MSCI ESG Research LLC

Net-Zero Alignment

Managing Portfolio Risk Along the Net-Zero Journey

Monika Szikszai, Donald Sze and Thomas Verbraken

April 2022

Executive summary

The goal of the Paris Agreement is to limit the average global temperature rise to well below 2°C, and preferably to no more than 1.5°C, by 2021 from pre-industrial levels. To achieve this objective, the world needs to reduce its net emission of greenhouse gases to zero — and soon. In this third MSCI Net-Zero Alignment paper, we examine the challenges presented by both climate change and the net-zero transition to investors looking to measure and manage climate risk in their portfolios.

Effective management of climate risk requires a clear understanding of its multifaceted nature. Broadly speaking, climate risk can be broken down into physical risk and transition risk, and it can impact companies and investors via both microeconomic and macroeconomic transmission channels.

One of the defining features of climate risk is the extraordinary degree of uncertainty surrounding it. The transition to net-zero depends on many factors: policymakers' decisions, the development and economic feasibility of green technologies, investors' attitude toward climate risk and net-zero investing and consumers' sentiment toward low-carbon consumption. This and the long horizon mean that investors face an elevated level of uncertainty when making investment decisions.

One approach is to undertake forward-looking scenario analysis, in which various outcomes for uncertain factors such as policy decisions and the development of green technology can be explored, along with their financial impacts. This is becoming a standard tool for climate risk analysis, supported by several major organizations such as the Task Force on Climate-related Financial Disclosures (TCFD).[1] In this paper, we use the MSCI Climate Value-at-Risk (Climate VaR) metric to examine climate risk in a set of hypothetical portfolios and explore a few strategies to reduce that climate risk.

A second approach could be to incorporate a carbon-emission factor in equity risk models to help quantify the impact of emissions on portfolio returns. As more investors begin to consider the risk of climate change when making investment decisions, financial markets may see a reallocation of capital from carbon-intensive to carbon-efficient investments — and companies' emission profiles may emerge as a systematic driver of equity returns.

Although climate risk management is not yet widespread among investors or fully standardized by regulation, industry trends are pointing in this direction. Investors may therefore wish to be aware of existing approaches for measuring and managing climate risk.

[1] In addition to the TCFD, there are climate initiatives led by the Network for Greening the Financial System, Bank of England and European Central Bank, among others.

Introduction

More and more institutional investors, organized in various industry groups, are committing to having net-zero investment strategies as they align with a broader effort to decarbonize the economy. “Net-zero” refers to the goal of reaching net-zero global greenhouse-gas (GHG) emissions by 2050.

As the economy goes through this dramatic transition, return surprises might occur as capital is reallocated toward sustainable investments. Currently, there is large uncertainty about the path for climate change and the net-zero transition itself, as well as about the potential impact it could have on the economy and investment portfolios. To prepare for this uncertain future, it may be a best practice to employ scenario analysis and assess ranges of potential outcomes and their impact on financial portfolios.

Furthermore, as more investors incorporate climate considerations in their investment processes, carbon emissions (intensity) may emerge as a systematic driver of equity risk and return. In this paper, we will discuss the rationale and considerations for incorporating a carbon-emission factor in equity factor risk models, along with the potential benefits of doing so.

This paper is the third in the MSCI Net-Zero Alignment series. We continue to build on the MSCI Net-Zero Investment Framework (see Exhibit 1) introduced in the first paper, which focused on the objectives of and strategic approaches to net-zero investing.[2] While the second paper[3] discussed portfolio construction in more detail, this paper will focus on risk management and consider the following questions:

- How might the net-zero transition and climate change in general affect portfolio risk?
- How can investors use climate scenario analysis to help understand the drivers of climate risk in their portfolio?
- How can we measure the impact of holding carbon-intensive stocks on portfolio returns?

[2] Giese, Guido, Nagy, Zoltan, and Cote, Chris. “Net-Zero Alignment: Objectives and Strategic Approaches for Investors.” MSCI Research Insight, Sept. 20, 2021.
[3] Cano, Guillermo, and Katiyar, Saurabh. “Net-Zero Alignment: Portfolio Construction Approaches for Investors.” MSCI Research Insight, Dec. 1, 2021.

Exhibit 1: MSCI net-zero investment framework

Climate risk in financial portfolios

The previous paper[4] focused on how financial institutions are increasingly embarking on a net-zero transition in which they align the emissions of their investments with a temperature-rise path of below 2°C or even 1.5°C. In other words, it examined how an investment portfolio impacts the world and whether it is aligned with the Paris Agreement.

In this paper we address the other direction: How could a net-zero transition, and the accompanying economic transformation, affect an investment portfolio? To answer this question, one needs to understand the drivers of climate risk and how their effect is transmitted to the portfolio.

Climate-risk drivers

Along with other organizations such as the TCFD, the Basel Committee on Banking Supervision (BCBS) provides a comprehensive overview of the drivers of climate risk.[5] First, there are physical risk drivers, which can be categorized into acute and chronic physical risks. Although climate change is a global phenomenon, the impact of physical risks depends significantly on the geographic location.

While physical risk drivers are tied to weather and climate change, transition risks stem from policy, technological and market changes due to a transition to a low-carbon economy. The table below summarizes the main drivers of transition risk, as categorized by the BCBS.

[4] Cano and Katiyar. "Net-Zero Alignment: Portfolio Construction Approaches for Investors."
[5] "Climate-related risk drivers and their transmission channels." Basel Committee on Banking Supervision, April 14, 2021.

Exhibit 2: Climate-related risk drivers

Physical-risk Drivers	Transition-risk drivers
Drivers of acute physical risk such as tropical cyclones, floods and wildfires.	**Climate policies** and measures taken to reduce emissions and transition to a low-carbon economy that could impact valuations.
Drivers of chronic physical risk such as rising sea levels and shifts in precipitation patterns.	**Technology** innovation related to low-carbon economy and resilience against climate change.
	Changing **investor sentiment**, with increasing focus on climate-aware investing.
	Consumer sentiment and behavior, which could shift to more climate-friendly alternatives.

Source: Basel Committee on Banking Supervision

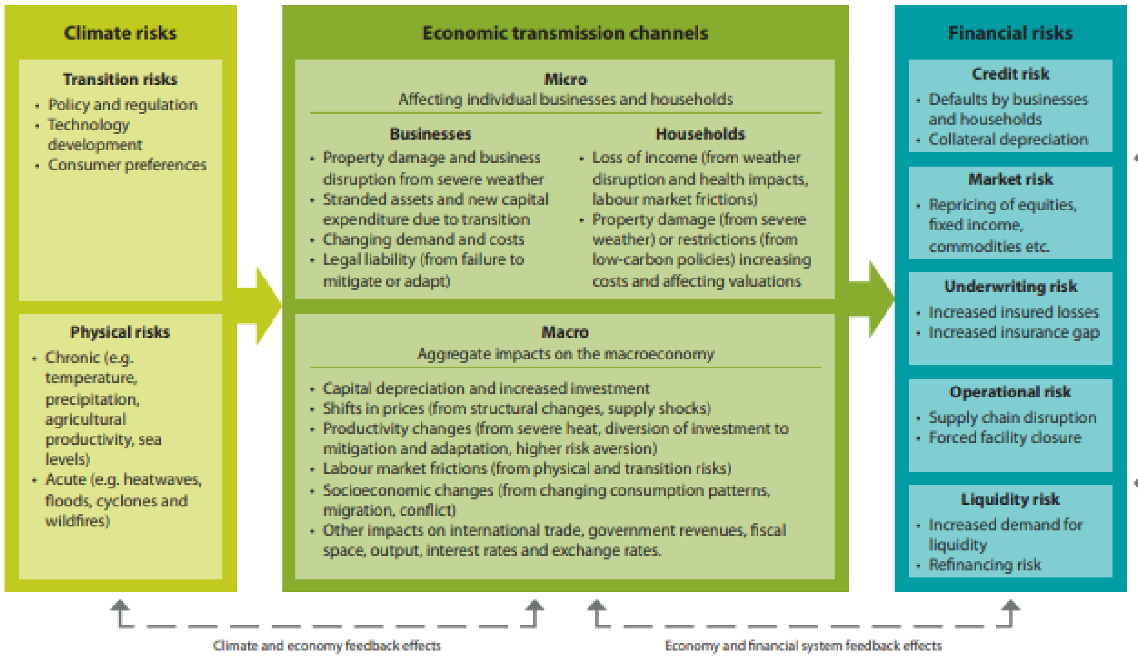
As the BCBS discusses in its paper, there is significant uncertainty about the evolution of climate risk drivers for several reasons. First, climate change and the speed at which it is evolving is unprecedented in human history, so there is little historical experience to draw on. Second, the climate system evolves in a nonlinear way: Reaching tipping points could cause abrupt, irreversible changes. And third, there is sizable geographical heterogeneity in the impacts of physical- and transition-risk drivers. This inherent uncertainty has implications for how financial markets could deal with climate risk, as we will discuss later.

Transmission channels

Climate risks are impacting financial portfolios through multiple transmission channels. Exhibit 3, from the Network for Greening the Financial System (NGFS), summarizes how climate risk drivers could affect the financial system through individual businesses and households (microeconomic drivers) and as aggregate impacts (macroeconomic drivers).[6] An example of the microeconomic transmission channel is how an extreme weather event, such as a tropical cyclone, creates damage to a company's assets, causing supply-chain disruption, which in turn results in loss of sales growth and then a drop in equity value. A macroeconomic transition example is the potential inflationary pressure from a green transition and its impact on bonds.

[6] "NGFS Climate Scenarios for Central Banks and Supervisors." Network for Greening the Financial System, June 2020.

Exhibit 3: Transmission channels: From climate risk to financial risk



Source: Network for Greening the Financial System

Scenario analysis for forward-looking risk assessment

In this section we describe the rationale for using scenario analysis for climate risk measurement and illustrate how to understand the drivers of climate risk and opportunity in a portfolio. This analysis could highlight vulnerabilities in the portfolio, such as potential policy risk in a fund focused on clean energy.

Although the probability of the climate scenarios is not known, scenario analysis may help institutions gauge their climate risk exposures and assess their portfolio's strengths and vulnerabilities.[7] This analysis may help them plan risk management strategies.

The foundations of climate-scenario analysis were laid in the 2017 Final Report of the TCFD, with the goal of establishing consistent and reliable financial disclosure

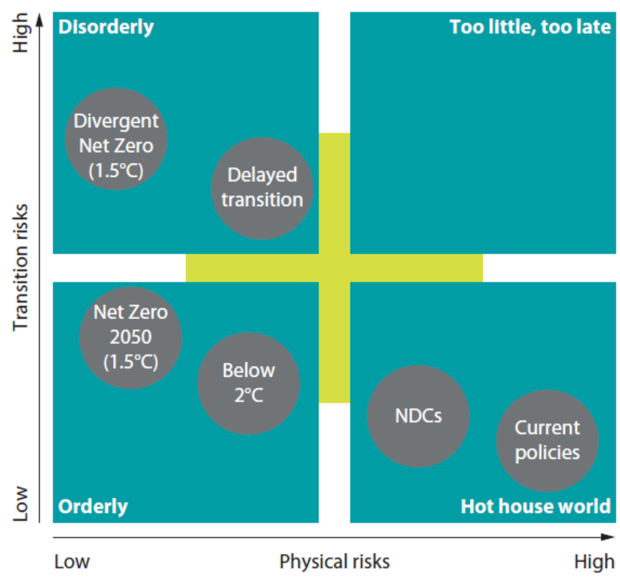
[7] Risk applies to situations in which a future outcome is unknown, but we know the probability distribution over a limited number of potential outcomes. In the case of uncertainty, however, we do not know the complete set of potential future outcomes, let alone the probabilities assigned to those. As discussed, there is vast uncertainty around climate change, so it is worthwhile to consider ranges of potential climate-change scenarios to deal with this uncertainty. Knight, F. *Risk, Uncertainty, and Profit*. 1921. Boston and New York: Houghton Mifflin Co.

standards to be used by financial institutions and their stakeholders.[8] These recommendations have evolved into mandatory reporting obligations in countries such as the U.K. (starting in 2022) and New Zealand (from 2023).[9]

Climate-change scenarios (NGFS)

In line with the TCFD recommendations, the NGFS, a group of central banks and supervisors, developed a set of scenarios for climate change. They developed six scenarios with varying severity of physical risks (from what it terms "hot house" world scenarios to scenarios with lower physical impacts) and varying degrees of transition risks (from an orderly transition to delayed and disorderly transitions).

Exhibit 4: NGFS Scenarios Framework



Source: Network for Greening the Financial System

The goal of these scenarios is to serve as a starting point for central banks and other financial organizations to standardize scenario analysis for climate-related risks and opportunities. They are currently being used by the European Central Bank, European

[8] "Recommendations of the Task Force on Climate-related Financial Disclosures." Task Force on Climate-related Financial Disclosures. June 15, 2017.
[9] "UK to enshrine mandatory climate disclosures for largest companies in law." gov.uk, Oct. 29, 2021. "Mandatory climate-related disclosures." environment.govt.nz, Dec. 1, 2021.

Banking Authority, U.K. Prudential Regulation Authority (, Banque de France and Banca d'Italia, among others.[10]

In the next section we illustrate how scenario analysis can help investors understand the potential impact of climate change on financial portfolios and how one can drill down to the various drivers of climate risk.

Measuring climate risk with scenario analysis

We use the MSCI Climate Value-at-Risk (Climate VaR) metric for the analysis, which provides a forward-looking and return-based valuation assessment to measure climate-related risks and opportunities in an investment portfolio via three transition-risk scenarios (1.5°C, 2°C and 3°C temperature rise) and two physical-risk scenarios (Average and Aggressive).[11]

We assess a set of hypothetical portfolios and identify the climate risk drivers for each.[12] First, we focus on transition risks and opportunities, for which we assess a 1.5°C temperature-rise scenario. Next, we turn our attention to physical risks the portfolios are exposed to. For instance, the "Oil & Gas Exploration Fund" has the largest Aggregate Climate VaR in the 1.5°C scenario: It could lose 51% of its market value. The Aggregate Climate VaR is made up of Transition Risk (Technology Opportunity (11%) and Policy Risk (-52%)) and Physical Risk (-10%). The latter can be further decomposed into extreme weather event types.

[10] "Scenarios in Action. A progress report on global supervisory and central bank climate scenario exercises." Network for Greening the Financial System, October 2021.

[11] Climate Value-at-Risk of a company is the present value of cost impacts in the chosen scenario until 2080 over the enterprise market value. In that sense, Climate VaR reflects the immediate repricing of a security if investors price in future costs related to climate change (assuming they were not priced in before). To aggregate to the portfolio level, we take the weighted average of the companies' Climate VaR and assume constant holdings over the horizon. MSCI ESG Research models the probability distribution of annual costs from weather extremes. The Average physical-risk scenario considers the expected value of costs, while the Aggressive scenario considers the 95th percentile of the distribution.

[12] For the purpose of this illustration, we used a set of hypothetical portfolios with varying geographical and sector exposure. These portfolios are not meant to be representative of the investible universe or to replicate specific investment funds. The purpose is to illustrate the insights one can gain concerning the physical and transition climate risk. We named the hypothetical portfolios such that the reader gets a sense of their investment strategy or geographical focus.

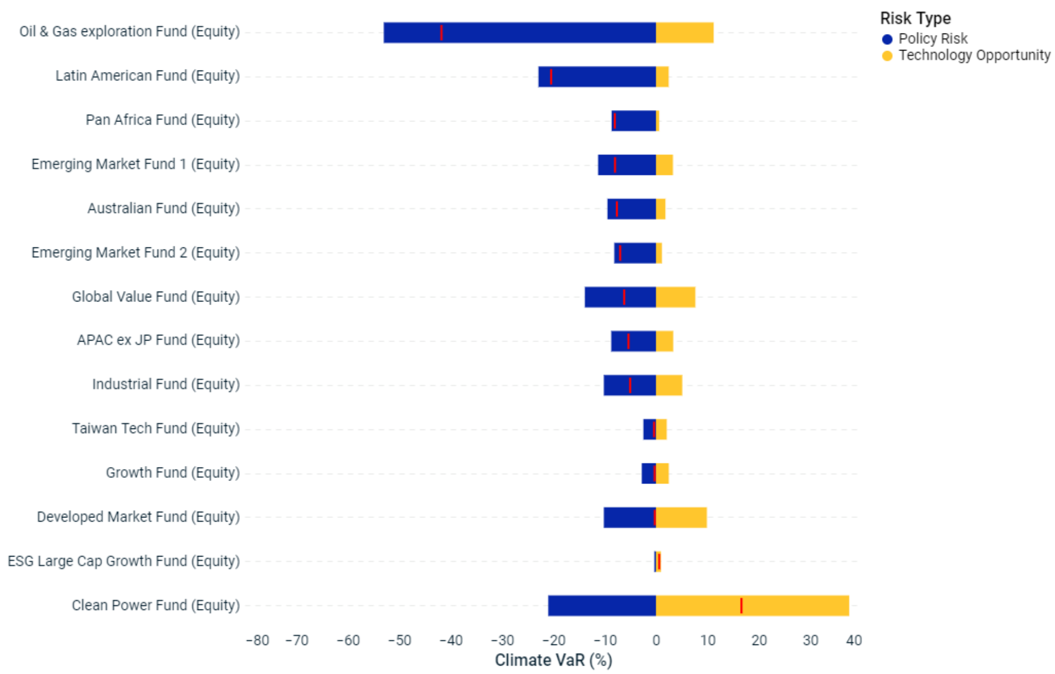
Exhibit 5: List of equity portfolios

Portfolio name	Category
APAC ex JP Fund	APAC ex-JP
Australian Fund	Australia
Clean Power Fund	ESG
Developed Market Fund	Developed Market
Emerging Market Fund 1	Emerging Market
Emerging Market Fund 2	Emerging Market
ESG Large Cap Growth Fund	ESG
Global Value Fund	Value
Growth Fund	Growth
Industrial Fund	Industrials
Latin American Fund	Latin America
Oil & Gas exploration Fund	Oil & Gas
Pan Africa Fund	Africa
Taiwan Tech Fund	Technology

Transition risks and opportunities

Exhibit 6 ranks these hypothetical portfolios from lowest to highest in terms of return impact under the 1.5°C temperature-rise scenario, which has the largest transition risk of both scenarios mentioned above and provides the breakdown in terms of policy-related (negative) impact and technology-related (positive) impact. Not surprisingly, the "Oil & Gas Exploration Fund" performs worst due to its carbon-intensive nature. Second-worst is the "Latin America Fund," not solely because of policy risk, but because of the lack of offsetting technology opportunities in its holdings. The best-performing "Clean Power Fund," for example, has a policy risk comparable to the "Latin America Fund" but counterbalances this with a high Technology Opportunity Climate VaR of +38%.

Exhibit 6: Transition risk of the funds



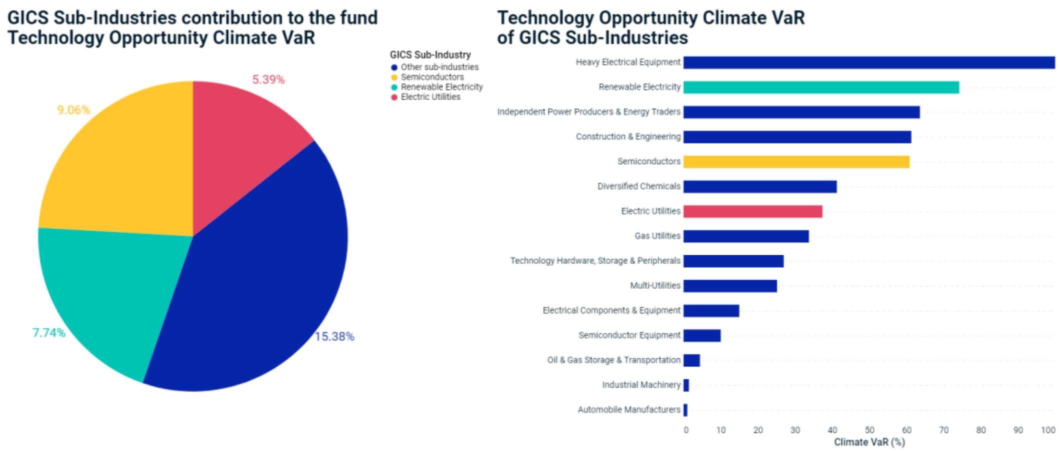
Analysis as of September 2021.

The above ranking helps one understand how the portfolios compared in terms of potential upside and downside return. We can also examine individual portfolios. For example, the best-performing Clean Power Fund, with a positive Climate Transition VaR, invests in U.S. stocks that offer products and services related to manufacturing renewable-energy technologies.

The left panel in Exhibit 7 links Technology Opportunity Climate VaR to Global Industry Classification Standard (GICS®)[13] sub-industries within the Clean Power Fund. The GICS subindustries with high Technology Opportunity Climate VaR (right panel) and significant weight are the largest contributors: semiconductors (15% market-cap weight in the portfolio), renewable electricity (10% weight) and electric utilities (14% weight).

[13] GICS is the global industry classification standard jointly developed by MSCI and S&P Global Market Intelligence.

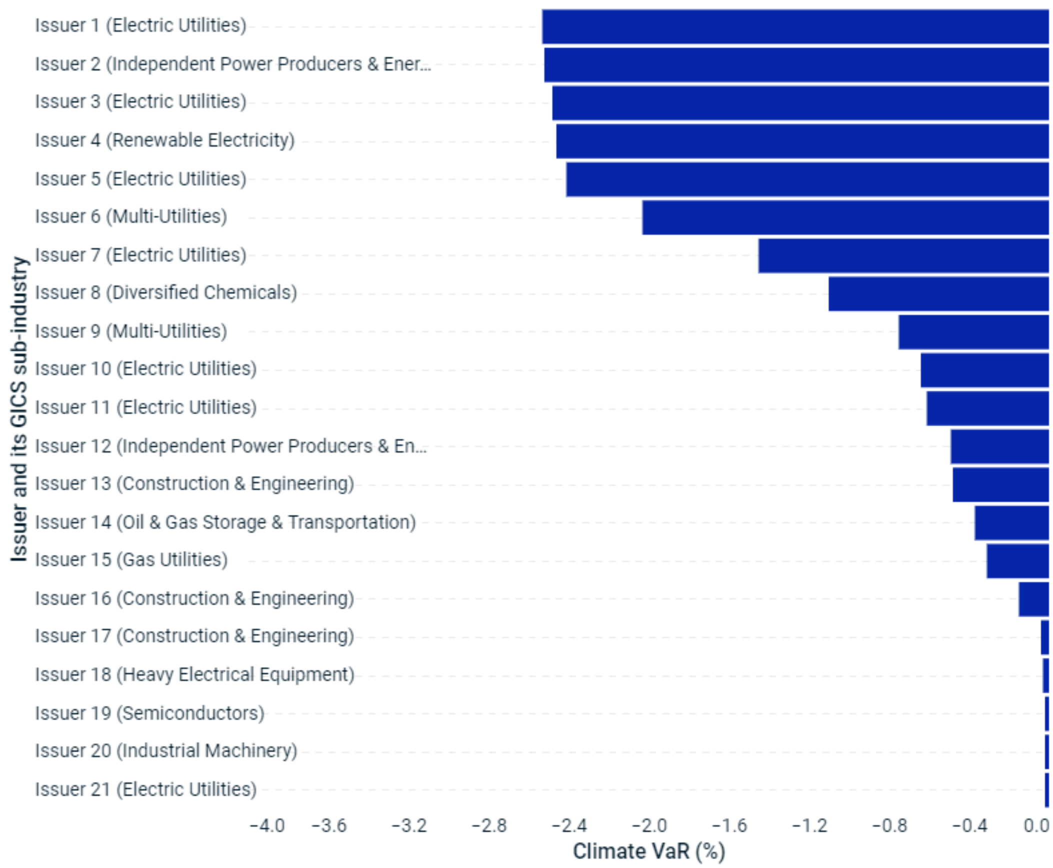
Exhibit 7: Technology Opportunity Climate VaR of the Clean Power Fund



Analysis as of September 2021

A remaining question about the Clean Power Fund is why its Policy Climate VaR is so high (comparable to the second-worst portfolio). Exhibit 8 shows the contribution of individual stocks to the portfolio’s Policy Climate VaR. More than two-thirds stems from only six stocks, all related to electricity generation and distribution. While the Clean Power Fund holds stocks of utilities companies that are investing in renewables ahead of peers and are greener than the average utilities company, they still partly rely on fossil fuels for their power generation, resulting in relatively high Policy Climate VaR.

Exhibit 8: Policy Climate VaR of issuers in the Clean Power Fund



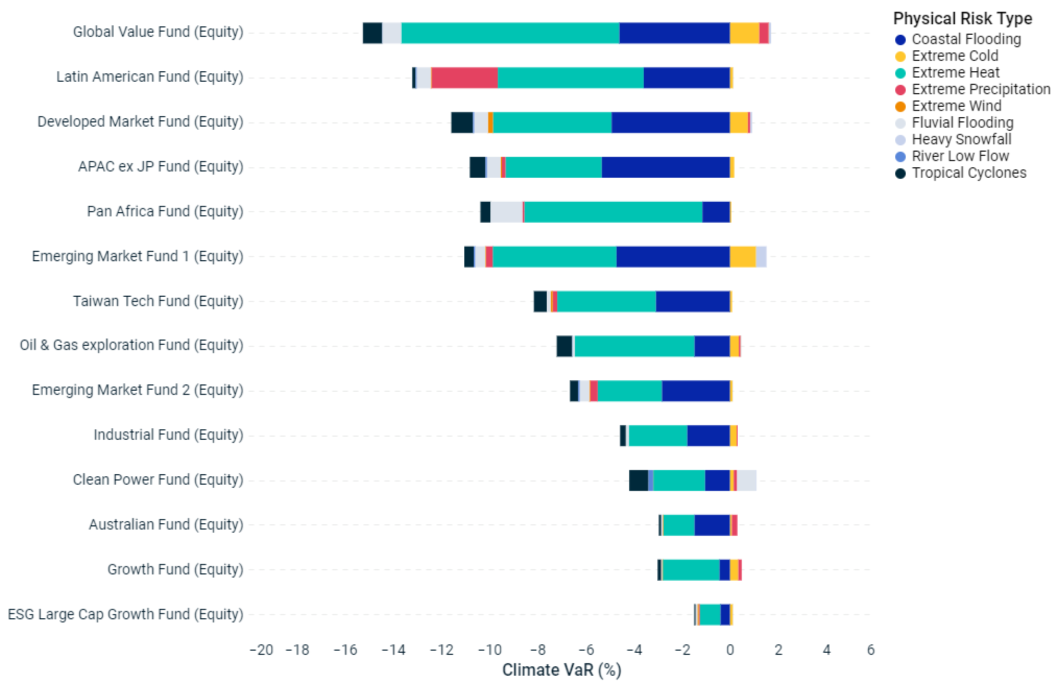
Analysis as of September 2021.

Physical risks

Next, we turn our attention to physical climate risks under the Average physical-risk scenario. For the "average" portfolio (if weighting the portfolios equally by market value) in our analysis, extreme heat is the main driver of the physical risks (-3.63%), while the next largest contributor, coastal flooding, accounts for about half of the extreme heat (-1.74%).[14] However, as can be seen in the Exhibit 9, the magnitude of the physical risk varies widely between portfolios.

[14] We used the Average physical-risk scenario.

Exhibit 9: Physical risks of the funds (Average scenario)



Analysis as of December 2021.

From climate-risk measurement to management

In the previous section we focused on the measurement of climate risk, which is only the first step. Once risk measurement is systematically part of the investment process, investors might want to incorporate it into the portfolio-construction process with the aim of creating portfolios more resilient against transition and physical risk.

The main approaches to lowering exposure to climate risk are engagement, divestment, exclusion and reweighting of issuers based on climate risk. For example, in our case study below, we excluded the bottom-decile market cap of the portfolio based on Climate VaR, which reduced the portfolio's Climate VaR by 74%.

Although many investors are still in the measurement phase, focusing on reporting climate risks, we list a few practical approaches for managing climate risk more actively, without being exhaustive. Although the approaches mentioned might effectively reduce portfolio risk, applying them does not necessarily result in the investment portfolio's having a positive impact on the world (a topic explored in the first paper of this series.)[15]

1) **Divestment from companies with stranded assets**

   To meet global climate goals, large quantities of fossil fuels need to remain underground and carbon-intensive technologies need to be retired early. Asset stranding could result from regulation, a shift in social norms and the falling costs of clean solutions that could replace emission-heavy technologies. Investors could suffer losses in the low-carbon shift due to these stranded assets. A potential risk-mitigation strategy is to exclude fossil-fuel companies exposed to such potential losses, although there might be practical limits to how much an investor wants to deviate from the broad-market portfolio.

2) **Exclusion of bottom-percentile companies from the portfolio**

   Another exclusion strategy is filtering out underperforming companies based on climate-risk measures such as Aggregated Climate VaR, carbon intensity or the Low Carbon Transition Score.[16]

3) **Reweighting constituents**

   A more advanced approach is reweighting, which involves increasing the weight of companies positively exposed to a potential low-carbon transition and decreasing the weight of companies that could potentially be exposed to greater risks in the event of a low-carbon transition, while maintaining the broad-market exposure of the portfolio.[17]

4) **Portfolio optimization targeting reduced levels of transition risk and limited tracking-error risk**

   One could also use optimization techniques to rebalance portfolios, where the goal is to reduce the portfolio's climate risk while taking into consideration a tracking-error budget and other potential constraints (e.g., constraints on portfolio duration, sector allocation, etc.).[18]

[15] Giese, et al. "Net-Zero Alignment: Objectives and Strategic Approaches for Investors."
[16] For an illustration of this analysis, see: "Managing Climate Risk in Equity Portfolios: A Case Study." MSCI Blog, July 15, 2020.
[17] Badani, Jaineel, Doole, Stuart, Neeraj, Kumar, and Shakdwipee, Manish. "Climate change and climate risk: An index perspective." MSCI Research Insight, July 10, 2019.
Doole, Stuart, Menou, Véronique, and Neeraj, Kumar. "Aligning with the Paris Agreement: An Index Approach." MSCI Blog, Oct. 22, 2020.
[18] For a discussion of using this methodology in fixed income, see:
Rauis, Bruno, Sampieri, Juan, and Sparks, Andy. "Climate Transition and Bonds: Risk or Opportunity?" MSCI Blog, Feb. 23, 2021.
Rauis, Bruno, Sampieri, Juan, and Sparks, Andy "Why Is Climate-Transition Risk High in High Yield?" MSCI Blog, May 6, 2021.

Examples of climate risk management in practice

We considered a combination of the above approaches for a hypothetical portfolio tracking the MSCI World index. First, we excluded the worst-performing 10% of companies by market capitalization, based on Aggregate Climate VaR. As Exhibit 10 illustrates, this improved the climate risk of the original portfolio.

Exhibit 10: Excluding 10% market cap with worst aggregate Climate VaR

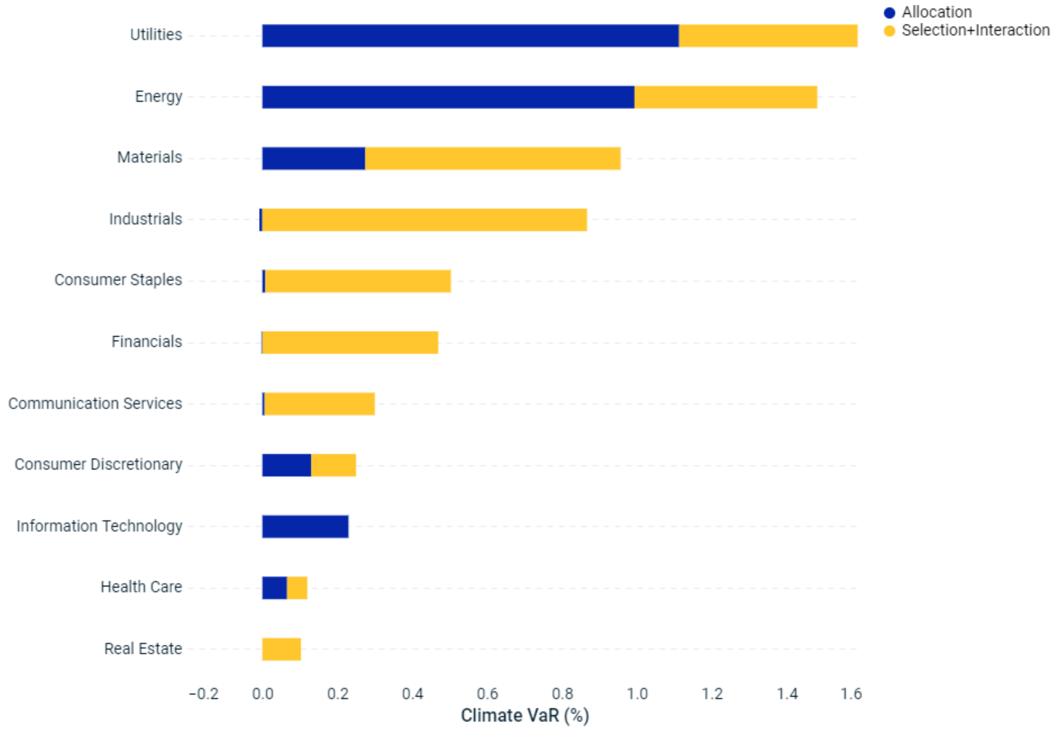
	Original	Exclusion Strategy
Aggregate Climate VaR	-9.24%	-2.38%
Transition Climate VaR	-2.95%	1.89%
Physical Climate VaR	-6.29%	-4.27%

We used Brinson attribution to understand the difference in Climate VaR between the original and new portfolios, and attribute that to sector-allocation and stock-selection effects.[19] As the Exhibit 11 shows, the improvement of Climate VaR was mostly driven by the stock-selection effect, although for some sectors the allocation effect dominated.

The allocation effect was most dominant for emission-heavy sectors such as utilities, energy and materials. Many companies in these sectors have negative Climate VaR, so removing even many of the worst did not improve the sector's average Climate VaR. One needs to underweight these sectors in their entirety to substantially improve the portfolio's Climate VaR. The selection effect was largest for the industrials sector, because Climate VaR is widely dispersed within that sector due to the wide diversity of product lines. Therefore, excluding the left tail of worst companies turned the sector's average Climate VaR from negative to positive.

[19] For a similar use of Brinson attribution, see: Nagy, Zoltan, and Droz, Helen. "Why Your Portfolio May Be Hot, Cold or Just Right." MSCI Blog, Jan. 19, 2022.

Exhibit 11: Brinson attribution of Climate VaR difference between original and rebalanced portfolios



Analysis as of September 2021.

Excluding the worst-performing 10% market capitalization of companies resulted in heavily underweighting the three sectors (utilities, energy and materials) that had the largest allocation effect.[20] It is realistic to think, however, that an investor may not want to underweight entire sectors, but rather maintain the original sector allocation. In that case, we could apply the 10% exclusion criterion separately in each sector. As Exhibit 12 shows, this constrained approach led to a smaller improvement in Climate VaR.

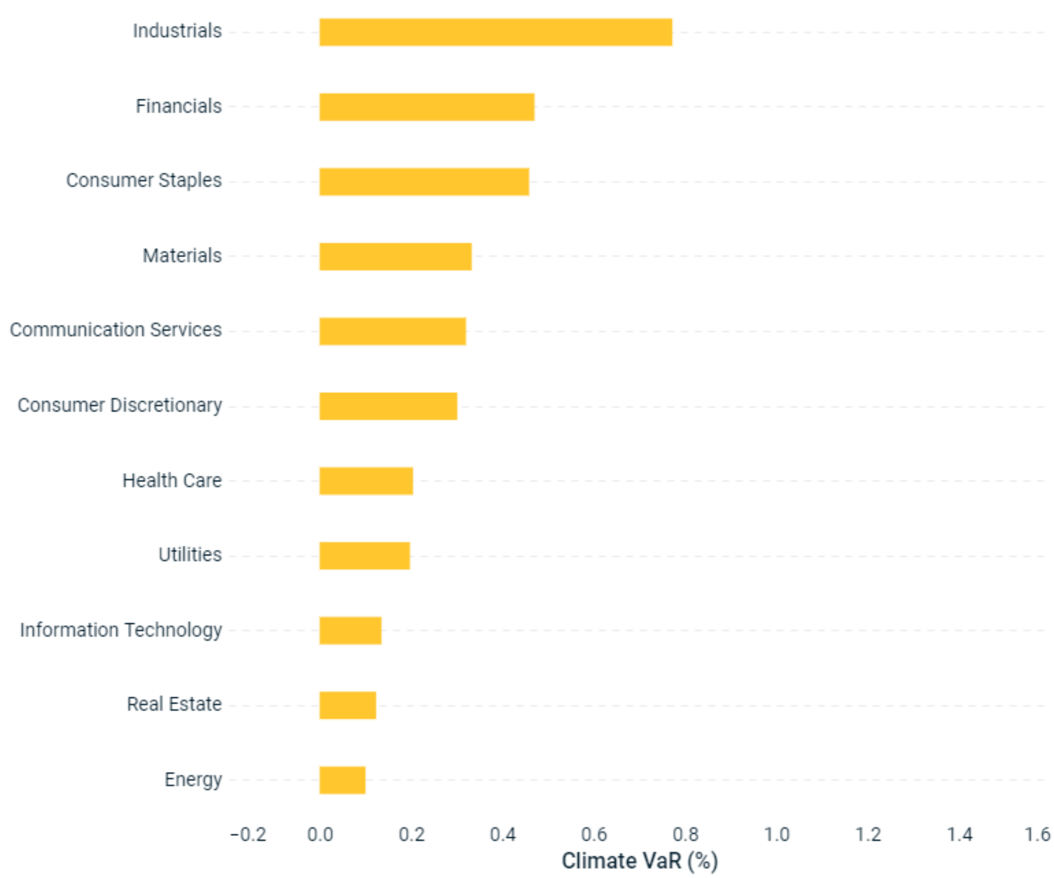
Exhibit 12: Excluding 10% market cap with worst Aggregate Climate VaR in each sector

	Original	Exclusion Strategy
Aggregate Climate VaR	-9.24%	-6.01%
Transition Climate VaR	-2.95%	-1.47%
Physical Climate VaR	-6.29%	-4.68%

[20] About 6 percentage points of market capitalization of the 10% exclusion came from these three sectors.

Again using the Brinson attribution, we can rank the sectors based on their contribution to the improvement in Climate VaR. Note that the allocation effect is zero because we kept the weights of the sectors fixed. As expected from the previous case, sectors with a wide Climate VaR distribution, such as industrials, had a larger improvement than sectors where the Climate VaR distribution is rather concentrated, such as energy.

Exhibit 13: Brinson attribution of Climate VaR difference between original and rebalanced portfolios



Analysis as of September 2021.

Beyond the constraints on sector allocation, one could employ optimization techniques to minimize Climate VaR under various constraints at once, such as a portfolio's tracking error relative to a benchmark, duration, sector allocation and other characteristics.

Carbon emissions as a systematic driver of risk and returns

While scenario analysis provides a powerful tool for understanding the potential long-term financial implications of climate risk, it doesn't say much about the impact of the net-zero transition on portfolio returns in the recent past or near-term future. As more investors consider the impact of their investment decisions on climate change, the financial markets may see a reallocation of capital from carbon-intensive to more carbon-efficient companies. Carbon emissions may emerge as a systematic driver of equity risk and return. Here, we present a carbon-efficiency factor that can help investors quantify the impact of carbon emissions on portfolio returns after accounting for the effect of standard equity factors.

The growing academic literature on climate finance provides a conceptual foundation for the incorporation of climate risk in risk models. Bolton et al. (2020) investigated the idea of carbon emissions as an equity factor and outlined several economic hypotheses for how emissions might affect stock returns.[21] They found that stocks with higher emission levels had higher returns in the U.S. equity market. In a subsequent study, Bolton et al. (2021) reported similar findings across countries and sectors.[22] For the interested reader, Giglio et al. (2021) provides a comprehensive overview of academic research on climate finance.[23]

For factor risk models, emission intensity, a standard metric for carbon footprinting, provides a simple and intuitive proxy for measuring the exposure to transition risk (but not, notably, physical risk). It measures the amount of greenhouse-gas emissions per unit of revenue, enterprise value including cash (EVIC) or other measures of economic outputs or activities. According to the EU technical expert group on sustainable finance, "emissions are the key indicator to assess a company's exposure to climate risks."[24] During the transition to a low-carbon economy, high-intensity firms may be avoided by investors who seek to decarbonize portfolios. These firms also may be more heavily affected by policies designed to limit emissions, increasing consumer preference for low-carbon consumption or disruptions from green technologies.

The emission intensity of a company depends on the nature of its business activities. Energy companies, on average, are more carbon-intensive than information-

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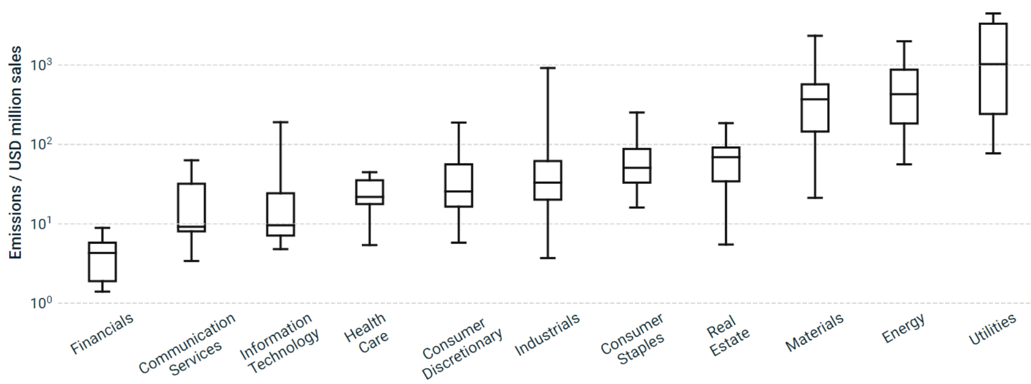
[21] Bolton, Patrick, and Kacperczyk, Marcin. "Do Investors Care about Carbon Risk?" European Corporate Governance Institute working paper, November 2020.
[22] Bolton, Patrick, and Kacperczyk, Marcin. "Global Pricing of Carbon-Transition Risk." National Bureau of Economic Research working paper, February 2021.
[23] Giglio, Stefano, Kelly, Bryan, and Stroebel, Johannes. "Climate Finance." Annual Review of Financial Economics, November 2021.
[24] Hoepner, Andreas, et al. "TEG Final Report on Climate Benchmarks and Benchmarks' ESG Disclosures." European Commission, Sept. 2019.

technology companies, for example. To account for the systematic variation of emission intensity across sectors, we define the “carbon efficiency” of a stock by comparing its emission intensity to its sectoral peers. As a result, a portfolio will only have a positive factor exposure if, on average, it invests in companies that have lower emission intensity than its peers.

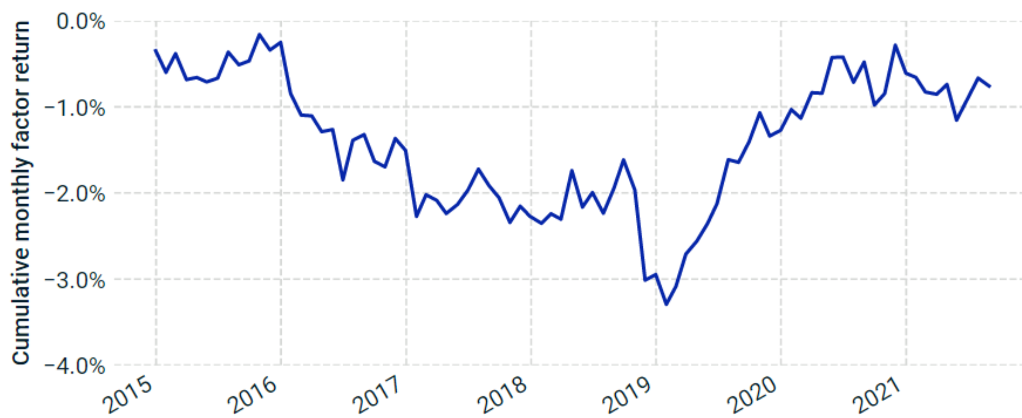
Exhibit 14: Distribution of Scope 1+2 emissions intensity by GICS sector



Scope 1+2 emissions intensity (relative to sales) for constituents of MSCI USA Investable Market Index as of March 31, 2022. The boxplot reflects the first, second and third quartiles (box) and fifth and 95th percentiles (whiskers) of emissions intensity.

We examined the performance of a carbon-efficiency factor based on the Scope 1+2 emission intensity for the U.S. equity market between December 2014 and August 2021. In our analysis, we did not observe a strong statistical relationship between the carbon-efficiency factor and stock returns: The factor has an average absolute t-statistic of 1.2. This is perhaps not surprising, because investors have started paying more attention to climate risk only in recent years. Many have yet to incorporate climate considerations in portfolio-management decisions. From that perspective, historical data may not be a useful guide for determining the future impact of emerging investment risks such as climate change.

Exhibit 15: Cumulative monthly factor return of a carbon-efficiency factor based on scope 1+2 emissions intensity



Cumulative monthly factor return of a carbon-efficiency factor based on Scope 1+2 emission intensity for the U.S. equity market. The factor returns were estimated using a multivariate regression with industry and style factors. The analysis shows the carbon-efficient stocks underperformed carbon-intensive stocks between 2015 and 2019.

|t|	%|t| >=2	Avg Return	Volatility	IR
1.2	14%	-0.11%	1.04%	-0.11

Factor statistics of the carbon-efficiency factor. |t| shows the average absolute t-statistics from the monthly regressions. %|t|>=2 shows the percentage of regressions with significant t-statistics. Avg Return, Volatility and IR show the average annualized return, annualized volatility and information ratio of the factor, respectively.

Will low emitters outperform high emitters in the future? What will be the impact of carbon emissions on portfolio returns? The answers to these questions depend on whether and how equity investors price climate risk in the future. Because the net-zero transition poses financial risk to investors, it is important to monitor portfolio exposures to carbon-intensive assets and the impact of carbon emissions on portfolio returns.

Conclusion

Climate risk is an emerging investment risk. To manage the impact of climate change and the net-zero transformation on the return and risk of investment portfolios, it is important to understand the drivers of climate risk (physical and transition risks) and their economic transmission channels (microeconomic and macroeconomic). An important feature of climate risk is its enormous degree of uncertainty about exactly what will happen, where and when. In addition, the unprecedented nature of climate change means investors cannot rely on historical data to gauge its future impact on portfolios. Scenario analysis may provide a powerful tool for handling the uncertainty, however, by helping investors understand their financial exposures under different transition- and physical-risk scenarios.

In this paper, we used MSCI Climate VaR in a climate stress test to analyze the climate risk in a set of hypothetical equity portfolios. We ranked the portfolios based on their risk exposures and examined the drivers of risks and opportunities. We described options to reduce climate-risk exposures and how they are applied.

Investors often use factor risk models to understand the drivers of portfolio returns. The net-zero transition may result in a flow of capital from carbon-intensive to carbon-efficient investments as investors consider the effect of their investment decisions on climate change. By incorporating carbon emissions in equity risk models, investors can quantify the impact of these emissions on portfolio returns after accounting for the effect of standard equity factors. Looking forward, we may gain a better understanding of the pricing of climate risk in equity markets with additional research and data.

Contact us

clientservice@msci.com

AMERICAS

Americas	1 888 588 4567 *
Atlanta	+ 1 404 551 3212
Boston	+ 1 617 532 0920
Chicago	+ 1 312 675 0545
Monterrey	+ 52 81 1253 4020
New York	+ 1 212 804 3901
San Francisco	+ 1 415 836 8800
São Paulo	+ 55 11 3706 1360
Toronto	+ 1 416 628 1007

EUROPE, MIDDLE EAST & AFRICA

Cape Town	+ 27 21 673 0100
Frankfurt	+ 49 69 133 859 00
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Milan	+ 39 02 5849 0415
Paris	0800 91 59 17 *

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China North	10800 852 1032 *
China South	10800 152 1032 *
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