of land use on grain production, which is not covered by the IEA. Third, it allows for a consistent view of transition risks and physical risks on the same plane. Fourth, it has an impact on the practices of global financial institutions.

(5) CDR

In Figure 2, it can be seen from the five sub-scenarios that CDR plays a very important role. Biofuels and the expansion of forest planting are examples, but in the U.S., the race to develop more drastic technologies to capture carbon dioxide from the atmosphere is in full swing. However, the technology currently on the chopping block involves using large "vacuum cleaners" to suck up the air, separating the CO₂ from the atmosphere using adsorbent materials, and sending the CO₂ underground to be sequestered, but the energy required to do this could be enormous.

The World Resources Institute (WRI) introduces the following six approaches to CDR:

- 1) Encourage carbon capture through forest expansion, restoration and management.
- 2) Promote carbon storage in agricultural soils.
- 3) Use biofuel CO₂ capture and storage (BECCS).
- 4) Capture and store carbon dioxide chemically from the atmosphere, rather than from emission sources.
- 5) Accelerate carbon mineralization by pumping alkaline spring water from underground and letting it react with air.
- 6) Accelerate the carbon cycle in the ocean.

Related to 2) of these methods, it is surprisingly unknown that charcoal, which is so familiar to us in Japan, is useful in combating global warming. Biochar, a product of carbonization of organic matter (biomass) such as agricultural and forestry wastes, waste wood, and food wastes, can reduce CO₂ emissions by sequestering carbon dioxide, which causes global warming, in soil and water for a long period of time. Carbon dioxide in the atmosphere is converted into organic carbon through photosynthesis by plants, and is stored in the plants. By carbonizing it into chemically stable carbon

and adding it to soil and water, it can improve soil and purify water, and promote the growth of crops and trees. In other words, it is not only a CDR, but also a promising technology for promoting agriculture. At present, a Japanese agricultural machinery manufacturer, Yanmar has developed a rice husk power generation system that extracts biochar (kunchar) from rice husks to solve the problem of rice husk disposal, which has become a major burden for farmers, and aims to realize recycling-oriented agriculture and a decarbonized society by extracting electricity, heat, and biochar and spreading biochar on farmland. The project has been attracting attention as a target of the "J-credit system," a system under which the government certifies the amount of CO² reduction and allows companies to sell the credits.

The Japan Biochar Promotion Association is working to reduce carbon dioxide emissions by semi-permanently immobilizing and sequestering carbon itself by using biochar for applications other than combustion, such as soil improvement, civil engineering and construction, and water treatment, and is aiming to establish a certification system for the GHG reduction effects of biochar use.

Some citizen groups, such as the NPO "Charcoal Making in the City Project," are working to make charcoal from park pruning waste and return the resulting charcoal to the park soil as a soil conditioner. This is an activity to build a natural cycle in the city, where charcoal is made from chipped pruning branch waste and returned to the soil as a soil conditioner.

5. afterword

Since the second Abe administration took office in 2012, so-called "Abenomics" has been launched and the strengthening of corporate governance has been proposed as a theoretical pillar to support the growth strategy as the third arrow. In 2013, in the "Strategy for the Rebirth of Japan," corporate pension funds were included in the "broad range of institutional investors" as asset owners and were encouraged to accept the stewardship code.

However, just as the Japanese version of the Stewardship Code was born under the influence of the UK version, the UK's revision in 2021 may become apparent in Japan in the form of "disclosure of climate change risks and opportunities based on TCFD recommendations for pensions" in the next revision in 2023, given the three-yearly revision cycle system and may be prevailing to other APAC countries. Therefore, this paper attempts to explain scenario analysis, which is the key to climate change analysis, in order to help AO including pension funds. As the best practices of scenario analysis have not yet been established even for the corporations, it is a heavy task for corporate pension funds throughout APAC region.