Analysis of Climate Change-Related Risks and Opportunities in the GPIF Portfolio

Supplementary Guide to GPIF ESG Report 2019

GPIF

Foreword :　Issue Awareness and Main Points of Report

Issue Awareness and Main Points of Report

Last year, GPIF disclosed climate change-related financial information in line with TCFD recommendations for the first time in our FY2018 ESG Report. Considering this was our first attempt at TCFD disclosure, we received largely positive feedback from a variety of different parties.

When publishing this information last year, however, the team responsible for creating the ESG Report and compiling our TCFD disclosures was keenly aware of the shortcomings of the data, and has been diligently working since fall of last year to try to overcome these problems in the FY2019 edition. Some particularly salient issues included 1) the analysis essentially only covered transition (policy) risk, 2) the timeframe for the transition risk analysis was quite limited, and 3) we were not able to provide an analysis and disclose information on the financial impact (in GPIF's case investment return impact) of climate change. To resolve these issues, GPIF contracted with MSCI to utilize the company's Climate VaR analysis method, developed by the MSCI Climate Risk Center (formerly known as Carbon Delta, which was acquired by MSCI in fall of 2019). This methodology enabled us to comprehensively assess the impact of not only policy risks and technological opportunities (as valued by patent information related to environmental technology), but also physical risks and opportunities on the corporate value of portfolio companies. While there is still room for improvement in the methodology for each area, we believe that this is an innovative analysis technique that puts us firmly on the path to solving the three issues outlined above.

In addition to the above, similar to last year, we had Trucost, a subsidiary of S&P Global, provide us with an analysis of our portfolio's carbon footprint using the same carbon efficiency assessment methodology used in the S&P Carbon Efficient Index series. We also enlisted Beyond Ratings, a subsidiary of FTSE and a company with particular expertise in sovereign bond climate risk and opportunity analysis, to examine our government bond portfolios. Each of these companies has deep experience in cutting-edge climate change risk and opportunity analysis, and GPIF is grateful for the exceptional contributions made by each. The main points of each company's analysis are reflected in the TCFD disclosures within our FY2019 ESG Report.

Since space limitations prevented us from fully describing these results within the main ESG Report, we've provided a more detailed explanation as well as other supplementary analyses within this "GPIF Portfolio Climate Change Risk and Opportunity Analysis," which serves as an ancillary guide to the FY2019 ESG Report. While in a direct sense this is an assessment of the effect of climate change on GPIF's portfolio, since we are a universal owner who invests in a broad range of listed companies both domestically and abroad, the analysis has wide implications for all Japanese and foreign companies, and therefore for countries all around the world. The report indicates what climate change issues and risks are present in the world, the value of the technology required to solve these problems, and the subsequent business opportunities that exist. We therefore believe that the content will be of interest to both investors and non-investors alike.

Realistically, attempting to accurately assess the impact of climate change risks and opportunities that will materialize over the course of decades into the future is an extremely difficult task, and it's therefore necessary to consider the results of a wide variety of analyses. We hope, however, that this report contains information that will be of value to investors and corporations alike when considering their own climate change risks and opportunities.

Composition and Main Points

This report is comprised of three chapters.

In Chapter 1, we measure the carbon footprint (greenhouse gas emissions) and greenhouse gas emissions per unit of revenue (value added) for investee companies. This year, we examine changes in carbon footprint and carbon intensity by looking at the contributions made by 1) corporate revenue, 2) investee company greenhouse gas emissions (“emissions” below), 3) each company’s weighting in the equity and fixed income portfolios (“portfolio weight” below), and 4) other factors. We also assess the emissions-related information that companies publish, and affirm that disclosure is improving year after year.

Compared to the last fiscal year, in FY2019 the carbon intensity (CO2-equivalent tons per ¥1 million) of GPIF’s portfolio declined by 15.3%, mainly due to changes in portfolio weight. A similar reduction was also seen in the portfolio’s carbon footprint. This is likely due to factors such as investment in the S&P/JPX Carbon Efficient Index announced in September, 2018.

In Chapter 2, we conduct a scenario analysis of climate risk and opportunities. Working from a 2˚C scenario (i.e. a scenario in which world average temperature increases are limited to 2˚C above the pre-industrial era), we assess the impact on corporate and security valuations resulting from not only policy risks and technological opportunities (as valued by patent information related to environmental technology), but also physical risks and opportunities. We also look at what happens under a 1.5˚C scenario and 3˚C scenario. Intriguingly, we found that 1) the 1.5˚C scenario, despite having the most stringent policy restrictions (i.e. policy risk), had the highest positive effect on the equity portfolio, while on the other hand, this effect turns negative as restrictions get looser and looser in the 2˚C and 3˚C scenarios, and 2) the fixed income portfolio shows precisely the opposite trend, with the negative impact on the portfolio becoming smaller as policy restrictions become more relaxed. The opposing effects on the equity and fixed income portfolios reflect the fundamental difference in nature of these two financial instruments.

The impact that technological opportunities and other upside risks have on stock values is relatively straightforward in terms of changes to the present value of future dividends or cash flows, but bonds differ in the sense that, although there may be some positive effect on prices coming from a lower probability of default, these instruments do not participate in any upside beyond their face value and coupons. Another interesting result of the analysis is the fact that, despite equities and fixed income being affected by climate change in conflicting ways, the prices of assets in GPIF’s portfolio as a whole (excluding government bonds) is negative in the 3˚C scenario, positive in the 2˚C scenario, and significantly positive in the 1.5˚C scenario. We look forward to the development of further research on the integration of climate change risk and opportunities into portfolio construction.

In addition, in Chapter 2 we break down the effect of climate change risks and opportunities on equity and fixed income prices by country and by sector. Under the 2˚C scenario, technological opportunities have a substantially positive effect on domestic equities, with the estimated value of this asset class rising by +11.2%. Conversely, foreign equities, for which the positive contribution of technological opportunities is more muted, actually decrease in value by -7.5%. Breaking down the analysis by sector, we observed that policy risk pushes down the value of equity and fixed income prices for companies in sectors in which the environmental burden is high, such as the energy, materials and utilities sectors. On the other hand, domestic equities in particular benefit greatly from technological opportunities, and we found that overall (i.e. in terms of aggregate CVaR), stock values for companies in the energy and materials industries actually increase. The demand for environmental-related technology will grow as policy risk becomes more acute, and the bigger the environmental footprint of the sector, the greater the need for such technology. In other words, climate change will play a huge factor in determining winners and losers in sectors with a high environmental burden.

Elsewhere in Chapter 2, we conduct a “portfolio warming potential” analysis that examines the extent to which the future business activities of investee companies can potentially contribute to global warming using a specific standard for increases, as well as an analysis of fossil fuel exposure and an assessment of climate change risks and opportunities for the government bond portfolio. With respect to the latter, like corporate bonds, sovereign bond prices may be affected by potential changes to the default rate due to fiscal spending differences stemming from climate change risks and opportunities. Such an analysis, however, is beyond the scope of this report. Conducting a CVaR analysis similar to equities and corporate bonds for this asset class requires solving several different issues and thus is not feasible at this point.

In Chapter 3, as a reference, we introduce the “Transition Pathway Initiative Management Quality Score (TPI MQ Score)” developed by FTSE, which measures the extent to which companies manage greenhouse gas emissions and how they respond to risks and opportunities related to the transition to a low carbon economy. We also provide an analysis performed by MSCI on SDG-related corporate revenue.

Figure 0-1: Aggregate CVaR by Temperature Change Scenario (1)[1]

CVaR for the 3˚C Scenario	Equities	Corporate Bonds	Total Portfolio
(1) Transition Risks and Opportunities	0.76	−0.32	0.69
Policy Risks	−1.69	−0.44	−1.61
Technological Opportunities	2.45	0.12	2.31
(2) Physical Risks and Opportunities	−6.75	−0.82	−6.37
(3) Aggregate	**−5.98**	**−1.14**	**−5.67**

CVaR for the 2˚C Scenario	Equities	Corporate Bonds	Total Portfolio
(1) Transition Risks and Opportunities	8.83	−3.06	8.09
Policy Risks	−6.77	−3.52	−6.57
Technological Opportunities	15.61	0.46	14.66
(2) Physical Risks and Opportunities	−6.75	−0.82	−6.37
(3) Aggregate	**2.09**	**−3.88**	**1.72**

CVaR for the 1.5˚C scenario	Equities	Corporate Bonds	Total Portfolio
(1) Transition Risks and Opportunities	25.17	−6.39	23.19
Policy Risks	−11.04	−7.13	−10.79
Technological Opportunities	36.20	0.73	33.98
(2) Physical Risks and Opportunities	−6.75	−0.82	−6.37
(3) Aggregate	**18.42**	**−7.21**	**16.82**

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Figure 0-2: Aggregate CVaR by Temperature Change Scenario (2)

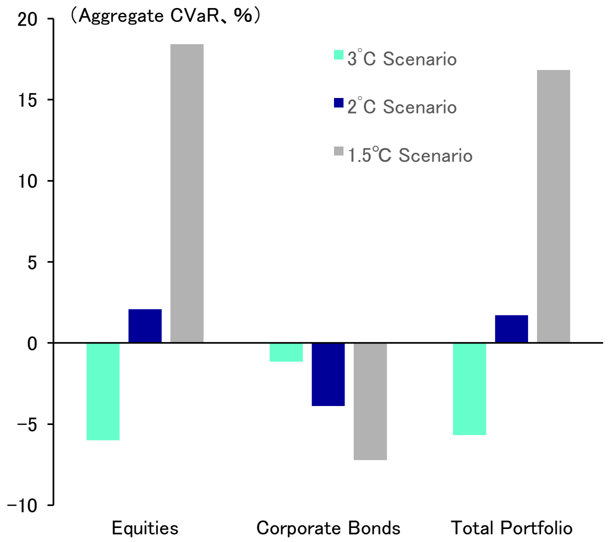

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Figure: 0-3 Equity Portfolio CVaR by Sector

	Domestic Equities					Foreign Equities				
	Aggregate CVaR	Transition Risks	Policy Risks	Technological Opportunities	Physical Risks and Opportunities	Aggregate CVaR	Transition Risks	Policy Risks	Technological Opportunities	Physical Risks and Opportunities
Total	11.2	21.3	−6.9	28.3	−10.1	−7.5	−3.3	−6.6	3.3	−4.2
Telecommunication Services	−19.2	−0.3	−0.9	0.6	−18.9	−9.9	−1.6	−1.8	0.2	−8.3
Consumer Discretionary	46.3	57.6	−4.2	61.8	−11.3	−2.3	1.8	−2.3	4.1	−4.1
Consumer Staples	−12.1	−2.6	−4.1	1.5	−9.5	−10.8	−5.3	−5.9	0.6	−5.5
Energy	13.4	60.8	−74.7	135.4	−47.3	−47.5	−40.0	−49.2	9.2	−7.6
Financials	−28.0	−0.7	−0.8	0.0	−27.3	−11.7	−1.2	−1.3	0.1	−10.5
Healthcare	−2.6	1.5	−0.6	2.1	−4.1	−4.6	−0.5	−0.9	0.3	−4.1
Industrials	20.5	31.1	−8.4	39.6	−10.7	−5.2	0.5	−10.0	10.4	−5.6
Information Technology	15.4	23.0	−2.0	25.0	−7.6	−2.7	1.1	−0.7	1.7	−3.8
Materials	5.7	25.6	−34.4	60.0	−19.8	−31.8	−25.5	−33.5	8.0	−6.4
Real Estate	−0.8	2.3	−1.8	4.2	−3.1	−5.1	−0.8	−1.4	0.6	−4.3
Utilities	−2.7	18.3	−51.6	69.9	−21.0	−10.9	−7.5	−29.1	21.7	−3.5

(Note)Calculated on the assumption of a 2℃ scenario.

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[1] The results of CVaR may not match the "ESG Report 2019" published in September 2020 due to the methodology update implemented by MSCI in September 2020.

Analysis Partners

<About FTSE Russell and Beyond Ratings>

FTSE Russell, part of London Stock Exchange Group (LSEG), is a pioneer of sustainable investment solutions for 20 years, providing innovative and transparent ESG indexes, analytics and ESG data for investors worldwide. In June 2019, LSEG acquired Beyond Ratings, a highly regarded provider of ESG data solutions, climate change research and modelling across asset classes.

<About MSCI Climate Risk Center>

MSCI's Climate Risk Center is the focal point for the development of climate change risk analytics at MSCI. The aim of the center is to develop partnerships with leading academic and research institutions to advance the use of climate science for financial risk analysis, building on the relationships already forged by Carbon Delta which was acquired by MSCI in October 2019.

<About Trucost>

Established in 2000, Trucost is a pioneer in the field of carbon data and reporting, and has compiled a comprehensive and growing dataset that includes over 15,000 companies. Acquired by S&P Global in October of 2016, Trucost is continuing to provide not only environmental data, but also essential ESG related data on a global scale.

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Chapter 1 : Carbon Footprint

Features of GPIF's Portfolio

Breakdown of GPIF Portfolio by Asset, Sector, and GHGs

The analysis looked at four asset classes in GPIF's portfolio: domestic and foreign bonds and domestic and foreign equities. Alternative assets and short-term assets were not included in the analysis. In the sections that follow, we analyze greenhouse gas emission volume (carbon footprint), transition risks, physical risks and opportunities relating to all four asset classes using data as of March 31, 2020. Because analysis results are heavily influenced by the investment amount and sector weighting of each asset class, it is important to understand the characteristics of our portfolio prior to interpreting these results.

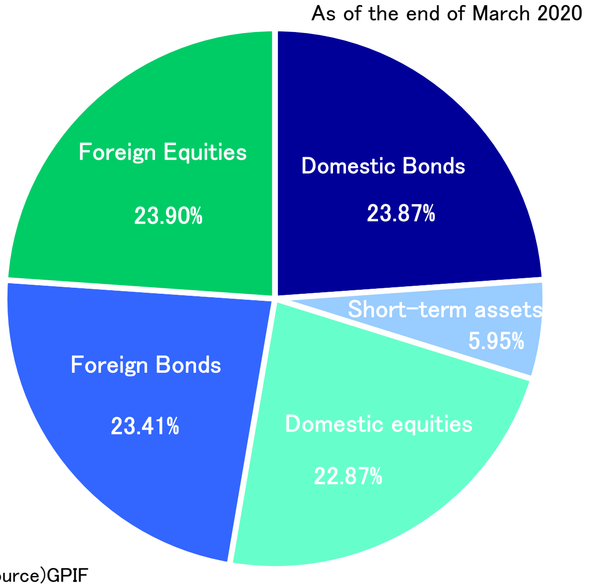
The GPIF portfolio is composed of roughly half bonds and half equities by overall market value. On the fixed income side, domestic bonds accounted for 23.87% of all holdings while foreign bonds accounted for 23.41%. For equities, domestic issues comprise 22.87% of the total portfolio and overseas issues 23.90% (Figure 1-1). The majority of bond holdings, both Japanese and foreign, consist of government bonds (Figure 1-2).

We observe a difference between domestic and foreign equities when we classify GPIF's equity portfolio by sector (Figure 1-3). The domestic equity portfolio has a higher proportion of market capitalization invested in industrials and consumer discretionary companies, which have a high level of greenhouse gas emission volumes, while the foreign equity portfolio has a high proportion in information technology companies, financials and healthcare companies, which are sectors with relatively low emissions.

When we categorize the corporate bond portfolio by sector based on total market value, the largest sector for both domestic and foreign bonds is financials (Figure 1-4). Among domestic corporate bonds, the proportion of industrials and utilities is higher than that for foreign corporate bonds. Since utilities includes electric power companies, this sector has relatively higher greenhouse gas emissions when compared with other sectors. Among foreign corporate bonds, the proportion of energy companies, which have relatively high greenhouse gas emission volumes, is greater than that for domestic corporate bonds (Figure 1-5). On the other hand, the proportion of corporate bonds issued by telecommunication services, healthcare and information technology companies, which have low emission volumes, is also high. Overall, the environmental impact of foreign corporate bond issuers is lower than that for domestic corporate bond issuers.

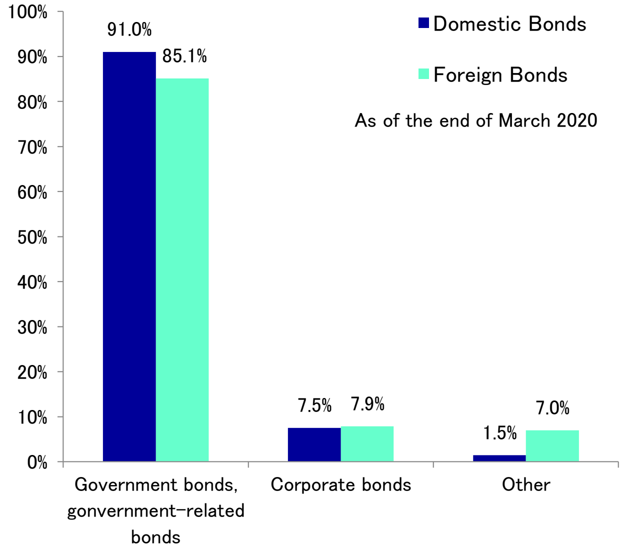
It is necessary to bear this sector bias in GHG emissions in mind when examining the results of the analysis presented in the following sections. Around 90% of stock investments and 70% of bond investments by GPIF are passive investments, which means our investment is virtually identical to the sector ratios of each benchmark.

Figure 1-1: Portfolio Asset Breakdown (Total Pension Reserve)



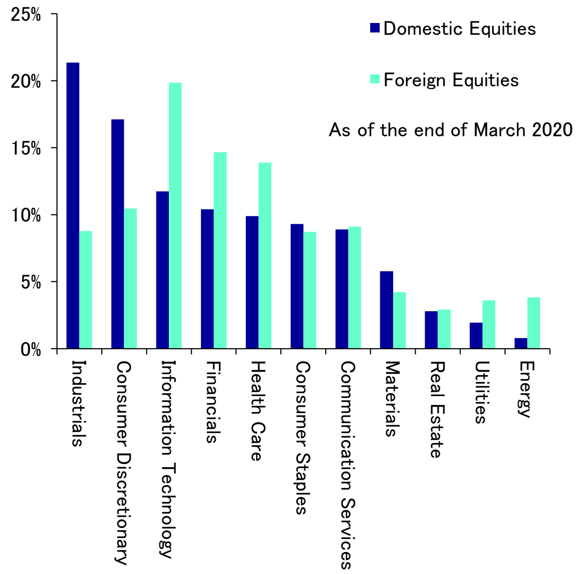
(Source)GPIF

Figure 1-2: Bond Portfolio Breakdown by Category



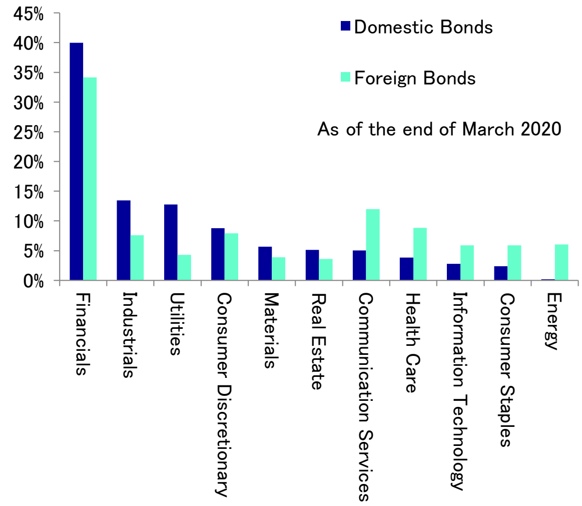
(Note)"Other" includes securitized products
(Source)GPIF

Figure 1-3: Equity Portfolio Breakdown by Sector



(Source) GPIF, S&P Trucost Limited©Trucost2020

Figure 1-4: Bond Portfolio Breakdown by Sector



(Note)Among Domestic and Foreign Bonds, only corprate issues are analysed

(Source)GPIF, S&P Trucost Limited©Trucost 2020

Figure 1-5: Carbon Intensity by Sector

Greenhouse Gases Emissions per million yen of sales(CO2 equivalent tons)

	Communication Services	Consumer Discretionary	Consumer Staples	Energy	Financials	Health Care	Industrials	Information Technology	Materials	Real Estate	Utilities
Domestic Equities	0.37	0.82	2.02	3.76	0.08	0.46	1.54	1.06	6.73	0.58	14.13
Foreign Equities	0.41	0.87	1.92	5.62	0.26	0.34	1.63	0.68	9.95	1.47	19.98
Domestic Bonds (Corporate)	0.40	0.84	1.42	3.49	0.08	0.42	1.99	1.04	10.81	0.82	16.90
Foreign Bonds (Corporate)	0.35	0.73	4.25	6.44	0.12	0.38	1.74	0.47	8.47	0.82	30.37

(Source)S&P Trucost Limited©Trucost 2020

Portfolio Greenhouse Gas (“GHG”) Emission Analysis

Carbon Footprint (GHG Emissions)

The scope of GHG emissions calculated includes each company’s direct carbon dioxide and other GHG emissions (Scope 1) in addition to CO2 emissions generated by purchased electricity and the 1st tier of the supply chain (Scope 2 and 3)[2].

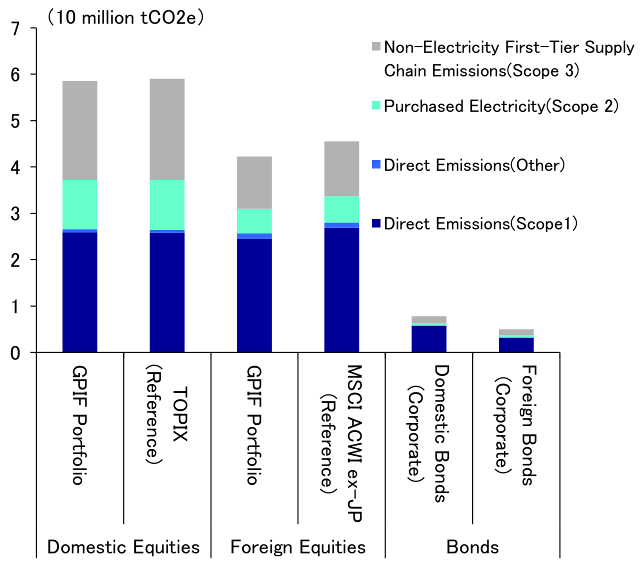
Looking at total emissions by asset class, domestic equities were found to have the highest level of emissions, followed by foreign equities, domestic corporate bonds, and foreign corporate bonds (Figure 1-6). This does not necessarily mean that domestic companies are less carbon efficient than foreign companies, but rather reflects the relative size and sector holding of each asset class within GPIF’s portfolio.

Looking at the breakdown of emission by scope, in the case of domestic equities, indirect emissions, comprising Scope 2 and 3 emissions, exceed direct Scope 1 emissions, illustrating how important it is for companies to consider their supply chains when formulating their GHG reduction strategies.

The trend in GHG emissions since fiscal 2016 (Figure 1-7) shows that emissions for both domestic and foreign equities remained mostly flat through fiscal 2018, but began to decline in fiscal 2019. For bonds, while emissions for domestic issues have declined for three consecutive years, emissions for foreign issues grew significantly to fiscal 2019. This is thought to be due to a decrease in the weight of domestic bonds in the portfolio, and a commensurate increase in the weight of foreign bonds in fiscal 2019. (GPIF will transition to a new basic portfolio from fiscal 2020, with reduced weighting of domestic bonds, and an increased weighting of foreign bonds.) In this way, the GHG emission trends for each asset class are affected not only by the carbon efficiency of investee companies, but are also highly dependent on the amount invested in that asset class.

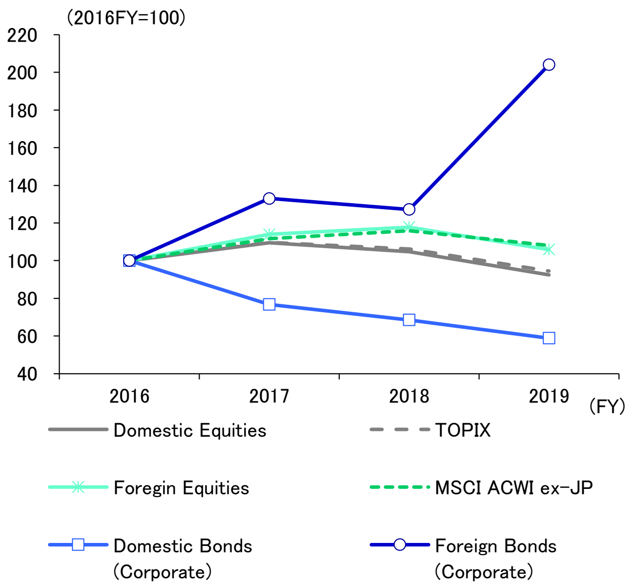
[2] Please refer to P.13 for the details of the scope of GHG emissions.

Figure 1-6: Greenhouse Gas Emissions by Scope



(Source)S&P Trucost Limited©Trucost 2020

Figure 1-7: Greenhouse Gas Emission Trends



(Source)S&P Trucost Limited©Trucost2020

(Supplementary Information) Coverage and Scope of Equities and Corporate Bonds Analyses

Coverage of Equities and Corporate Bonds

All portfolio carbon footprint and carbon intensity analyses for GPIF's portfolio are performed using Trucost's data. Equity instruments are mapped to the issuing entity, providing that entity exists in the Trucost database and has sufficiently up-to-date environmental and financial data available. This includes data published a maximum of 3 years prior to the analysis year. As of July 2020, 99.4% of domestic equities and 99.5% of foreign equities based on market capitalization were covered (Figure 1-8).

Debt instruments (corporate bonds) are mapped to the first publicly listed entity in the instrument's parent chain (starting with the bond's issuer, followed by the bond issuer's immediate parent, and finally its ultimate parent), providing that entity exists in the Trucost database with sufficiently up-to-date environmental and financial data available. As with equity mappings, this includes data published up to a maximum of three years prior to the analysis year. As of July 2020, 83.5% of domestic corporate bonds and 70.0% of foreign corporate bonds based on market capitalization were covered.

Figure 1-8: Percent Coverage for Portfolio Analyses Utilizing Data Provided by Trucost.

	VOH	Companies
Domestic Equites	99.4	96.5
(TOPIX)	99.3	99.0
Foreign Equities	99.5	97.1
(MSCI ACWI ex-JP)	99.6	98.8
Domestic Bonds (Corporate)	83.5	84.3
Foreign Bonds (Corporate)	70.0	75.0

(Source)S&P Trucost Limited©Trucost 2020

Scope of Equity and Corporate Bond Analyses

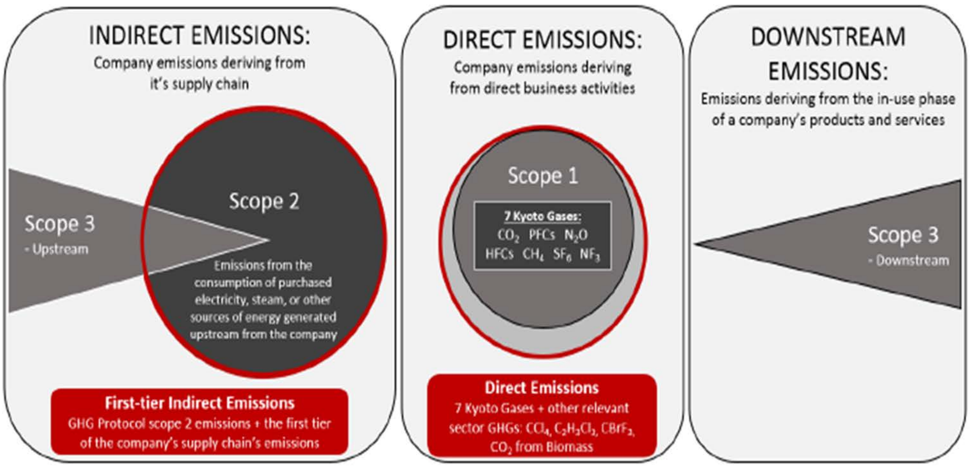
The GHG emissions covered – subject to the analysis type – comprise both a company's direct operational emissions (scope 1) through its value chain emissions (scopes 2 and 3). The full list of scopes used by Trucost in the analysis is shown below (Figure 1-9 to Figure 1-10).

Figure 1-9: Description of Each Scope (1)

Emissions	Scope	Description
Direct	Scope1	CO2e emissions based on the Kyoto Protocol greenhouse gases generated by direct company operations.
	Other	Additional direct emissions, including those from CCl4, C2H3Cl3, CBrF3, and CO2 from Biomass.
Purchased Electricity	Scope2	CO2e emissions generated by purchased electricity, heat or steam.
Non-Electricity First Tier Supply Chain	Scope3	CO2e emissions generated by companies providing goods and services in the first tier of the supply chain.
Other Supply Chain		CO2e emissions generated by companies providing goods and services in the second to final tier of the supply chain.
Downstream		CO2e emissions generated by the distribution, processing and use of the goods and services provided by a company.

(Source)S&P Trucost Limited©Trucost2020

Figure 1-10: Description of Each Scope (2)



(Source)S&P Trucost Limited©Trucost 2020

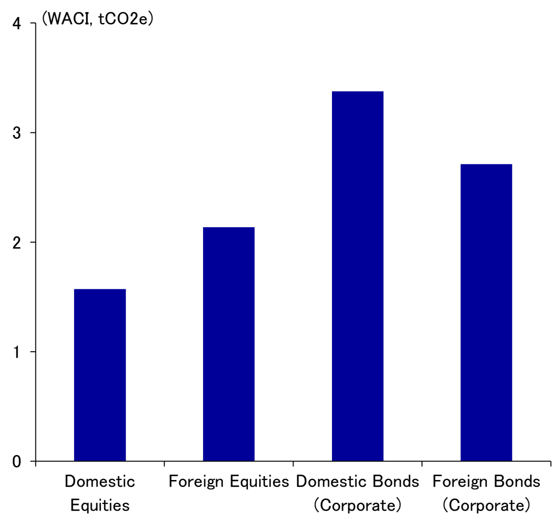
Carbon Intensity

Carbon Intensity of GPIF's Portfolio by Asset

Carbon intensity is calculated by dividing GHG emissions by value added per unit or some other metric. While carbon intensity can be calculated a variety of ways, we measured carbon intensity for equities and corporate bonds based on the weighted average carbon intensity ("WACI") approach, in line with TCFD recommendations. WACI is calculated by multiplying each company's carbon emissions to revenue (C/R) by the weight of that company in the portfolio, then taking the sum of those products to get the weighted average of carbon intensity.

Out of GPIF's equity and corporate bond portfolios, WACI was found to be highest for domestic corporate bonds (Figure 1-11). As previously explained in the "Portfolio Climate-Related Risk" section (pages 49 to 50), we infer that sector biases are the main drivers of these differences. Compared to foreign corporate bonds, the domestic corporate bond portfolio includes issuances by many high GHG-emitting electric companies and other utilities, and since the ratio of utilities is relatively high even for an investor such as GPIF which holds assets across nearly the entire market, WACI for the domestic corporate bond portfolio can be expected to be higher than that for the foreign corporate bond portfolio. When reviewing the equity portfolio, we found that, as in the previous fiscal year, carbon footprints and carbon intensities did not necessarily trend in the same direction. Domestic equities had higher total GHG emissions, but also turned out to be more carbon efficient in terms of WACI when compared with foreign equities. One main reason why domestic equities had higher total GHG emissions is because the portfolio is heavily weighted towards the manufacturing sector.

Figure 1-11: WACI by Asset



(Source)S&P Trucost Limited©Trucost 2020

Performance and Attribution Analysis of Changes in Carbon Footprint

Performance Drivers of Portfolio Footprint Changes

This section highlights potential drivers of change for both the carbon footprint and carbon intensity in GPIF's portfolios. There are two main factors that drive change in the carbon footprint. The first is changes in the quantity of GHGs emitted by investees, and the other is changes in the proportion of investees owned or financed by the investor.

The result of the carbon footprint performance analysis is shown in Figure 1-12. The analysis breaks down the causes of carbon footprint change between FY 2018 and FY 2019 into (1) changes in the quantity of GHG emissions of investees (absolute emissions) only, (2) changes in the proportion of each investee owned or financed by the investor (ownership) only, and (3) the interaction of changes in both absolute emissions and ownership together. The total carbon footprint for the overall portfolio decreased by 9.44% year on year, and the most significant cause of this lay in ownership changes.

From 2018, GPIF began investing part of its equities portfolio in the S&P/JPX Carbon Efficient Index (domestic equities) and S&P Global Ex-Japan LargeMidCap Carbon Efficient Index (foreign equities), which are designed to overweight highly carbon-efficient companies, and it is thought that this is partly responsible for the decrease in carbon intensity.

In terms of total carbon intensity for the overall portfolio, the result of the attribution analysis is shown in Figure 1-13.

In this analysis, we decomposed the change in carbon intensity from fiscal 2018 to fiscal 2019 into changes in (1) corporate profits, (2) corporate emissions volumes, (3) weight of each company in the portfolio, and (4) other causes. The carbon intensity (CO2 equivalent tons per million yen of sales) of GPIF's equity and corporate bond portfolio decreased by 15.3%, from 2.29 tons to 1.94 tons, in the space of a year. The largest contribution was from the change in (3) weight of each company in the portfolio. In addition, there was an overall decrease in (2) corporate emissions volumes, while (1) corporate profits also contributed to lower carbon intensity thanks to favorable economic conditions in fiscal 2019.

As with the carbon footprint, the intensity reduction can be seen as the positive result of our investment in the carbon efficient index.

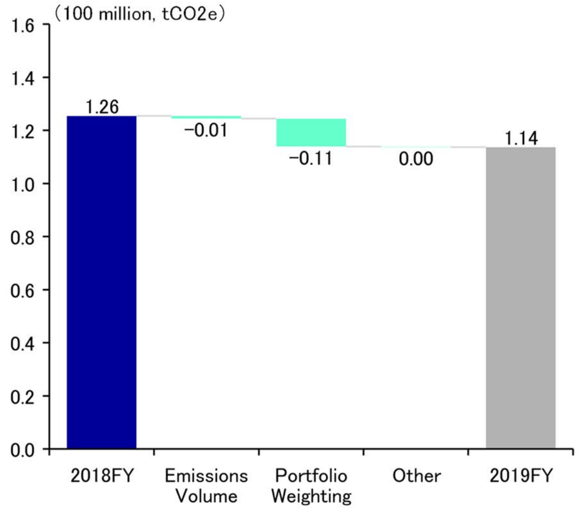
Attribution Analysis of Difference in Performance Between Portfolios and Benchmarks

The principal reasons for the carbon intensity of a portfolio to differ from the benchmark can be divided into a) sector allocation decisions and b) company selection decisions. For example, if a portfolio is overweight a high carbon sector, then it is more likely to have a higher overall intensity than the benchmark. However, if the companies selected within a high carbon sector are the most carbon efficient, then it is still possible that the portfolio may have a lower overall intensity.

Figure 1-18 shows effects of sector (sector attribution) and company (company selection) allocation decisions for the benchmark for each portfolio.

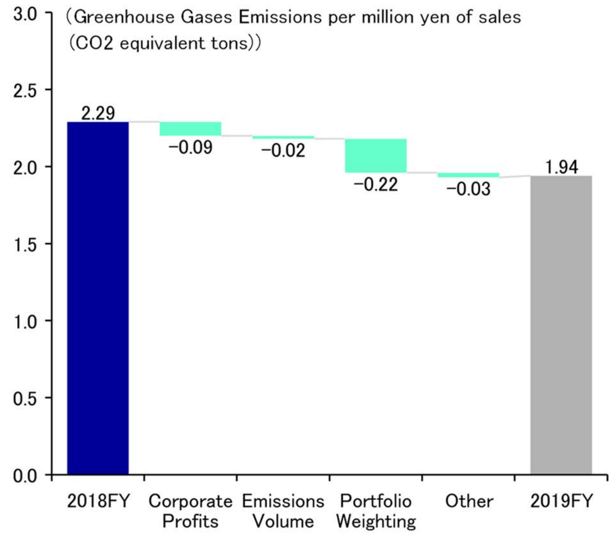
Carbon intensities for domestic and foreign equities portfolios slightly outperformed respective benchmarks. All outperformed cases are driven by both positive sector attribution and company selection factors.

Figure 1-12: Breakdown of Carbon Footprint Performance Drivers for the Total Aggregate Portfolio



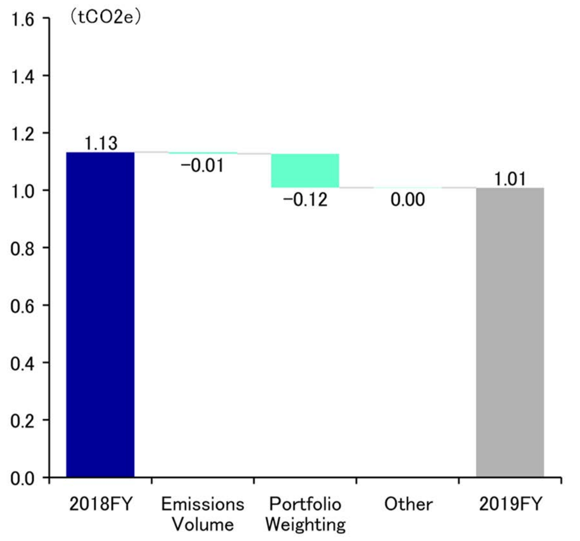
(Note) "Other" represents the cross term of "Emissions Volume" and "Portfolio Weighting".
(Source) S&P Trucost Limited © Trucost 2020

Figure 1-13: Breakdown of Carbon Intensity Performance Drivers for the Total Aggregate Portfolio



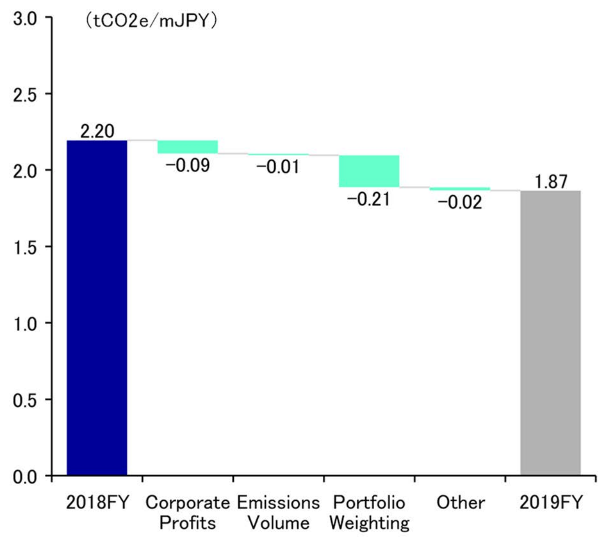
(Note) "Other" represents the cross term of "Corporate Profits," "Emissions Volume" and "Portfolio Weighting."
(Source) S&P Trucost Limited©Trucost 2020

Figure 1-14: Breakdown of Carbon Footprint Performance for Equities



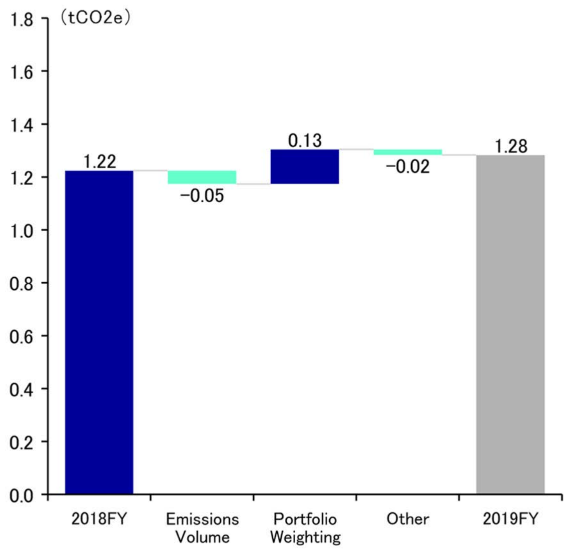
(Note) "Other" represents the cross term of "Emissions Volume" and "Portfolio Weighting."
(Source) S&P Trucost Limited © Trucost 2020

Figure 1-15: Breakdown of Carbon Intensity Performance for Equities



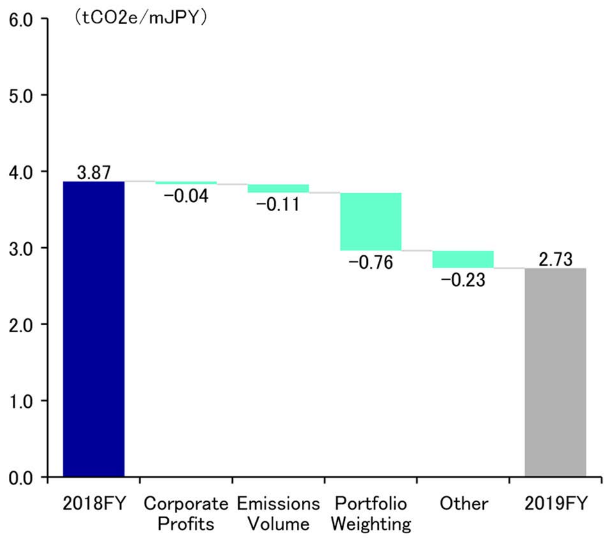
(Note) "Other" represents the cross term of "Corporate Profits," "Emissions Volume" and "Portfolio Weighting."
(Source) S&P Trucost Limited © Trucost 2020

Figure 1-16: Breakdown of Carbon Footprint Performance for Corporate Bonds



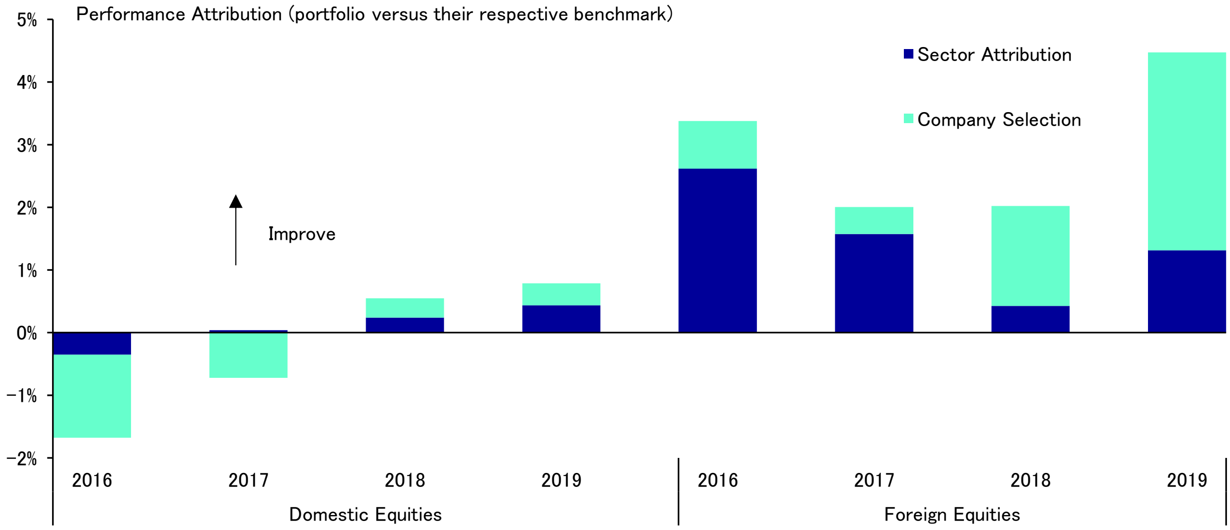
(Note) "Other" represents the cross term of "Emissions Volume" and "Portfolio Weighting."
(Source) S&P Trucost Limited © Trucost 2020

Figure 1-17: Breakdown of Carbon Intensity Performance for Corporate Bonds



(Note) "Other" represents the cross term of "Corporate Profits," "Emissions Volume" and "Portfolio Weighting."
(Source) S&P Trucost Limited © Trucost 2020

Figure 1-18: Attribution Analysis of Domestic and Foreign Equities and Their Respective Benchmarks



(Note)Sector allocation effects are determined using the 11 GICS Sector classifications, and the analysis uses the Carbon-to-Revenue intensity metric. A positive value in the figure indicate a lower carbon intensity. In other words, the portfolio has a higher carbon efficiency.
(Source)S&P Trucost Limited©Trucost 2020

Current State of Corporate Disclosure of GHG Emissions

Disclosure rates based on the number of companies, the value of holdings, and the absolute GHG emissions.

This section reviews the level of carbon disclosure across GPIF's equity and fixed income portfolios. Disclosure rates were calculated using three approaches: (1) weighted by the number of companies (Figure 1-19), (2) weighted by the value of holdings (Figure 1-20), and (3) weighted by the apportioned GHG emissions (Figure 1-21).

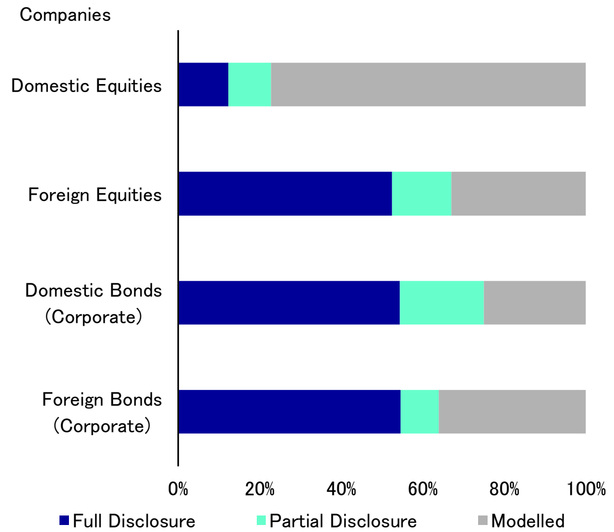
Based on the number of companies, foreign corporate bonds had a slightly higher full disclosure rate at 55% versus domestic corporate bonds at 54% and foreign equities at 52%. For domestic equities, only 12% of companies fully disclosed GHG emissions. When combined with partially disclosing companies, 75% of domestic corporate bonds, 67% of foreign equities, 64% of foreign corporate bonds, and 23% of domestic equities disclosed GHG emissions. The disclosure rate for domestic equities remains substantially lower than the other portfolios even when considering both full and partial disclosure. Across all four portfolios, disclosure rates have increased from the previous fiscal year, and the disclosure rate for all assets, accounting for both full and partial disclosure, improved from 47% to 51% year on year.

Under the value of holdings approach, 78% of foreign equities fully disclosed GHG emissions, followed by foreign corporate bonds at 70%, domestic corporate bonds at 64%, and domestic equities at 62%. When combined with partially disclosing companies, disclosure rates rise to 85% for foreign equities, 84% for domestic corporate bonds, 80% for foreign corporate bonds, and 76% for domestic equities. The value of holdings approach produces a considerably higher disclosure rate for each portfolio compared to the calculation based on the number of companies. This is likely explained in part due to the additional resources that large and mid-cap companies are able to devote to disclosing climate-related information compared to small-cap companies. The value of holdings-based disclosure rate for domestic equities is comparable to the rates for the rest of the portfolios. Across all the portfolios, disclosure rates have increased from the previous fiscal year. The disclosure rate for all assets, accounting for both full and partial disclosure levels, improved from 77% to 80% year on year.

Under the absolute GHG emissions approach, foreign equities had the highest rate of full disclosure of GHG emissions at 81%, followed by domestic equities at 72%, foreign corporate bonds at 69%, and domestic corporate bonds at 66%. When combined with partially disclosing companies, the proportion reaches as high as 99% for domestic corporate bonds, 95% for both foreign equities and foreign corporate bonds, and 85% for domestic equities. In general, the absolute emissions approach resulted in higher disclosure rates than the value of holdings approach, which demonstrates a greater inclination for higher emitters to disclose emissions data. Across all the portfolios, disclosure rates have risen from the previous fiscal year. The disclosure rate for all assets, accounting for both full and partial disclosure levels, has improved from 87% to 91% year on year.

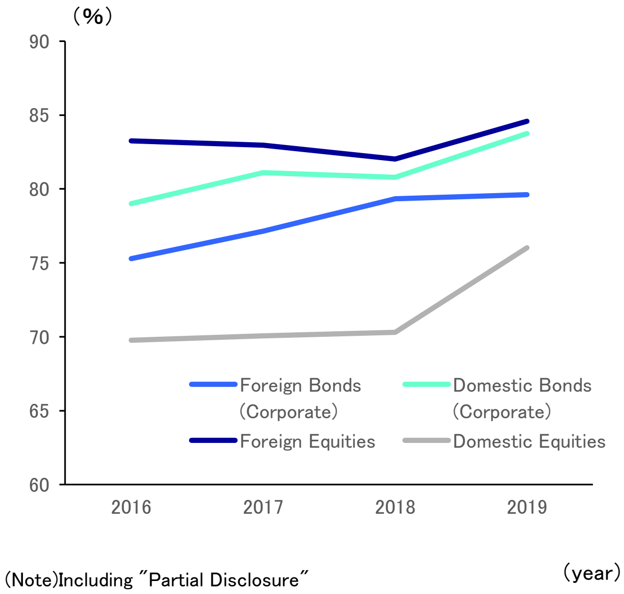
Further increases in corporate disclosure and enhanced breadth, depth and quality of disclosed data will be critical in better understanding and managing climate-associated risks in the future.

Figure 1-19: Disclosure Rates Based on Number of Companies



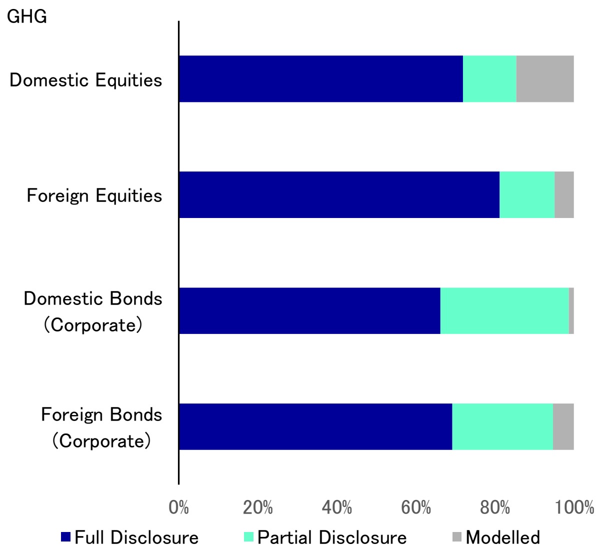
(Source)S&P Trucost Limited©Trucost 2020

Figure 1-20: Change in Value of Holdings-Based Disclosure Rates Between 2016 and 2019



(Note)Including "Partial Disclosure"
(Source)S&P Trucost Limited©Trucost 2020

Figure 1-21: Disclosure Rates Based on Absolute GHG Emissions



(Source)S&P Trucost Limited©Trucost 2020

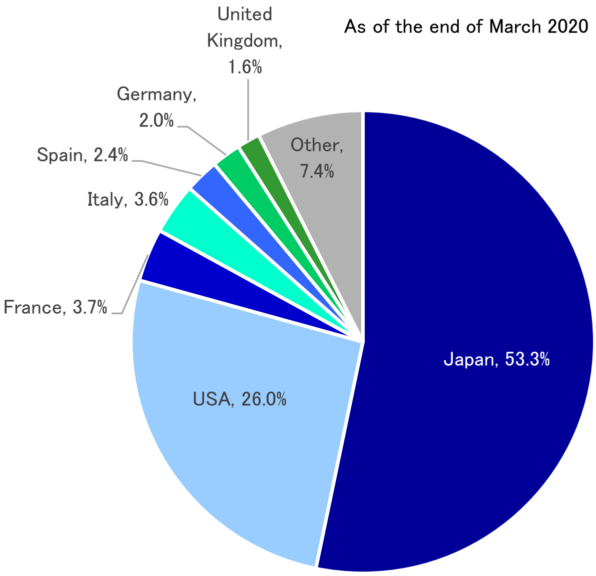
Features of GPIF’s Government Bond Portfolio

Analysis of GPIF Government Bond Portfolio

Up to this point, we analyzed the stocks and corporate bonds issued by companies in which GPIF invests. Below, we analyze sovereign bonds issued by national governments. At present, the relationship between the value of government bonds and risks associated with climate change remains unclear. However, more non-financial information is being disclosed and the way we think about finance is continuing to evolve. When the financial burden of responding to the transition and physical risks of climate change and the possible impact on tax revenue from lower corporate profits are taken into account, a negative climate change-related impact on GPIF’s government bond portfolio occurring in the future is certainly within the realm of possibility. There are basically two ways of analyzing the climate change risk of sovereign bonds: one is to consider only greenhouse gas emissions produced by the government sector of the nation issuing the bond, and another takes into account the entire sphere of influence of the nation as a whole, including greenhouse gas emissions generated by the activities of that country’s corporations and individuals. The analysis conducted for this report adopts the latter viewpoint.

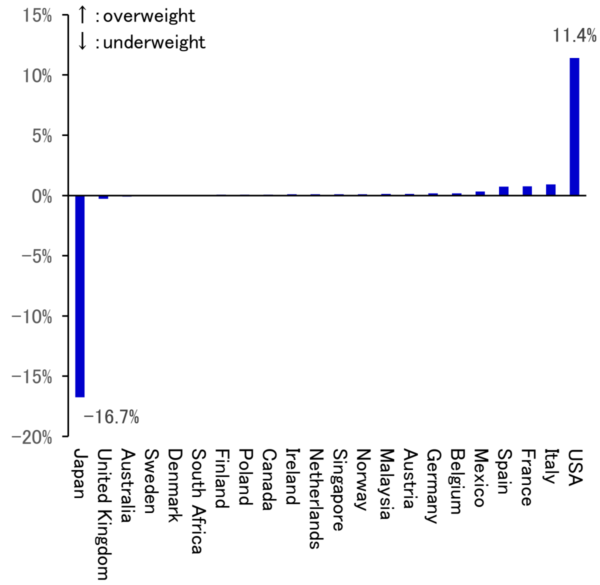
In the analysis of government bonds, just as when analyzing stocks and corporate bonds, it is important to understand that results are significantly influenced by factors such as which specific sovereign bonds make up the portfolio. The overall GPIF portfolio of foreign and domestic government bonds (hereinafter, “GPIF’s overall government bond portfolio”) is made up of about half foreign and half domestic government bonds (Figure 1-22). In addition, when we examine the difference between the country weights of GPIF’s overall government bond portfolio versus a weighted average benchmark of foreign and Japanese government bonds derived from the ratios in the policy asset mix, the overall government bond portfolio in GPIF was shown to have lower holdings in Japanese and U.K. bonds, but higher holdings in countries such as the U.S., Italy, and others (Figure 1-23).

Figure 1-22: Government Bond Portfolio Breakdown by Country



(Source) FTSE Russell, Beyond Ratings

Figure 1-23: Country Portfolio Weights Compared to Benchmark (%)



(Source) FTSE Russell, Beyond Ratings

Carbon Footprint of Government Bond Portfolios

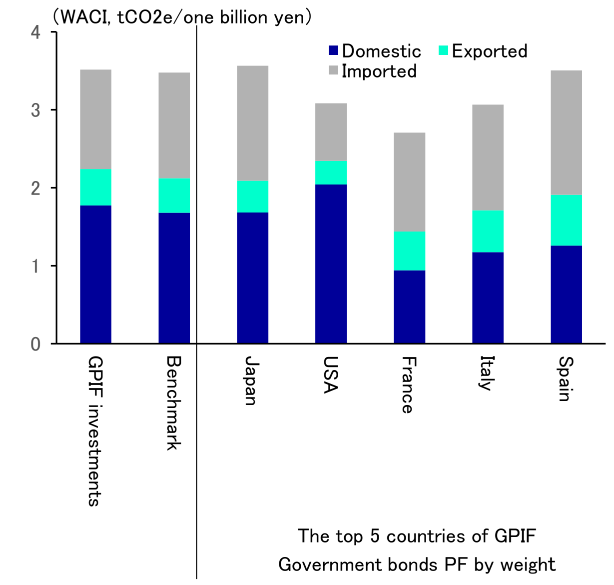
Measuring Carbon Footprint

To analyze the carbon footprint of the government bond portfolio, we used carbon intensity by dividing greenhouse gas emissions by GDP (Gross Domestic Product). It is alternatively possible to measure and compare the carbon footprint measured by the absolute level of greenhouse gas emissions for the whole country. But the carbon footprint is affected by the size of the territory and the population of each country. Therefore, it is not possible to correctly understand the actual situation with a simple comparison. Accordingly, we conducted an analysis of carbon intensity standardized by GDP.

In the climate change risk analysis of GPIF's government bond portfolio, greenhouse gas emissions are categorized by demand from within a territory (domestic demand and imports), and demand from overseas (exports). Based on these assumptions, we measured carbon intensity based on the WACI concept. For the countries included in the government bond portfolio, we measured the greenhouse gas emissions per ¥1 billion in GDP for (1) GPIF's entire government bond portfolio, (2) a composite benchmark that consists of the foreign government bond benchmark and domestic government bond benchmark using weights in GPIF's basic portfolio ("the benchmark"), and (3) the top five countries (in terms of investment amount) in GPIF's government bond portfolios (Figure 1-24).

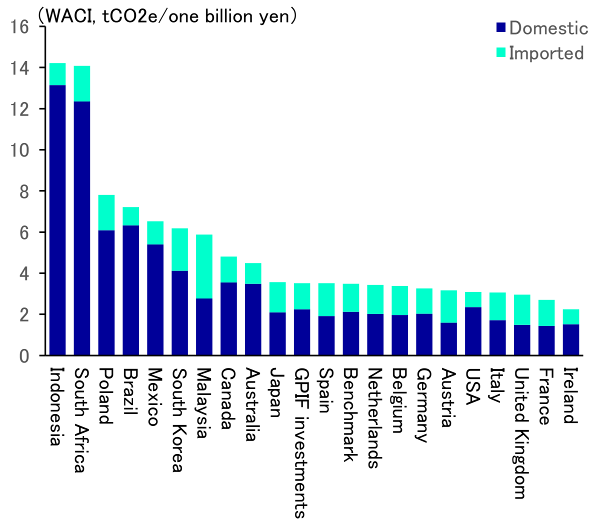
The analysis shows that the overall GPIF government bond portfolio has a slightly higher WACI than the benchmark. Many of the top five countries have lower WACIs than the benchmark, but the portfolio's high weight in Japan, which has larger greenhouse gas emissions than other countries, as well as Indonesia and South Africa led to higher WACI. Looking at the carbon intensity of the top five countries in more detail, Japan's greenhouse gas emissions associated with domestic demand and exports are slightly lower than those of the benchmark. On the other hand, Japan's greenhouse gas emissions from imports are larger than the benchmark. For the US, greenhouse gas emissions from exports and imports are lower than the benchmark, while domestic greenhouse gas emissions are higher. In addition, it was recognized that most of the carbon intensity in Europe is due to exports and imports, and emissions related to production for domestic demand are small. However, relatively smaller "domestic" emissions in European countries may result from active intra-regional trade in Europe. In addition, by limiting carbon emissions to "domestic" and "imported" to check the carbon intensity of each country (Figure 1-25), Indonesia and South Africa showed high carbon intensity.

Figure 1-24: Carbon Intensity of Government Bond Portfolio



(Source)FTSE Russell, Beyond Ratings

Figure 1-25: Carbon Intensity by Country



(Source)FTSE Russell, Beyond Ratings

Changes in Carbon Intensity of Government Bond Portfolio

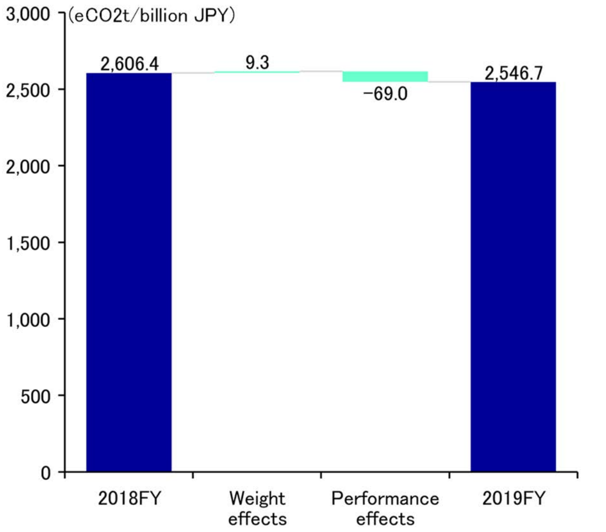
In the previous section, we compared the carbon intensity of GPIF's portfolio with that of the benchmark. Here, we decompose the changes in carbon intensity from the previous year into two factors: (1) changes in the country weights of government bonds in GPIF's portfolio, and (2) changes in carbon intensity of each country.

First, the carbon intensity of GPIF's entire government bond portfolio declined from FY2018 to FY2019 (Figure 1-26). This was the net effect of (1) changes in the country weights of government bonds in the portfolio, which increased total carbon intensity and (2) changes in carbon intensity of each country, which decreased total carbon intensity. The latter is comprised of changes in greenhouse gas emissions and changes in GDP, and thus the strong global economy throughout FY2019 likely contributed to the decline in carbon intensity.

Similarly, the carbon intensity of GPIF's domestic government bond portfolio declined due to (1) changes in the country weights of government bonds in the portfolio, which increased carbon intensity (note that the domestic government bond portfolio includes yen-denominated bonds issued by foreign governments), and (2) carbon intensity changes of each country, which decreased carbon intensity(Figure 1-27). The Japanese economy grew by a little less than 1% in FY2019, which is reflected in (2).

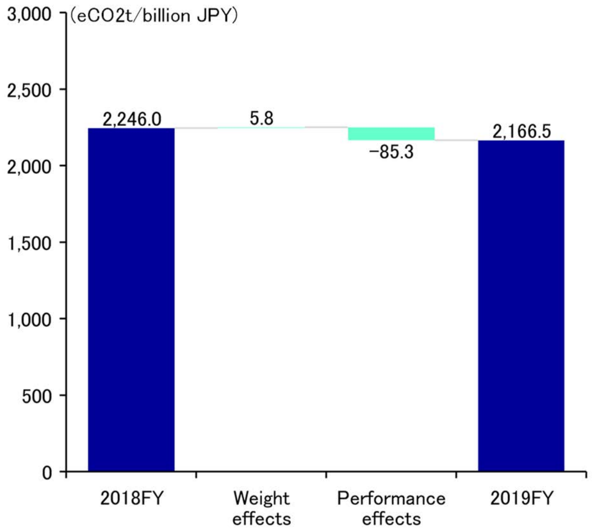
Finally, regarding foreign government bonds, both (1) and (2) contributed to lower carbon intensity. The reason for (2) is the same as above. For (1), an increase in the weights of countries whose carbon intensity is lower than that of the entire portfolio towards the end of fiscal 2019, such as developed countries like the US, France, and Italy, contributed to the decline in carbon intensity (Figure 1-28).

Figure 1-26: Factors Contributing to Carbon Intensity of Total Government Bond Portfolio



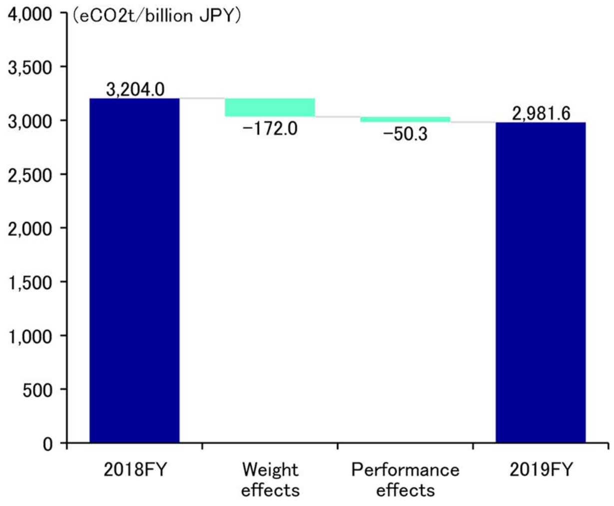
(Note)Performance Effect is composed of a change in greenhouse gas emissions and a change in GDP
(Source)FTSE Russell, Beyond Ratings

Figure 1-27: Factors Contributing to Carbon Intensity of Domestic Government Bond Portfolio



(Note)Performance Effect is composed of a change in greenhouse gas emissions and a change in GDP
(Source)FTSE Russell, Beyond Ratings

Figure 1-28: Factors Contributing to Carbon Intensity of Foreign Government Bond Portfolio



(Note)Performance Effect is composed of a change in greenhouse gas emissions and a change in GDP
(Source)FTSE Russell, Beyond Ratings

Chapter 2 : Scenario Analyses for Risks and Opportunities

Overview of Climate Value-at-Risk（CVaR）Analysis

CVaR Analysis

In the previous sections, we examined the overall carbon footprint of GPIF's portfolio and provided an analysis of the fund's government bond portfolio. In the following sections, we analyze the risks (transition and physical) and opportunities related to climate change in GPIF's equity and corporate bond portfolio based on TCFD recommendations.

We use the Climate Value-at-Risk (hereinafter, "CVaR") method to analyze stocks and corporate bonds. This approach allows us to calculate the present value of the costs and benefits arising from climate change based on an assumed climate change scenario. The CVaR of a company can show how much a company's value will change in the future due to climate change and allows climate change to be viewed as a sort of financial shock that impacts corporate value. For example, if the CVaR of Company A is -10% (or +10%), it means that Company A will lose (or gain) 10% of its corporate value under the climate change scenario being assumed. CVaR enables integrated disclosure of the transition risks, physical risks, and opportunities recommended by TCFD, because it allows (1) policy risks, (2) technological opportunities, and (3) physical risks and opportunities to be analyzed using the same yardstick—that is, their impact on corporate value[3].

The aggregate scope of greenhouse gas emissions used in the CVaR method includes emissions related to purchased electricity (Scope 2) and direct emissions by the company (Scope 1). To calculate policy risk (1), we calculated each company's cost of reducing greenhouse gas emissions in order to meet goals such as the 2˚C target[4]. Specifically, the future cost to each company of reducing greenhouse gas emissions can be estimated by calculating the amount emissions need to be reduced annually and multiplying this by the cost of achieving that reduction. On the other hand, technological opportunities (2) focuses on the business opportunities arising from climate change. For this element, we analyze the patents for environmental technologies owned by each company. Using a mathematical model in which the environmental patent share of each company in each sector is

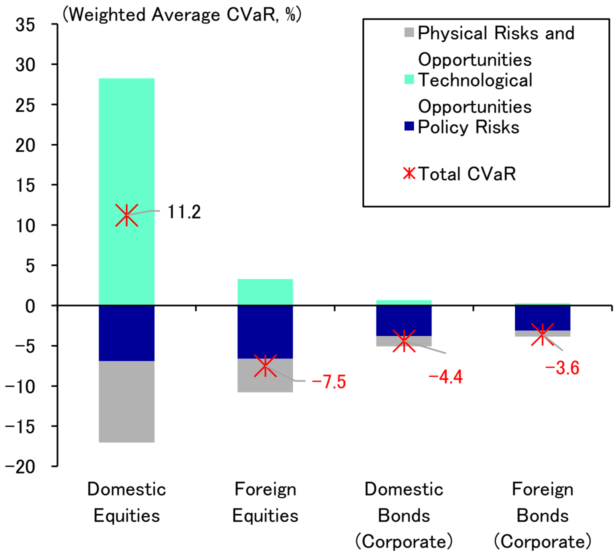
[3] See P.54 "CVaR Concepts and Analytical Methodology."
[4] The 2 ˚C target aim for keeping the temperature rise below 2 ˚C until the end of this century after the Industrial Revolution. It was stipulated in the Paris Agreement.

multiplied by that sector's level of green revenue (i.e. revenue from business lines that contribute to a low-carbon society) and profit margin allows us to reflect the potential business opportunities arising from climate change in terms of corporate profit. (1) Policy risks and (2) technological opportunities correspond to the transition risks that must be disclosed according to TCFD recommendations. The CVaR framework measures "transition risk" in terms of risks and opportunities through these two analyses. In addition, in our analysis of physical risks and opportunities (3), physical risks are expressed as an estimate of the losses a company may incur due to damage to facilities and property they own that is attributable to climate change. In some cases, climate change may lead to increased productivity and an increase in earnings. In contrast to physical risks, such cases can be considered business opportunities.

Key Results from CVaR Analysis

One important discovery made from the results of this year's analysis was the possibility that Japanese companies may actually increase in value as a result of international initiatives to reduce greenhouse gas (GHG) emissions to meet goals such as the 2˚C target (Figure 2-1). While it is generally understood that companies incur additional costs in reducing GHG emissions to meet this target, a more holistic analysis incorporating the environmental technological "opportunities" inherent in achieving the target reveals that in some cases, the boost to corporate value resulting from such technologies actually exceeds the cost of reducing GHG emissions. This tendency is particularly noticeable among domestic equities, for which the boost from opportunities related to environmental technologies was stronger than for foreign equities. The CVaR framework can be used to analyze the impact of both risks and opportunities on corporate value as measured by the value of both equities and corporate bonds. Unlike in the case of equities, upside opportunities for corporate bonds are small for both domestic and foreign companies, and the total CVaR for this asset class is negative. This seems to be due to the fact that, in the case of Japanese companies, the proportion invested in each company and sector is different for GPIF's equity and bond portfolios.

Figure 2-1: GPIF's Portfolio Climate Value-at-Risk (CVaR)



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【Main Points】
Weighted average CVaR is greater for domestic equities (+11.2%) than foreign equities (−7.5%). This means that the present value of domestic equities is estimated to increase by +11.2% under the 2 degree scenario.

Environmental technologies provide an overall boost for domestic equities overall, despite the negative impact of physical risks.

Although foreign equities have a smaller exposure to physical risks, the overall negative pressure from risks is greater than the technological opportunities they present.

Overview of CVaR Analysis

The CVaR model calculates Climate Value-at-Risk at the enterprise value level, which includes both equity and debt. The following sector analysis of GPIF's portfolio breaks down CVaR assessments into equity and debt（Figure 2-2 to Figure 2-3）.

In the equity portfolio, as mentioned in the previous section, technology opportunities drove the CVaR results for domestic equities into positive territory. Looking at technology opportunities by sector, the effect was strikingly high in the energy sector, which normally generates high environmental externalities (135.4%), followed by the utilities (69.9%), consumer discretionary (61.8%) and materials sectors (60.0%). These sectors registered positive values for transition risks, which combine the values for technology opportunities and policy risks. These results indicate the potential for technology opportunities to drive enterprise values higher in these sectors due to heightened policy risk if the world transitions to a low carbon economy in line with the 2.0 degrees goal scenario.

On the other hand, climate-related risks drove negative values across all sectors for domestic and foreign bonds in the fixed income portfolios.

Figure 2-2: GPIF’s Equity Portfolio CVaR by Sector

	Domestic Equities					Foreign Equities				
	Aggregate CVaR	Transition Risks	Policy Risks	Technological Opportunities	Physical Risks and Opportunities	Aggregate CVaR	Transition Risks	Policy Risks	Technological Opportunities	Physical Risks and Opportunities
Total	11.2	21.3	−6.9	28.3	−10.1	−7.5	−3.3	−6.6	3.3	−4.2
Telecommunication Services	−19.2	−0.3	−0.9	0.6	−18.9	−9.9	−1.6	−1.8	0.2	−8.3
Consumer Discretionary	46.3	57.6	−4.2	61.8	−11.3	−2.3	1.8	−2.3	4.1	−4.1
Consumer Staples	−12.1	−2.6	−4.1	1.5	−9.5	−10.8	−5.3	−5.9	0.6	−5.5
Energy	13.4	60.8	−74.7	135.4	−47.3	−47.5	−40.0	−49.2	9.2	−7.6
Financials	−28.0	−0.7	−0.8	0.0	−27.3	−11.7	−1.2	−1.3	0.1	−10.5
Healthcare	−2.6	1.5	−0.6	2.1	−4.1	−4.6	−0.5	−0.9	0.3	−4.1
Industrials	20.5	31.1	−8.4	39.6	−10.7	−5.2	0.5	−10.0	10.4	−5.6
Information Technology	15.4	23.0	−2.0	25.0	−7.6	−2.7	1.1	−0.7	1.7	−3.8
Materials	5.7	25.6	−34.4	60.0	−19.8	−31.8	−25.5	−33.5	8.0	−6.4
Real Estate	−0.8	2.3	−1.8	4.2	−3.1	−5.1	−0.8	−1.4	0.6	−4.3
Utilities	−2.7	18.3	−51.6	69.9	−21.0	−10.9	−7.5	−29.1	21.7	−3.5

(Note)Calculated on the assumption of a 2℃ scenario.

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Figure 2-3: GPIF’s Bond Portfolio CVaR by Sector

	Domestic Bonds					Foreign Bonds				
	Aggregate CVaR	Transition Risks	Policy Risks	Technological Opportunities	Physical Risks and Opportunities	Aggregate CVaR	Transition Risks	Policy Risks	Technological Opportunities	Physical Risks and Opportunities
Total	−4.4	−3.1	−3.8	0.7	−1.3	−3.6	−2.9	−3.1	0.3	−0.8
Telecommunication Services	−3.3	0.0	0.0	0.0	−3.3	−0.9	−0.3	−0.3	0.0	−0.6
Consumer Discretionary	0.3	0.8	−0.2	0.9	−0.5	−1.5	0.0	−0.4	0.4	−1.5
Consumer Staples	−1.8	−0.3	−0.3	0.0	−1.5	−1.8	−0.7	−0.8	0.1	−1.1
Energy	−47.3	−46.8	−47.1	0.3	−0.5	−13.0	−12.1	−12.6	0.5	−0.8
Financials	−0.6	0.0	0.0	0.0	−0.6	−0.7	0.0	−0.1	0.1	−0.8
Healthcare	−1.1	0.0	−0.1	0.0	−1.0	−0.6	−0.2	−0.2	0.0	−0.4
Industrials	−3.7	−2.2	−3.7	1.5	−1.5	−3.7	−2.8	−3.8	1.0	−0.9
Information Technology	0.1	0.3	−0.3	0.6	−0.2	−3.0	0.1	−0.1	0.2	−3.1
Materials	−28.1	−24.2	−28.0	3.7	−3.9	−14.0	−13.5	−14.3	0.8	−0.5
Real Estate	−0.1	0.0	−0.1	0.1	−0.1	−1.5	−0.1	−0.1	0.0	−1.5
Utilities	−8.7	−7.8	−8.4	0.6	−0.9	−23.3	−22.5	−24.6	2.0	−0.8

(Note)Calculated on the assumption of a 2℃ scenario.

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CVaR Scenario Analysis

CVaR by Temperature Rise Scenario

CVaR results vary depending on the temperature increase scenario being assumed. We therefore tried calculating CVaR for GPIF's equity and corporate bond portfolios assuming temperature increases of 1.5˚C, 2˚C, and 3˚C (Figure 2-4 to Figure 2-5). To understand the overall trend represented by each of the scenarios, we first focus on aggregate CVaR for the total portfolio. Here we find that the portfolio is negatively impacted the most in the 3˚C scenario, while the positive impact increases more as we move toward the 2˚C and 1.5˚C scenarios. The fact that more technological opportunities open up as rules and regulations to curb rising temperatures grow tighter plays a big role in these results, particularly in the case of equities. This can be considered a new insight gained from incorporating technological opportunities into the analysis. Furthermore, compared to bonds, the impact on equities varies dramatically depending on the specific scenario assumed, and it thus seems likely that investors will have to pay close attention to climate change policy trends going forward as these will play a pivotal role in investment decisions[5].

In our assumptions for the analysis of physical risks and opportunities, we referred to Representative Concentration Pathway 8.5 as compiled by the Intergovernmental Panel on Climate Change. The analysis is therefore not based on the same 1.5˚C, 2˚C, and 3˚C scenarios being assumed to evaluate policy risks and opportunities, but rather under assumptions that correspond to a 4 to 6˚C warming scenario. Because physical risks likely grow in severity at higher magnitudes of temperature increase, the negative results for the 3˚C scenario as compared to the 1.5˚C and 2˚C scenarios may actually be understated. In particular, if temperatures reach a certain tipping point, sharp rises in sea levels caused by the thawing of permafrost, large scale mass migration, reduced food production capacity, and other such worldwide social disruption has the potential to profoundly affect the value of portfolio assets in a negative way.

[5] CVaR results are also analyzed on P.41 and later in a histogram showing sectoral and country-specific distributions for equities and bonds (corporate bonds). Similar analyses are conducted on transition risks (policy risks and technical opportunities), physical risks and opportunities, and potential warming temperatures, which is how CVaR is broken down.

Figure 2-4: CVaR by Temperature Increase Scenario (1)

CVaR for the 3˚C Scenario	Equities	Corporate Bonds	Total Portfolio
(1) Transition Risks and Opportunities	0.76	−0.32	0.69
Policy Risks	−1.69	−0.44	−1.61
Technological Opportunities	2.45	0.12	2.31
(2) Physical Risks and Opportunities	−6.75	−0.82	−6.37
(3) Aggregate	**−5.98**	**−1.14**	**−5.67**

CVaR for the 2˚C Scenario	Equities	Corporate Bonds	Total Portfolio
(1) Transition Risks and Opportunities	8.83	−3.06	8.09
Policy Risks	−6.77	−3.52	−6.57
Technological Opportunities	15.61	0.46	14.66
(2) Physical Risks and Opportunities	−6.75	−0.82	−6.37
(3) Aggregate	**2.09**	**−3.88**	**1.72**

CVaR for the 1.5˚C scenario	Equities	Corporate Bonds	Total Portfolio
(1) Transition Risks and Opportunities	25.17	−6.39	23.19
Policy Risks	−11.04	−7.13	−10.79
Technological Opportunities	36.20	0.73	33.98
(2) Physical Risks and Opportunities	−6.75	−0.82	−6.37
(3) Aggregate	**18.42**	**−7.21**	**16.82**

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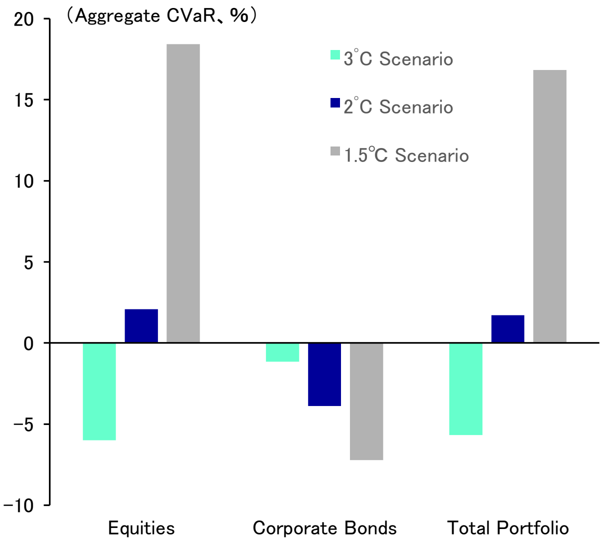
Figure 2-5: CVaR by Temperature Increase Scenario (2)



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Policy Risks

Policy Risks Show Similar Trends at Home and Abroad

In the policy risk analysis for GPIF's equity and corporate bond portfolios, we examined Japanese equities and corporate bonds by industry sector, while for foreign equities and corporate bonds, we broke down the assessment by country as well as by industry sector (Figure 2-6 to Figure 2-9).

The results showed that the biggest risk among domestic equities is in the energy sector, which includes companies such as fossil fuel miners, followed by the utilities sector, which includes electric power and other companies. In addition, compared to other industries, the risk is extremely high in industries such as the materials industry, which includes petrochemicals, and in industries that emit relatively large amounts of greenhouse gases over the course of their operations. Conversely, industries such as healthcare and finance were found to have lower risk. The same tendencies can be seen with foreign equities, but the ranking differs slightly for industries with less policy risk. Furthermore, although the risk is greater in the U.S., where the investment ratio in each industry is high, the rest of the risk is generally spread out across a number of other countries, such as the U.K. and France.

In the corporate bond analysis, while the ranking of the industries with the highest policy risk is somewhat different than for equities, the three industries with the highest risk remain the energy, utilities, and materials industries, both domestically and overseas. Looking at foreign corporate bonds by country, the risk is extremely high in the U.S. This is likely due to the fact that the percentage of U.S. investments in the corporate bond portfolio is higher than that for the equity portfolio.

Assessing investee companies in terms of policy risk this way suggests that the costs associated with reducing greenhouse gas emissions pose a significant risk of depressing the corporate value of energy-intensive industries unless specific countermeasures are taken.

Figure 2-6: Policy Risk – Domestic Equities Portfolio

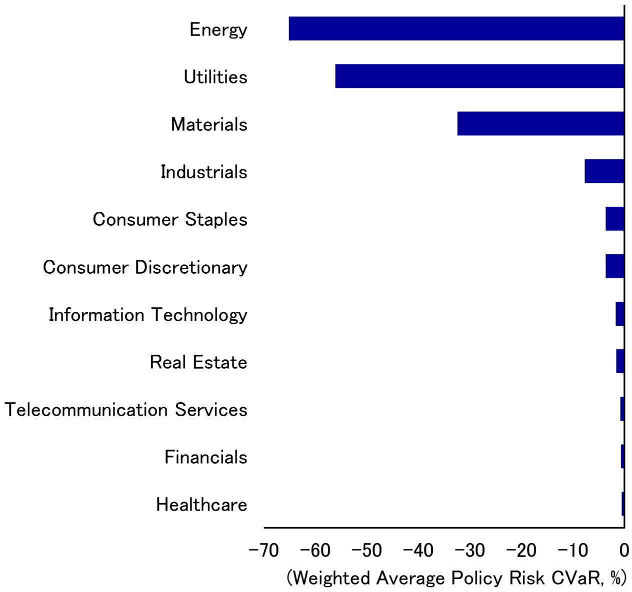

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Figure 2-7: Policy Risk – Foreign Equities Portfolio

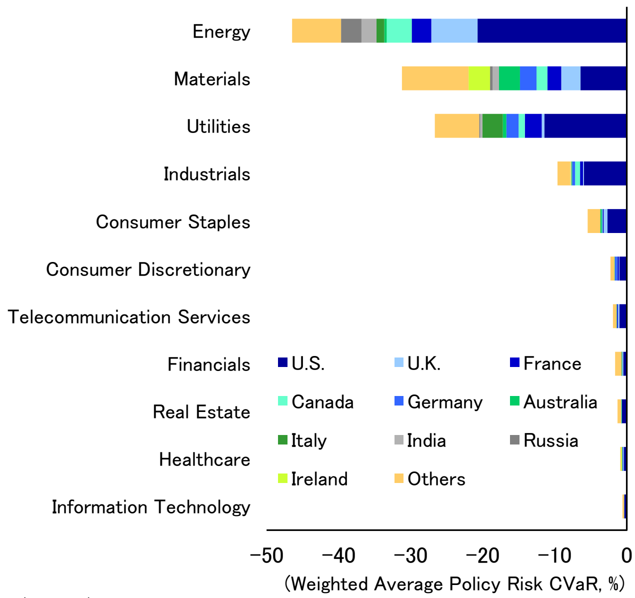

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Figure 2-8: Policy Risk – Domestic Corporate Bond Portfolio

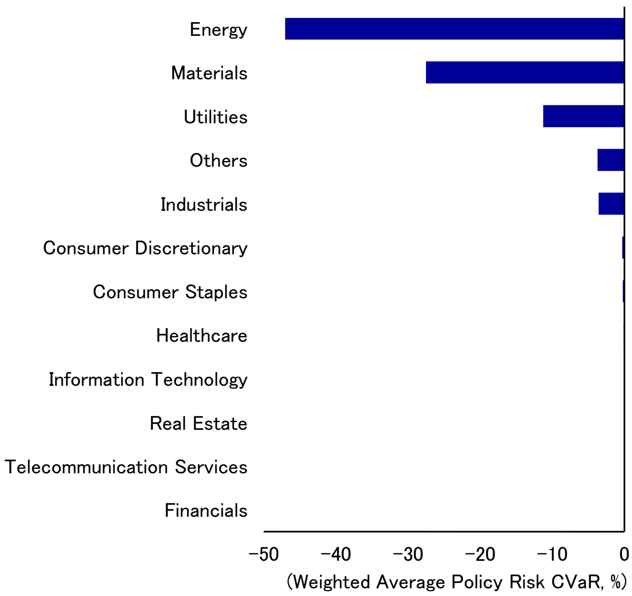

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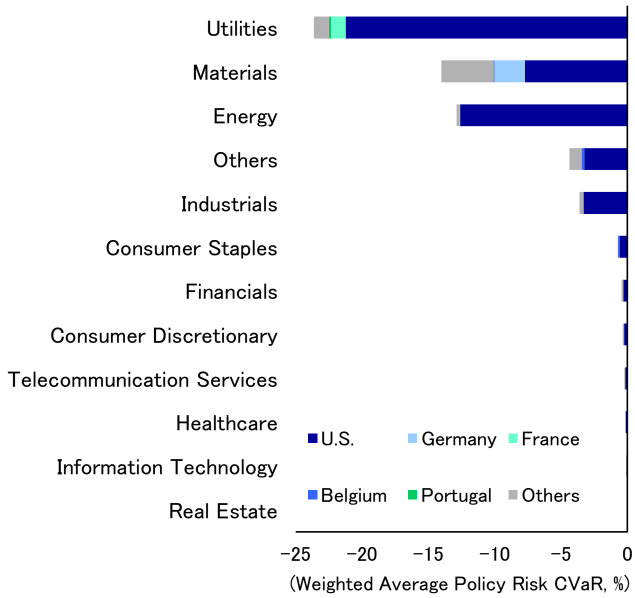
Figure 2-9: Policy Risk – Foreign Corporate Bond Portfolio



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Technological Opportunities

Remarkably High Scores for Domestic Companies

Here, we analyze technological opportunities by focusing on corporate patent scores. In these terms, domestic companies generally have higher scores than foreign companies. There are many domestic companies that could capitalize on increased demand for environmental-related technologies due to heightened policy risks and other factors in a low carbon scenario, leading to profit opportunities.

Looking at the breakdown by patent category, domestic equities scored exceptionally high in the automotive industry, with a large gap between this and the next highest-rated industries – energy supply, electric vehicles, and chemicals (Figure 2-10). Not only do domestic automobile manufacturers possess a high degree of environmental technology and know-how, but the large size of the automotive sector in the domestic market and the subsequent high investment ratio of automobile manufacturers in GPIF's portfolio also play a role in these results. In this analysis, the automotive category includes patents related to improving the efficiency of internal combustion engines, and the electric vehicles category includes technologies related to batteries, hybrid technology and fuel cells. Meanwhile, in the case of foreign equities, the scores for the aircraft and information technology categories are higher than for the automotive category (Figure 2-11).

In the case of domestic corporate bonds, as with domestic equities, the automotive category has the highest score, while the scores for the energy supply and solar categories are relatively higher (Figure 2-12). This is also influenced by the fact that electric power companies account for a larger proportion of the corporate bond portfolio overall than in the equity portfolio. The patent score was highest in the aircraft category in the case of foreign corporate bonds, as with foreign equities. Not only did the order differ for other patent classifications, but the share of patent classifications by country was also different (Figure 2-13). This is likely due to the fact that the equities portfolio and corporate bond portfolio have different industry and country weightings.

Figure 2-10: Technological Opportunities – Domestic Equities Portfolio

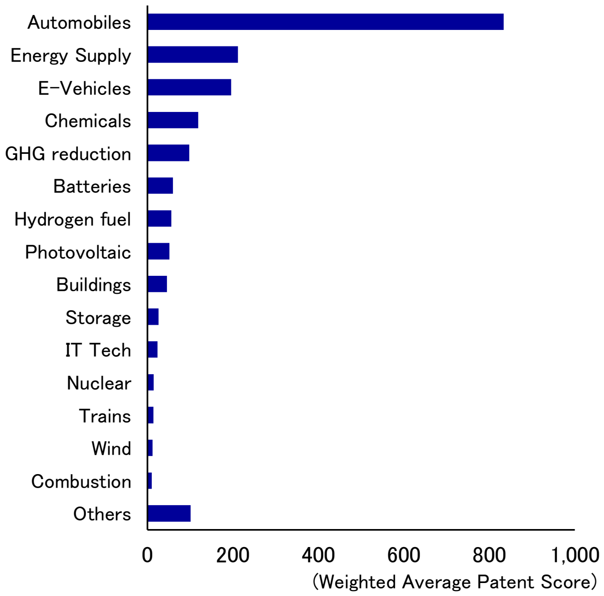

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Figure 2-11: Technological Opportunities – Foreign Equities Portfolio

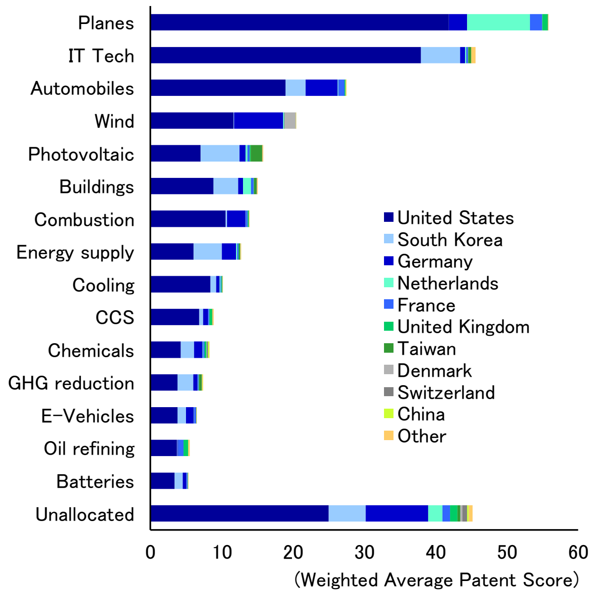

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Figure 2-12: Technological Opportunities – Domestic Government Bond Portfolio

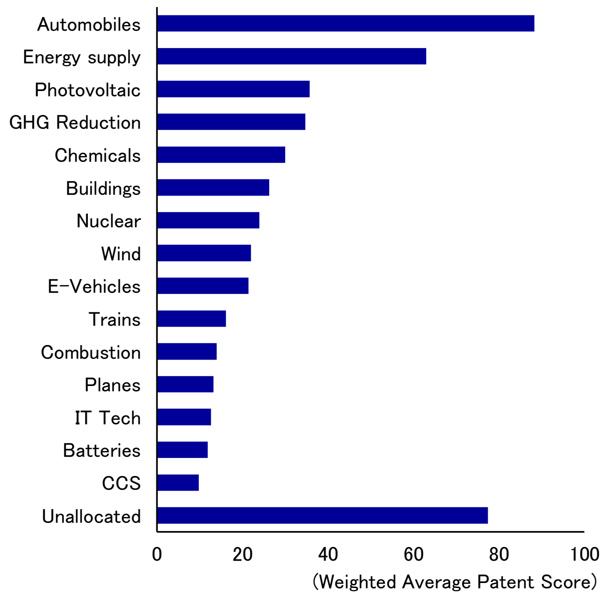

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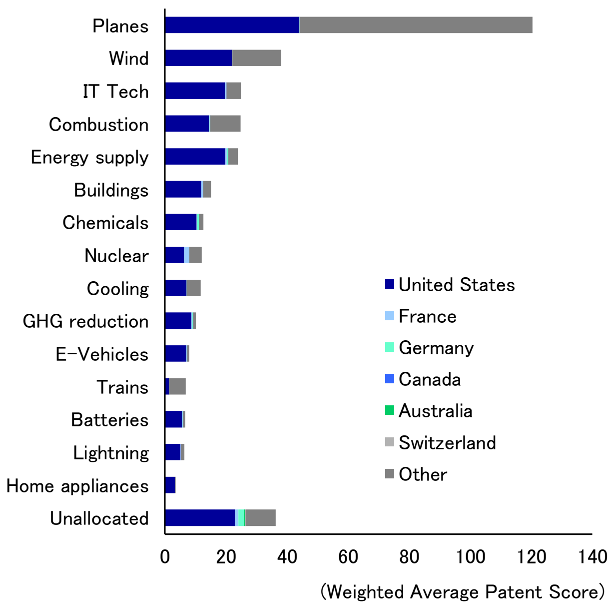
Figure 2-13: Technological Opportunities – Foreign Government Bond Portfolio



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Physical Risks and Opportunities

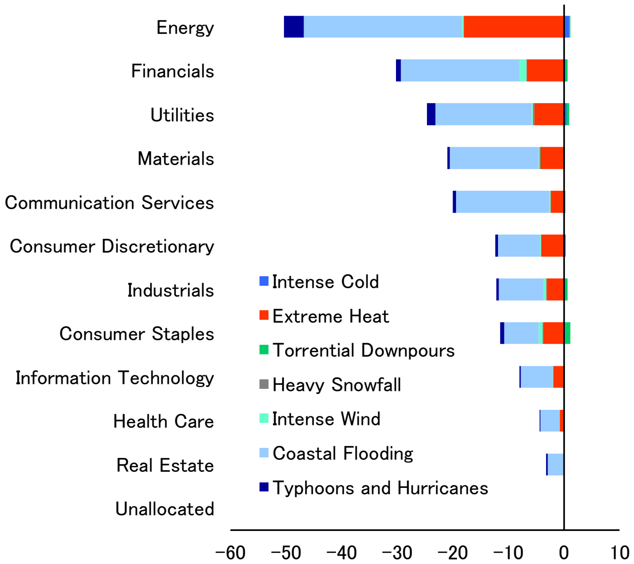
Contrast with Policy Risks and Technical Opportunities

Next, we analyze physical risks and opportunities. The opportunities in this analysis differ from the technological opportunities calculated based on patent scores presented in the previous section.

As contrasted against physical risks, here, opportunities indicate the potential for increased corporate profits due to environmental changes caused by climate change. Examples include things like expanded energy extraction in the Arctic Ocean and reductions in heating and other costs made possible by higher temperatures. In addition, as global temperatures rise, the number of extremely hot days is expected to decrease in very localized areas such as northern India, with some productivity gains expected to be made in that country's oil refining business.

Physical risks and opportunities by sector and country tend to differ from policy risks and technological opportunities (Figure 2-14 to Figure 2-17). First, in the domestic equity portfolio, the energy and utilities sectors were shown to have significant physical risk in addition to policy risk, and even the financial sector, which had less policy risk, was shown to have notable physical risk. Among foreign equities, we found there to be meaningful risk in the telecommunications services and financial sectors. Both domestically and overseas, coastal flooding and extreme heat account for the vast majority of this risk. The fact that many offices in the financial sector and equipment in the telecommunications services sector is located in densely populated areas at low elevations likely contributes to this higher physical risk. However, we may be overestimating physical risks for the financial sector, as the importance of brick-and-mortar offices is declining with more and more financial transactions being conducted online. The analysis of the physical risks and opportunities used in this study has not assessed the adaption measures being taken at each facility. For example, the construction of breakwaters and embankments for "coastal floods" and the installation of air conditioning in the facilities for "extreme heat" could reduce the exposure to physical risks. Naturally, measures have already been taken in the areas with potential physical risks, and in such cases, these elements could be incorporated into the risk assessments. GPIF believes that there is room for the assessment of physical risks to be reflected in the analyses in the future. Another interesting outcome of the analysis was that physical risks were relatively limited in some sectors with significant policy risk, such as the industrials sector in the case of domestic equities and in the utilities sector in the case of foreign equities. For domestic corporate bonds, physical risks were found to be highest in the materials sector, followed by the telecommunications services and consumer staples sectors, while for foreign corporate bonds, the information technology, consumer discretionary, and real estate sectors had the highest risk.

Figure 2-14: Physical Risks and Opportunities – Domestic Equities Portfolio



(Weighted Average Physical Risks and Opportunities CVaR, %)
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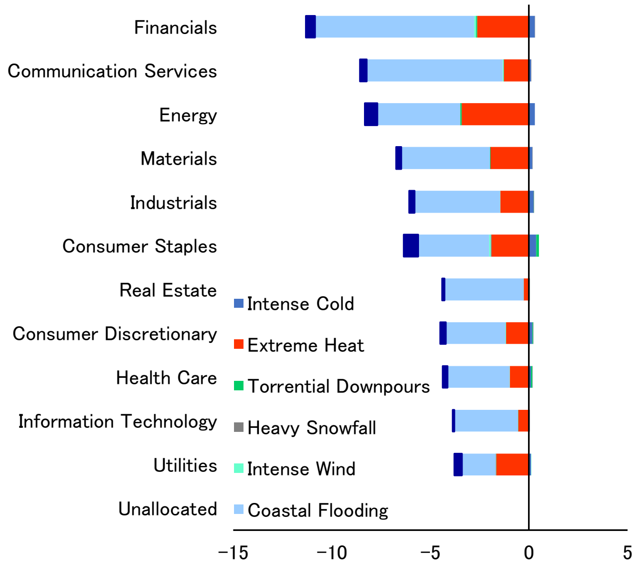
Figure 2-15: Physical Risks and Opportunities – Foreign Equities Portfolio



(Weighted Average Physical Risks and Opportunities CVaR, %)
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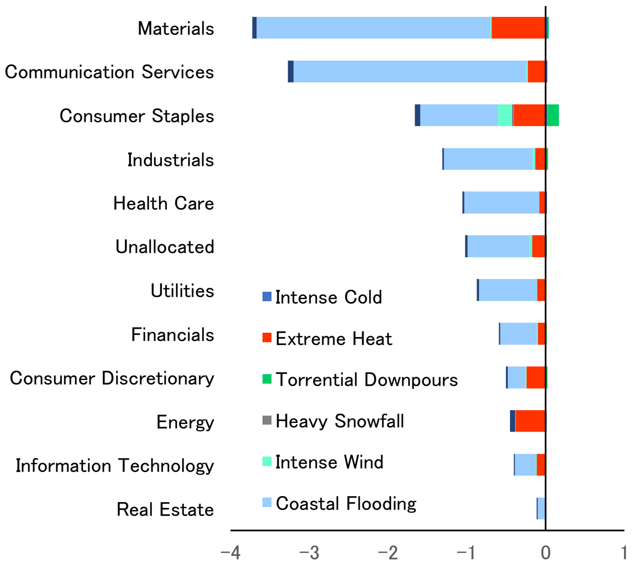
Figure 2-16: Physical Risks and Opportunities – Domestic Corporate Bond Portfolio



(Weighted Average Physical Risks and Opportunities CVaR, %)
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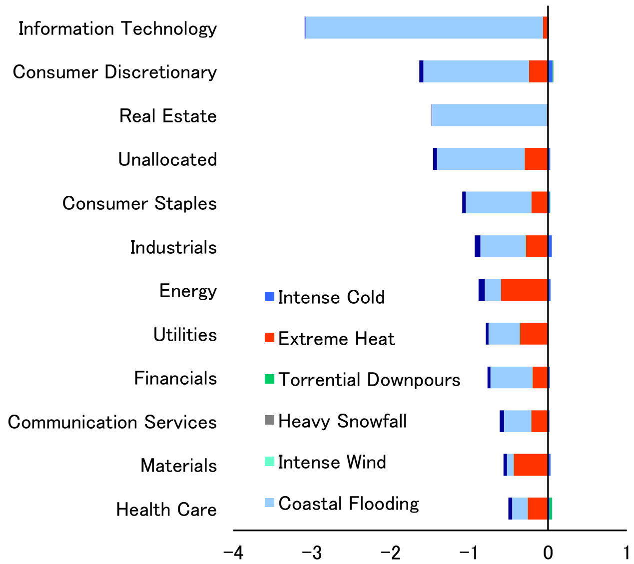
Figure 2-17: Physical Risks and Opportunities – Foreign Corporate Bond Portfolio



(Weighted Average Physical Risks and Opportunities CVaR, %)
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Distributions of Aggregate CVaR by Sector and Country

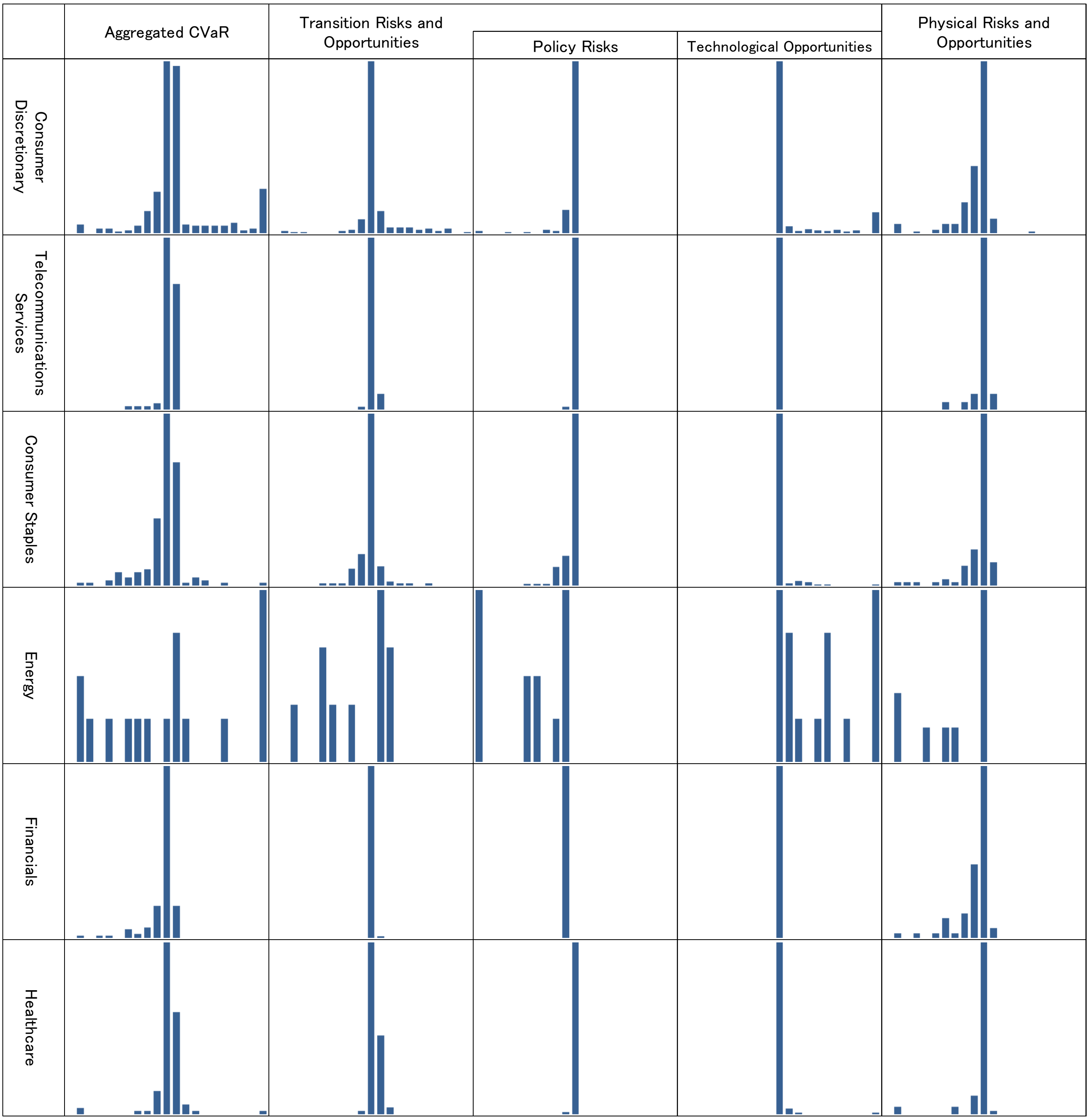
Histogram Analysis of Aggregate CVaR

In this section, we analyze GPIF's equity and bond portfolios using histograms that show the distributions of aggregate CVaR by sector and country. The horizontal axis in each histogram shows aggregate CVaR grouped into 20 deciles, with a maximum value of +100% and a minimum value of-100%. CVaR registers as a positive value when the value of the firm (security value) rises and a negative value when the value of the firm declines. The vertical axis represents the number of companies, but is standardized to 100% as the maximum value. Thus, even at the same height, the actual frequency varies from sector to sector and from country to country.

Aggregate CVaR for the domestic and international equity portfolios can be broadly categorized into three types: ① sectors that are concentrated in a narrow range around 0 (e.g. communication services, financials, health care, information technology, materials, and real estate), ② sectors that are distributed evenly (e.g. energy and utilities), and ③ sectors that are distributed normally (e.g. consumer discretionary, consumer staples and industrials) (Figure 2-18 to Figure 2-21). The way that this is interpreted is that, in a comprehensive assessment of risks and opportunities, climate change has relatively little impact on corporate and securities values for the companies in group ① sectors, while for ②, there is large intra-industry disparity and opportunities and risks depend heavily on corporate behavior. It is noteworthy that for domestic equities, the energy sector in particular has a large number of companies with significant potential upside in terms of technological opportunities compared to foreign equities.

Looking next at the bond portfolios, it is clear that in contrast to equities, the distribution is concentrated in a narrow range centered on zero (Figure 2-22 to Figure 2-25). The difference in the shape of the distribution between the two is, of course, attributable to differences in the characteristics of bonds and equities as financial instruments, in addition to differences in the characteristics of the companies in the portfolio. That is, since bonds are redeemed at face value except in the case of default, CVaR does not significantly change unless climate change leads to a risk of corporate survival (default risk). Looking at the histogram breakdown by country (Figure 2-26 to Figure 2-29), we see that the distribution of the Japanese equity portfolio is symmetrically spread to the left and right from the center, confirming that there are large-risk firms and similarly large-opportunity firms. On the other hand, we confirmed that many companies in India, Russia, South Korea, China, the United Kingdom, and other countries have negative values.

Figure 2-18: CVaR Histogram for GPIF Domestic Equity Portfolio by Sector (1)



(Note)The horizontal axis represents 20 deciles (i.e. 20 bins at 10% intervals), with a maximum value of +100% and a minimum value of -100%. The value on the horizontal axis is positive when the value of the firm increases, and negative when the value of the firm decreases. The vertical axis represents the number of enterprises, with maximum frequency standardized to 100% within each sector/country. Thus, the frequency of the maximum value is not necessarily the same for each sector/country.

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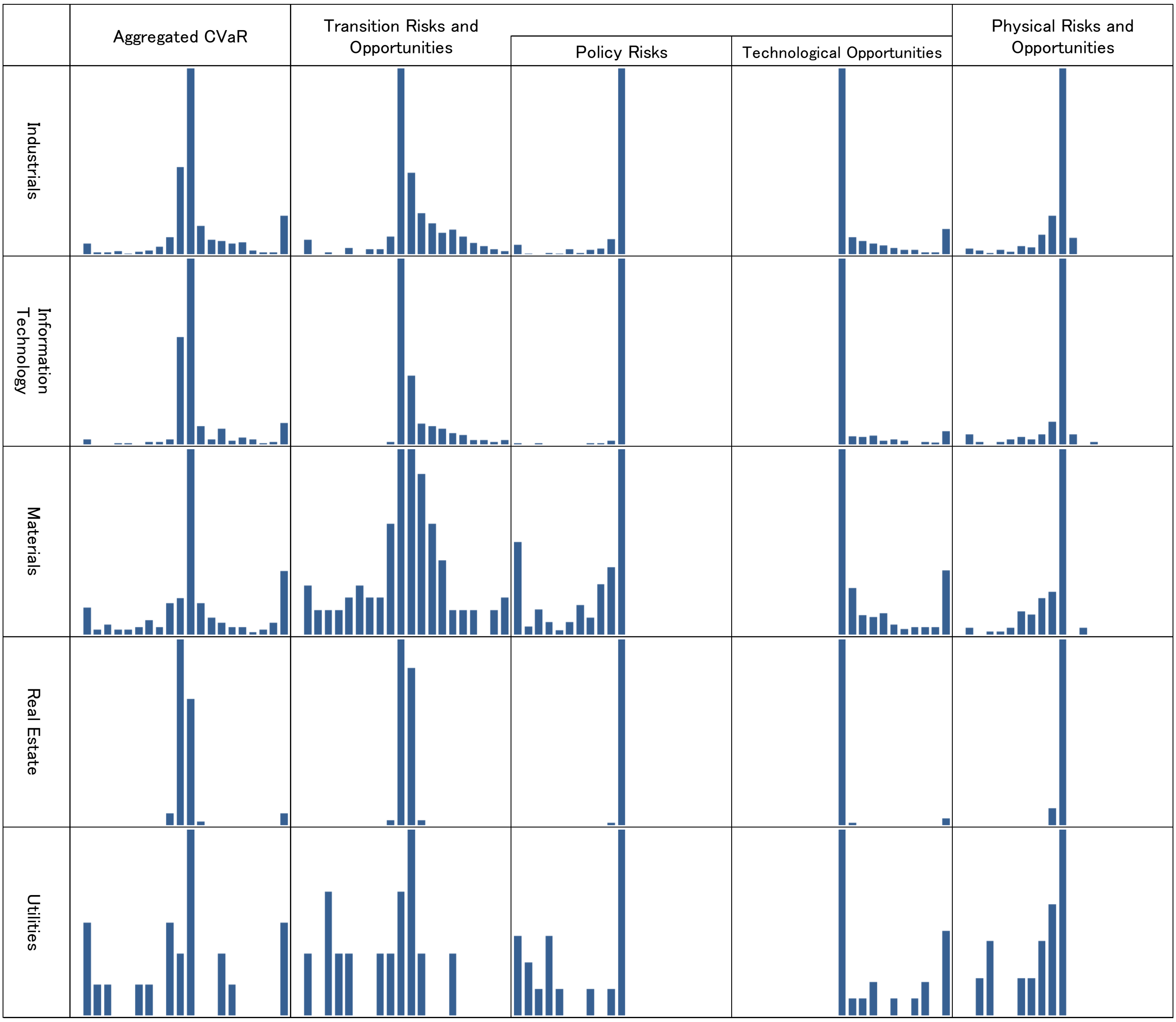
Figure 2-19: CVaR Histogram for GPIF Domestic Equity Portfolio by Sector (2)



(Note)The horizontal axis represents 20 deciles (i.e. 20 bins at 10% intervals), with a maximum value of +100% and a minimum value of -100%. The value on the horizontal axis is positive when the value of the firm increases, and negative when the value of the firm decreases. The vertical axis represents the number of enterprises, with maximum frequency standardized to 100% within each sector/country. Thus, the frequency of the maximum value is not necessarily the same for each sector/country.

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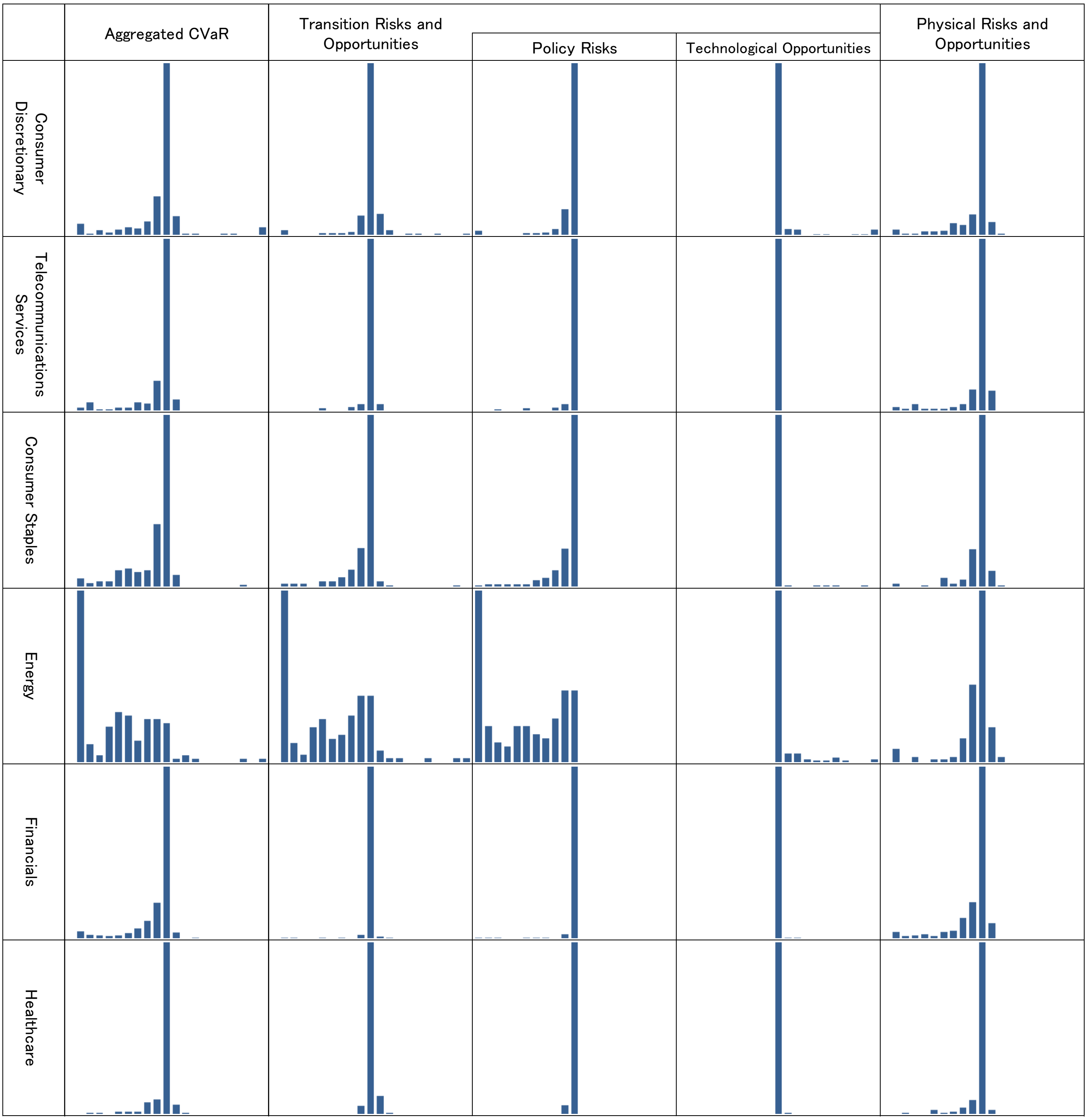
Figure 2-20: CVaR Histogram for GPIF Foreign Equity Portfolio by Sector (1)



（Note）The horizontal axis represents 20 deciles (i.e. 20 bins at 10% intervals), with a maximum value of +100% and a minimum value of -100%. The value on the horizontal axis is positive when the value of the firm increases, and negative when the value of the firm decreases. The vertical axis represents the number of enterprises, with maximum frequency standardized to 100% within each sector/country. Thus, the frequency of the maximum value is not necessarily the same for each sector/country.

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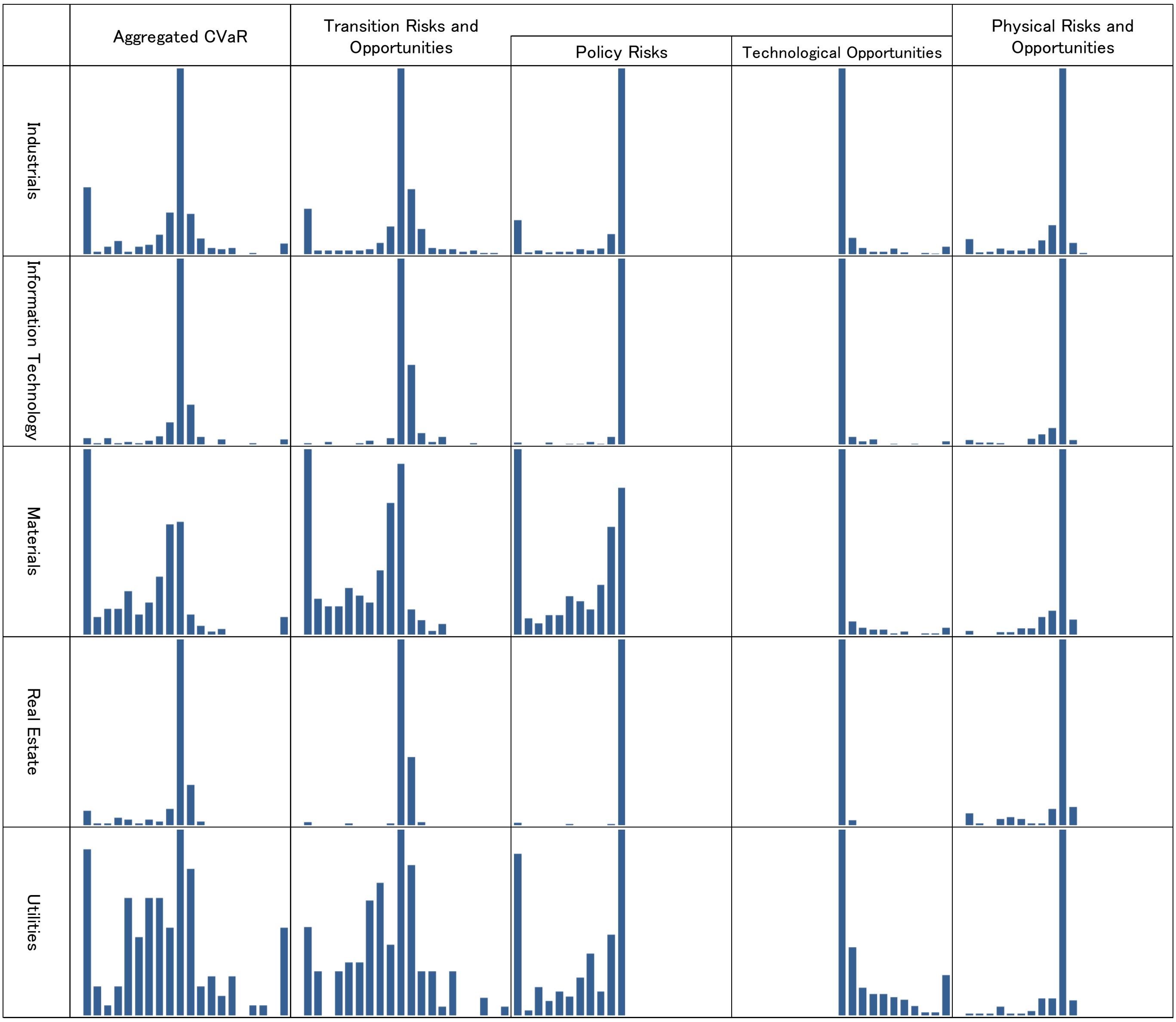
Figure 2-21: CVaR Histogram for GPIF Foreign Equity Portfolio by Sector (2)



(Note)The horizontal axis represents 20 deciles (i.e. 20 bins at 10% intervals), with a maximum value of +100% and a minimum value of -100%. The value on the horizontal axis is positive when the value of the firm increases, and negative when the value of the firm decreases. The vertical axis represents the number of enterprises, with maximum frequency standardized to 100% within each sector/country. Thus, the frequency of the maximum value is not necessarily the same for each sector/country.

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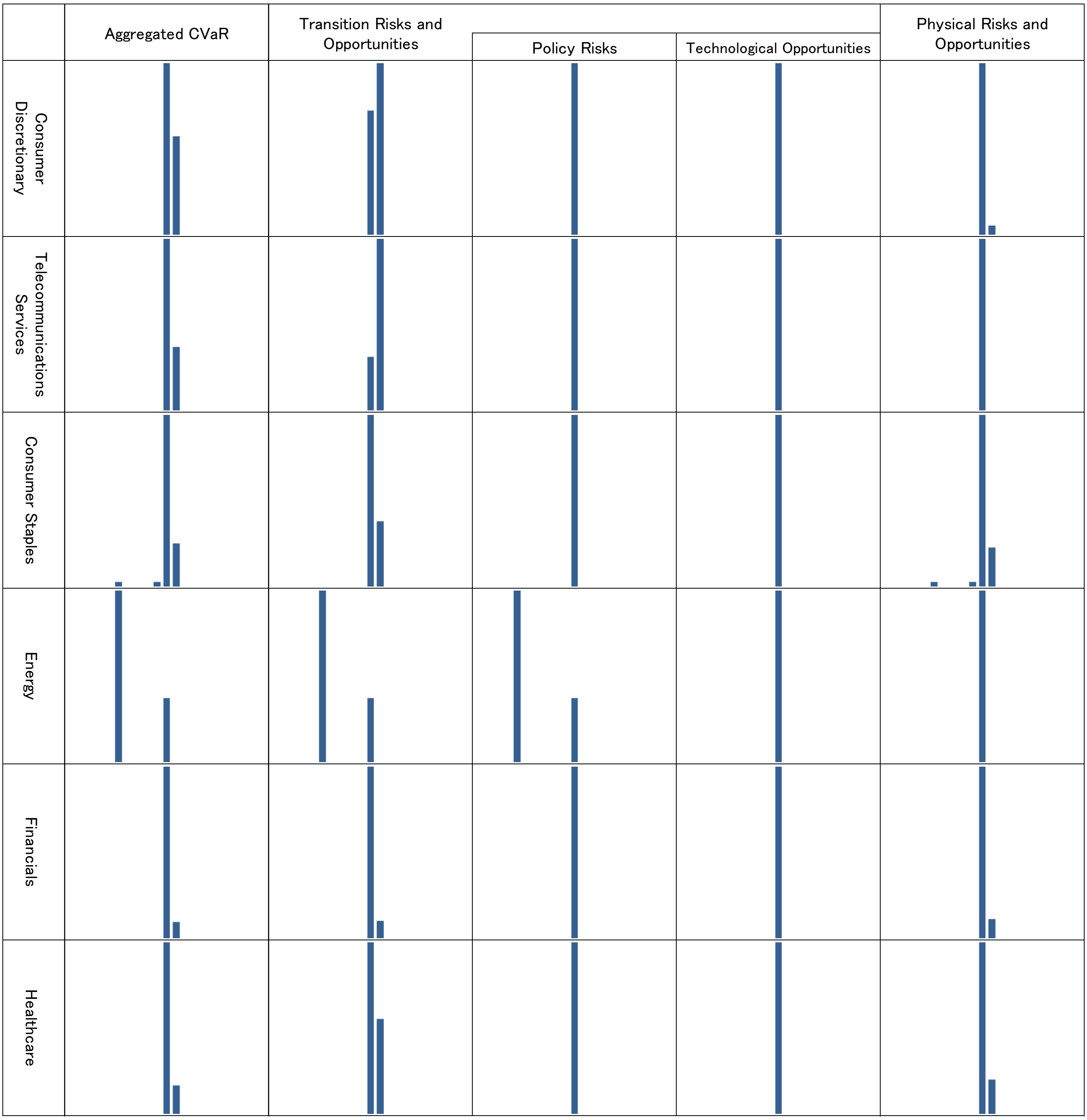
Figure 2-22: CVaR Histogram for GPIF Domestic Corporate Bonds Portfolio by Sector (1)



(Note)The horizontal axis represents 20 deciles (i.e. 20 bins at 10% intervals), with a maximum value of +100% and a minimum value of -100%. The value on the horizontal axis is positive when the value of the firm increases, and negative when the value of the firm decreases. The vertical axis represents the number of enterprises, with maximum frequency standardized to 100% within each sector/country. Thus, the frequency of the maximum value is not necessarily the same for each sector/country.

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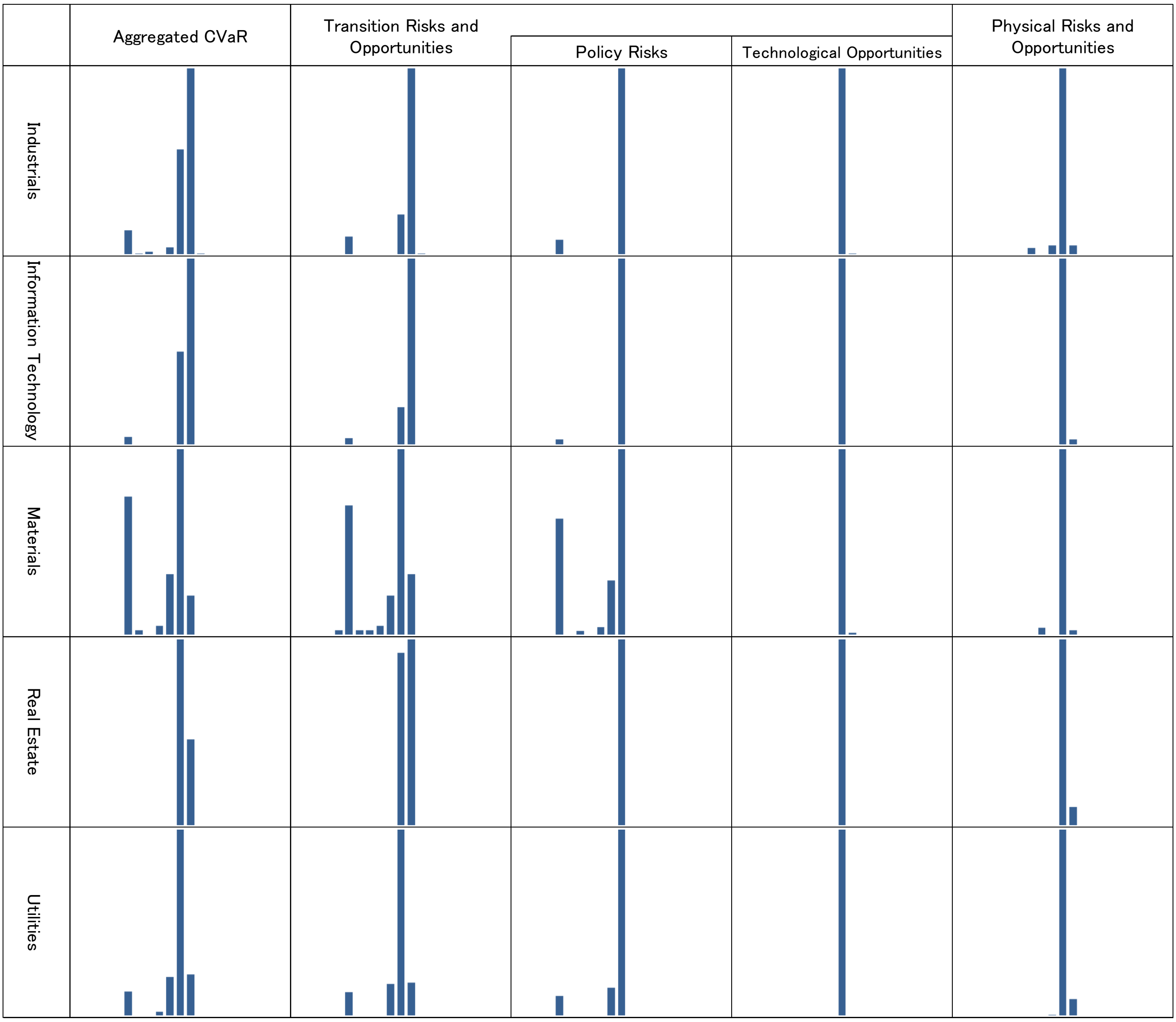
Figure 2-23: CVaR Histogram for GPIF Domestic Corporate Bonds Portfolio by Sector (2)



(Note) The horizontal axis represents 20 deciles (i.e. 20 bins at 10% intervals), with a maximum value of +100% and a minimum value of -100%. The value on the horizontal axis is positive when the value of the firm increases, and negative when the value of the firm decreases. The vertical axis represents the number of enterprises, with maximum frequency standardized to 100% within each sector/country. Thus, the frequency of the maximum value is not necessarily the same for each sector/country.

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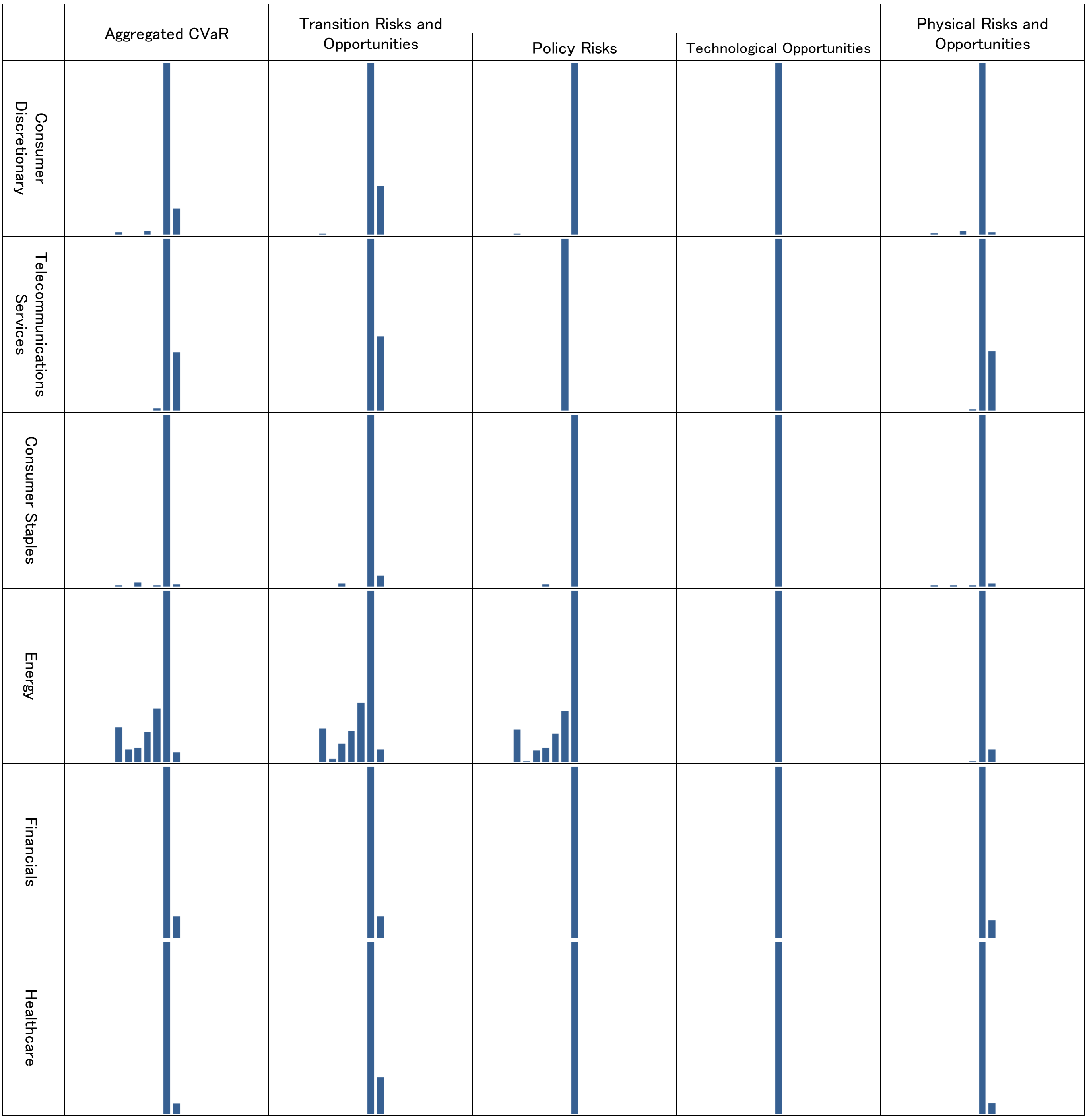
Figure 2-24: CVaR Histogram for GPIF Foreign Corporate Bonds Portfolio by Sector (1)



(Note) The horizontal axis represents 20 deciles (i.e. 20 bins at 10% intervals), with a maximum value of +100% and a minimum value of -100%. The value on the horizontal axis is positive when the value of the firm increases, and negative when the value of the firm decreases. The vertical axis represents the number of enterprises, with maximum frequency standardized to 100% within each sector/country. Thus, the frequency of the maximum value is not necessarily the same for each sector/country.

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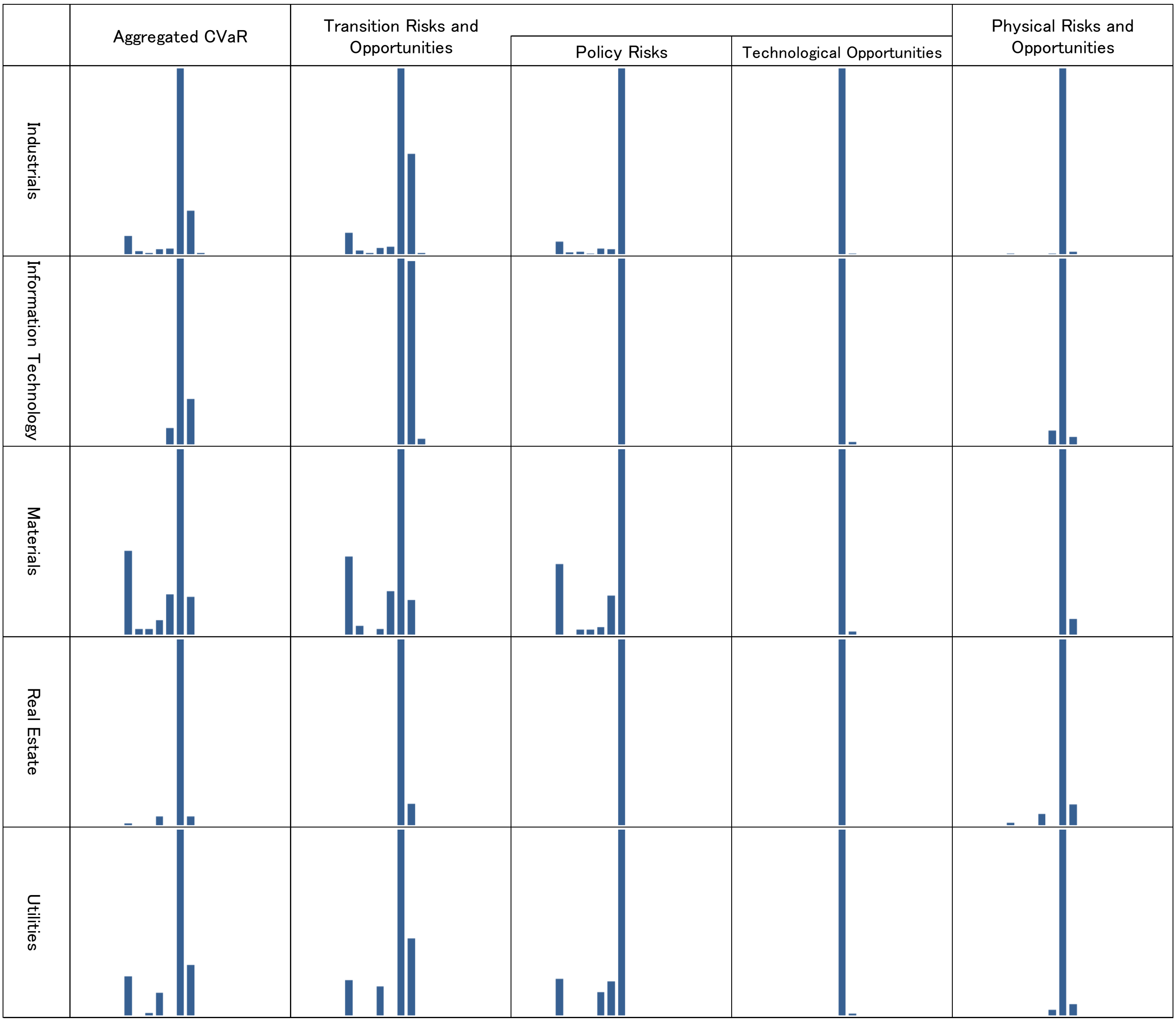
Figure 2-25: CVaR Histogram for GPIF Foreign Corporate Bonds Portfolio by Sector (2)



(Note)The horizontal axis represents 20 deciles (i.e. 20 bins at 10% intervals), with a maximum value of +100% and a minimum value of -100%. The value on the horizontal axis is positive when the value of the firm increases, and negative when the value of the firm decreases. The vertical axis represents the number of enterprises, with maximum frequency standardized to 100% within each sector/country. Thus, the frequency of the maximum value is not necessarily the same for each sector/country.

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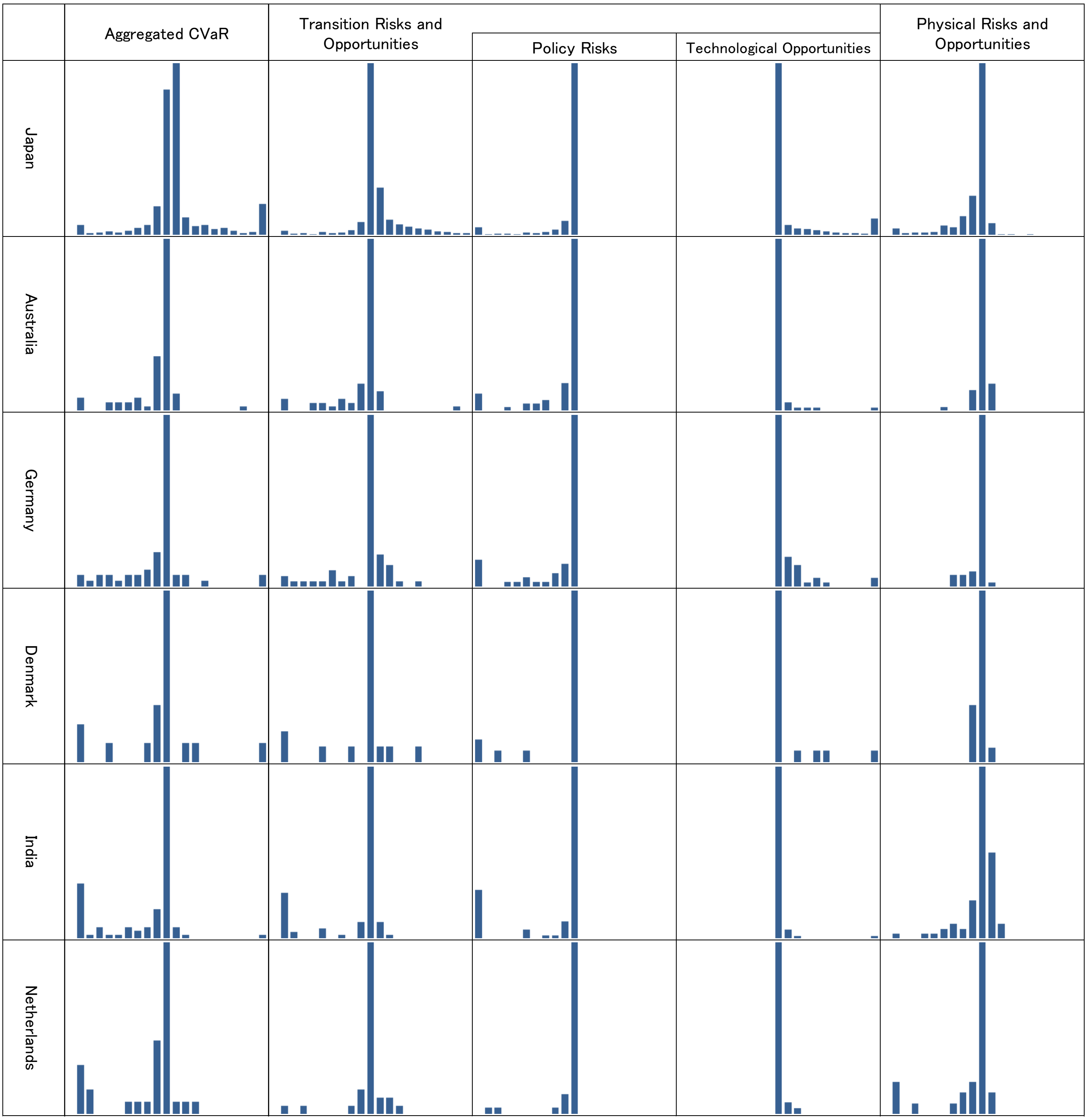
Figure 2-26: CVaR Histogram for GPIF Equities Portfolio by Country (1)



(Note)The horizontal axis represents 20 deciles (i.e. 20 bins at 10% intervals), with a maximum value of +100% and a minimum value of -100%. The value on the horizontal axis is positive when the value of the firm increases, and negative when the value of the firm decreases. The vertical axis represents the number of enterprises, with maximum frequency standardized to 100% within each sector/country. Thus, the frequency of the maximum value is not necessarily the same for each sector/country.

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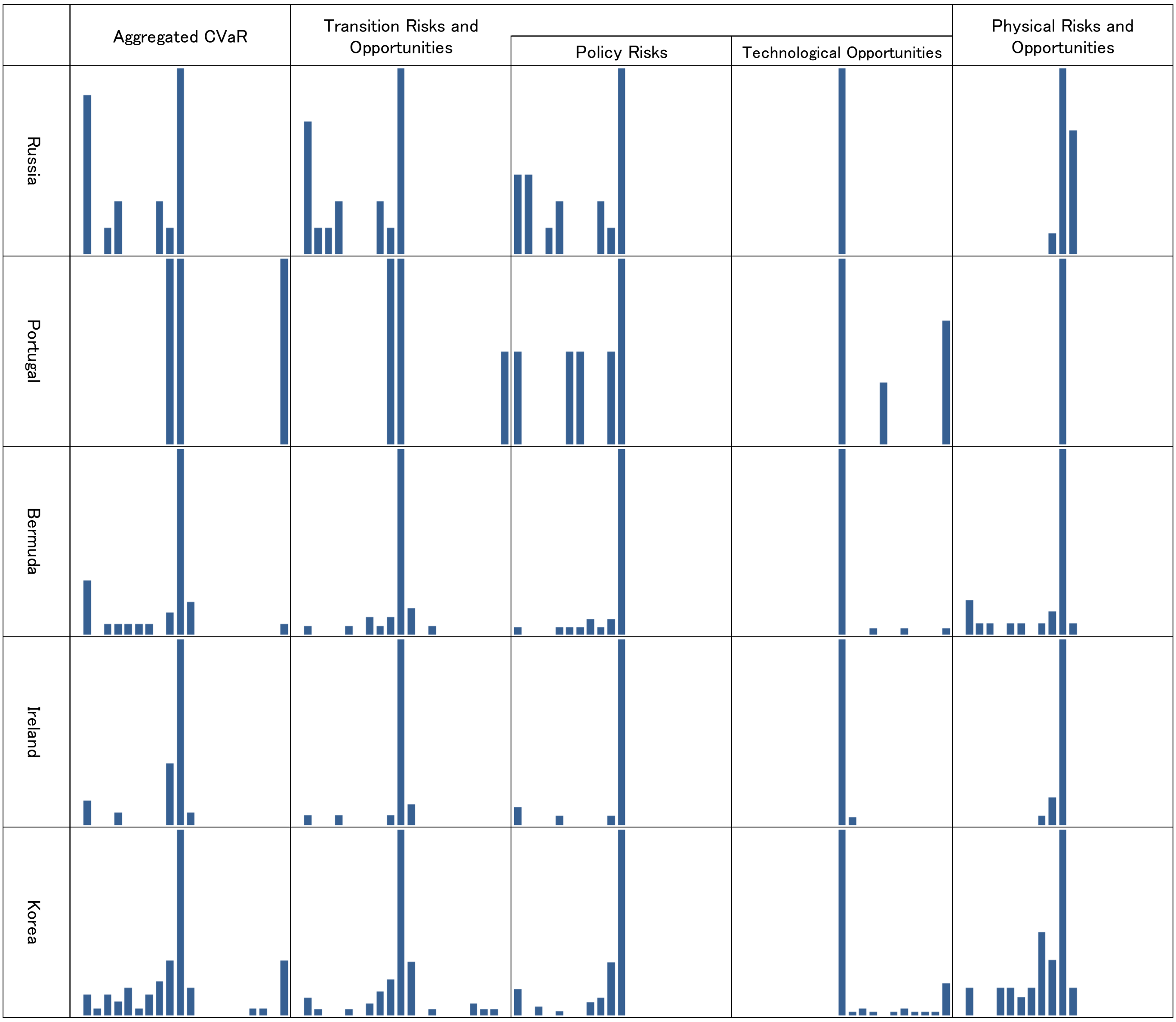
Figure 2-27: CVaR Histogram for GPIF Equities Portfolio by Country (2)



(Note)The horizontal axis represents 20 deciles (i.e. 20 bins at 10% intervals), with a maximum value of +100% and a minimum value of -100%. The value on the horizontal axis is positive when the value of the firm increases, and negative when the value of the firm decreases. The vertical axis represents the number of enterprises, with maximum frequency standardized to 100% within each sector/country. Thus, the frequency of the maximum value is not necessarily the same for each sector/country.

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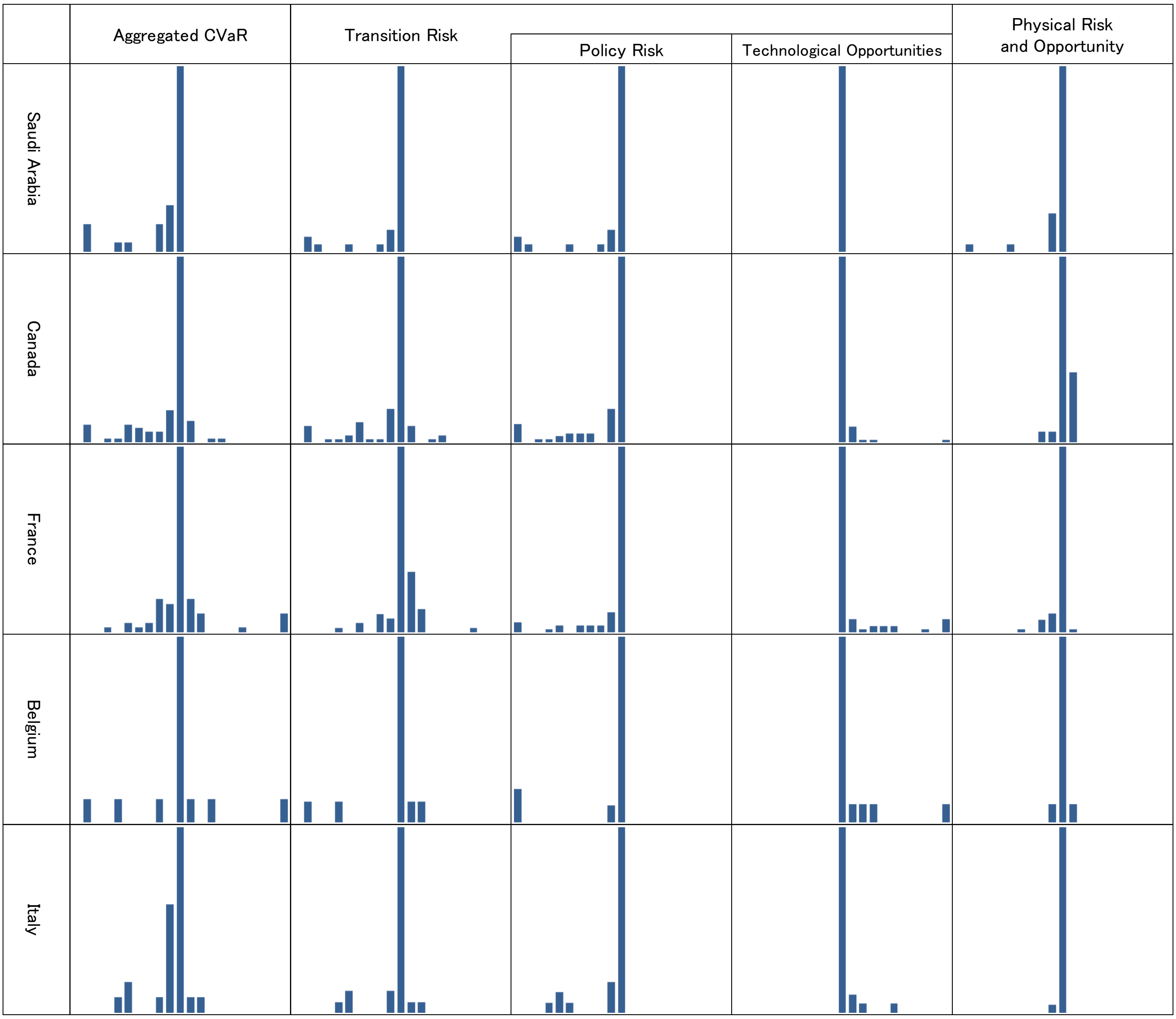
Figure 2-28: CVaR Histogram for GPIF Equities Portfolio by Country (3)



(Note)The horizontal axis represents 20 deciles (i.e. 20 bins at 10% intervals), with a maximum value of +100% and a minimum value of -100%. The value on the horizontal axis is positive when the value of the firm increases, and negative when the value of the firm decreases. The vertical axis represents the number of enterprises, with maximum frequency standardized to 100% within each sector/country. Thus, the frequency of the maximum value is not necessarily the same for each sector/country.

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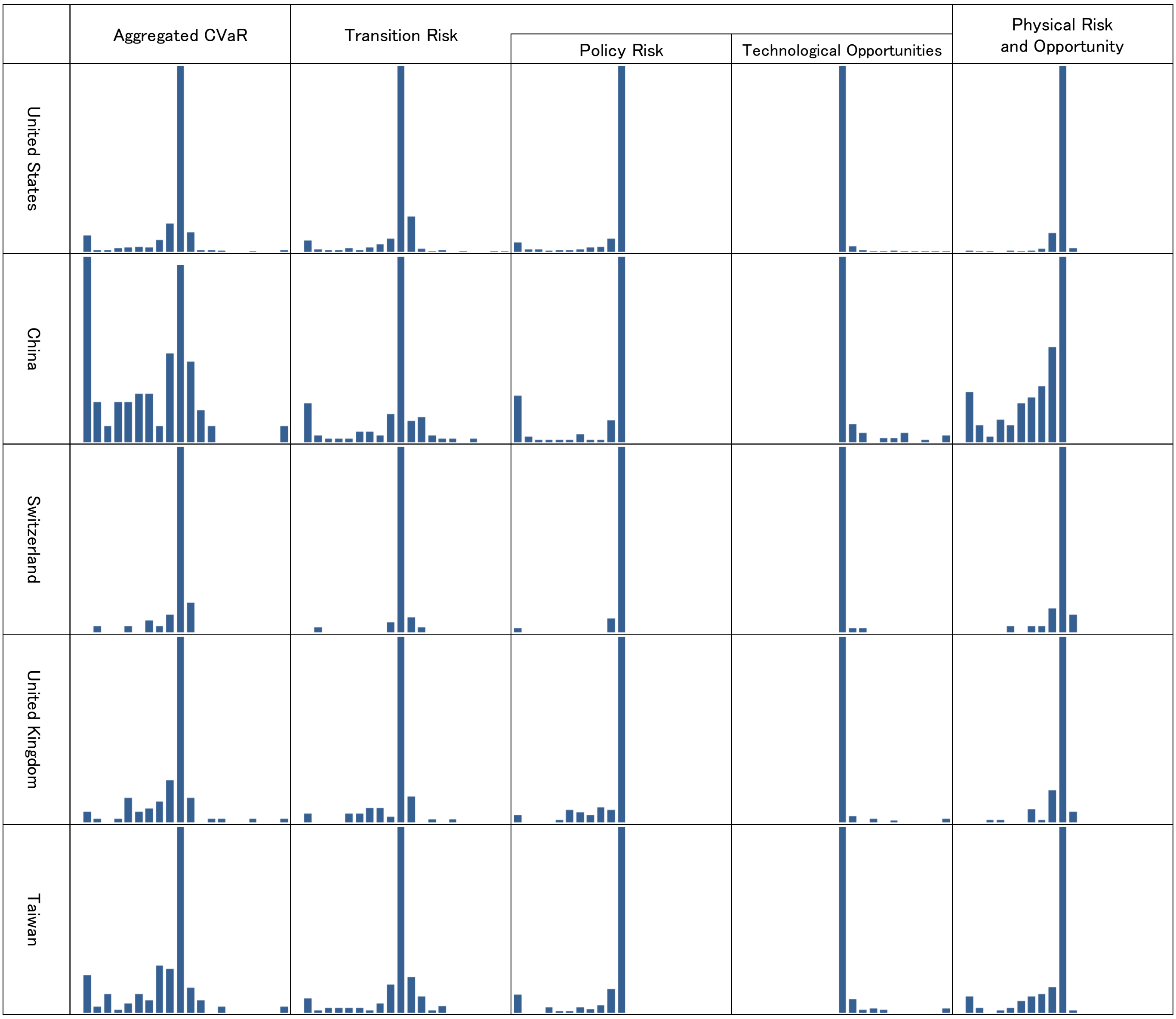
Figure 2-29: CVaR Histogram for GPIF Equities Portfolio by Country (4)



(Note)The horizontal axis represents 20 deciles (i.e. 20 bins at 10% intervals), with a maximum value of +100% and a minimum value of -100%. The value on the horizontal axis is positive when the value of the firm increases, and negative when the value of the firm decreases. The vertical axis represents the number of enterprises, with maximum frequency standardized to 100% within each sector/country. Thus, the frequency of the maximum value is not necessarily the same for each sector/country.

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(Supplementary Information) CVaR Concepts and Analytical Methodology

Characteristics of CVaR

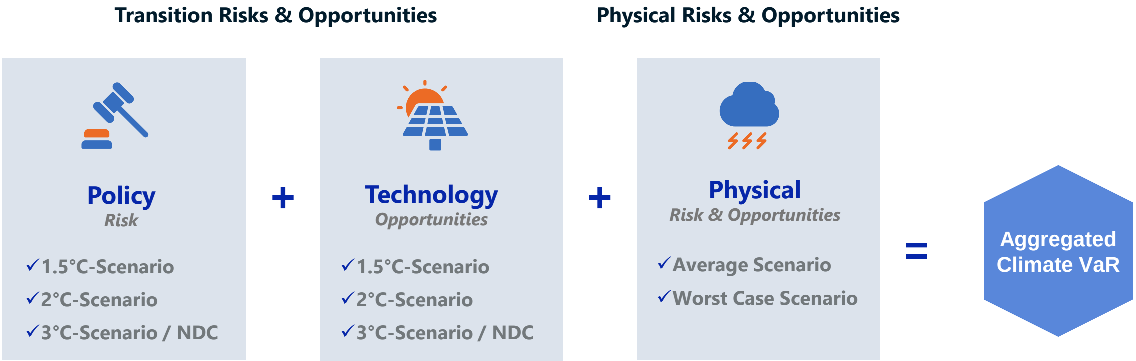
Climate Value at Risk (CVaR: Climate Value-at-Risk) is a valuation model that measures the potential impact of climate change on the value of a company and the securities it issues. In its “ESG Report 2018” published last year, GPIF disclosed information in line with the recommendations of the Task force on Climate-related Financial Disclosures (TCFD) by analyzing how its portfolio is aligned with different temperature rises based on an analysis by Trucost (note: page 61 of this report provides a similar analysis). MSCI CVaR offers an entirely different approach from the previous analysis as it measures the potential impact of future climate change-related costs and revenue opportunities arising from low carbon technologies on enterprise values and securities. While it is fair to say that there is still room for further improvement in this measurement approach, CVaR is a highly innovative analytical method as it uses financial theory to provide a holistic measure of aggregate climate change impact.

CVaR measures the impact of climate change-related costs and low carbon technology-related profits (potential revenue opportunities) on corporate equities and bonds using the following 4 steps:

Step 1: Estimate future climate change-related costs and profits
Step 2: Discount future climate-related costs and profits to present value
Step 3: Divide the present value of costs and profits by the current enterprise market value (EV: Enterprise Value)
Step 4: Apportion the present value into impacts on equity and debt securities

CVaR categorizes the various impacts of climate change into three components: ① Policy CVaR, ② Technology Opportunity CVaR and ③ Physical Risk and Opportunity CVaR, which are combined into Aggregated CVaR. ① and ② are known as "transition risks and opportunities" and can be directly added to the "physical risks and opportunities" estimated in ③. The following sections provide specific details on each of the three components of CVaR.

Figure 2-30: Composition of Aggregated CVaR and Scenario Analysis Assumptions



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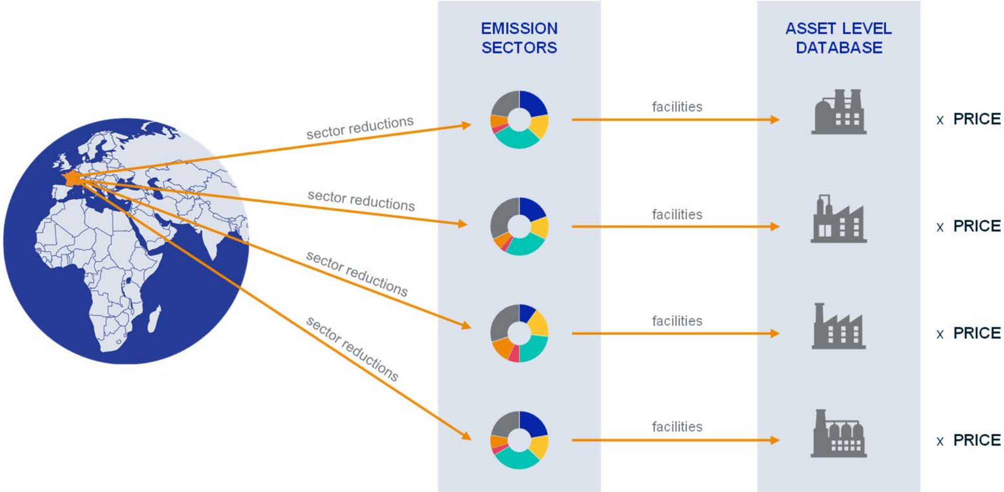
Climate Change Policy CVaR

Policy CVaR estimates a company's costs associated with reaching emissions reduction targets under future climate change policies through the end of the 21st century. The Policy CVaR model analyzes the downside risk of climate policy to a company and its securities by estimating the future cost to that company of reducing emissions to comply with these policies.

Policy CVaR begins with the quantification of country-level greenhouse gas (GHG) emission reduction targets proposed as Nationally Determined Contributions (NDCs) under the Paris Agreement. Country level emission reduction targets are then broken down into sector level targets based on the details within the NDCs as well as recently proposed national climate regulations. Next, the in-country sectoral targets are allocated to the companies in those countries and sectors using a "fair share" principle – i.e. all companies active in a given sector in a given country reduce their emissions in proportion to the amount that they contribute to the sector's total emissions level.

Utilizing corporate asset data in the MSCI ESG Research database, sector emission reduction targets are then assigned to each company's production facilities. With this, we are able to determine the emission reduction required from each individual facility owned and operated by various companies located around the world. The estimated climate policy cost is calculated for every company by multiplying the carbon reduction requirements for each by future carbon prices (Figure 2-31). The carbon price here is determined by using Integrated Assessment Models (IAMs: socio-economic system models that calculate the impact of climate change). Estimations of future carbon prices differ under specific policy scenarios (1.5 ℃, 2.0 ℃ and 3.0℃).

Figure 2-31: Schematic Diagram of CVaR Model for Climate-Change Policy Risks



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Low Carbon Technology Opportunity CVaR

The Technology Opportunity CVaR model forecasts low-carbon profits based on current estimated low-carbon revenues as well as company-specific patent data. The model aims to analyze companies' exposure to low carbon revenue opportunities as the world transitions to a low carbon society. The Swiss Federal Institute of Intellectual Property has collaborated extensively with MSCI ESG Research to support the development of the patent valuation and scoring assessment methodologies.

The model currently covers about 100 million unique patents granted from over 70 patent authorities worldwide. The quality of patents across more than 400 different groups of low carbon technologies are assessed. Using patent quality as a proxy for low-carbon innovative capacity, this model aims to provide an indicator of which companies are exposed to growth opportunities if 3ºC, 2ºC or 1.5ºC aligned climate policies are implemented on a global level. Technology Opportunity CVaR can be thought of as the flip side of Policy CVaR, as it pushes up the company's EV and security value.

Not all patents are of equal value, so the number of patent filings alone does not represent the innovative capacity of a company nor does it indicate future market innovation potential. Technology Opportunity CVaR therefore uses four statistical measures in patent valuation and scoring assessment (Figure 2-32).

Figure 2-32: Statistical Measures in Calculation of Patent Scores

Forward Citations	When patents are cited by other patents this is known as a forward citation. Therefore, the number of forward citations a patent receives is often used as a measure of a patent's significance. If a patent is frequently cited by others patent applications, such a highly cited patent is likely to be a fundamental technology or important technology patent.
Backward Citations	The number of patents cited by the patent in question when the application is filed. A higher number of backward citations means that the issuer of a patent refers to many established, older patent technologies. This therefore decreases the overall patent score.
Market Coverage	Total GDP of country/countries in which the patent application was filed. The higher the market coverage, the higher the patent score.
CPC Coverage	The number of CPC patent groups tagged. The Cooperative Patent Classification (CPC) system is based on the International Patent Classification (IPC) system. The CPC evaluates the relevance of each patent to a patent group based on various technology classifications. The higher the number of patent groups tagged, the higher the value.

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The profit from each company's low carbon technology is calculated by using a company’s aggregated patent scores to determine its share of future environmental revenue in the sector, then multiplying this by the average profit margin for the sector. The sector-level revenue forecasts for each year are equal to the associated policy costs for a given scenario calculated under Policy CVaR. This model is based on the assumption that one company’s cost to comply with climate policy is another company’s low-carbon revenue, as a result of selling products to help the regulated company to reduce emissions.

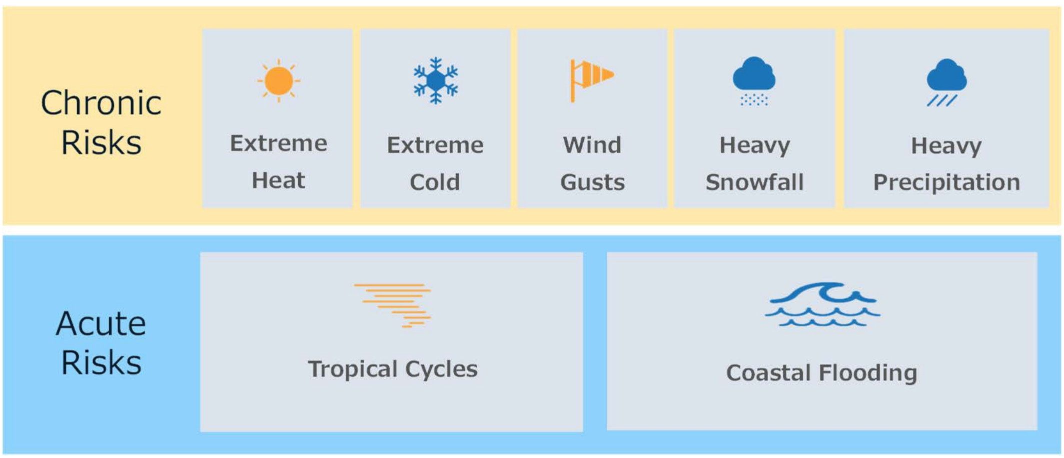
Physical Risk and Opportunity CVaR

Physical Risk and Opportunity CVaR uses observed weather patterns over the past 40 years to analyze the financial impact of acute and chronic weather events on companies over the next 15 years. The impact of physical risk can be aggregated on a regional, sectoral or company basis.

Physical CVaR estimates the physical risks and opportunities at the company facility level under selected scenario conditions (i.e. average scenario or aggressive scenario) using three factors: "exposure (geographical location, size, type and value of asset)", "hazards (the probability of occurrence and intensity of extreme weather events)" and "vulnerabilities (the propensity or predisposition of an asset to be affected)."

Physical CVaR analyzes the financial impacts of extreme weather events and models two types of climate risk in the context of its extreme weather analysis: chronic climate risks and acute climate risks, which are currently broken down into the following seven types of extreme weather events (Figure 2-33).

Figure 2-33: Physical Risks and Opportunities – Natural Disasters Subject to CVaR Analysis



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Financial Modelling Reflecting Climate Change Risks and Opportunities in Security Valuation

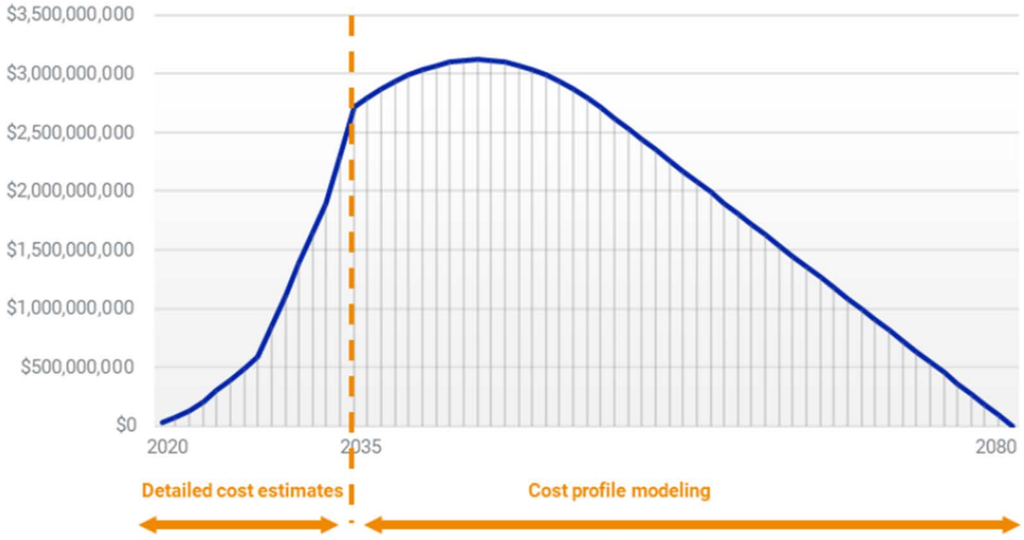
As mentioned earlier, the CVaR model estimates the impact of climate change related costs and opportunities on a company's equity and debt by following the 4 steps below:

Step 1: Estimate future climate change-related costs and profits
Step 2: Discount future climate-related costs and profits to present value
Step 3: Divide the present value of costs and profits by current EV
Step 4: Apportion the present values into impacts on equity and debt securities

Step 1 uses different approaches to estimate climate related costs and profits for the next 15 years and for year 16 and beyond. Climate costs for the first 15 years are calculated in detail for policy risks, technology opportunities and losses from business operations and damage to facilities caused by extreme weather (physical risk and opportunities). For year 16 and beyond, a separate mathematical model is used to estimate climate costs until the year 2080.

For Policy and Technology Opportunity CVaRs, the model assumes costs and profits will peak during the next 25 years then eventually decrease in a linear fashion to 0 in 2080 (Figure 2-34). On the other hand, actual global warming and other climate change effects are expected to continue over the long term, and thus Physical CVaR assumes that risks and opportunities will grow at a rate of 3% per annum until 2080.

Figure 2-34: Estimation Methods and Image of Climate Change Policy Costs and Low Carbon Technology Profits



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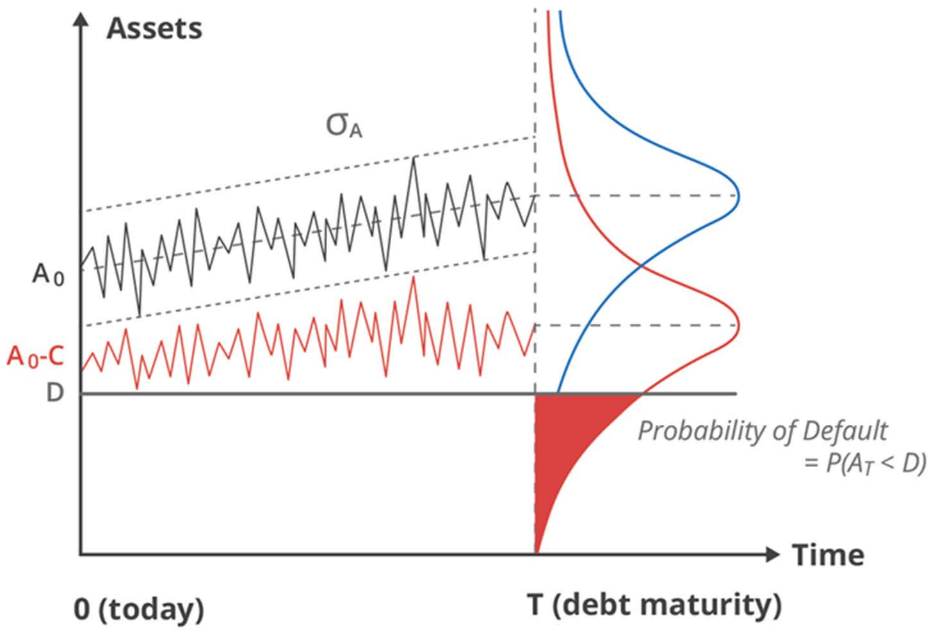
Step 2 is to discount the yearly future climate costs and profits calculated under Step 1 to present value using the weighted average cost of capital (WACC) of companies and the sectors in which they operate. The model assumes that the discount rate used for the first year is equal to company WACC and over time the rate transitions to average WACC for the sector by 2080.

Step 3 calculates CVaR for a company based on the present value of the cost and profit impact (as calculated in the previous step) divided by the current EV of the company. This value is interpreted as the impact of climate change-related costs and profits on enterprise value[6].

Finally, Step 4 breaks down the present value into the impacts on that company's equity and debt securities. In this step, the CVaR for debt securities is determined by applying the Merton model to estimate changes in the company's default probability resulting from climate-related costs and profits (Figure 2-35). Equity CVaR is then calculated using the values for the company's Aggregate CVaR and the CVaR for debt securities.

Figure 2-35: Merton Model Image



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6 Climate change-related costs and profits are assumed to not be priced into (i.e. are not reflected in) current enterprise value.

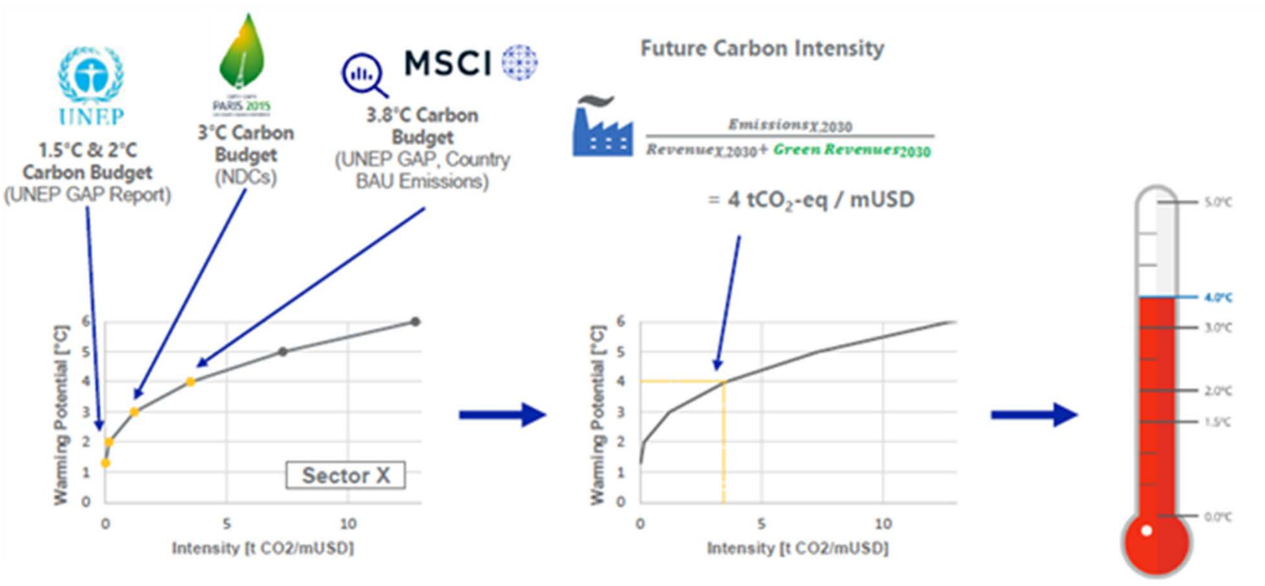
Portfolio Warming Potential

Warming Potential Methodology

Warming potential represents the global temperature increase by the year 2100 (from 1.3°C to 6.0°C) associated with a specific company's activities based on that company's projected future greenhouse gas emissions. In other words, it is possible to indicate the extent to which a company's current and future activities potentially contribute to global warming within a specific temperature range.

MSCI's warming potential estimation model references several different research papers and reports, including the Emissions Gap Report published by the UNEP (United Nations Environment Programme).[7] This literature forms the basis for deriving the relationship between warming potential and carbon intensity by sector, which makes it possible to estimate the level of temperature increase associated with a company's future business activities by plugging that company's projected future carbon intensity into the model (Figure 2-36). The portfolio temperature is the weighted average of the warming potential of its constituents. Note that warming potential is estimated at issuer levels, while CVaR values differ for equities and bonds even by the same issuer.

Figure 2-36: Warming Potential Methodology



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[7] Various analyses were conducted on the "emission gap," which is the difference between projected future greenhouse gas emissions and greenhouse gas emissions necessary to achieve the Paris target.

Warming Potential by Asset and Sector

Looking at the GPIF portfolio by asset, the warming potential of domestic equities is estimated at 2.76°C, which is below the 2.97°C estimated for foreign equities. Domestic bonds is estimated at 2.88°C, and foreign bonds is estimated at 2.76°C. Among GPIF investee companies, each asset class is still far from achieving the 2℃ target.

Turning to warming potential by sector, energy, utilities, materials, and consumer staples tended to show high values across all asset classes (Figure 2-37). In the case of communications services, consumer discretionary and financials, the warming potential of domestic assets is lower than foreign assets, while the warming potential of foreign assets in the information technology sector is lower than their domestic counterparts.

Figure 2-37: Warming Potential by Asset and Sector

(℃)	Domestic Assets		Foreign Assets	
	Equities	Corporate Bonds	Equities	Corporate Bonds
Total	2.76	2.88	2.97	2.76
Telecommunication Services	1.70	1.54	2.48	3.67
Consumer Discretionary	2.45	2.26	3.74	3.40
Consumer Staples	3.97	4.69	4.60	5.11
Energy	5.52	5.63	5.55	5.68
Financials	1.43	1.41	1.70	1.55
Healthcare	2.16	1.85	2.03	2.01
Industrials	3.14	3.49	3.27	3.25
Information Technology	2.40	3.76	2.11	1.96
Materials	4.68	5.29	5.11	5.50
Real Estate	3.42	3.55	3.85	3.99
Utilities	5.14	5.02	4.85	4.96

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Distribution of Warming Potential by Sector and Country

This section provides an analysis of GPIF's equity and bond portfolios broken down by sector and country using histograms to show the range of potential temperature increases. The horizontal axis in each histogram shows global warming potential grouped into 20 deciles, with a maximum value of 6°C and a minimum value of 1.3°C. The companies aligned to warming of 2°C or less appear in the 0 to 2nd decile. The vertical axis represents the number of companies, but is standardized to 100% as the maximum value. Thus, even at the same height, the actual frequency varies from sector to sector and from country to country.

The distribution of the domestic and foreign equity and bond portfolios can be broadly categorized into three types: ① sectors with the highest frequency close to 1.3℃ (e.g. communication services, financials, information technology), ② sectors with the highest frequency close to 6.0℃ (e.g. consumer staples, energy, materials, and utilities), and ③ sectors with an even distribution ranging from 1.3℃ to 6.0℃ (e.g. consumer discretionary, health care, industrials, and real estate) (Figure 2-38 to Figure 2-39).

This can be interpreted as follows: for group ①, the industry wide impact on global warming is limited in light of current business activities and future greenhouse gas emissions in the industry; for group ②, business activities in the overall industry are likely to have a major impact on global warming; and for group ③, there is a large difference in mitigation initiatives among companies in the industry.

The histograms by country (Figure 2-40) show that in most countries, many companies are distributed within the vicinity of 1.3℃ and 6.0℃, with the remaining companies are distributed uniformly between 1.3℃ and 6.0℃.

Figure 2-38: Distribution of Warming Potential for Each Asset Class by Sector (1)

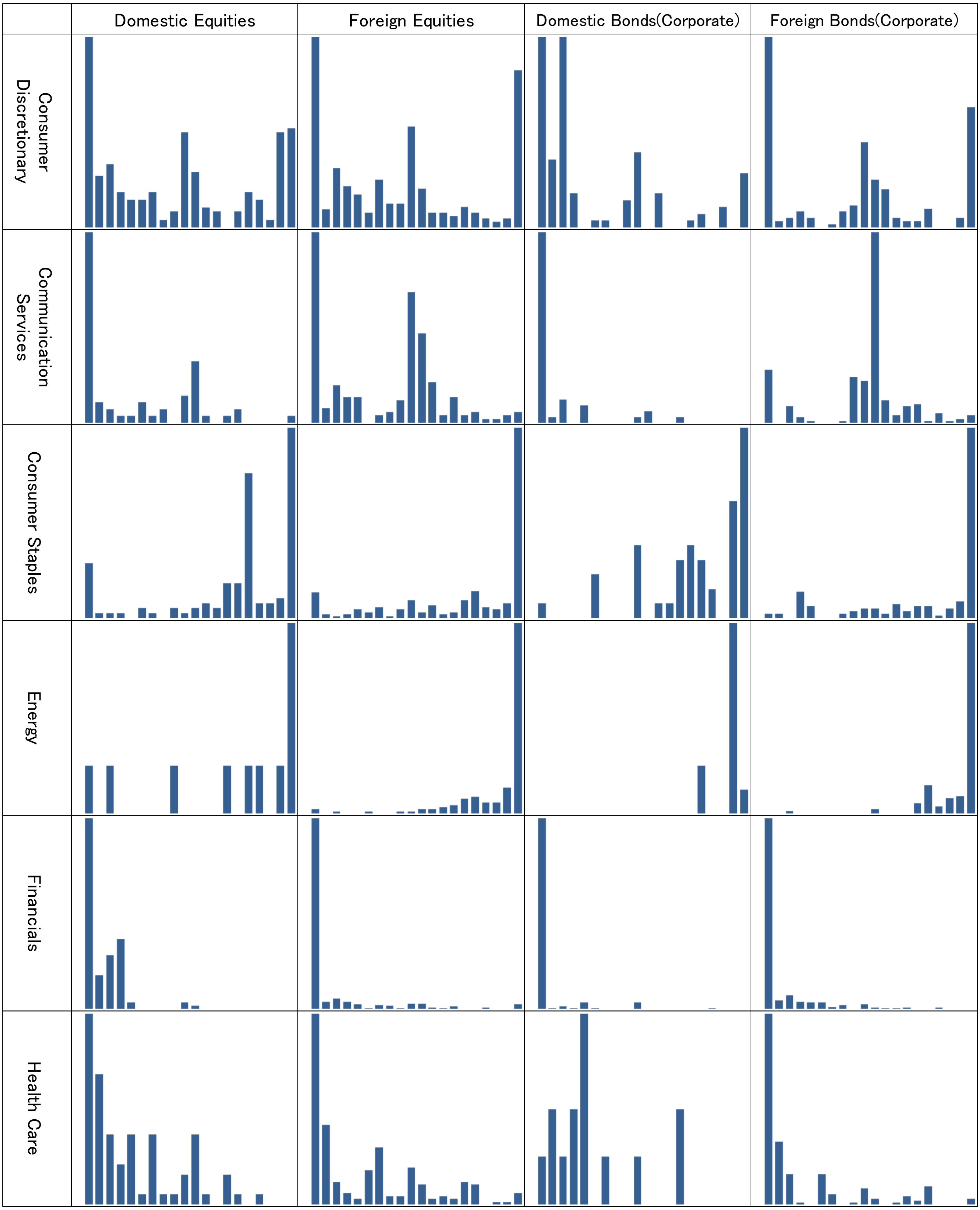
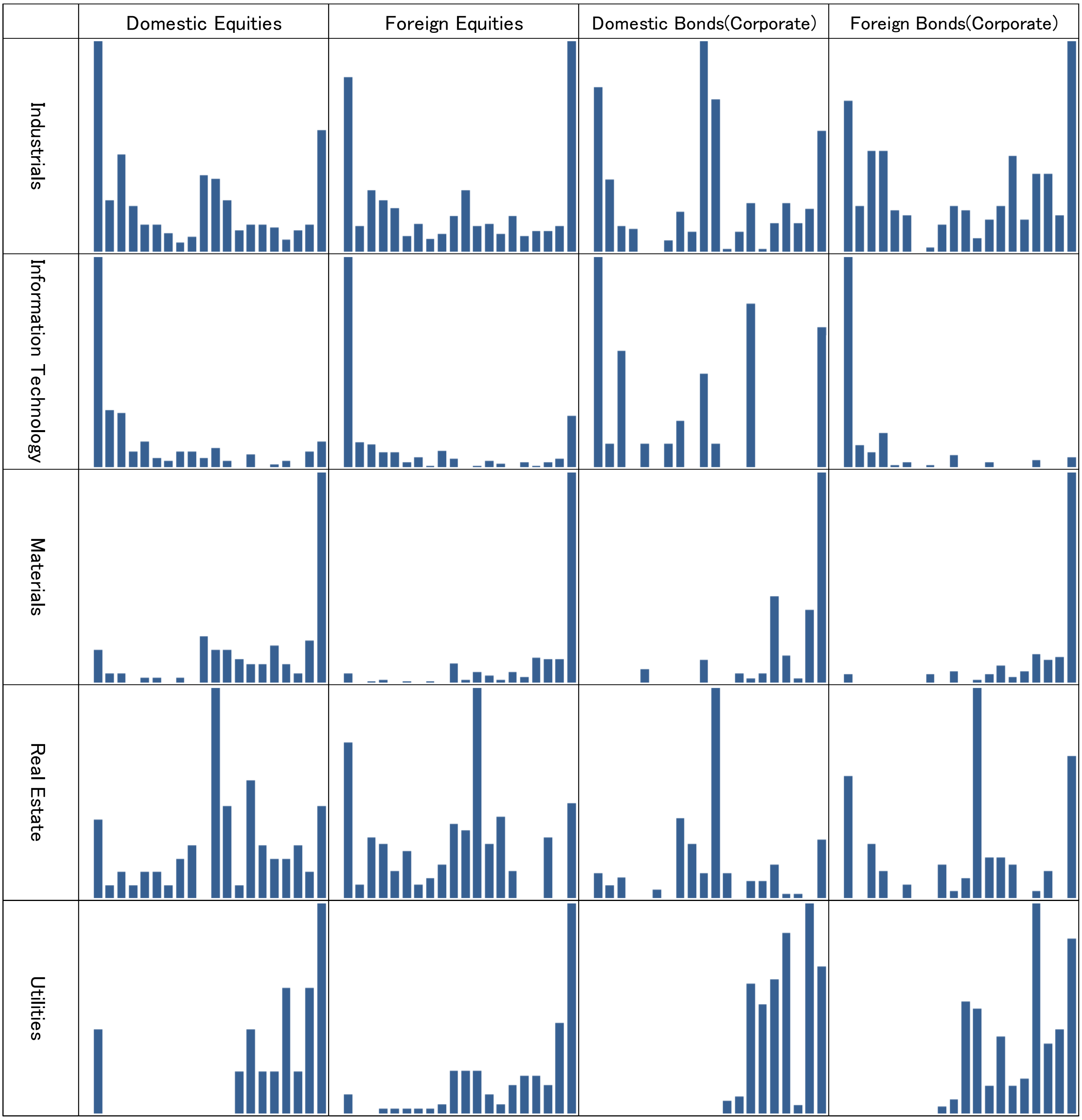


Figure 2-39: Distribution of Warming Potential for Each Asset Class by Sector (2)



(Note) The horizontal axis represents 20 bins at equal intervals, with a maximum value of +6.0°C and a minimum of +1.3°C. The vertical axis represents the number of enterprises, with maximum frequency standardized to 100% within each sector/country. Thus, the frequency of the maximum value is not necessarily the same for each sector/country.

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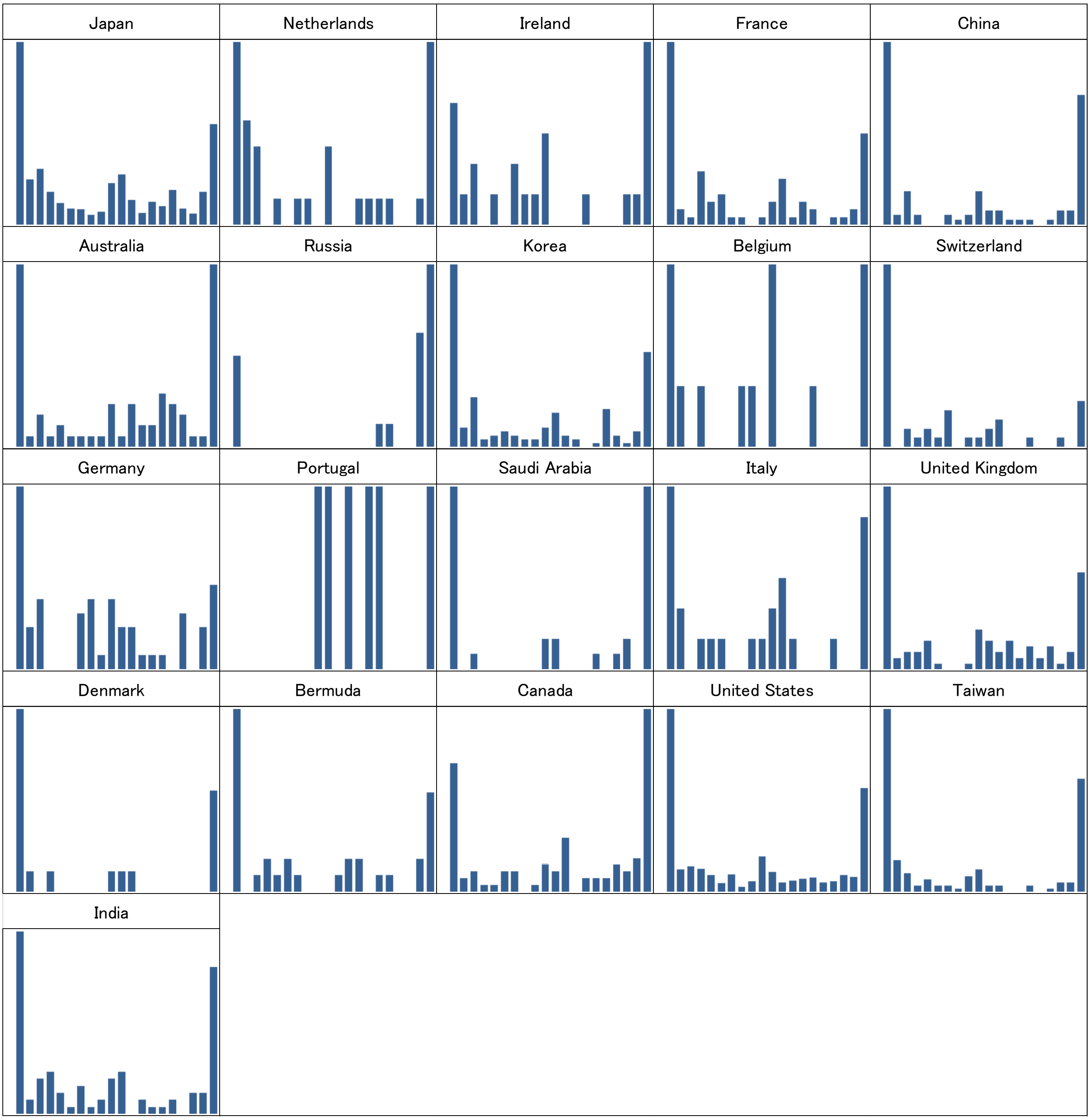
Figure 2-40: Distribution of Warming Potential for Equities Portfolio by Country



(Note) The horizontal axis represents 20 bins at equal intervals, with a maximum value of +6.0°C and a minimum of +1.3°C. The vertical axis represents the number of enterprises, with maximum frequency standardized to 100% within each sector/country. Thus, the frequency of the maximum value is not necessarily the same for each sector/country.

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Exposure to Fossil Fuel Activities

Share of Apportioned Revenues Derived from Fossil Fuel Activities

As part of our climate transition risk assessment, in this section we assess the exposure of GPIF's portfolio to fossil fuel activities using data provided by Trucost.

First, Figure 2-41 shows the portfolio's level of revenue dependency on fossil fuel-related activities by industry sector.

Domestic bonds have the highest exposure to companies engaging in fossil fuel-related activities. This is due to the high exposure of the domestic bond portfolio to the utilities and energy sectors. In the domestic bond portfolio, the share of total revenue coming from fossil-fuel activities reached approximately 6.1% in FY 2019. Among the different types of fossil fuel activities investee companies engage in, the portfolio has the highest exposure to natural gas power generation at 3.79%, followed by coal power generation at 1.57% and petroleum power generation at 0.34%. This is higher than other asset classes in aggregate, but is approximately 3% lower than FY 2018.

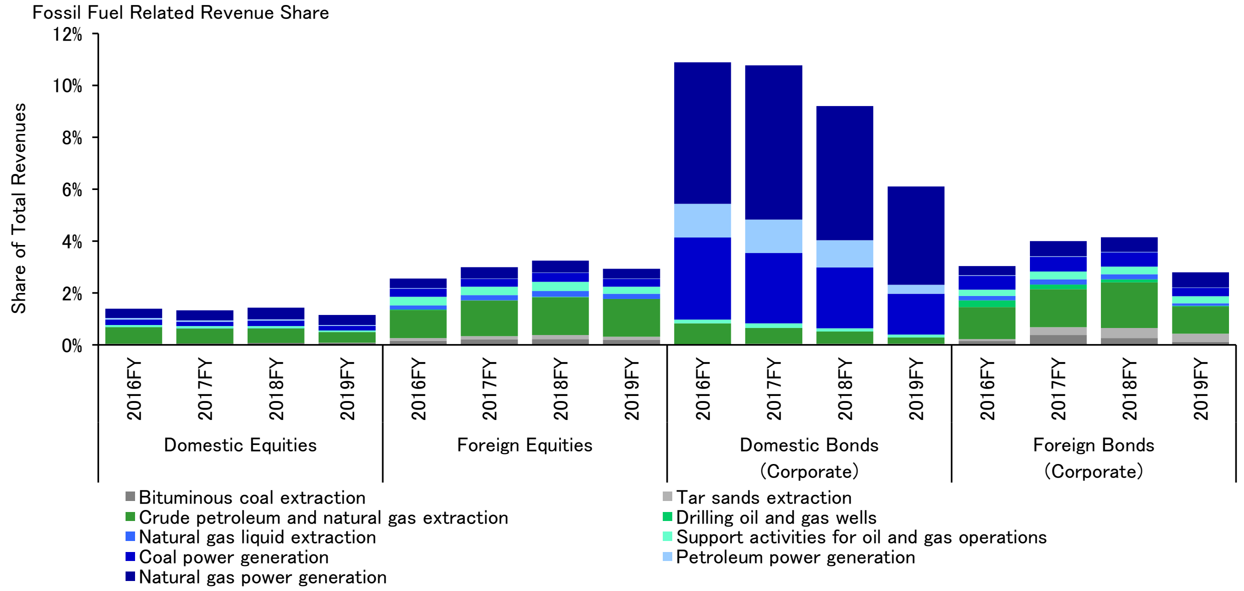
Exposure to Reserves and Fossil Fuel Related CAPEX

Second, we analyze two additional metrics that provide additional insight into stranded asset risk. First are the carbon emissions embedded within company owned fossil fuel reserves, which can be considered 'unburnable' if 2˚C targets are to be achieved. Second are the capital expenditures set aside for future fossil fuel related activities such as further exploration and extraction. Both metrics are based on disclosures published by investee companies.

Figure 2-42 shows total tons of apportioned "future" CO2 from reserves, broken down by reserve type. Figure 2-43 shows the total apportioned capital expenditure on fossil fuel related activities, again broken out by reserve type.

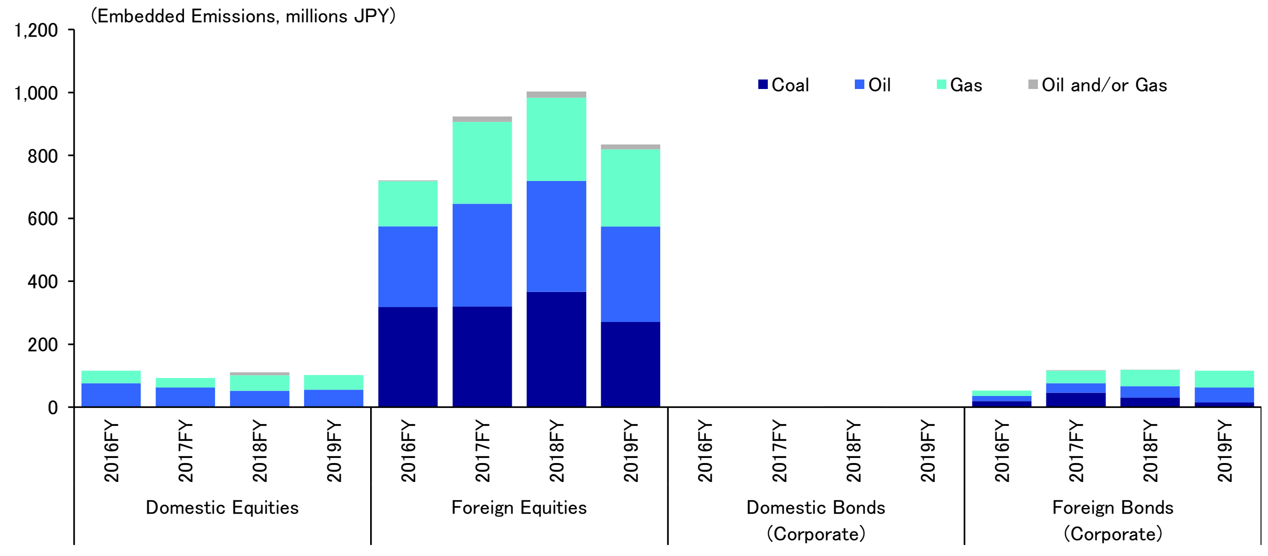
The foreign equities portfolio remains the primary source of apportioned reserves and fossil fuel related CAPEX. However, it should be noted that this may indicate higher disclosure among companies in the portfolio rather than fewer actual reserves. Nevertheless, the foreign equities portfolio has seen a noticeable drop versus FY 2018.

Figure 2-41 Fossil Fuel Revenues as a Share of Total Apportioned Revenues



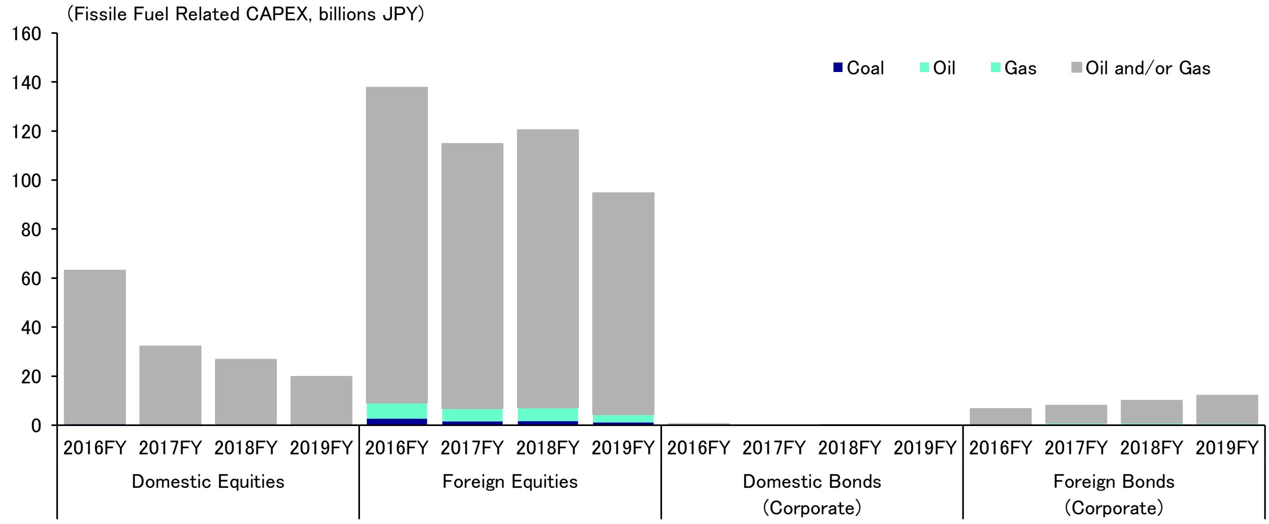
(Source)S&P Trucost Limited©Trucost 2020

Figure 2-42: Apportioned Embedded Emissions from Fossil Fuel Reserves



(Source)S&P Trucost Limited©Trucost 2020

Figure 2-43: Apportioned Capital Expenditure on Fossil Fuel Related Activities



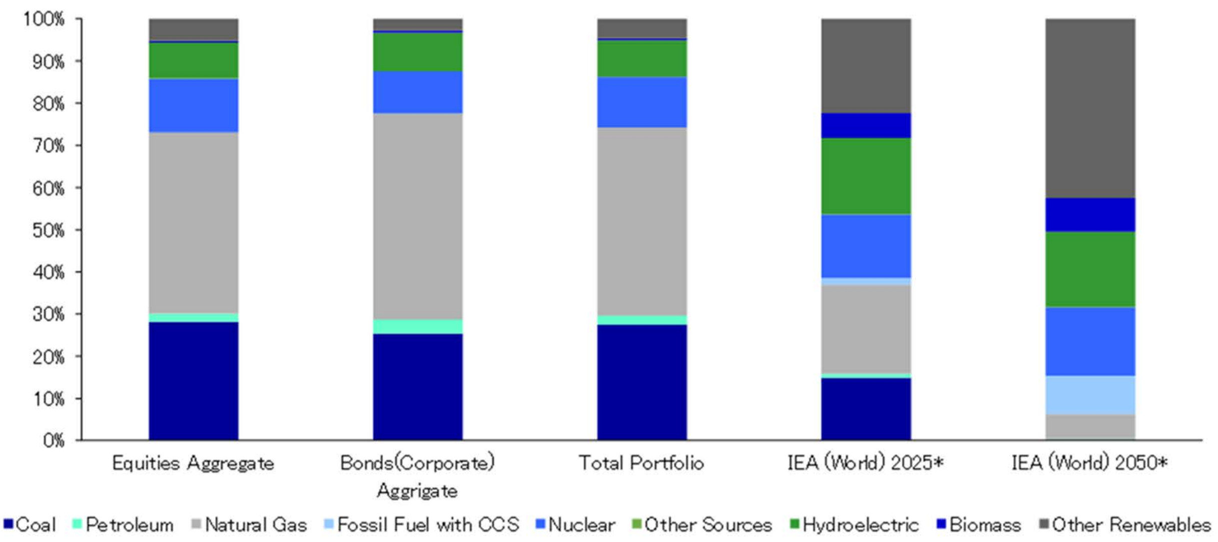
(Source)S&P Trucost Limited©Trucost 2020

Energy Mix

This section reviews the amount of physical units of power (GWh) generated by companies within the equity, corporate bond, and total aggregate portfolios in order to calculate the corresponding energy mix. The figures rely on company disclosures. The energy mix is then compared to the 2-degree aligned energy mix requirements for 2025 and 2050 respectively – as estimated by the International Energy Agency (IEA) (Figure 2-44). The results show that all portfolios have a higher share of fossil fuel energy (derived from coal, petroleum, and natural gas) and a lower share of renewable energy (derived from hydroelectric, biomass, and other renewables) than IEA's 2-degree scenarios.

In comparison to FY 2018, FY 2019 saw an increase in the share of natural gas-derived energy across all portfolios. The share of hydroelectric energy in foreign corporate bonds have nearly doubled to 10.16%.

Figure 2-44: 2-Degree Alignment: Energy Mix



(Source)S&P Trucost Limited©Trucost 2020

Climate Change Related Analysis of Government Bond Portfolios

Here, we analyzed climate-related risks (transition risk and physical risk) and opportunities in GPIF government bond portfolios in accordance with TCFD recommendations. Figure 2-45 summarizes the results of these analyses. In this table, a positive (negative) number denotes a smaller (larger) risk compared to the benchmark. For Japan, we compared the benchmark against a portfolio that assumes GPIF holds 100% Japanese government bonds. This allows us to observe the climate change risk in domestic bonds compared to the benchmark, which includes foreign bonds.

We found transition risks were higher for the overall portfolio compared to the benchmark for all three categories examined: (1) The difference between current greenhouse gas emissions and 2050 emissions consistent with the 2˚C target; (2) The difference between current actual greenhouse gas emission trends and the trends assumed in emission targets set by each country itself; and (3) The temperature increase resulting from greenhouse gas emission reduction targets set by national governments to contribute to achievement of the 2˚C target (NDCs). Japan exceeds the benchmark except for item (1). In addition, in terms of the physical risks, the risk to agriculture and the risk of natural disaster associated with climate change is higher than the benchmark for the overall government bond portfolio. Meanwhile, the magnitude of the risk of sea level rise is remarkably high for Japan.

In addition, we analyzed the ratio of green bond issuance to GDP and the share of green energy in energy use as a part of the low-carbonization opportunity analysis. In each analysis, GPIF’s entire government bond portfolio outperformed the benchmark, but Japan underperformed the benchmark (Figure 2-46 to Figure 2-47).

Figure 2-45: Summary of Government Bonds Portfolio Analyses

	GPIF investments	Japan
Carbon footprinting		
Territorial GHG / GDP	−5.6%	1.6%
[Territorial + imported] GHG / GDP	−1.1%	−2.5%
Transition risk analysis		
①GHG distance to 2050 2° C target	−0.2%	−1.2%
②GHG emissions gap between distance to target and trend	−6.2%	3.6%
③NDC equivalent temperature	−5.0%	4.6%
Physical risk analysis		
Sea level exposure	15.2%	−23.8%
Climate-related natural disaster exposure	−12.4%	40.5%
Agricultural exposure	−62.1%	47.3%
Low carbon opportunities analysis		
Green bonds performance ratio	6.7%	−35.5%
Green Share	1.6%	−2.9%

(Note)The unit of GHG emission is thousand tCO_2e/ billion yen.
The benchmark is the weighted average of foreign sovereign bonds and Japanese government bonds based on the ratio in the basic portfolio. For Japan, we compared the benchmark against a portfolio that assumes GPIF holds 100% Japanese government bonds.

(Source)FTSE Russell, Beyond Ratings

Figure 2-46: Country vs Portfolio Performance Gaps for Most Relevant Countries

	Territorial GHG / GDP	[Territorial + imported] GHG / GDP	①GHG distance to 2050 2° C target	②GHG emissions gap between DTT and trend	③NDC equivalent temperature	Sea level exposure	Agricultural exposure	Climate-related natural disaster exp.	Green bonds performance ratio	Green Share
Japan	7%	-1%	-1%	9%	9%	-46%	68%	47%	-40%	-4%
USA	-5%	12%	-17%	-37%	-41%	71%	-2%	38%	-63%	-27%
France	36%	23%	37%	39%	50%	67%	-51%	-686%	490%	-15%
Spain	15%	0%	31%	35%	35%	49%	-180%	65%	112%	98%
Belgium	13%	4%	11%	10%	19%	-29%	65%	-1289%	310%	-47%
Netherlands	10%	2%	-1%	-21%	14%	-575%	-51%	-640%	1066%	-59%
Mexico	-141%	-86%	54%	-5%	45%	82%	-311%	-32%	-91%	-11%
Indonesia	-486%	-304%	43%	36%	23%	15%	-3502%	33%	32%	131%
Malaysia	-24%	-67%	88%	-187%	-32%	41%	-2787%	66%	-61%	-50%
Brazil	-182%	-105%	35%	-25%	24%	70%	-881%	63%	-60%	207%
PF vs BM	-6%	-1%	0%	-6%	-5%	15%	-62%	-12%	7%	2%

(Note)The benchmark is the weighted average of foreign sovereign bonds and Japanese government bonds based on the ratio in the Policy Asset Mix.
Positive values indicate where the country has better performance than the portfolio, negative values show where a country underperforms the portfolio.
(Source)FTSE Russell, Beyond Ratings

Figure 2-47: Contributions to the Portfolio vs Benchmark Performance Gap for Most Relevant Countries

	Territorial GHG / GDP	[Territorial + imported] GHG / GDP	①GHG distance to 2050 2° C target	②GHG emissions gap between DTT and trend	③NDC equivalent temperature	Sea level exposure	Agricultural exposure	Climate-related natural disaster exp.	Green bonds performance ratio	Green Share
Japan	-0.3%	0.4%	0.2%	-0.6%	-0.8%	4.0%	-7.9%	-6.7%	5.9%	0.5%
USA	-1.2%	1.3%	-2.0%	-5.2%	-5.5%	8.6%	-7.5%	3.5%	-6.9%	-3.0%
France	0.2%	0.2%	0.3%	0.3%	0.4%	0.6%	-1.1%	-5.9%	4.1%	-0.1%
Spain	0.1%	0.0%	0.2%	0.2%	0.2%	0.4%	-2.6%	0.4%	0.9%	0.7%
Belgium	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	-2.5%	0.6%	-0.1%
Netherlands	0.0%	0.0%	0.0%	0.0%	0.0%	-0.5%	-0.2%	-0.8%	1.3%	-0.1%
Mexico	-0.5%	-0.3%	0.2%	0.0%	0.1%	0.3%	-1.9%	-0.2%	-0.3%	0.0%
Indonesia	-1.5%	-0.9%	0.1%	0.1%	0.1%	0.1%	-16.5%	0.1%	0.1%	0.4%
Malaysia	0.0%	-0.1%	0.1%	-0.3%	-0.1%	0.1%	-5.9%	0.1%	-0.1%	-0.1%
Brazil	-0.5%	-0.3%	0.1%	-0.1%	0.1%	0.2%	-4.0%	0.2%	-0.2%	0.6%
Other	-1.9%	-1.4%	0.6%	-0.6%	0.5%	1.5%	-14.8%	-0.6%	1.2%	2.7%
PF vs BM	-5.6%	-1.1%	-0.2%	-6.2%	-5.0%	15.2%	-62.1%	-12.4%	6.7%	1.6%

(Note)The benchmark is the weighted average of foreign sovereign bonds and Japanese government bonds based on the ratio in the Policy Asset Mix.
Positive values indicate where the country has better performance than the benchmark, negative values show where a country underperforms the benchmark.
(Source)FTSE Russell, Beyond Ratings

Transition Risk Analysis

Transition Risks: Most Countries Far from Achieving the 2˚C Target

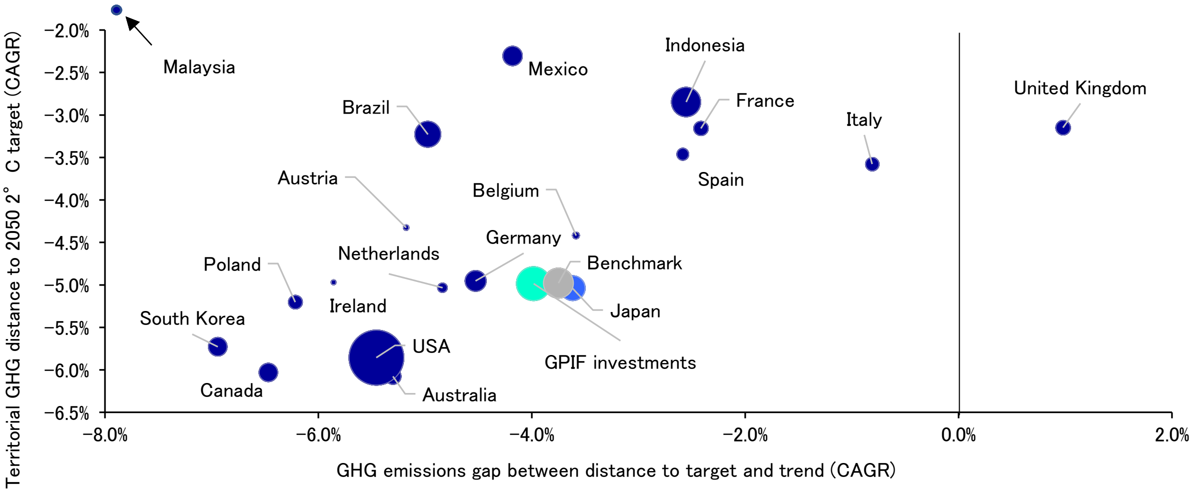
The risk of increased fiscal spending associated with the reduction of greenhouse gas emissions to achieve the 2˚C target could have an impact on government bond prices in the future. Therefore, the transition risk analysis focuses primarily on current greenhouse gas emissions and indicators related to greenhouse gas emission reductions consistent with the 2˚C target (Figure 2-48). Here, we analyze greenhouse gas emissions in terms of the categories "Domestic" and "Exports".

The vertical axis in the graph represents "Annual reduction in greenhouse gas emissions required to achieve the 2˚C target" (1). The smaller the dot, the less greenhouse gas emissions need to be reduced to achieve greenhouse gas emissions consistent with the 2˚C target by 2050. The horizontal axis represents "Difference between greenhouse gas emissions consistent with the 2˚C target and historical trend" (2). Positive values indicate that current trends will result in greenhouse gas emissions being reduced by more than the target set for that country.

The nations needing to reduce greenhouse gas emissions the least to achieve the 2˚C target are Malaysia, Mexico, Indonesia and the U.K., in that order. However, if we look at the current trend in greenhouse gas emission reductions on the horizontal axis, the U.K. is the only country on track to reduce emissions more than required to meet their target.

GPIF's government bond portfolio has a more negative value for (2) than the benchmark. For Japan, while the value for (1) is about the same as the benchmark and GPIF's government bond portfolio, we were able to confirm that the country was able to successfully reduce actual greenhouse gas emissions as shown by the values for (2).

Figure 2-48: 2˚C Target and Greenhouse Gas (GHG) Emissions



(Note)GPIF investments and benchmark data are based on averages weighted by the value of holdings (VOH); Bubble size represents total territorial GHG emissions for 2019

Benchmark aggregation approach: Share of JP PF in the policy PF's former target allocation (70% JP)

(Source)FTSE Russell, Beyond Ratings

Physical Risk Analysis

Physical Risks: Physical Risks Can be a Financial Burden on Countries

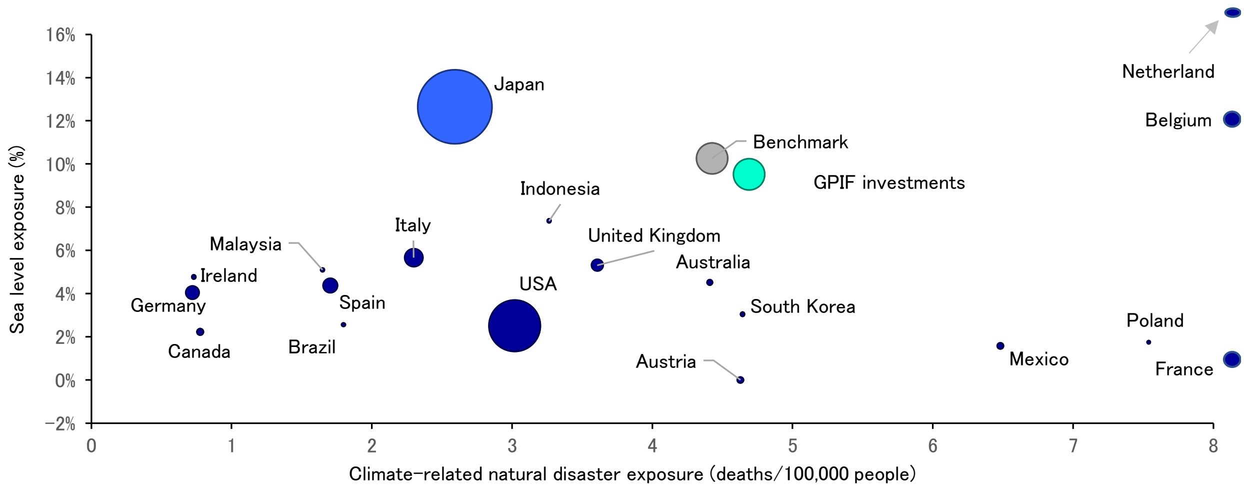
Among the currently measurable indicators, the physical risks considered to have the largest impact on a country's fiscal spending and the value of its government bonds are exposure to sea level rise and exposure to climate change-related natural disasters, such as droughts, floods and heat waves. These indicators are analyzed below.

The Netherlands has the largest exposure to the risk of sea level rise (58.5%). Our analysis showed that next in line are Japan, Belgium, Indonesia, Italy and the United Kingdom (Figure 2-49). The countries with the greatest exposure to the risk of natural disasters associated with climate change are Belgium (68.0 deaths per 100,000 people), France (38.4 deaths per 100,000 people), the Netherlands (36.2 deaths per 100,000 people), and Poland (7.5 deaths per 100,000 people), in that order. Against this backdrop, the share of Japanese holdings in GPIF's portfolio are small compared to the benchmark, so the risk of sea level rise is slightly less than the benchmark. On the other hand, the risk of natural disasters related to climate change was slightly higher than the benchmark.

Note that we think there is room for improvement in the physical risk analysis used in this study. The data used in this analysis for exposure to risk of sea level rise is based on the percentage of the total population living at or below 5 meters above sea level, and does not take into account various measures intended to deal with sea level rise, such as the construction of breakwaters and seawalls. Of course, some measures have already been taken in countries such as the Netherlands and Japan, which face potential risks. Furthermore, the data regarding exposure to the risk of natural disasters associated with climate change is based on the number of fatalities in the past from that type of disaster. However, results can be affected by the exact conditions surrounding relatively recent disasters.

GPIF believes that it is important to include factors such as measures being taken against risks in future analyses in order to fully understand the status of physical risks.

Figure 2-49: Country Exposure to Sea Level Rise Risk and Climate Change-Related Natural Disaster Risk



(Note)GPIF investments and benchmark data are based on averages weighted by the value of holdings (VOH); Bubble size represents total portfolio weights; Singapore data are not applicable
Benchmark aggregation approach: Share of JP PF in the policy PF's former target allocation (70% JP)
(Source)FTSE Russell, Beyond Ratings

Analysis of Agricultural Exposure

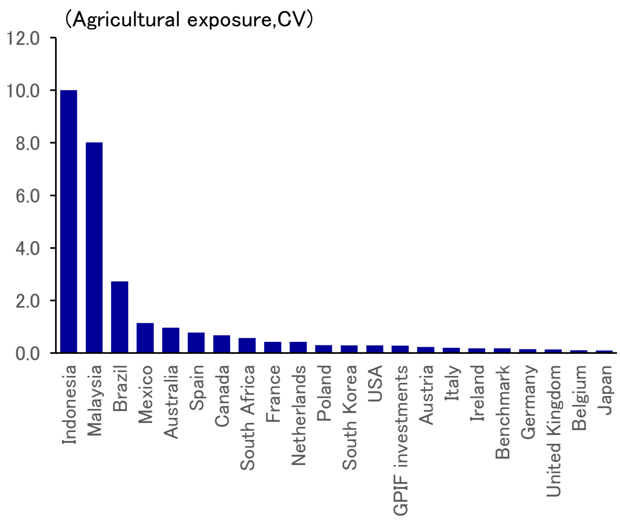
Another indicator that measures physical risks of government bonds is agricultural exposure. This shows the fluctuations of agricultural production for each country[8]. Agricultural exposure allows us to analyze the impact of climate change on agricultural production within a country's economy.

In this analysis, countries with a higher weight of agricultural production in GDP and greater fluctuations in agricultural production due to climate change are at higher risk. Looking at the agricultural exposure by country, we can see that while the agricultural exposure of emerging countries such as Indonesia, Malaysia and Brazil are high, the agricultural exposure is small in developed countries such as the United States and Japan. (Figure 2-50).

Looking at the degree of contribution to the GPIF portfolio as a whole, in addition to the large influence by the United States and Japan due to large holdings, the agricultural exposure itself is extremely high in Indonesia and Malaysia, which have smaller weights. These countries are the main countries contributing to the increase in the portfolio's agricultural exposure (Figure 2-51).

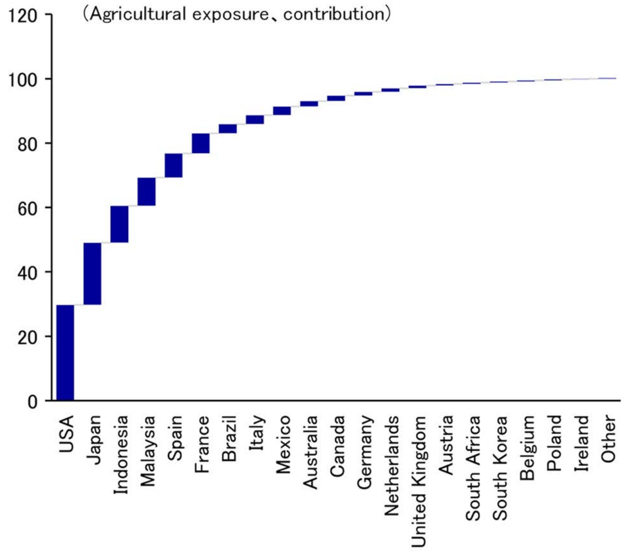
[8] Agricultural Exposure is Coefficient of variation of agricultural production (in kilocalories) weighted by the share of agriculture in GDP.

Figure 2-50: Agricultural Exposure by Country



(Source)FTSE Russell, Beyond Ratings

Figure 2-51: GPIF Government Bond Portfolio Agricultural Exposure Contributions of Each Country



(Source)FTSE Russell, Beyond Ratings

Opportunities in Government Bond Portfolios

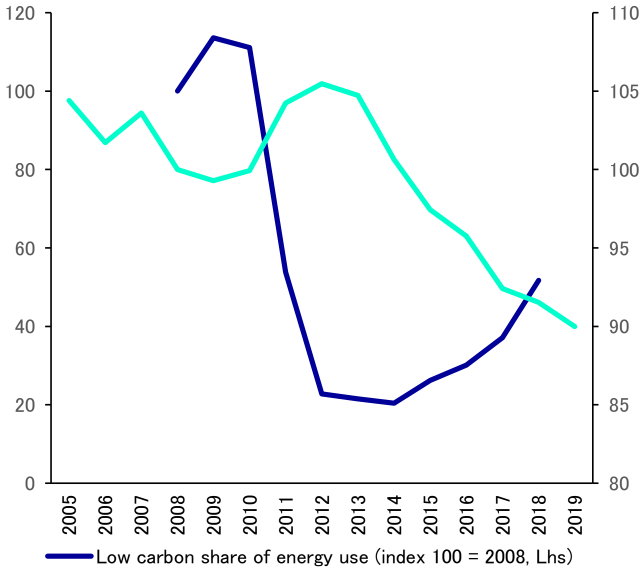
Issuance of Green Bonds and Low-Carbon Power Generation

In Japan, the proportion of low-carbon power generation, including nuclear power generation, dropped sharply after 2011 following the Fukushima Daiichi Nuclear Power Plant accident caused by the Great East Japan Earthquake (Figure 2-52). There is controversy over whether nuclear power generation should be positioned as environmentally friendly power generation due to the magnitude of the environmental impact at the time of the accident. But in Japan, the supply of power by thermal power generation increased due to the suspension of nuclear power generation. As a result, greenhouse gas emissions per GDP increased over 2012 and remained at a high level thereafter. However, due to the increase in the low-carbon power generation ratio supported by the expansion of solar power and hydropower, greenhouse gas emissions have started to decline. At the same time, the ratio of green bond issuance to GDP in Japan has been gradually increasing since 2017(Figure 2-53).

However, if we compare the ratio of green bond issuance to GDP and the share of green energy in energy use in each country (Figure 2-54), while there seems to be a correlation in some countries, it does not appear to be strong. The Netherlands (1.5%), France (0.8%) and Ireland (0.6%) have high green bond issuance ratios, but their green share in energy use is not high compared to other countries. On the other hand, in Brazil (13.3%), Austria (12.4%) and Canada (12.0%), where green energy ratios are high, the ratio of green bonds remains at the benchmark level.

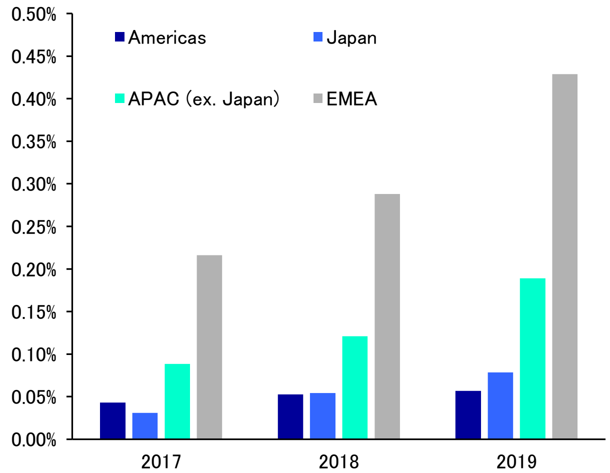
A lack of correlation may seem natural due to the fact that not all green bonds are issued to finance power generation facilities, but increased issuance of green bonds may signal an improvement in financing for carbon power generation since this is one of the main uses of green bond proceeds. With that in mind, there is a possibility that the issuance of green bonds and the profit opportunities associated with climate change will become more correlated in the future.

Figure 2-52: Low Carbon Share (Including Nuclear Power) in Primary Energy Consumption and Territorial GHG emissions / GDP



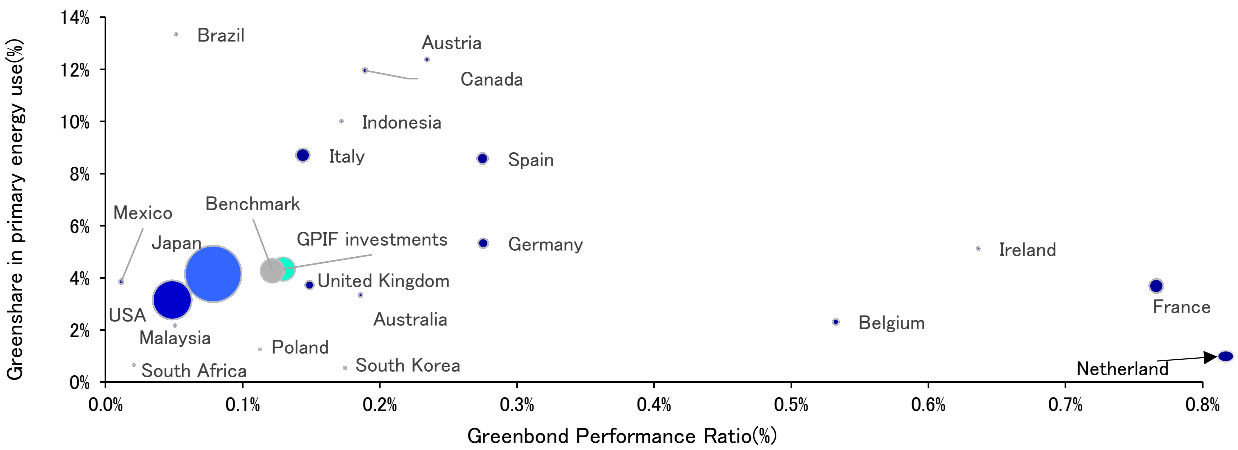
(Source)FTSE Russell, Beyond Ratings

Figure 2-53: Green Bonds Performance Ratio



(Note)Based on regional averages weighted by GDP
– China is not part of the WGBI
(Source)FTSE Russell, Beyond Ratings

Figure 2-54: Low Carbon Share (Including Nuclear Power) in Primary Energy Consumption and Green Bond Performance Ratio



(Note)GPIF investments and benchmark data are based on averages weighted by the value of holdings (VOH); Bubble size represents total portfolio weights; Share of JP PF in the policy PF's former target allocation (70% JP).
Greenshare is the share of low-carbon energy in primary energy use, excluding nuclear power. Energy included in the calculation of the green proxy: hydropower, wind, solar, geothermal, tidal.
(Source)FTSE Russell, Beyond Ratings

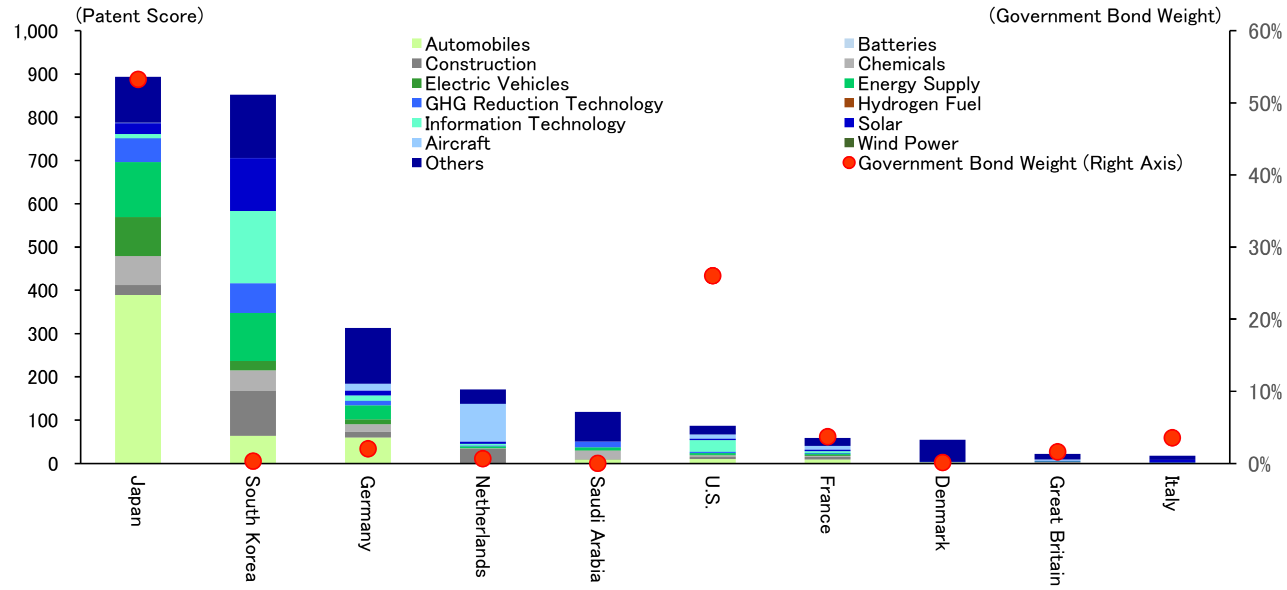
Climate Change-Related Patents

In addition to the issuance of green bonds and low-carbon power generation, there are many other options for government bond portfolios. In this section, we analyze the patent scores of companies calculated by MSCI and aggregate them by country[9].

A patent score is a numerical representation of the importance of a patented technology used in products, services and other patents. This analysis considers corporate patents related to technologies that are expected to be in high demand as the world responds to climate change (e.g., patents related to storage batteries, electric vehicles, hydrogen fuel, etc.). Although patent scores are not used to directly evaluate countries or their government bonds, they represent one aspect of a country's competitiveness, and may also affect tax revenues and thus the creditworthiness of government bonds.

When aggregating all patent scores by country, we found that Japan had the highest overall score, followed by South Korea, Germany, and the Netherlands (Figure 2-55). Breaking this down further into total patent score by technology for each country, the concentration of automobile patents is high in Japan, followed by energy supply and electric vehicle patents. On the other hand, South Korea has a large proportion of information technology and solar power patents, while Germany has patents for a wide range of environmental technologies including those related to automobiles.

Figure 2-55: Patent Score and Ownership Weight by Country



(Source)Reproduced by permission of MSCI ESG Research LLC©2020

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9 This patent analysis covers approximately 100 million corporate patent data points from more than 70 patent authorities worldwide. See P.54 "(Supplementary) CVaR Concepts and Analytical Methodology."

Chapter 3 : Other Analyses

TPI MQ Score Analysis

Assessment of Corporate Management of Climate Change

The Transition Pathway Initiative ("TPI") is a global initiative to assess companies' management of greenhouse gas emissions and of risks and opportunities in the transition to a low-carbon economy. In cooperation with data partner FTSE Russell, TPI calculates the TPI Management Quality (MQ) score ("TPI MQ score"). In this section, we analyze the TPI MQ score for equities[10].

The TPI MQ score assesses corporate climate change initiatives into 6 levels: "0: No acknowledgement of climate risk", "1: Acknowledgement of climate risk", "2: Building capacity", "3: Integration", "4: Strategic assessment", and "5: All indicators met". By scoring individual companies and then aggregating these for the entire portfolio, we can gain insight into the trends in corporate climate change efforts by asset class and industry sector. In addition, the TPI MQ score references the disclosure items recommended by TCFD, and thus the more a company follows TCFD recommendations, the higher their TPI MQ score tends to be.

In order to understand the status of global companies' climate change efforts, we examined the distribution of TPI MQ scores for constituents of the FTSE All World Index – is a global equity index calculated and distributed by FTSE Russell (Figure 3-1). According to this analysis, while many companies have begun to address climate change, a large number are still in the "1: Acknowledgement of climate risk" phase, indicating that they are still in the early stages. At the same time, many companies are classified in the "3: Integration" category, which is an intermediate stage, or higher. This may mean that companies are divided into two groups: those that are more advanced and those that are lagging in terms of preparedness for climate change, including response to the TCFD.

In an analysis of TPI MQ scores by sector, more than half of companies were classified as "3: Integration" (intermediate rating) or higher in most sectors. On the other hand, the majority of companies in the finance and consumer services sectors were still in between the "0: No acknowledgement of climate risk" and "2: Building capacity" phases.

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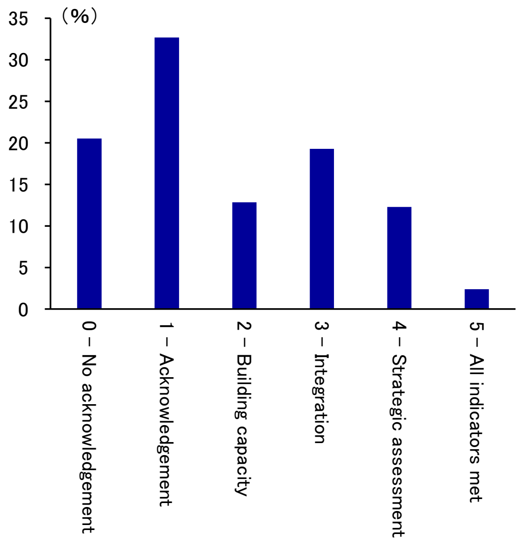
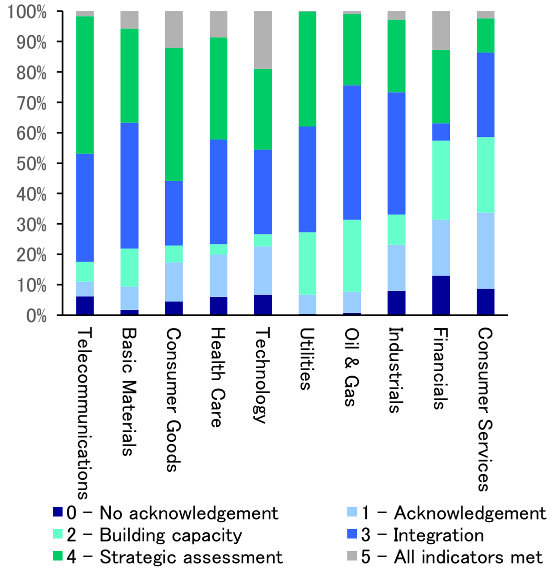
10 See P.87 for the details of TPI MQ Score.

Figure 3-1: Distribution of TPI MQ Scores (Number of Companies)



(Note)TPI MQ scores for constituents of FTSE All World Index
(Source)FTSE Russell, Beyond Ratings

Figure 3-2: TPI MQ Score by Sector (Number of Companies)



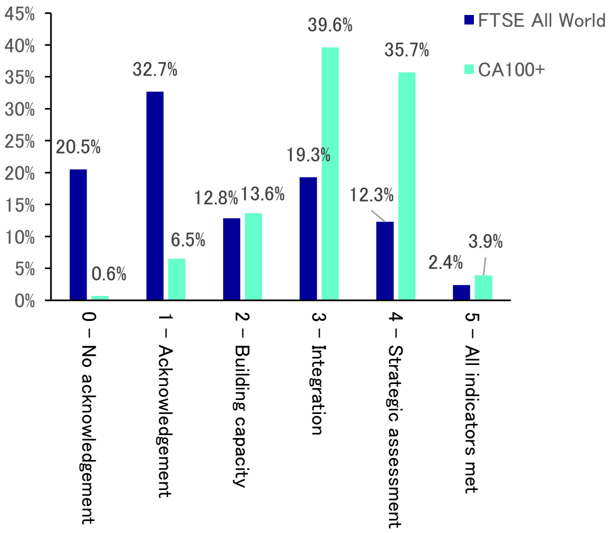
(Note)TPI MQ scores for constituents of FTSE All World Index
(Source)FTSE Russell, Beyond Ratings

CA100+ and TPI MQ Scores

We then divided global companies into two groups: companies that are targeted for engagement under Climate Action 100+ ("CA100+")[11] and companies that are not, and analyzed their TPI MQ scores (Figure 3-3). This analysis shows that CA100+ target companies tend to have higher TPI MQ scores than non-targeted companies. This is partly due to the fact that the companies targeted for CA100+ engagement are larger companies and have sufficient management resources. At the same time, engagement by institutional investors under CA100+ may have helped those companies accelerate efforts to solve climate change problems. Looking at historical changes in the TPI MQ scores by sector for CA100+ target companies, scores increased in sectors that are generally considered to have a large environmental impact, such as basic materials, utilities, industrials, and oil & gas. This shows that efforts to tackle climate change are becoming more active in those sectors (Figure 3-4).

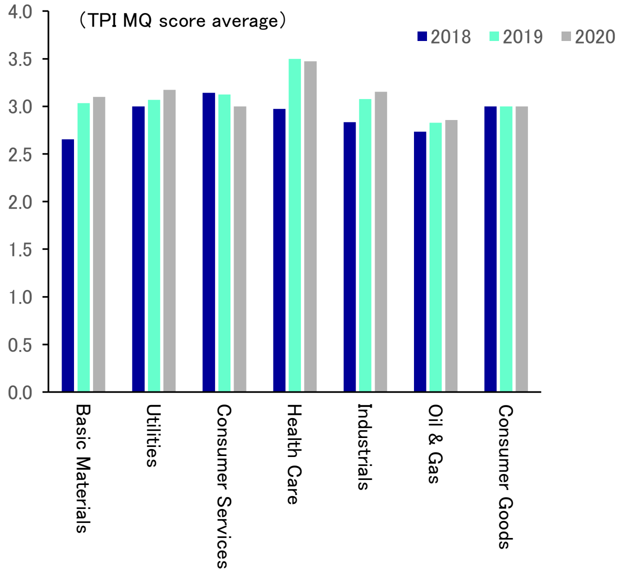
[11] CA100 + is a global initiative of institutional investors to engage in constructive dialogue with companies that have a great influence on solving global environmental problems, such as information disclosure and efforts to reduce greenhouse gas emissions.

Figure 3-3: CA100+ and TPI MQ Scores



(Note)TPI MQ scores for constituents of FTSE All World Index
(Source)FTSE Russell, Beyond Ratings

Figure 3-4: Evolution of CA100+ Companies' TPI MQ Scores

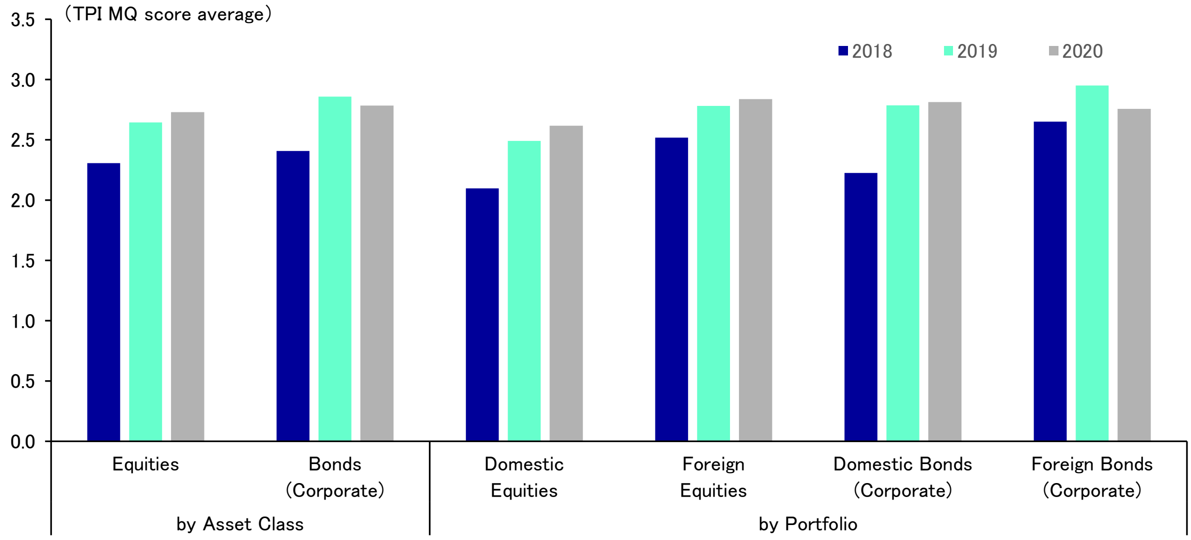


(Note)TPI MQ scores for constituents of FTSE All World Index
(Source)FTSE Russell, Beyond Ratings

GPIF Portfolio TPI MQ Scores

Finally, historical analysis of the TPI MQ scores for the GPIF portfolio broken down by asset class and region shows that scores generally improved from FY2018 to FY2020 (Figure 3-5). One reason may be that companies are becoming more acutely aware of climate change issues. Another cause may be increased engagement from investors through CA100+ and other initiatives.

Figure 3-5: TPI MQ Scores for GPIF Portfolio



(Source)FTSE Russell, Beyond Ratings

(Supplementary Information) TPI MQ Score Methodology

What is the Transition Pathway Initiative (TPI)?

The TPI was established in 2017 by the Church of England's Church Asset Management Organization and the UK Environmental Protection Agency Pension Fund in order to assess companies' efforts in addressing climate change and transitioning to a low-carbon economy. FTSE Russell is a data partner of TPI and the Grantham Institute for Climate Change and Environment at the London School of Economics (LSE) as an academic partner. More than 80 institutional investors around the world with assets under management of over USD 20.9 trillion support the TPI.

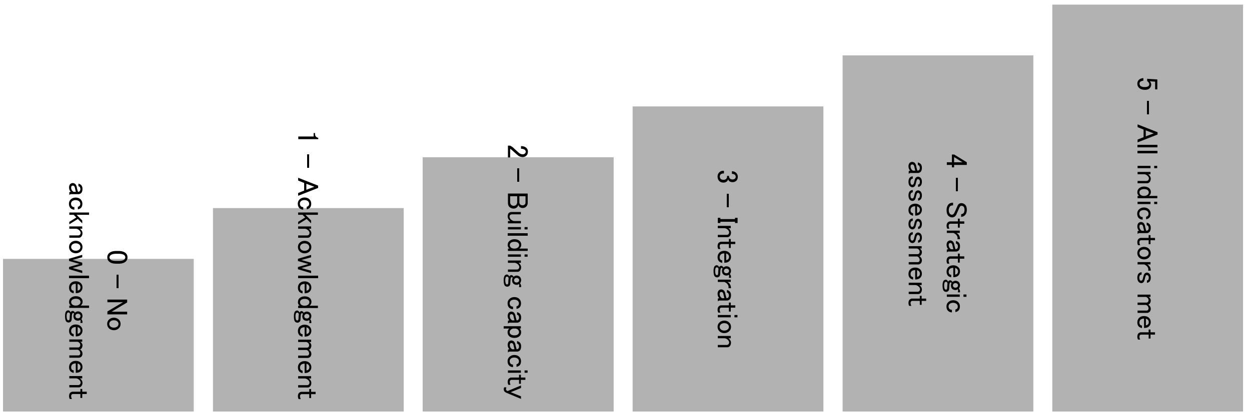
The TPI is operated by a TPI steering group consisting of representatives of asset owners, and TPI analysis results are published online by the Grantham Institute.

TPI MQ Score Methodology

TPI Management Quality (MQ) scores use corporate disclosures to assess the quality of risks and opportunities in managing greenhouse gas emissions and transitioning to a low-carbon economy. It also helps identify companies that are more likely to take advantage of opportunities by assessing how companies are responding to the transition to a low-carbon economy.

TPI MQ scores evaluate the details and implementation status of companies' greenhouse gas management systems and processes in a staged and structured way. Companies must meet specific indicators in order to reach each score level, and achieving higher scores requires more sophisticated initiatives (Figure 3-6). The indicators used reflect the disclosures recommended by TCFD. For example, companies must disclose greenhouse gas emissions and reduction targets in order to score 3 or higher. All indicators used for TPI MQ scores are included in the climate change theme of the FTSE Russell ESG ratings model.

Figure 3-6: TPI Management Quality “Staircase”



(Source) FTSE Russell, Beyond Ratings, THE TRANSITION PATHWAY INITIATIVE

SDG-Related Corporate Earnings

In the previous sections, we used patent data within the CVaR framework to analyze opportunities for portfolio companies in the context of climate change, but in this section, we expand the discussion beyond climate change by assessing the opportunities that arise as a result of solving the social challenges identified by the United Nations Sustainable Development Goals (SDGs)[12].

In this analysis, companies that are included in the global stock index (MSCI ACWI Investable Market Index (MSCI ACWI IMI) are summarized into 2 categories, namely "social impact," which leads to the solution of social issues among SDGs' 17 targets, and "environmental impact," which leads to the solution of environmental issues, and their revenues and exposures are measured in sub-categories(Figure 3-7 to Figure 3-8).

Looking at the results, we found that the SDG-related share of corporate profits in Japan was 10.2% overall, which was higher than in the US (6.6%) or Europe (6.6%). Revenue related to environmental impact (4.7%) accounts for about half of the total. This was also shown to be higher than that in the U.S. (3.0%) or Europe (3.3%). These results seem to be consistent with the analysis provided in “Technological Opportunities: Remarkably High Scores for Domestic Companies” (P.37). Breaking down environmental impact further, we find that exposure to energy efficiency (2.8%) and green buildings (1.1%) play a large part. Energy efficiency also represents a large share in the U.S. (2.1%) and Europe (1.2%), but alternative energy (1.0%) is also large in Europe, indicating that overseas companies and Japanese companies are skilled at different technologies. In terms of social impact, all three regions showed significant exposure to the “Disease” sub-category. This was followed by “Hygiene Control” in the U.S. A high proportion of social impact-related profit came from the “Nutrition” sub-category in both Japan and Europe.

Naturally, the framework used for the SDG-based analysis differs from the TCFD, but by analyzing the portfolio from various perspectives, we can deepen our understanding of the ESG risks and opportunities inherent in the portfolio without limiting our analysis to climate change.

[12] The Sustainable Development Goals (SDGs) are international goals aimed at achieving a sustainable and better world by 2030, as described in the 2030 Agenda for Sustainable Development, which was adopted at the UN Summit in September 2015 as a successor to the Millennium Development Goals (MDGs) formulated in 2001. Consisting of 17 goals and 169 targets, we pledge that "no one is left behind (leave no one behind)" on the planet. SDGs is a universal initiative undertaken not only by developing countries but also by developed countries themselves. (from the Ministry of Foreign Affairs website: https://www.mofa.go.jp/mofaj/gaiko/oda/sdgs/index.html)

Column: (Supplementary) SDGs Analytics Methodology

MSCI Sustainable Impact Metrics allows investors to analyze companies' revenues that are generated by products and services, and that are able to contribute to addressing social or environmental issues as defined by the United Nations Sustainable Development Goals (UN SDGs). Of SDG's 17 targets, 6 are social issues and 7 are environmental issues. This report analyzes companies in a universe of MSCI ACWI IMI.

Figure 3-7: Corporate Profit Exposure to SDGs by Region

	World(MSCI ACWI IMI)				(Reference) TOPIX
	Total	U.S.	Europe	Japan	
Social Impact	3.6%	3.6%	3.3%	5.4%	5.4%
Nutrition	0.4%	0.3%	0.6%	1.2%	1.3%
Housing	0.1%	0.1%	0.4%	0.0%	0.0%
Disease	2.1%	2.3%	1.7%	3.0%	2.8%
Hygiene Control	0.8%	0.9%	0.4%	0.9%	0.8%
Finance	0.2%	0.0%	0.1%	0.3%	0.3%
Education	0.0%	0.0%	0.1%	0.0%	0.0%
Environmental Impact	2.9%	3.0%	3.3%	4.7%	3.9%
Alternative Energy	0.4%	0.3%	1.0%	0.3%	0.2%
Energy Efficiency	1.9%	2.1%	1.2%	2.8%	2.9%
Green Buildings	0.4%	0.3%	0.5%	1.1%	0.2%
Sustainable Water Resource Management	0.1%	0.1%	0.2%	0.2%	0.2%
Pollution Prevention	0.1%	0.1%	0.3%	0.3%	0.3%
Total	6.5%	6.6%	6.6%	10.2%	9.3%

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Figure 3-8: MSCI Classification for SDGs

	Classification by MSCI	17 targets of SDGs
Social Impact	Basic needs：Nutrition,Housing,Disease,Hygiene Control	1 NO POVERTY; 2 ZERO HUNGER; 3 GOOD HEALTH AND WELL-BEING; 6 CLEAN WATER AND SANITATION; 11 SUSTAINABLE CITIES AND COMMUNITIES
	Empowerment:Finance,Education	4 QUALITY EDUCATION; 5 GENDER EQUALITY; 8 DECENT WORK AND ECONOMIC GROWTH; 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE; 10 REDUCED INEQUALITIES
Environmental Impact	Climate change:Alternative Energy,Energy Efficiency,Green Buildings	7 AFFORDABLE AND CLEAN ENERGY; 13 CLIMATE ACTION
	Natural capital:Sustainable Water Resource Management,Pollution Prevention	12 RESPONSIBLE CONSUMPTION AND PRODUCTION; 14 LIFE BELOW WATER; 15 LIFE ON LAND
	Governance	16 PEACE, JUSTICE AND STRONG INSTITUTIONS; 17 PARTNERSHIPS FOR THE GOALS

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