Allianz Global Investors | risklab

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Evaluating and addressing climate impact on portfolio returns

Content

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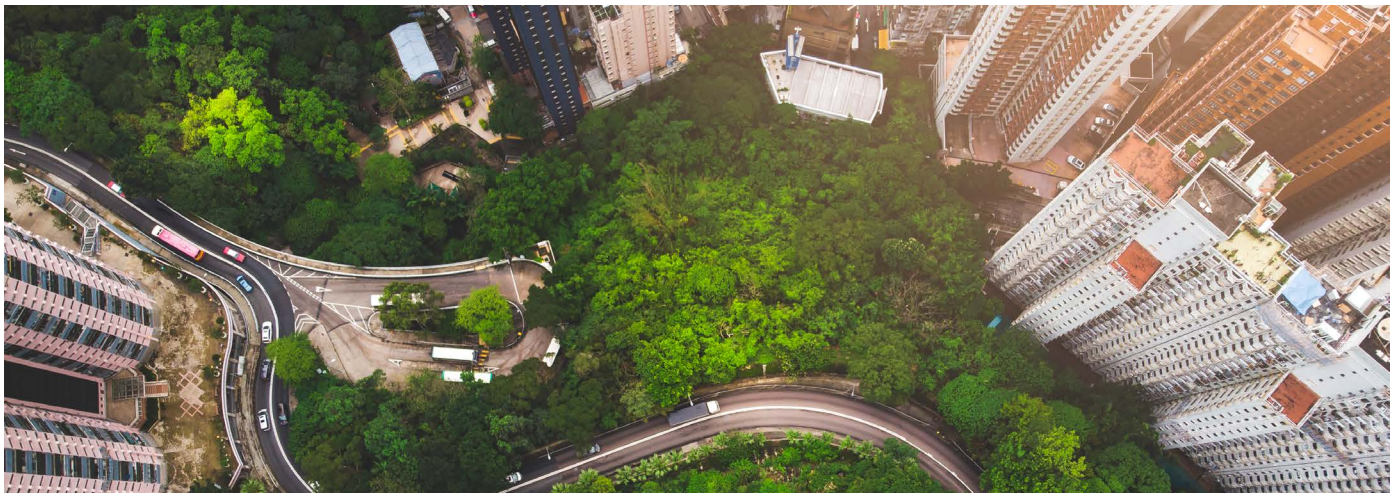

EXECUTIVE SUMMARY

- Climate change will have a considerable impact on the economy and investment portfolios, both from the physical risks posed by shifts in weather and temperatures and transition risks associated with how companies and economies adapt to a changing climate. But high uncertainties about the extent of the impact mean investors need to consider a range of possible scenarios. Climate scenarios can provide a useful tool to evaluate climate risks, pointing to several hypothetical futures with different degrees of climate risk.
- Our proprietary Capital Markets Model[1] measures the impact of climate risk on asset class returns by taking account of macroeconomic data such as GDP growth, inflation and interest rates, as well as climate-change-related future costs for individual companies.
- Our analysis, which we call Climate Navigator, suggests that the degree of climate risk asset classes is exposed will vary depending on how the world responds to climate change. In the scenario of a disorderly climate transition, meaning elevated costs for businesses and economies from climate change mitigation and adaptation, all equity and fixed income asset classes are at significant risk of lower return over the next ten years. Lower growth, higher interest rates and lower stock and corporate bond values are the main factors behind the smaller return.
- Investors may want to consider pivoting to climate-aware investment approaches as an initial step to reduce the risk of lower returns, without the need to make wholesale changes to asset allocations.

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1. The Capital Markets Model is risklab's proprietary model to generate 10,000 forward-looking scenarios for risk factors such as GDP growth, inflation and interest rates in various economies and credit spreads of companies. It covers a wide range of asset classes including fixed income, equities and private assets.

Adapting to a changing climate today

Since the pre-industrial period, human activities have increased the average global temperature by more than 1°C. If we do not drastically reduce our use of fossil fuels, we are heading towards a world in which average temperatures are almost 3°C hotter than pre-industrial times, according to an intermediate greenhouse gas emissions scenario.[2]

The human cost of such a development could be very high. Approximately 3.3–3.6 billion people live in conditions that are "highly vulnerable to climate change", according to the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report.[3] Therefore, action to minimise climate change is needed urgently: the report states that "Deep, rapid and sustained mitigation and accelerated implementation of adaptation actions in this decade would reduce future losses and damages related to climate change for humans and ecosystems."

In this whitepaper, risklab, our global advisory and solutions capability, analyses the impact of climate change on the returns of various asset classes and investment portfolios caused by changes in economies and companies. We use our Capital Markets Model to measure the effect of a range of climate scenarios across asset classes over the next decade. We show how the results can help investors reduce the risk of lower returns – and integrate climate risk into their portfolio.

Defining scenarios and measuring climate risk

As a starting point for our analysis of likely climate change scenarios, we need to consider both physical and transition risks.

Physical risks from climate change materialise in two ways. First, extreme weather events such as flooding and high winds can disrupt business operations and lead to damage to property and impaired asset values. Second, chronic physical risks such as increased temperatures or reduced rainfall may affect land, capital and productivity and require businesses, households and governments to make substantial investments to adapt.

Transition risks are those linked to the pace and extent at which a company or economy manages to lower greenhouse gas emissions or to adapt to existing impacts of climate change.

A transition to a low-carbon economy creates opportunities for businesses. For example, companies that offer goods and services that comply with climate policy, develop climate-friendly technology or adapt to changing consumer preferences could benefit. Conversely, companies that rely on fossil fuels or unsustainable business practices are likely to experience reduced profitability due to higher carbon prices, reduced demand from consumers, higher legal liabilities or stranded assets. Low-carbon policies could raise costs for households too – for example, by requiring them to convert from gas to electricity heating.

The impacts of transition and physical risks on individual businesses and households will have a knock-on aggregate effect on the economy. A transition to a low-carbon world will require more capital expenditure and may affect the valuation of companies. In some cases, productivity may fall as more investment goes to mitigation and adaptation in response to physical risks. Labour market friction (for example, worker redundancies at a closing power plant) may rise, as might conflicts and migration.

Climate policies will lead to short- and medium-term transition risks for the economy, whereas physical risks play out over varying timescales. In the short term, acute physical risks (such as extreme weather events) can represent an immediate challenge, whereas chronic physical risk (such as sustained higher temperatures) will increase over the long run.

Natural weather and climate patterns such as El Niño and La Niña can be chaotic – their timing and impact can vary, so a precise prediction of their exact sequence is not possible. Similarly, the impacts of climate change rarely unfold in a linear manner due to feedback processes and tipping points[3] potentially being breached. This means there is significant uncertainty about forecasts of how physical climate risks will develop. Forecasts of transition risks are also highly uncertain as the speed and intensity of climate policy implementation, technological developments and societies' responses to the physical impact of climate change are also difficult to predict.

Climate scenarios

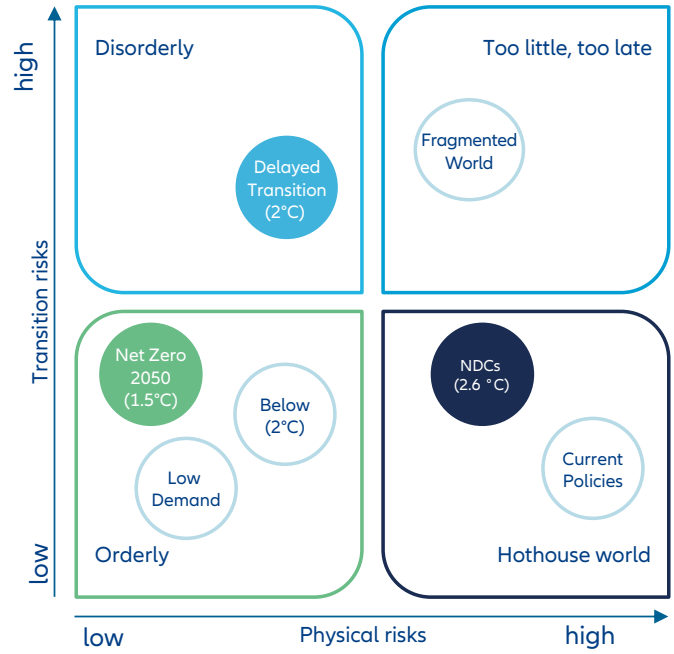
To calculate climate risk, forward-looking scenarios help us define the various possible outcomes, making the impact of climate change more tangible. Although climate scenarios are not exact projections of the future, they can help us evaluate future climate risks.

2. Synthesis report of the IPCC Sixth Assessment Report (AR6), https://report.ipcc.ch/ar6syr/pdf/IPCC_AR6_SYR_SPM.pdf
3. Synthesis report of the IPCC Sixth Assessment Report (AR6), https://report.ipcc.ch/ar6syr/pdf/IPCC_AR6_SYR_SPM.pdf

Policymakers and international organisations have developed various climate scenarios. The best-known are those from the Intergovernmental Panel on Climate Change (IPCC), the International Energy Agency (IEA) and the Network for Greening the Financial System (NGFS), a group of central banks and financial supervisors aiming to accelerate the scaling up of green finance:

- IPCC's Sixth Assessment Report presents five possible future climate scenarios. They range from a most optimistic scenario, equivalent to an implied temperature rise of 1.5°C by 2050 (known as SSP1-1.9) to a worst-case failed transition scenario in which temperatures rise to 4.4°C above pre-industrial levels by 2100 (SSP5-8.5).
- IEA's Global Energy and Climate Model consists of three climate scenarios: Net Zero Emission by 2050 (with a similar trajectory to IPCC's 1.5°C scenario), Stated Policies and Announced Pledges.
- The NGFS has developed seven climate scenarios. During their development, it compared them with the IPCC and IEA scenarios for risk assessment purposes. We describe the scenarios below. One of them, the Net Zero 2050 scenario, is closely aligned to the IPCC's 1.5°C scenario and the IEA's Net Zero Emission scenario.

Exhibit 1: Climate scenarios can help investors evaluate probable outcomes



Source: https://www.ngfs.net/sites/default/files/medias/documents/ngfs_climate_scenarios_for_central_banks_and_supervisors_phase_iv.pdf For illustrative purposes only

In our view, the NGFS scenarios are most useful in quantifying climate risks in a portfolio setting for two reasons. First, the NGFS explicitly integrates physical risk in its climate scenarios, not just transition risk. Second, the NGFS uses an economic model to translate climate impact on real world variables. For example, energy use and carbon emissions are factored into country-specific macroeconomic variables such as GDP growth, inflation and interest rates. The results are used to reflect the top-down climate impact on asset price returns, as we will see in the How we quantify climate risk section.

The NGFS scenarios are becoming more commonly used by regulators, financial institutions and market participants to assess and communicate climate risks. Data providers are also aligning their climate-risk-related metrics and analysis with the scenario data used by the NGFS. That said, we need to remember that all climate scenarios are imperfect. We discuss this in more detail in the Critically appraising our work section.

The NGFS has defined different groups of climate scenarios (see Exhibit 1):

- Orderly climate scenarios assume there is timely and smooth implementation of climate actions. Transition risks are medium in magnitude in these scenarios. The Net Zero 2050 scenario implies that the world achieves the greenhouse gas reduction goals of the Paris Agreement.
- The Disorderly climate scenario assumes the transition doesn't begin until 2030 (Delayed Transition). Both the Orderly and Disorderly scenarios assume that temperature rises by 2050 are limited and physical risks are kept in check.
- Hothouse world scenarios involve insufficient climate action that leads to significant global heating. Severe physical risks would materialise over the long run, with negative impacts on the economy and financial markets.
- The too little, too late scenario assumes a delayed and divergent global climate policy response. Some countries partially achieve their net zero targets, while others follow their current climate policies. The uncoordinated and, therefore, extremely costly climate transition eventually fails, leading to high physical risks.

Measuring climate risk

How much climate risk is currently reflected in market prices? Countries' self-defined pledges to reduce national emissions are at the heart of the Paris Agreement's Nationally Determined Contributions (NDCs). The projected policy pathways required to meet NDCs are being incorporated in forecasts for economies and companies, so we assume that

the impact of NDCs is priced in by the market. Therefore, we use the adoption of NDCs as our baseline scenario and measure the risks of other climate scenarios relative to this baseline scenario. As we do not know which scenario will become a reality, we are aware that we are making an assumption. We examine this assumption in the Critically appraising our work section.

Why should we measure climate risks? Although the effects of climate change can take time to become apparent, investors should not assume that they can be ignored. Climate risks can make it less likely that our clients are able to meet their financial objectives, so later on in this paper we provide some ideas about how to reduce the climate risks their portfolios are exposed to.

First, we describe how we quantify climate risk for a horizon of 10 years. Second, we show how climate change could have a negative impact on various asset classes that can be part of a typical institutional portfolio. We go on to examine possible ways to deal with these risks.

How we quantify climate risk

The change to portfolio returns as a result of the scenarios set out above are driven by the lower expected performance of individual asset classes due to the climate risks they are exposed to. Climate change will affect asset class returns on two levels. First, the performance of each asset class is subject to developments in individual economies that can have an impact on macroeconomic and financial variables. Second, companies have different business models, sources of revenue and costs, so company-specific climate costs play an important role in determining the returns of individual stocks and corporate bonds.

Top-down climate risk

The NGFS provides a dataset that includes projected country-specific GDP, inflation and short- and long-term nominal interest rates for every year up to 2050. For the analysis we detail in the section above, we use data from 2024 to 2033.[4]

The process of transitioning to a lower-carbon world will initially put a burden on the economy, as reflected in changes in macroeconomic variables as follows:

- **Real GDP growth:** the transition is likely to have a moderately negative impact on GDP growth. Reduced demand due to higher carbon prices and energy costs are unlikely to be entirely offset by recycling revenues from carbon taxes.
- **Inflation:** implementing carbon pricing tends to result in higher energy costs, which will lead to a modest but temporary increase in inflation.
- **Long-term nominal rates:** long-term nominal rates are expected to rise due to the higher demand for capital resulting from the investment spurred by the transition.

Transition and physical risks could lead to a negative impact on countries' GDP growth, higher inflation and higher long-term interest rates.

In the event of a failed transition, physical risks would have a more severe impact:

- **Real GDP growth:** chronic physical impacts will lead to reduced productivity and losses from damage caused to buildings and infrastructure. Damage from acute physical risks will depend on a region's exposure and vulnerability to extreme weather events.
- **Inflation:** lower crop yields and productivity will lead to increased inflationary pressure.
- **Long-term nominal rates:** increased economic uncertainty will mean investors demand higher compensation for locking their money away in longer-term fixed income. This rise in the term premium will add upward pressure on long-term interest rates.

In this paper, the investment horizon is 10 years. Based on the assumptions of the NGFS' Orderly and Disorderly scenarios, severe chronic physical risks play a minor role in our analysis.[5] For this reason, we do not investigate further the scenario that no or insufficient additional climate actions are taken.[6]

4. The data we use to model transition risk is based on the Integrated Assessment Model REMIND-MAgPIE by the Potsdam Institute for Climate Impact Research.
5. We acknowledge that severe acute physical risk could lead to abrupt and high financial risks in the short to medium term. However, chronic risk will play out in the medium to long term.
6. These outcomes include Current Policies under Hothouse world and Fragmented world under Too little, too late.

Integrating bottom-up climate risks enables investors to differentiate companies facing high climate risks from those with low climate risks. It also helps distinguish between those investment approaches with the highest and lowest climate risks.

Some energy companies may face a 100% discount in their share or bond price in a scenario of a failed transition due to the high climate risk their business models involve.

By comparison, those companies providing climate-friendly technology will receive a revenue boost, which should be reflected positively in their asset prices.

As the Below 2°C scenario is between the Net Zero 2050 and the Disorderly scenario, we do not discuss this scenario in this paper, although we do include it in our analysis.

Bottom-up climate risk

The benefits or costs of climate risk for individual companies vary depending on their approach to the transition to a low-carbon economy and on their exposure and vulnerability to physical risks. Taking bottom-up climate risk into account is crucial. For instance, a utility company generating a significant proportion of its revenue from thermal coal power generation could face a significantly higher transition cost than another utility company that uses wind as its main power source.

In our analysis, we use MSCI's Climate Value-at-Risk measure to assess the climate-related risks that companies are exposed to.

After estimating the future climate cost for each company for every year up to 2080, MSCI obtains the overall face value of the cost by discounting the future climate cost based on the cost of capital for each company as of today. The face value is then reflected in each company's equity and debt price. The result represents the discount or premium of the company's stock or bond price resulting from climate impact.

Future climate cost is the starting point of MSCI's calculation. It consists of three components:

- **Policy risk:** the cost of reducing greenhouse gas emissions for individual companies is estimated based on country-specific greenhouse gas emissions pathways for Scope 1 emissions, electricity prices for Scope 2 emissions and global greenhouse reduction requirements for Scope 3 emissions,[7] all aligned with inputs from the NGFS.
- **Technology opportunities:** companies generating revenues from low-carbon sources should benefit from the transition.
- **Physical risk:** MSCI uses geospatial data to identify companies' fixed assets' vulnerability to different chronic hazards, such as extreme heat. For acute risks, MSCI uses natural catastrophe models[8] to estimate damages to companies' asset value and revenue losses.

A Climate Value-at-Risk of -10% for a company's security (bond or stock) in a certain scenario represents the discount at which that security should trade if the market assumes that that climate scenario will occur in future. Therefore, the risk of the future impact is discounted from the security's current price.

Combining top-down and bottom-up climate risk

For equities, dividend yield and buybacks, earnings growth and valuation are the main determinants of returns. The earnings growth of a particular equity market, such as European equities, can be approximated by the nominal GDP growth of the region. We calculate the climate-informed GDP growth by combining the long-term assumption for real GDP growth and inflation rates in our Capital Markets Model with the change in these variables under various climate scenarios. While we see no clear evidence of a change in the dividend yield and buybacks across companies as a result of climate impact, the valuations of individual firms will change

7. Scope 1 are emissions from sources that an organisation owns or controls directly. Scope 2 are emissions that an organisation causes indirectly and come from where the energy it purchases and uses is produced. Scope 3 are emissions that are not produced by the organisation itself and are not the result of activities from assets owned or controlled by them, but by those that it is indirectly responsible for up and down its value chain. Source: What are scope 1, 2 and 3 carbon emissions?, National Grid Group.
8. Natural catastrophe models are computerised processes simulating potential catastrophic episodes based on historical events.

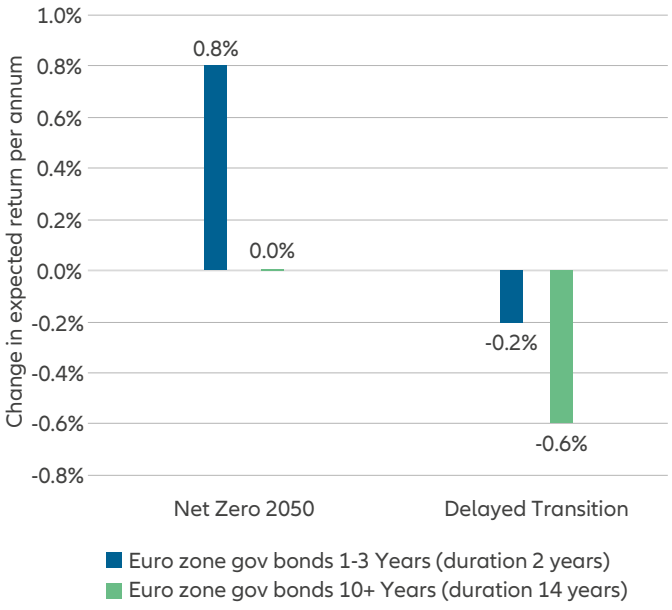
and can be quantified using the Climate Value-at-Risk for each climate scenario.

For fixed income, the changes in interest rates used in the NGFS data directly impact bond returns. For corporate bonds and equities, the climate cost for each company is reflected in its security prices by incorporating Climate Value-at-Risk.

Changes in interest rates have two effects on return expectations for bonds. First, higher interest rates lead to a lower return because they have a negative impact on bond prices. Bonds with longer duration experience a more negative impact. Second, the timing of any increase in interest rates and how long interest rates remain high for are also important.

Exhibit 2: Euro zone government bond returns are likely to be better if the world meets Net Zero 2050

Change in expected annual return over the next 10 years



Source: Holdings data from Allianz Global Investors. Holdings data as of 29 September 2023. Input data from NGFS Scenarios Portal, MSCI. Input data as of 30 November 2023. Forecasts do not predict future returns. Future performance is subject to taxation which depends on the personal situation of each investor and which may change in the future. The hypothetical performance and simulations shown are for illustrative purposes only and do not represent actual performance; they do not predict future returns. Please see important information above the end disclaimer. The statements contained herein may include statements of future expectations and other forward-looking statements that are based on management's current views and assumptions and involve known and unknown risks and uncertainties that could cause actual results, performance or events to differ materially from those expressed or implied in such statements. We assume no obligation to update any forward-looking statement.

In Exhibit 2, euro zone government bonds that are longer than 10 years (euro zone gov bonds 10+) have the same expected return in the Net Zero 2050 scenario than in our baseline scenario and a lower expected return over the next 10 years on average in the Delayed Transition scenario. Euro zone government bonds with a two-years duration have a higher expected return in the Net Zero 2050 scenario and a lower return in the Delayed Transition scenario.

In the Net Zero 2050 scenario, interest rates rise immediately over the next three years and remain high. The interest rate at which the notional amount of matured bonds can be reinvested increases so that the carry an investor can earn over the 10-year period outweighs the amount the bonds fall in value. However, for bonds with higher interest rate sensitivity, the negative effect on the bonds' value cancels out the increased carry. The Delayed Transition scenario assumes that the transition does not get going properly until 2030, so the period in which there is higher carry only accounts for a small proportion of the investment horizon we are considering, and this moderately higher carry is not enough to compensate for the devaluation that both groups of bonds suffer.

Exhibit 3: Euro zone corporate bonds are expected to fare better than equities

Change in expected annual return over the next 10 years

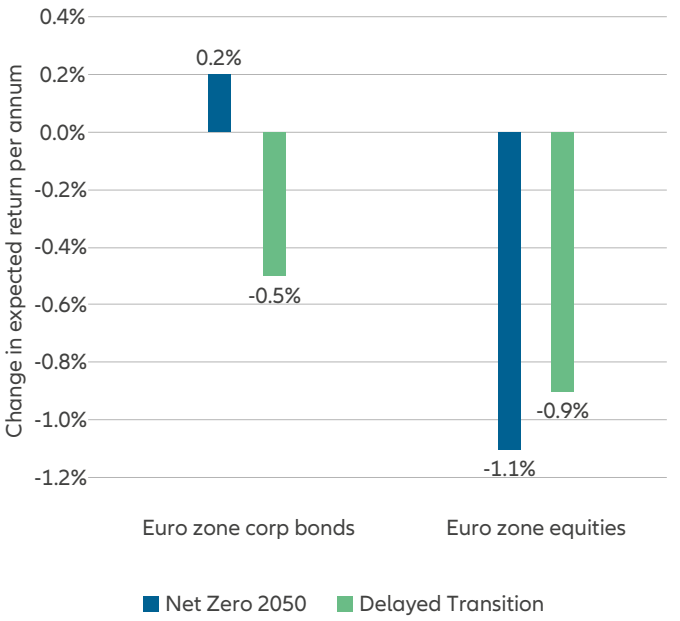


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Exhibit 4: Annualised expected returns for various asset classes in the Net Zero 2050 scenario

	US Treasuries	Euro zone govt bonds	Euro zone govt bonds 10+	Emerging market govt bonds	US investment- grade corp. bonds	Euro zone investment-grade corp bonds	US high-yield bonds	Euro zone high-yield bonds	Developed world equities	Euro zone equities	Emerging market equities
Return in baseline scenario	3.70%	3.80%	4.80%	5.70%	4.90%	4.60%	5.40%	5.20%	6.60%	9.10%	7.10%
Return in Net Zero 2050 scenario	4.00%	4.20%	4.80%	5.90%	5.00%	4.80%	5.40%	5.30%	5.20%	8.00%	5.70%
Difference in return	0.3 ppt	0.4 ppt	0.0 ppt	0.2 ppt	0.1 ppt	0.2 ppt	0.0 ppt	0.1 ppt	-1.4 ppt	-1.1 ppt	-1.4 ppt

Source: Holdings data from Allianz Global Investors. Holdings data as of 29 September 2023. Input data from NGFS Scenarios Portal, MSCI. Input data as of 30 November 2023. Note: ppt = percentage points.

This is not an indication of expected results. It should not be considered a recommendation to purchase or sell any particular security or strategy or an investment advice. Because market and economic conditions are subject to rapid change, all opinions and views expressed constitute judgments as of the date of the writing and may change at any time without notice and with no obligation to update. Past performance, or any prediction, projection or forecast, is not indicative of future performance.

For euro zone corporate bonds, similarly to euro zone government bonds, the change in return depends on the path of interest rates in the individual scenarios. It is much less negative for Net Zero 2050 than for the Delayed Transition scenario. Company-specific future climate costs, which negatively affect returns, also play an important role. In the Net Zero 2050 scenario, the negative impact from climate risk does not completely erode the boost to returns from the change in interest rates. In the Delayed Transition scenario, returns are negatively affected by a delayed interest rate rise and company-specific climate costs (see Exhibit 3).

The expected change in returns is more negative for stocks than it is for bonds. This is because company-specific risks are usually higher for stocks than for corporate bonds as shareholders will have to foot much of the bill for future climate costs. Debt holders will then have to bear the remainder of the cost. The negative impact of company-specific climate risk outweighs the positive impact from companies' higher earnings growth, represented by higher nominal GDP growth in both scenarios.

Assessing climate risk impact on various asset classes

Our analysis across asset classes can help us develop approaches to respond to any reduction in returns under the different scenarios.

In the Net Zero 2050 scenario (see Exhibit 4), we see that:

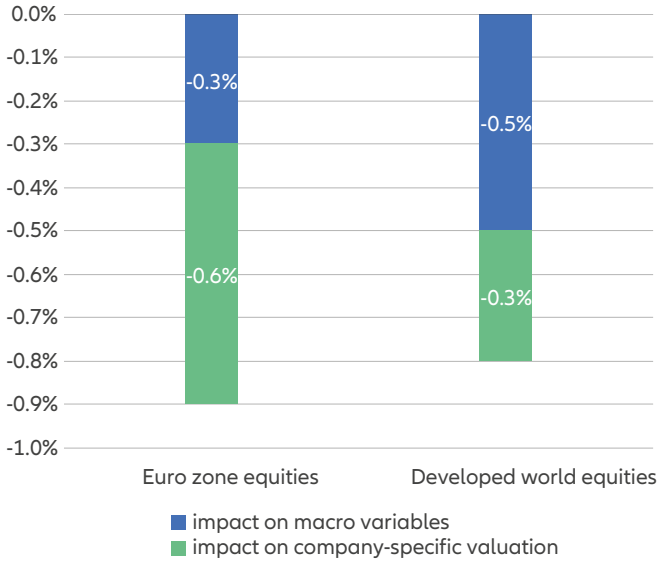
- Equities (developed world, euro zone and emerging market equities) suffer significant falls in expected return, in part due to company-specific future climate costs.
- Government bonds with relatively low interest rate sensitivity – meaning they have shorter duration – show an increase in return because of the higher interest rate level throughout the investment horizon.
- Investment-grade corporate bonds also mostly show an increase in return as the boost from higher interest rates outweigh company-specific future climate costs.

There are winners and losers in the Net Zero 2050 scenario. But the Delayed Transition scenario shows that the expected returns of all asset classes are at risk:

- All asset classes show a decrease in expected return.
- Higher-risk asset classes such as equities and high-yield corporate bonds suffer the biggest fall in expected return.
- The fall in return is more pronounced for euro zone equities, as we show in Exhibit 5:
  - The climate impact on macroeconomic variables is lower for euro zone equities than for developed world equities, reflecting the transition progress in euro zone countries.
  - The climate impact from company-specific future climate cost is higher for euro zone equities than developed world equities in part due to differences in the types of businesses. For example, the US, which is the largest part of the developed world equity universe, has a relatively high proportion of information technology companies, which typically have relatively low future climate-related costs. In contrast, the euro area has a higher proportion of sectors such as utilities, basic materials and industrials, which are likely to face higher climate-related costs, and as such have a bigger reduction in expected returns.

Exhibit 5: The changes in the expected returns of euro zone equities and developed world equities in the Delayed Transition scenario

Factors behind the change in expected annual returns



Source: Source: Holdings data from Allianz Global Investors. Holdings data as of 29 September 2023. Input data from NGFS Scenarios Portal, MSCI. Input data as of 30 November 2023

- Government bond returns are least affected as company-specific climate costs are assumed to be borne by businesses, not governments.
- Investment-grade corporate bonds have a significantly lower expected return, but the drop is smaller than for stocks as equity shareholders will have to bear the brunt of climate costs.

The relative attractiveness of the various asset classes changes when we incorporate climate risks in our return expectations (see Exhibit 4 and 6). Overall, government bonds become more attractive, and equities become less attractive.

In the Net Zero 2050 scenario, equities appear significantly less attractive. Fixed income asset classes appear more attractive because of a boost in returns. Government bonds show the highest improvement in return.

In the Delayed Transition scenario, while equities still have the highest expected return, their expected outperformance of asset classes such as corporate bonds and, especially, government bonds shrink. Similarly, euro zone high-yield bonds' expected outperformance of euro zone government bonds falls when we incorporate climate risk.

One could certainly challenge the assumption that a greater proportion of future climate costs will be borne by companies than by governments. As it is very difficult to forecast whether there will be political measures to reduce the burden on companies in the future, such as through a redistribution of income from carbon taxes, we are not at present assuming that there will be a transfer of the cost from companies to governments.

Exhibit 6: Annualised expected returns for various asset classes in the Delayed Transition scenario

	US Treasuries	Euro zone govt bonds	Euro zone govt bonds 10+	Emerging market govt bonds	US investment grade corp bonds	Euro zone investment grade corp bonds	US high-yield bonds	Euro zone high-yield bonds	Developed world equities	Euro zone equities	Emerging market equities
Return in Baseline scenario	3.7%	3.8%	4.8%	5.7%	4.9%	4.6%	5.4%	5.2%	6.6%	9.1%	7.1%
Return in Delayed Transition scenario	3.3%	3.5%	4.2%	5.2%	4.3%	4.1%	4.8%	4.6%	5.8%	8.2%	6.3%
Difference in return	-0.4 ppt	-0.3 ppt	-0.6 ppt	-0.5 ppt	-0.6 ppt	-0.5 ppt	-0.6 ppt	-0.6 ppt	-0.8 ppt	-0.9 ppt	-0.8 ppt

Source: Holdings data from Allianz Global Investors. Holdings data as of 29 September 2023. Input data from NGFS Scenarios Portal, MSCI. Input data as of 30 November 2023. Note: ppt = percentage points.

In the climate scenarios that involve high transition risk, equities still deliver the most attractive expected returns but their expected outperformance of government bonds is lower.

Reducing climate risks

As seen in the previous section, under the different climate scenarios, investors with a high share of equities would see a bigger decrease in their expected portfolio return than an investor more focused on fixed income assets. Within fixed income, a higher share of corporate bonds means higher climate risk. Also, fixed income assets with higher sensitivity to interest rates lead to lower expected returns when incorporating the impact from top-down climate risk.

Based on these findings, there are three options to reduce the climate risk that an investment portfolio is exposed to:

1. Adjusting a portfolio's allocation

Given the changes in the relative attractiveness of the asset classes that we discussed above, and assuming the volatility of the asset classes remains unchanged in the face of climate issues over the next 10 years,[9] adjusting a portfolio's allocation to account for climate risk would lead to a portfolio with more government bonds to achieve an optimal risk-return profile. However, such a portfolio would not deliver the portfolio return the investor expects in our baseline scenario without a substantial shift to government bonds.[10]

An alternative approach would be to set the minimum return requirement to the baseline scenario return and allow higher portfolio volatility. In this case, the optimisation process would result in a portfolio with higher weights in equities and higher volatility.

2. Altering the interest rate sensitivity

A second possibility would be to reduce the duration of the portfolio's fixed income holdings in expectation of higher interest rates. In theory, this option would lead to higher expected return in the climate scenarios because of the reduced duration.

However, for asset-only investors,[11] shortening the portfolio's overall duration from medium term to short term would only lead to a moderate change in its interest rate sensitivity. For liability-driven investors with long-term liabilities, shortening the duration would potentially make it more difficult to safeguard the funding ratio. As such, we would only recommend altering the portfolio's duration if doing so is expected to meaningfully reduce the negative change in return and align with the investor's objective.

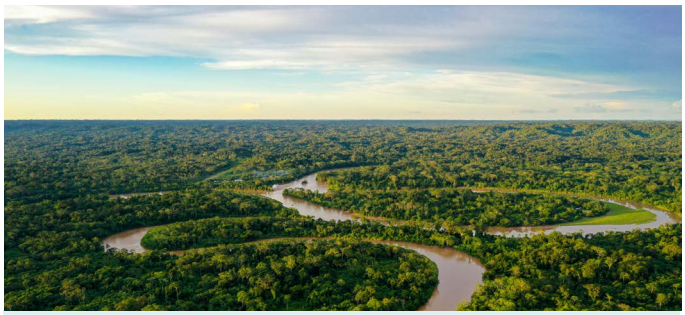
Investors often choose their asset allocation based on their return expectations for the various asset classes or what they may owe in the future (their liabilities), without incorporating any views on the potential effects of climate risk on asset class returns. This means that taking on more risk or altering the portfolio's duration might not align with their objectives or the constraints they face.

3. Using climate-aware investment approaches

The third option is to keep the portfolio's asset allocation and interest rate sensitivity unchanged but switch to climate-aware strategies within each asset class. As companies' stock and bond prices will be affected by climate costs differently depending on their exposure to climate risks and opportunities, investing in companies with low Climate Value-at-Risk should reduce company-specific climate risks in the portfolio. While traditional market-capitalisation-weighted strategies are not designed for this aim, some sustainable investment approaches are. For some asset classes, reducing the proportion of high emitters from sectors such as energy or utilities may help, while for others seeking to reduce the carbon footprint in all sectors is more effective. A good option may be to choose an approach that follows a certain greenhouse gas emission reduction pathway over time, which

9. Please refer to the critical appraisal of our work section to see our thoughts on the climate change induced change of market volatility.
10. This description refers to the Net Zero 2050 scenario. In the Delayed Transition scenario, as all asset classes show lower expected returns, the portfolio return is lower irrespective of the change in the asset allocation.
11. Investors with short-term liabilities or asset-only investors tend to hold bonds with short or medium-term maturities.

would naturally increase the weight in companies with lower future climate costs or even take climate-risk-related metrics explicitly into account in the construction of the portfolio.



What are climate-aware strategies?

These strategies are designed to help investors reflect the changing risks posed by climate change in their portfolios – with a view to benefitting their potential returns.

Climate-aware strategies incorporate specific carbon reduction targets and objectives related to the transition to a low-carbon economy through the selection and weighting of underlying constituents. Among various categories of climate-aware strategies, we found the following approaches to be particularly useful as solutions to reduce portfolio climate risks:

- Low-carbon strategies aim to invest in businesses with lower carbon footprints than benchmarks.
- Climate transition and Paris-aligned strategies focus on decarbonisation pathways. Both invest in businesses with lower carbon footprints and require a year-on-year decarbonisation of the investments.

In our view, investors should carefully consider the change in the risk profile a sustainable investment approach introduces. For fixed income, investors would want to ensure factors such as bond yield, interest rate sensitivity and credit risk do not vary significantly between traditional and sustainable investment approaches. Investors should also monitor any deviation in the portfolio's expected tracking error when switching to a sustainable approach. For equities, investors would want to avoid significant variation in valuation and income yield (yield from dividends, share buybacks and dilution) between the two approaches. Significant deviations in sector weights and idiosyncratic risks, such as excessive concentration in a single company's stock or bond, should be avoided.

Exhibit 7: Switching to a climate-aware investment approach may help protect portfolios in different scenarios

Difference in average annual returns over the next 10 years

Net Zero 2050	Difference in return using traditional benchmarks	Difference in return using climate-aware investment approach
US investment-grade corp bonds	0.1%	0.2%
Euro zone investment-grade corp bonds	0.2%	0.4%
Developed world equities	-1.5%	-1.1%
Euro zone equities	-1.2%	-0.5%
Emerging market equities	-1.4%	-0.9%

Delayed Transition	Difference in return using traditional benchmarks	Difference in return using climate-aware investment approach
US investment-grade corp bonds	-0.6%	-0.5%
Euro zone investment-grade corp bonds	-0.5%	-0.3%
Developed world equities	-0.8%	-0.5%
Euro zone equities	-0.9%	-0.53%
Emerging market equities	-0.8%	-0.5%

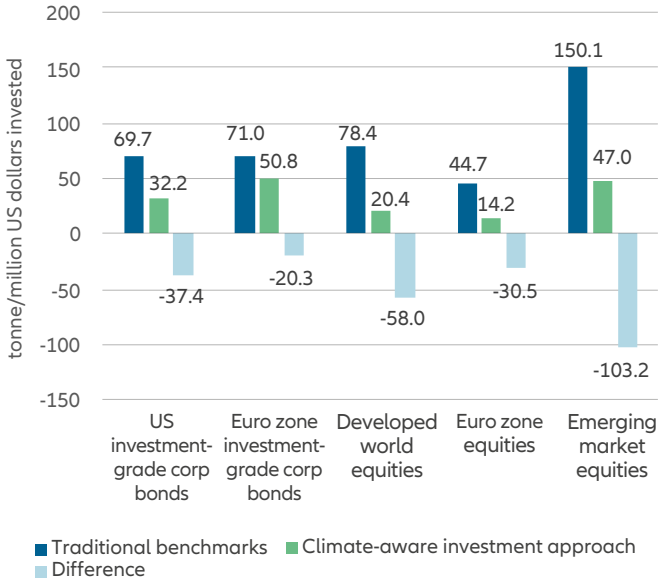
Source: Holdings data from Allianz Global Investors as of 29 September 2023. Input data from NGFS, MSCI and Bloomberg as of 30 November 2023.

This is not an indication of expected results. It should not be considered a recommendation to purchase or sell any particular security or strategy or an investment advice. Because market and economic conditions are subject to rapid change, all opinions and views expressed constitute judgments as of the date of the writing and may change at any time without notice and with no obligation to update. Past performance, or any prediction, projection or forecast, is not indicative of future performance.

Adopting this kind of climate-aware investment approach would not completely eradicate the negative impact on the return of the asset classes and the investment portfolio, but it helps to reduce it without changing the asset allocation substantially (see Exhibit 7).

For many investors, the carbon footprint is another important metric. A climate-aware investment approach can help investors track their portfolio's carbon footprint – and reduce it (see Exhibit 8). By switching from traditional benchmarks to the climate-aware approach across the asset classes most impacted by climate risk, the carbon footprint, measured in terms of Scope 1 and 2 absolute carbon emission for each USD 1 million dollars invested, falls.[12]

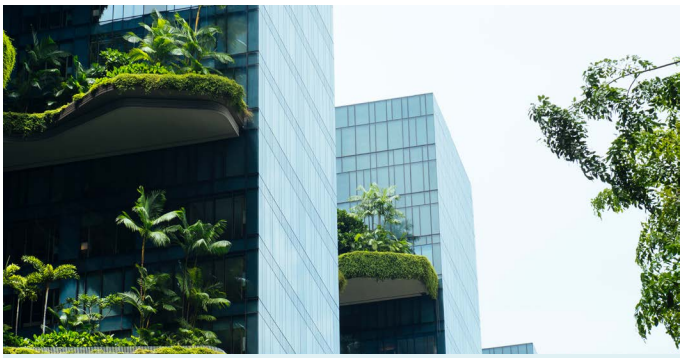
Exhibit 8: Switching to a climate-aware investment approach can help reduce the carbon footprint of the investment portfolio



Source: Holdings data from AllianzGI as of 29 September 2023. Input data from MSCI, Bloomberg as of 30 November 2023.

The benefit of the climate-aware approach is that the return expectation is close to that of the traditional benchmark in our baseline scenario (we assume that available public information based on the NDCs has been priced in by the market). As a result, the portfolio's risk-return profile does not change significantly, and the portfolio becomes more resilient against climate risks, reflected in the lower negative impact on return in the various climate scenarios.

There are several ways to integrate climate impact in a portfolio allocation as there are a range of climate-aware approaches using different benchmarks and adopting different processes. For a climate-informed asset allocation to be implemented efficiently, factors such as liquidity and cost need to be carefully considered. In a second white paper, we will elaborate on the three solutions in greater detail.



We are aware that the underlying climate science, economic and capital market models that we use in our analysis are subject to uncertainty. The extent of climate risks priced in by financial markets and the climate's impact on market volatility are also areas where further research may be useful.

Critically appraising our work

It is important to point out that the underlying climate science models and economic models our work is based on are subject to uncertainties. Climate scientists are confident that global warming will lead to increased frequency and severity of extreme weather events. But the extent, location and timing of these extreme weather events and how they interact with societal, economic and geopolitical factors are subject to significant uncertainty. One of the reasons that exact climate risk forecasts are not possible is that various processes that result from climate change can either diminish or amplify how the climate responds to warming in what are known as feedback loops. One example is the formation of North Atlantic Deep Water (NADW), a deep-water mass in the North Atlantic Ocean that probably impacts the strength of the Gulf Stream, a warm-water current that originates in the Gulf of Mexico and flows towards northern Europe. Were the melting of icesheets around the Arctic to change the flow of NADW, the implications for the climate, particularly in Europe, could be severe.

Beyond the inherent uncertainties of the climate science models and data, there is also room for improvement in the underlying methodology and data that the NGFS scenarios are based on. For instance, physical risks seem too low in the scenarios. The NGFS acknowledges that its modelling of physical risks needs to be improved and plans to do so.

12. The analysis of the carbon footprint is performed in the Sustainability Analytics Research and Advisory Hub (SARAH). This is Allianz Global Investors' proprietary sustainability analytics tool, which combines different sustainability datasets to assess the sustainability profile of a given portfolio or asset allocation by analysing a range of sustainability key performance indicators (KPIs) and financial KPIs.

Risks that are not captured by the models and, therefore, not accounted for by market participants could lead to higher chances of a market crash. Meanwhile, existing climate models generally do not consider the role of investors. However, investors committed to net zero can play a significant role in shifting capital away from companies contributing most to polluting activities and towards those contributing to climate solutions. By changing the cost of capital and by directly funding new activities that reduce emissions, investors can act in a way that is not directly incorporated in climate models. By regularly updating our analysis, we aim to incorporate the improvements to models and data and the impact of changing investor behaviour.

It is hard to say to what extent climate risks are reflected in market prices. We assume that NDCs are priced in as they represent a public policy commitment. However, as has been shown by the UK government backtracking on its climate commitments, this does not mean that policy paths are entirely predictable. More generally, governments are challenged by the increased costs borne by voters in reducing emissions. This may lead to swings in policy. What's more, governments are not fully in control of the process. For example, changes in the behaviour of investors and fossil fuel owners in the face of the transition could have a major effect on cashflows and the discount factors associated with them. Therefore, the scope for future repricing remains extremely high.

In this paper we show the expected return for three scenarios. This is clearly a simplification given that there is a range of uncertainty around any scenario. The evidence from historic temperature changes suggests that temperature variability increases as the temperature deviates from its historic average. This suggests that uncertainty around climate changes should be considered when assessing the implications for growth. This is particularly pertinent at the regional level, where the modelling of climate scenarios is subject to greater uncertainty. Meanwhile, in standard finance modelling, increased uncertainty about growth demands a risk premium as risk-averse investors seek to reduce their exposure to the sources of uncertainty. This suggests that the knock-on effects of increased climate uncertainty on market risk premiums are likely to be compounded. One study,[13] based on US stock returns, suggested that the deviation of temperatures from historic norms had a negative impact on returns. The most sensitive sectors were energy and utilities, while consumer stocks were also affected.

It is unclear how long these higher risk premiums might persist. Those risks associated with the transition should presumably be temporary, but the evidence suggests that adaptation has had limited benefits in terms of reducing the negative effect of weather shocks on growth or agricultural productivity. If that proves to be the case in the future, the shock caused by increased climate vulnerability might result in persistently higher risk premiums. We believe further research in this area is needed.

Outlook: anticipating climate transition risk trends

Based on the evidence of climate science, climate change will have a negative impact on private households, businesses and economies if no action is taken. Recognising the implications of climate risk on their business models and the role they could play in the transition, companies have started to act. Businesses are committing to decarbonisation, to contribute to the transition and to keep future climate costs and their cost of capital in check. In 2022, the Science Based Targets initiative saw more than 1,000 companies and financial institutions have their targets validated[14] – more than in the previous seven years combined. These companies make up over a third of the global economy in terms of market capitalisation.[15] If the process of decarbonisation progresses smoothly, company-specific climate costs should decrease.

13. Bortolan, Leonardo and Dey, Atreya and Taschini, Luca, Nailing Down Volatile Temperatures: Examining Their Effects on Asset Prices (February 2, 2022). Available at SSRN: https://ssrn.com/abstract=4023755 or http://dx.doi.org/10.2139/ssrn.4023755
14. Meaning these companies are following a credible carbon reduction pathway.
15. SBTi monitoring report 2022. https://sciencebasedtargets.org/resources/files/SBTiMonitoringReport2022.pdf

Asset owners and investors have formed initiatives to establish frameworks for the decarbonisation of their portfolios to protect their portfolios against climate risk and to drive the companies they invest in towards net zero emissions. Commitment-based initiatives such as the Net Zero Asset Owner Alliance are leading the decarbonisation of large investment portfolios by setting guidelines such as the Target Setting Protocol and through immediate actions such as engagement. The assets under management of members of the Alliance grew from USD 2.4 trillion in 2019[16] to USD 10.6 trillion by 2022.[17]

Meanwhile, regulatory requirements could tighten, driven by public bodies' mandate to safeguard financial stability and support the climate transition. Besides regulatory requirements about sustainability-related disclosures in the financial sector, EU regulators have begun voluntary climate stress tests for banks, insurance companies and pension funds.

The use of climate scenario analysis is increasing, and not just due to the need to perform regulatory climate stress tests. According to a 2023 survey by the NGFS primarily of financial institutions, central banks and consulting firms,[18] NGFS's climate scenarios are primarily used as a tool to assess climate impact on companies' financial health. What's more, demand for and supply of investment strategies that reduce portfolio climate risk are increasing.

For investors, assessing the climate risks their portfolios are exposed to is the first step in understanding these risks and determining the changes they need to make. By understanding the options available to them to protect their portfolio against climate risks and taking actions in response, investors can make a positive contribution to the climate transition and position themselves well before climate risks start to be more clearly reflected in market prices and some climate solutions become more expensive.

Conclusion: reflecting the climate impact on portfolio returns

Within the next 10 years, the impact of climate change on economies and companies may lead to a substantial decrease of expected asset class returns and, therefore, portfolio returns, especially in the case of high transition risks. The future climate cost to be paid by companies, reflected in the valuation of their stock and bond prices, makes higher-risk asset classes such as equities and high-yield corporate bonds generally less attractive than government bonds.

To address potential return shortfalls, pivoting to climate-aware investment approaches can help, without the need to significantly shift a portfolio's risk profile or asset allocation. It is a sensible and relatively inexpensive option that investors can take up today as the market consequences of an inefficient transition and long-term physical risks have not been clearly priced in. In a second step, a climate-informed portfolio allocation could provide a good indication of the risk-return profile that can be achieved under a particular climate scenario.

We acknowledge there is uncertainty in the climate science, economic and capital market models we base our analysis on. But investors should not assume that climate impact can be safely ignored because of the inherent uncertainties involved in forecasting into the future. Climate scenarios can be an effective tool to test the robustness of a portfolio – and our analysis aims to help investors not only consider climate risk as a tangible, measurable new type of risk, but also integrate climate impact into the shaping of their strategic asset allocations.

16 https://www.allianz.com/en/press/news/commitment/environment/190923_Allianz-UN-backed-asset-owner-alliance-commitment-to-net-zero-emissions-by-2050.html, September 2019

17. https://www.unepfi.org/industries/investment/net-zero-asset-owner-alliance-progress-report-demonstrates-advance-on-decarbonisation-targets/, September 2022

18. The NGFS survey on climate scenarios – Key findings in June 2023. https://www.ngfs.net/sites/default/files/media/2023/06/09/2023-06-08_presentation_on_ngfs_survey_results_spring_2023_for_ngfs_publication.pdf

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