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Global Macro Insights: Race to net zero

From the top down: Capital market assumptions in the climate crisis

Fidelity INTERNATIONAL

Foreword

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Climate change occurs over decades and centuries, whereas portfolios are measured in quarters and years, making it a particular challenge when implementing a climate-aware investment strategy. Yet, if we do not act to keep the average global temperature rises well below 2°C to meet the goals of the Paris Agreement, the consequences to the planet, the world economy, and financial markets will be far worse.

For example, Russia's invasion of Ukraine has given us a tiny glimpse into what a disorderly energy transition might entail. Delayed or divergent worldwide responses disrupt economic activities, raise uncertainties in financial markets and heighten transition risks. Climate physical risks are also intensifying. Extreme weather events have caused more lives lost and commercial damages, upended critical economic ecosystems, and interfered with global supply chains. Additionally, chronic climate developments such as rising sea levels negatively affect the global economy, potentially increasing the risk premia in assets such as real estate or infrastructure in coastal cities.

It is becoming increasingly clear that climate risk is financial risk. According to the Intergovernmental Panel on Climate Change, climate risk will likely cause substantial direct economic damage and reduce economic growth in the short and long term.[1] Research by others including the Carbon Disclosure Project, McKinsey, Brookings Institution, and the International Finance Corporation have also reached similar conclusions, offering a better understanding of how climate risk shapes the global economy and financial markets over time.

However, as with any investment risk, the question becomes to what extent has it been priced in and incorporated into asset allocation frameworks? In our view, investors must assess green premia and brown discounts from both bottom-up and top-down perspectives. To the latter point, our macro team has been integrating the climate risk analysis framework by the Network for Greening the Financial System (NGFS) into our capital market assumptions (CMAs) modelling, which underpin our Strategic Asset Allocation framework. We believe the influence of climate change scenarios should be incorporated into these assumptions, and therefore, should be reflected in risk-return expectations and integrated into the investment decision-making process.

Earlier this year, we updated our CMAs to harmonise with the NGFS's third iteration of its framework released in 2022, delving deeper into the granularities of how climate change may influence key macroeconomic and financial variables such as growth in gross domestic product, inflation, and central bank policy rates. Taking the analysis further, we modelled the effects of the variables under six climate scenarios on various asset risk-return drivers related to income, growth, and valuation. Results are also analysed according to regions and asset classes.

In the coming years, our collective global responses will determine the path of climate change and its ramifications for macro-financial risks. The interconnections between various direct and non-direct climate risks have yet to be fully understood. Therefore, when modelling climate change, it is important to note the high level of uncertainties.

This is only the beginning of the journey. We will continue to hone our understanding and calibrations of how climate risks affect CMAs and asset allocation decisions. Our aim in sharing these findings is not to present them as forecasts but as an anchor to gauge plausible outcomes and their drivers to assess climate-related risks and opportunities using a framework-driven approach.

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Highlights

- Climate change adds uncertainty to the global economy and therefore increases macroeconomic and financial risks, materially impacting the risk-return characteristics of investment portfolios.
- There is a negative effect on GDP growth in all NGFS climate scenarios, but it is not equal across different climate scenarios. The effects of climate change are substantially lower in scenarios in which the world experiences an orderly transition towards net zero relative to a disorderly transition and a hot house world.
- This is largely due to how climate transition and physical risks interact with macroeconomic variables such as GDP growth, inflation, and interest rates. Transition risk, for example, dominates in the short- to medium-term while physical risk becomes more relevant closer to 2050 based on the current understanding of climate change science.
- Applying the effects of both transition and physical risks under the NGFS framework to our CMAs modelling, we disaggregate three key fundamental performance drivers - income, growth, and valuation - to analyse how shifts in these drivers due to climate risks alter performance, including real return expectations.
- Fixed income is less affected by climate change as price impact is typically offset by higher income, although the magnitude of each component can vary. An exception is in a disorderly transition, in which delayed efforts to manage climate risks result in sudden rises in base rates and, therefore, bond yields towards the end of the decade.
- Equities exhibit greater sensitivity to climate change given their valuation is typically based on discounted future cash flows, which are most punitive under disorderly transition and hot house world scenarios due to higher transition and physical risks, respectively.
- The volatility of returns is also expected to rise when climate change is integrated into our CMAs modelling, particularly under the disorderly and hot house world scenarios. This is partly due to higher uncertainty due to sudden, delayed, and uncoordinated climate mitigation and adaptation efforts worldwide.
- To strengthen the results of the CMAs modelling, it helps to track pathways of individual issuers and map the results against the various climate scenarios. For example, Fidelity's Climate Ratings platform assesses the transition potential for about 2,000 issuers.
- Understanding CMAs projections can help investors incorporate evidence-based climate change scenarios into their strategic asset allocation, and ultimately, inform investment decisions to build climate resilience into their portfolios.

Navigating the portfolio implications of climate change

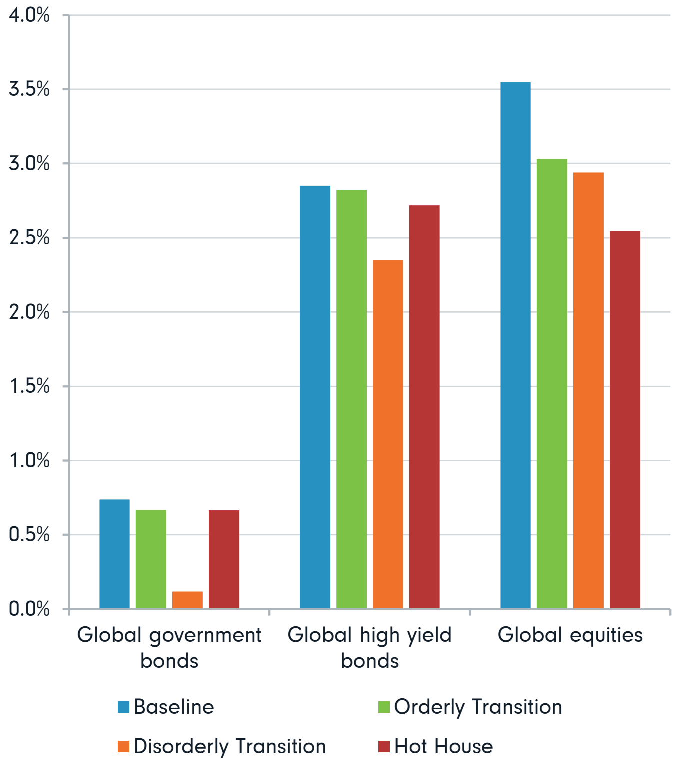
For a low-carbon economic transition to occur, at least three things must happen. First, credible regulations must incentivise businesses and consumers to decarbonise. Second, enabling technology is essential. Third, well-functioning capital markets can effectively channel capital to align with climate goals.

In one of the clearest examples of how these three components can coalesce to advance the net zero pathway, the auto industry is in the middle of a low-carbon transformation that will have knock-on effects to the wider economy and financial markets. Indicators such as revenues, price to earnings, weighted average cost of capital, and valuation gains on research and development are increasingly more favourable for auto manufacturers with stronger climate-aware business models and transition plans.[2] As developments in this sector demonstrate, climate risk is financial risk.

However, the extent to which current prices reflect these risks remains unclear. A meta-analysis by the Bank of International Settlements (BIS) concluded that they do not, complicated by uncertainty and imperfect information.[3] Furthermore, concerns are rising that investors may not have the right tools to consider them sufficiently, especially from a top-down perspective.

For example, climate risks are rarely integrated into capital market assumptions (CMAs) in a forward-looking, transparent, and consistent fashion. This is critical since CMAs feed into strategic asset allocation (SAA) design, so any failure to adequately consider climate risks may lead to misguided return expectations at best. At worst, investors may fail to recognise the increasing possibility of negative and systemic financial market disruptions as the impact of climate change broadens and intensifies. (See Figure 1.) Additionally, ignoring climate risks also results in missed opportunities as the global economy adapts to climate physical and transition risks.

Figure 1: Estimated 10Y annualised real returns, baseline vs. climate scenarios



Source: Fidelity International, March 2023. Assumptions are US-dollar denominated, based on proprietary CMA modelling. Baseline refers to Fidelity's climate-agnostic baseline. **For illustrative purposes only**.
Note: The 10-year period is from February 28, 2023, to February 27, 2033.

To bridge this gap, we have been advancing our risk modelling infrastructure over the past several years to assess how the climate crisis may impact macroeconomic and financial risks, CMAs, and SAA decisions. Our methodology is anchored in a widely accepted scenario-based framework for assessing and managing climate risk in the financial system. Provided by the Network for Greening the Financial System (NGFS), a global coalition of about 135 central banks and supervisors, the framework is built around six scenarios organised into three categories in Figure 2.[4] (See Appendix section for more information on NGFS climate modelling.)

Figure 2: NGFS six scenarios

Orderly

Net Zero 2050 limits global warming to 1.5°C through stringent climate policies and innovation, reaching global net zero CO2 emissions around 2050. Some jurisdictions such as the US, EU, UK, Canada, Australia and Japan reach net zero for all GHGs.

Below 2°C gradually increases the stringency of climate policies, giving a 67% chance of limiting global warming below 2°C

Disorderly

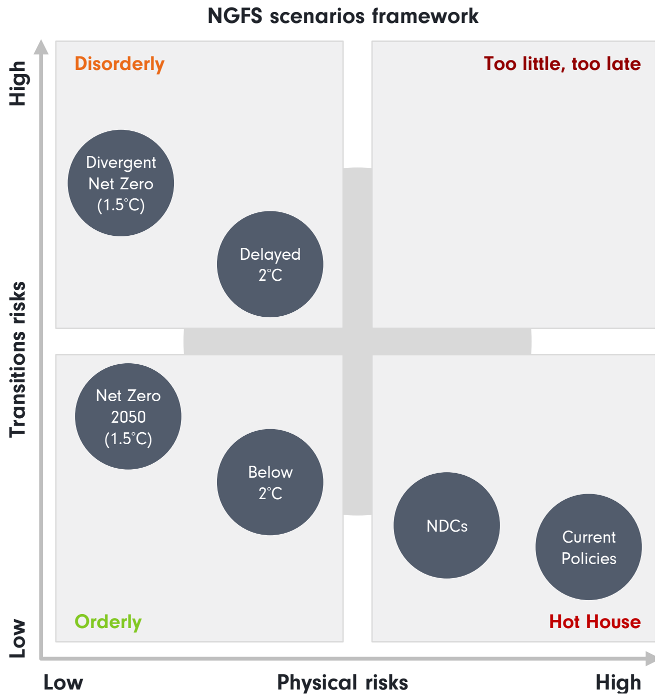
Divergent Net Zero reaches net zero around 2050 but with higher costs due to divergent policies introduced across sectors, leading to a quicker phase out of oil use.

Delayed transition assumes annual emissions do not decrease until 2030. Strong policies are needed to limit warming to below 2°C. Negative emissions are limited.

Hot House

Nationally Determined Contributions (NDCs) includes all pledged targets even if not yet backed up by implemented effective policies.

Current Policies assumes that only currently implemented policies are preserved, leading to high physical risks.



Source: NGFS, September 2022.

However, we also recognised that predicting the climate change pathway remains riddled with uncertainty. Modelling the effects of climate change has its limitations[5] due to the following:

- Uncertainty about the future path of climate change, including the energy transition.
- Uncertainty about regulations, government fiscal policies and central bank monetary policies. This is further complicated by ambiguities to the degree by which they are adopted by individuals, companies, and communities.
- Uncertainty about the interconnectivities between the impact of climate transition and physical risks on the global economy and financial markets.
- Uncertainty due to a lack of reliable and adequate historical data on 1) climate disasters to the extent that they are adequate predictors of future events since extreme weather events are increasing in frequency and magnitude, and 2) the impact of these events on the economy and financial markets.

Despite these challenges, CMAs modelling methodology based on forward-looking scenario analysis incorporating a broad range of scenarios, the most updated information, and expert judgement can become a vital tool to quantify the impact of possible future outcomes. We believe investors cannot afford a wait-and-see approach. By the time there is absolute certainty of climate change's impact on investments, it will likely be too late to help change that future. Instead, investors should prepare investment portfolios for market conditions in which the global economy is increasingly linked to climate risks.

In this paper, we present our findings on how the NGFS's latest iteration published in September 2022 affects our CMAs, the cascading effects on various asset classes against our climate-agnostic baseline scenario, and how investors can apply the results to asset allocation decisions using a framework-driven approach.

Planetary impacts to GDP, base rates, and inflation

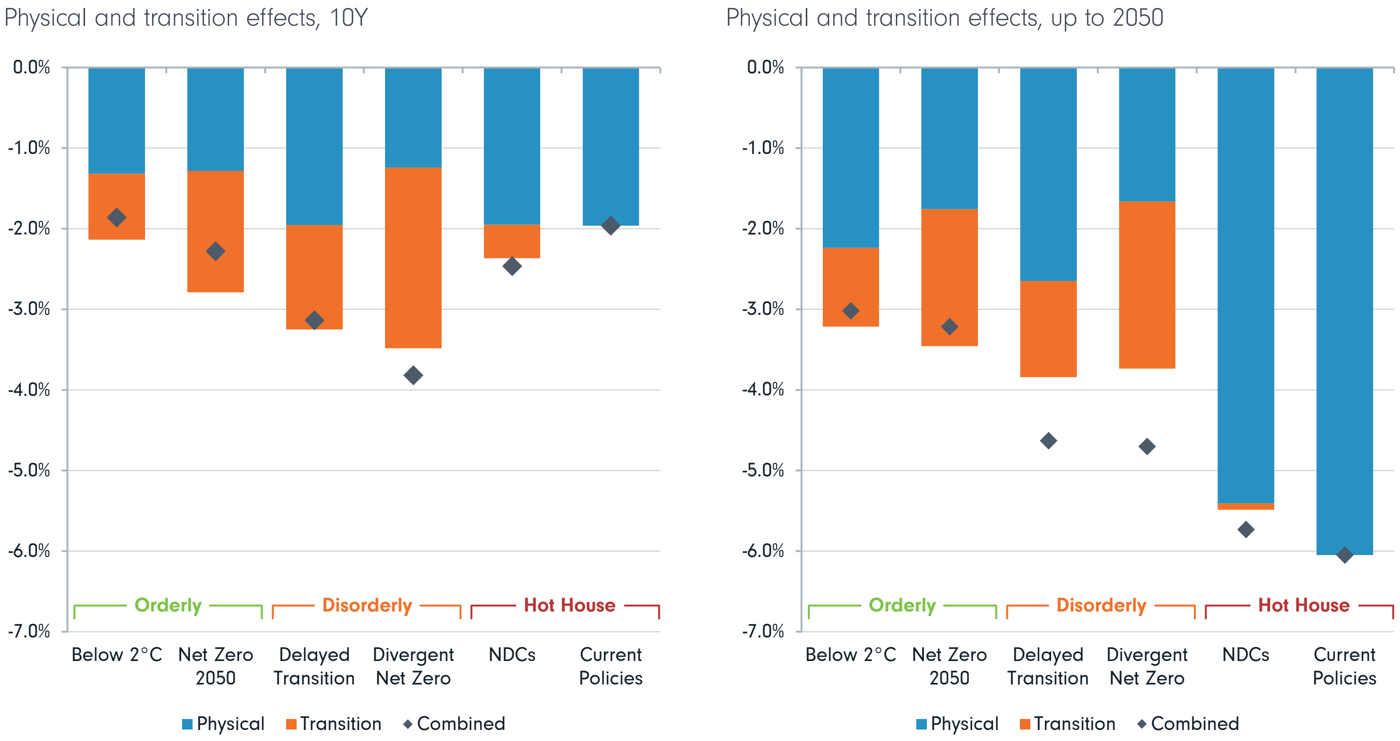
According to scientists, this decade is the most crucial in mitigating the environmental degradation caused by human activities. And an orderly transition is the best opportunity to minimise both transition and physical costs and meet the goals of the Paris Agreement by 2050 (see Figure 3).

Current climate policies and nationally determined contributions (NDCs) - which are national climate action plans under the Paris Agreement - are not enough to avoid a path to a 'hot house world', according to the NGFS. In the two hot house scenarios, greenhouse gas (GHG) emissions will likely reach such dangerous levels that it will become far more difficult for the world's population to mitigate or adapt to climate change. Furthermore, these scenarios incur the most damaging economic costs in the long term, which we defined as 2032 to 2050 in this paper. This is due to higher physical damage risks.

Over the coming decade, however, a disorderly transition takes the highest toll on the global economy in terms of gross domestic product (GDP). However, relative to a hot house scenario, the economic costs are redirected through a different path, with higher transition costs, as illustrated in Figure 3.

The extent to which the climate crisis influences macroeconomic indicators such as GDP, inflation and central bank policy rates depends on the interaction with climate transition and physical risks. Physical risks are typically divided into two categories: acute and chronic. Acute physical risks involve extreme weather events like droughts, floods, and wildfires. An example is short-term flash flooding causing property damages, operational disruptions, and higher capital expenditures. Meanwhile, chronic physical risks reflect more gradual environmental changes such as sea level rises, ocean acidification and ice mass losses. For instance, sea level rises can reduce real estate valuations and increase costs such as higher insurance premiums, particularly in coastal regions.

Figure 3: Cumulative impact of climate physical and transition risks on global GDP, 10Y vs. 2050

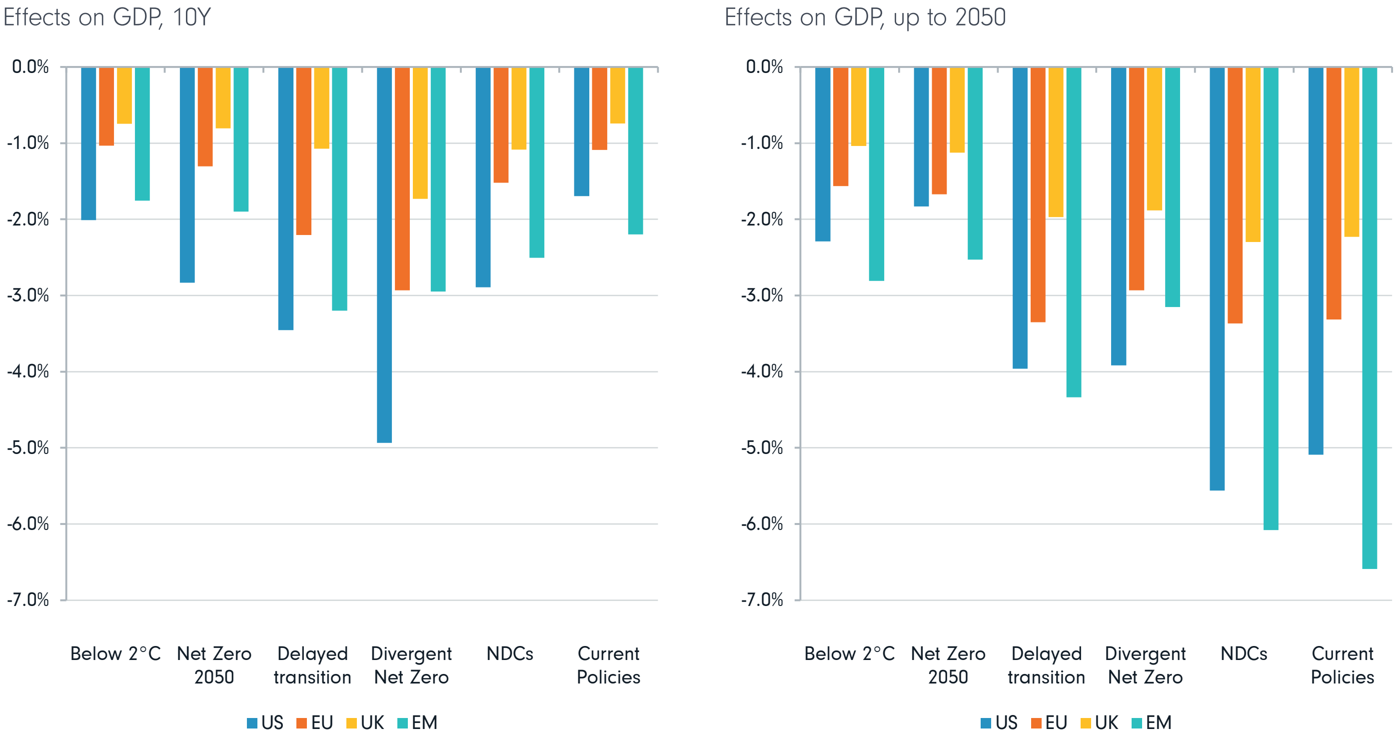


Source: NGFS, Fidelity International, March 2023. **For illustrative purposes only**. The 10-year period is from February 28, 2023, to February 27, 2033, and the period up to 2050 from February 28, 2023, to December 31, 2050. Note: Combined effects of physical and transition risks can be higher than the sum of the two parts because a positive feedback loop amplifies damage risks.

In contrast, transition risks relate to policies and regulations, environmental litigation, consumer preferences, technological developments and other actions taken to mitigate and adapt to the effects of the climate crisis. Navigating these changes often increases costs such as higher capital expenditure, operational expenses, and insurance premiums. Transition risks depend on factors such as the structure of the economy, energy security, and trade composition. In this sense, developed economies - led by the US, the world's largest by nominal gross domestic product (GDP) - tend to carry more of the transition cost burden than emerging markets.

The combined effect of physical and transition risks is not the sum of the two parts because a feedback loop amplifies environmental damages. For example, droughts may increase the risk of wildfires, resulting in clouds producing less rain and lengthening the drought spell. In the long term, the resulting acute physical damages can lead to a higher risk of chronic physical damages, such as more frequent and extreme wildfires contributing to average temperature rises. The impact of climate change on global GDP can substantially fluctuate and affects regions unevenly (see Figure 4), depending on factors such as exposure and vulnerability to temperature increases.

Figure 4: Cumulative impact of climate risks on GDP, by region, 10Y vs. 2050



Source: NGFS, Fidelity International, March 2023. **For illustrative purposes only**. The 10-year period is from February 28, 2023, to February 27, 2033, and the period up to 2050 from February 28, 2023, to December 31, 2050. Baseline refers to Fidelity's climate-agnostic baseline. EU refers to the Economic and Monetary Union (EMU) of the European Union.

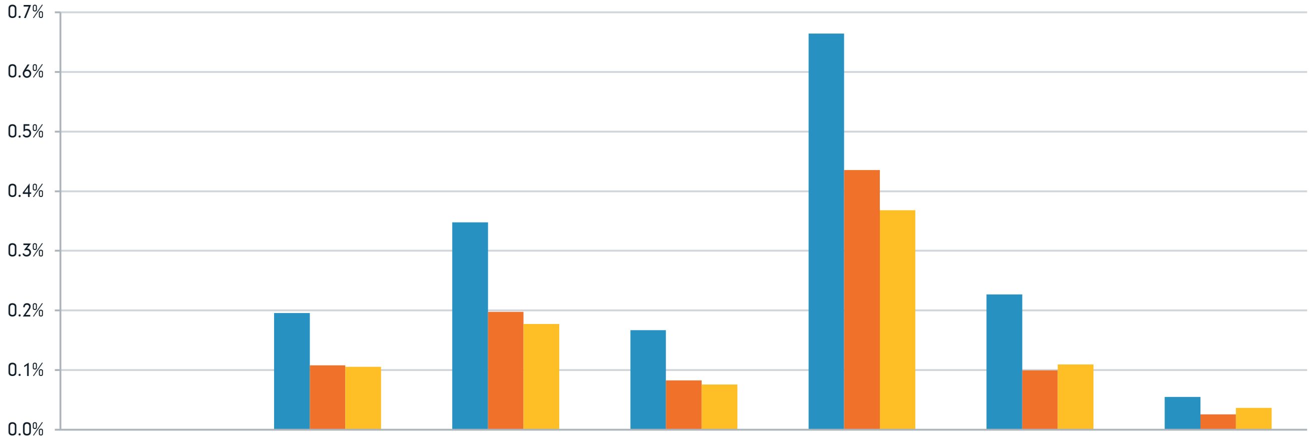
Climate change also adds uncertainty to inflation, and therefore, the responses from central banks when setting base rates to manage it. The variations in inflation relative to our baseline will vary by region (see Figure 5). For example, under the orderly and disorderly scenarios, inflationary pressures are reflected in surging carbon prices - a proxy for transition risks based on changes in government policy, technology, corporate trends, and consumer preferences.

The pace and extent of carbon price increases depend on the following factors[6]:

- Level of climate-related ambition by governments, capital markets, and consumers
- Timing and coordination of policy implementation across sectors and regions
- Technological advances to support ambition

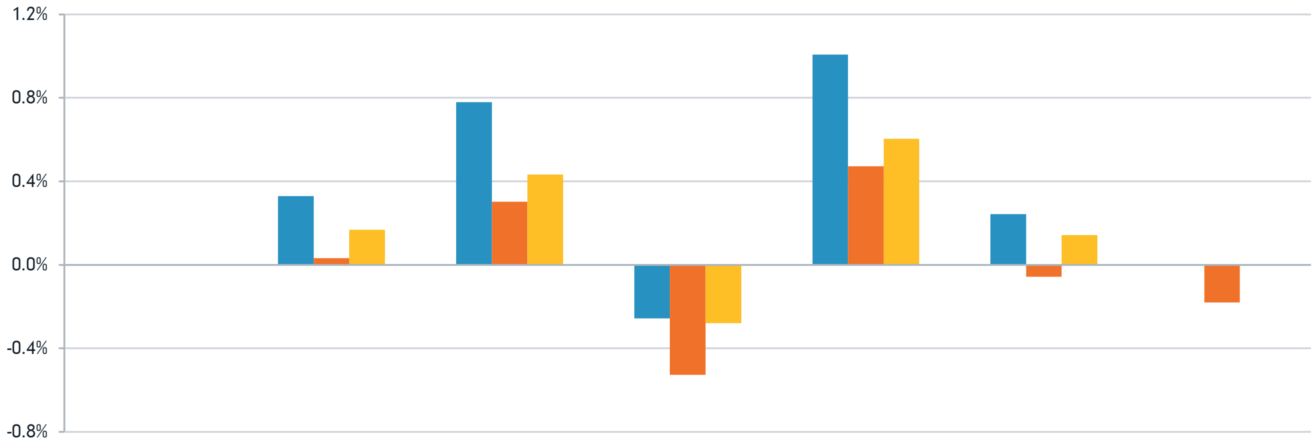
Figure 5: Effects of climate risks on 10Y annualised inflation and base rates, by region

10Y annualised inflation deviation from baseline



10Y inflation	Baseline	Below 2°C	Net Zero 2050	Delayed Transition	Divergent Net Zero	NDCs	Current Policies
US	3.0%	3.2%	3.3%	3.1%	3.6%	3.2%	3.0%
EU	2.5%	2.6%	2.7%	2.5%	2.9%	2.6%	2.5%
UK	3.0%	3.1%	3.1%	3.0%	3.3%	3.1%	3.0%

10Y annualised base rate deviation from baseline



10Y base rate	Baseline	Below 2°C	Net Zero 2050	Delayed Transition	Divergent Net Zero	NDCs	Current Policies
US	3.3%	3.6%	4.0%	3.0%	4.3%	3.5%	3.3%
EU	1.9%	1.9%	2.2%	1.4%	2.4%	1.8%	1.7%
UK	2.9%	3.1%	3.4%	2.6%	3.5%	3.1%	2.9%

Source: Fidelity International, March 2023. Assumptions are based on proprietary CMA modelling. **For illustrative purposes only**. Note: The 10-year period is from February 28, 2023, to February 27, 2033. Baseline refers to Fidelity's climate-agnostic baseline. EU refers to the EMU.

Under the two orderly transition scenarios, stricter climate ambitions tend to increase transition costs and therefore shadow carbon prices. For example, a 'net zero by 2050' scenario would raise carbon prices to US$140 per ton of CO2 by 2032 and US$450 per ton of CO2 by 2050. In contrast, under a less ambitious scenario of below 2°C, carbon prices are assumed to increase more gradually to US$54 per ton of CO2 by 2032 and US$135 per ton of CO2 by 2050.

If the world is to meet the goals of the Paris Agreement, disorderly transition scenarios are far more costly both in terms of the carbon pricing level and its rate of increase due to higher transition costs. Under the divergent net zero scenario, for example, prices increase to US$260 per ton of CO2 by 2032 and US$700 per ton of CO2 by 2050. Meanwhile, under the two hot house world scenarios, with little or negligible transition costs, carbon pricing remains minimal relative to the alternative scenarios.

While the US, UK and EU may experience similar dynamics between inflation, GDP growth, and interest rates when climate risks are considered, these factors will likely evolve differently under each of the six scenarios (see Figure 6). Relative to the UK and US, for example, the EU tends to implement more stringent environmental regulations, which increases costs and potentially lowers GDP growth. Therefore, the EU base rate is likely to be lower relative to our baseline scenario to support its economy, relative to the UK and US under all scenarios. As is the case in the current macroeconomic climate, there is always a trade-off between managing inflation and GDP growth when central banks set policy interest rates.

In the long term, macroeconomic and financial risks may return closer to our baseline under transition scenarios. For example, the transition costs to support technological progress may be inflationary in the short to medium term. However, further down the timeline, technology tends to lower manufacturing and operational costs - and therefore inflation trends - while improving efficiency. GDP growth rates also could return to the baseline, depending on other factors such as fiscal policies, including any increased investments to transition the economy, the recycling of carbon tax revenues, and the growth potential of investing in climate solutions.

Figure 6: Impact of NGFS scenarios on GDP, base rates, and inflation in the next decade

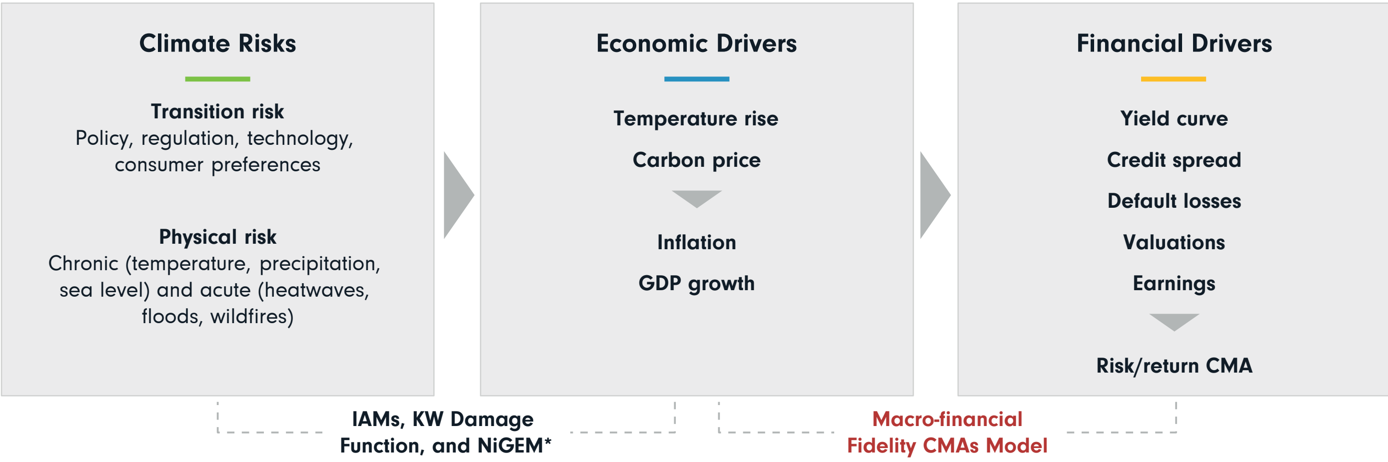
			Scenario effects on macroeconomic risks		
Category	**Scenario**	**Temperature alignment/ assumptions**	**GDP**	**Policy base interest rates**	**Inflation**
Orderly	**Net Zero by 2050**	**1.4°C** Rapid technological advances; medium regional variation in policies incorporated and stringently applied.	Physical and transition risks lower GDP; transition costs are higher vs. the 'below 2°C' scenario.	High transition risk requires a gradual increase in base rates to transition the global economy.	Inflation risk is elevated due to high climate ambition level but can be managed.
	Below 2°C	**1.6°C** Adequate technological changes and regional variation in policies; implementation is not as stringent vs. 'net zero by 2050'.	Less ambitious temperature target and more gradual policy implementation, so GDP damage from transition risk is less vs. the 'net zero by 2050'.	Lower base rates vs. 'net zero by 2050' due to less ambitious temperature target.	Inflation risk is lower and more gradual vs. 'net zero by 2050'.
Disorderly	**Divergent Net Zero**	**1.4°C** Global warming is restricted to 1.5°C by 2100, but with deviations in policies across regions and sectors.	GDP damage is highest by 2032 due to uncoordinated transition costs, particularly in developed markets.	Uncoordinated transition of the global economy requires higher base rates vs. 'net zero by 2050'.	Inflation risk is greatest among NGFS scenarios due to higher economic uncertainty and rising investment costs to meet net zero goals.
	Delayed Transition	**1.6°C** Sudden and late implementation of transition policies lead to physical and transition risks impairing the global economy.	Higher physical damage costs but lower transition costs, so GDP damage is less pronounced vs. 'divergent net zero'.	Delayed transition increases the risk that global GDP suddenly contracts, forcing a decrease in base rates to support growth.	Less ambitious than 'divergent net zero', so inflation is lower and occurs later.
Hot house world	**NDCs**	**2.6°C** Pledged policies are implemented but are disparate and less stringent vs. orderly and disorderly transitions. Technological change is slow.	GDP damage is mostly from physical risk, with little transition risk.	Higher base rates are needed but at a slower pace under NDCs vs. orderly and disorderly transitions.	Discord across nations and slow technological change increase inflationary pressure, at a similar level to the 'below 2°C' scenario but without reaching a similar global temperature target.
	Current Policies	**3°C +** Highest physical damage risk because only policies that have already been implemented are counted; no strengthening of ambition levels.	GDP damage is mostly from physical risk, with negligible impact from transition risk.	Little change or lower base rates to support growth as physical risk increasingly weakens the global economy.	Low transition costs result in low inflation risk in the next decade; Longer term, planetary, financial, and social damage risks are highest among NGFS scenarios.

Source: Fidelity International, March 2023. Note: The 10-year period is from February 28, 2023, to February 27, 2033.

From climate risks to financial risks

As markets recognise increasing climate risks due to regulation, industry trends, consumer preferences and market events, we expect financial assets will likely be repriced. This poses significant challenges when making asset allocation decisions. In this section, we further extend the work from the NGFS framework to our CMAs modelling to map how climate change influences macroeconomic and financial risks, channelling to asset class risk and return characteristics. (See Figure 7.)

Figure 7: Transmission channels



Source: Fidelity International, March 2023. *See the appendix for more information about NGFS modelling. They include integrated assessment models (IAMs), Kalkuhl & Wenz (KW) damage function, and National Institute Global Econometric Model (NiGEM).

Our CMAs model separates the components of asset returns into relevant financial drivers, including yield curve, credit spreads, default losses, valuations, and earnings. We then stress test these variables against NGFS scenarios and climate-aware assumptions on inflation, base rates, and GDP growth to estimate the net effect on overall risk and return expectations.

Due to the complexity of climate analysis, the transmission channels are not clear-cut. Therefore, we consider as wide a range of scenarios as possible when applying our proprietary quantitative models for capital market assumptions. Iterating different scenarios against different outcomes aims to help investors navigate uncertainties, risks and opportunities related to climate change, no matter which scenario they subscribe to.

Based on the results from our CMAs modelling, we found that climate change will likely negatively impact return assumptions in the next decade under all six NGFS scenarios, with a magnitude that varies across developed economies relative to emerging markets. (See Figure 8.)

Figure 8: Changes in 10Y annualised real returns (USD) due to climate risks vs. baseline

10Y annualised real expected returns (USD)

		Cash	Global Govt	Global IG	Global HY	EM Sov HC	Global Equity	EM Equity
	FIL Baseline	0.3%	0.7%	2.2%	2.9%	4.6%	3.5%	4.8%
Orderly	Below 2°C	0.4%	0.7%	2.1%	2.8%	4.4%	3.1%	4.2%
Orderly	Net Zero 2050	0.7%	0.7%	2.2%	2.9%	4.4%	2.9%	4.3%
Disorderly	Delayed Transition	-0.1%	0.0%	1.6%	2.2%	3.9%	3.1%	4.3%
Disorderly	Divergent Net Zero	0.6%	0.2%	1.8%	2.5%	3.9%	2.8%	4.6%
Hot House	NDCs	0.3%	0.6%	2.1%	2.7%	4.4%	2.5%	3.8%
Hot House	Current Policies	0.2%	0.7%	2.2%	2.8%	4.6%	2.6%	3.4%

10Y annualised real returns deviation from baseline (USD)

		Cash	Global Govt	Global IG	Global HY	EM Sov HC	Global Equity	EM Equity
Orderly	Below 2°C	0.1%	-0.1%	-0.1%	-0.1%	-0.2%	-0.4%	-0.6%
Orderly	Net Zero 2050	0.4%	-0.1%	0.0%	0.0%	-0.2%	-0.6%	-0.5%
Disorderly	Delayed Transition	-0.4%	-0.7%	-0.6%	-0.6%	-0.7%	-0.5%	-0.5%
Disorderly	Divergent Net Zero	0.3%	-0.5%	-0.4%	-0.4%	-0.8%	-0.7%	-0.2%
Hot House	NDCs	0.0%	-0.1%	-0.1%	-0.2%	-0.3%	-1.0%	-1.0%
Hot House	Current Policies	-0.1%	0.0%	0.0%	-0.1%	-0.1%	-1.0%	-1.4%

Source: Fidelity International, March 2023. Assumptions are based on proprietary CMAs modelling. Baseline refers to Fidelity's climate-agnostic baseline. **For illustrative purposes only**. Note: The 10-year period from February 28, 2023, to February 27, 2033. Global Govt refers to global government bonds. Global IG refers to global investment grade bonds. Global HY refers to global high yield bonds. EM Sov HC refers to emerging market sovereign bonds in hard currency.

These regional differences reflect how three fundamental return drivers - income, growth, and valuation - may interact when stress tested against climate-linked macroeconomic variables. For example, return expectations on government bonds depend on how much improving income from higher policy rates can offset capital losses from increasing yields. Under the delayed transition scenario, yields rise towards the end of the 10-year investment horizon, resulting in larger capital losses that are not adequately offset by improved income. Therefore, the deviation from our baseline is higher than in other scenarios.

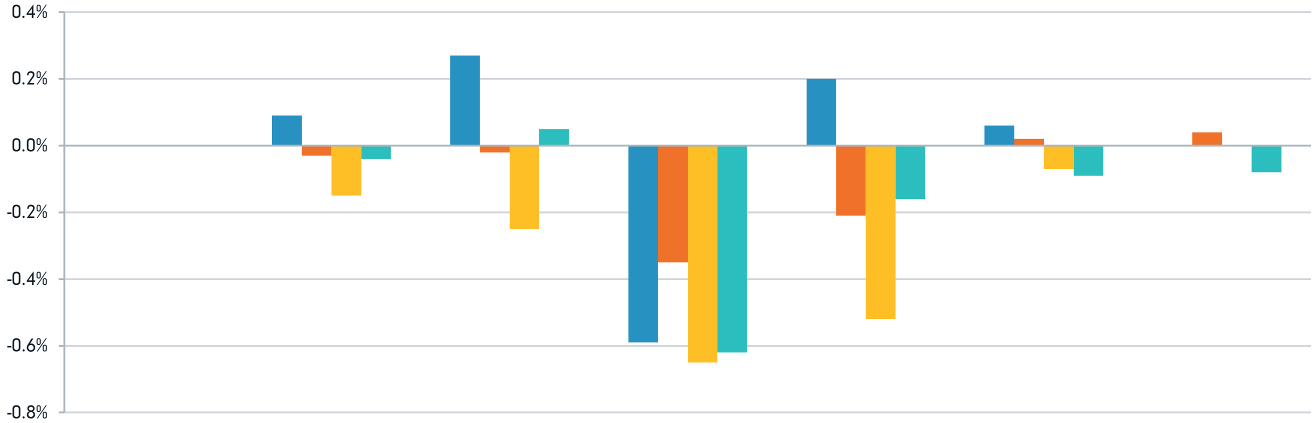
In the case of the EU, however, the deviation from the baseline is more subdued in comparison. As previously discussed, base rates are likely to be relatively lower to stimulate growth. Therefore, the deviation of EU government bonds from our baseline scenario also tends to be somewhat less prominent under most scenarios. Here, the ability of the EU to strengthen its common and unified fiscal set-up is critical. (See Figure 9.)

Equities are generally more sensitive to climate change, given their perpetual cash flow nature. Relative to emerging markets, developed economies - led by the US - tend to assume more of the transition risk burden. Therefore, developed market equity drawdown risk due to climate change is also higher under the divergent net zero and the net zero by 2050 scenarios, in which transition risk is relatively higher.

On the other hand, emerging market equities fare worse than developed economies under current policies in a hot house world scenario (see Figure 9). The variance from our baseline scenario is most notable for equities due to higher physical risks. And while both developed and emerging economies are likely to be affected by physical risks, emerging markets are more negatively impacted, causing multiples in the latter to be repriced more significantly.

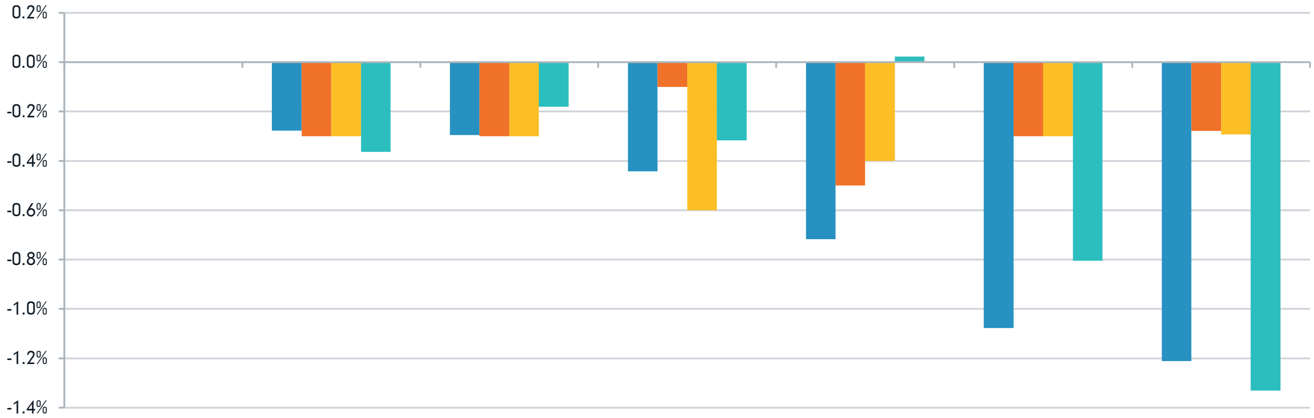
Figure 9: Expected deviations from baseline due to climate change

10Y annualised expected returns, government bonds



Government Bonds	Baseline	Below 2°C	Net Zero 2050	Delayed Transition	Divergent Net Zero	NDCs	Current Policies
US	3.7%	3.8%	4.0%	3.1%	3.9%	3.8%	3.7%
EU	2.5%	2.5%	2.5%	2.2%	2.3%	2.5%	2.5%
UK	3.7%	3.5%	3.4%	3.0%	3.1%	3.6%	3.7%
EM	7.6%	7.6%	7.6%	7.0%	7.4%	7.5%	7.5%

10Y annualised expected returns, equities



Equities	Baseline	Below 2°C	Net Zero 2050	Delayed Transition	Divergent Net Zero	NDCs	Current Policies
US	6.2%	5.9%	5.9%	5.8%	5.5%	5.1%	5.0%
EU	5.3%	5.0%	5.0%	5.2%	4.8%	5.0%	5.0%
UK	6.9%	6.6%	6.6%	6.3%	6.5%	6.6%	6.6%
EM	7.8%	7.4%	7.6%	7.4%	7.8%	7.0%	6.4%

Source: Fidelity International, 2023. **For illustrative purposes only**. Assumptions are based on proprietary modelling. They reflect the views of investment professionals at Fidelity International. Baseline refers to Fidelity's climate-agnostic baseline. EU refers to the EMU. The 10-year period is from February 28, 2023, to February 27, 2033.

Furthermore, investors should expect higher volatility when climate risks are integrated into CMAs (see Figure 10). Historically, volatility in risky assets has been linked to higher macroeconomic volatility. In our CMAs modelling, GDP growth volatility and oil price volatility serve as proxies for macroeconomic volatility.

To estimate values for the realised volatility of asset classes, we rely on a regression-based relationship of long-term volatility of risky assets such as equities and realised volatility of GDP growth and oil volatility. The latter is used as a proxy for the volatility generated by increases in the carbon price. However, we note that under certain scenarios in which transition risk is elevated - such as the case of divergent net zero - high carbon pricing may result in higher macroeconomic and financial volatility relative to oil pricing.

In general, climate risks introduce more uncertainty. Therefore, the level of return divergence between regions, sectors and asset classes is likely to be exacerbated. As demonstrated in Figure 10, the Sharpe ratio - the expected excess return over the risk-free rate divided by the expected volatility - is likely to decrease across all scenarios, along with expected returns.

Again, volatility is most pronounced in the divergent net zero scenario, where transition risks appear most damaging due to higher uncertainty in GDP growth from abrupt changes in environmental regulation, central bank base rates, and government fiscal policies. Market participants are then expected to respond by swiftly pricing in expected future transition and physical risks, including extreme climate events. Additionally, a higher risk of technological shocks can structurally change segments of the economy and cause volatility to spike.

As is the case for expected real returns when climate risks are integrated, volatility reverberates more negatively through physical risks in emerging markets. These economies also exhibit higher sensitivity to foreign capital flows to manage climate change.

Figure 10: Deviation in 10Y annualised Sharpe ratio from baseline due to climate change

		Global Govt	Global IG	Global HY	EM Sov HC	Global Equity	EM Equity
Orderly	Below 2°C	-0.07	-0.04	-0.02	-0.03	-0.04	-0.03
	Net Zero 2050	-0.15	-0.10	-0.04	-0.07	-0.07	-0.05
Disorderly	Delayed Transition	-0.11	-0.09	-0.05	-0.09	-0.03	-0.03
	Divergent Net Zero	-0.25	-0.20	-0.11	-0.16	-0.09	-0.05
Hot House	NDCs	-0.06	-0.08	-0.05	-0.08	-0.09	-0.07
	Current Policies	-0.01	-0.05	-0.04	-0.06	-0.08	-0.08

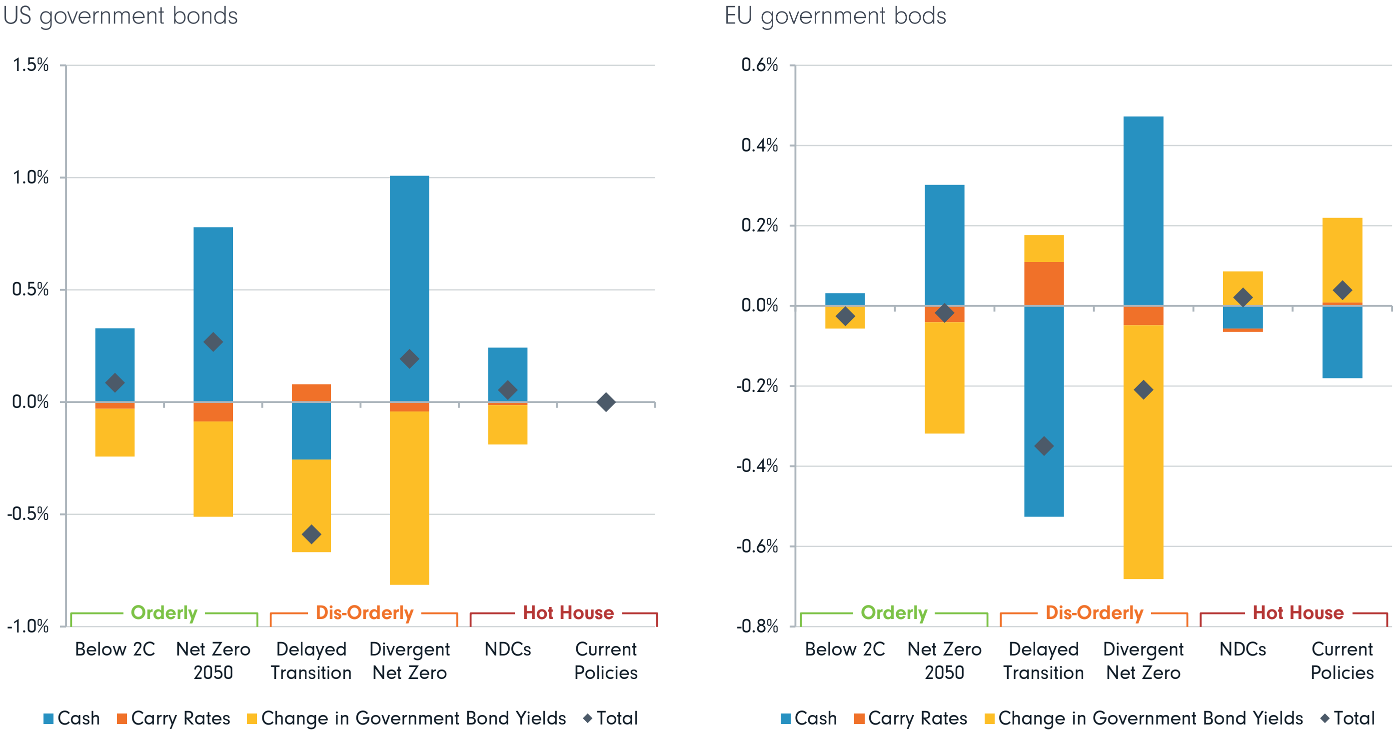
Source: Fidelity International, 2023. **For illustrative purposes only**. Assumptions are based on proprietary modelling. They reflect the views of investment professionals at Fidelity International. Baseline refers to Fidelity's climate-agnostic baseline. The 10-year period is from February 28, 2023, to February 27, 2033.

Underlying climate-aware performance drivers

In our view, investors need to assess investment strategies at a deeper level than simply looking at aggregated returns. Only by understanding the underlying determinants of the risk can they make clear choices of what risk they want to take, what risk they need to hedge, what risk to minimise, and what risk they simply cannot avoid. In this section, we delve deeper into risk-return characteristics at a more granular level for government bonds and equities.

Returns of **government bonds** are most sensitive to changes in yields, so higher interest rates imply capital losses offset by higher income levels over time. For example, the net effect tends to oscillate around zero under the orderly and hot house scenarios because the path of interest rate increases is expected to be relatively gradual. However, if the environment is more consistent with a disorderly transition, higher income may not offset capital losses. In the latter, governments must react to more volatile transition scenarios requiring unexpected interest rate hikes, which potentially raise downside risks.

Figure 11: Climate effects on 10Y annualised expected returns, US vs. EU government bonds

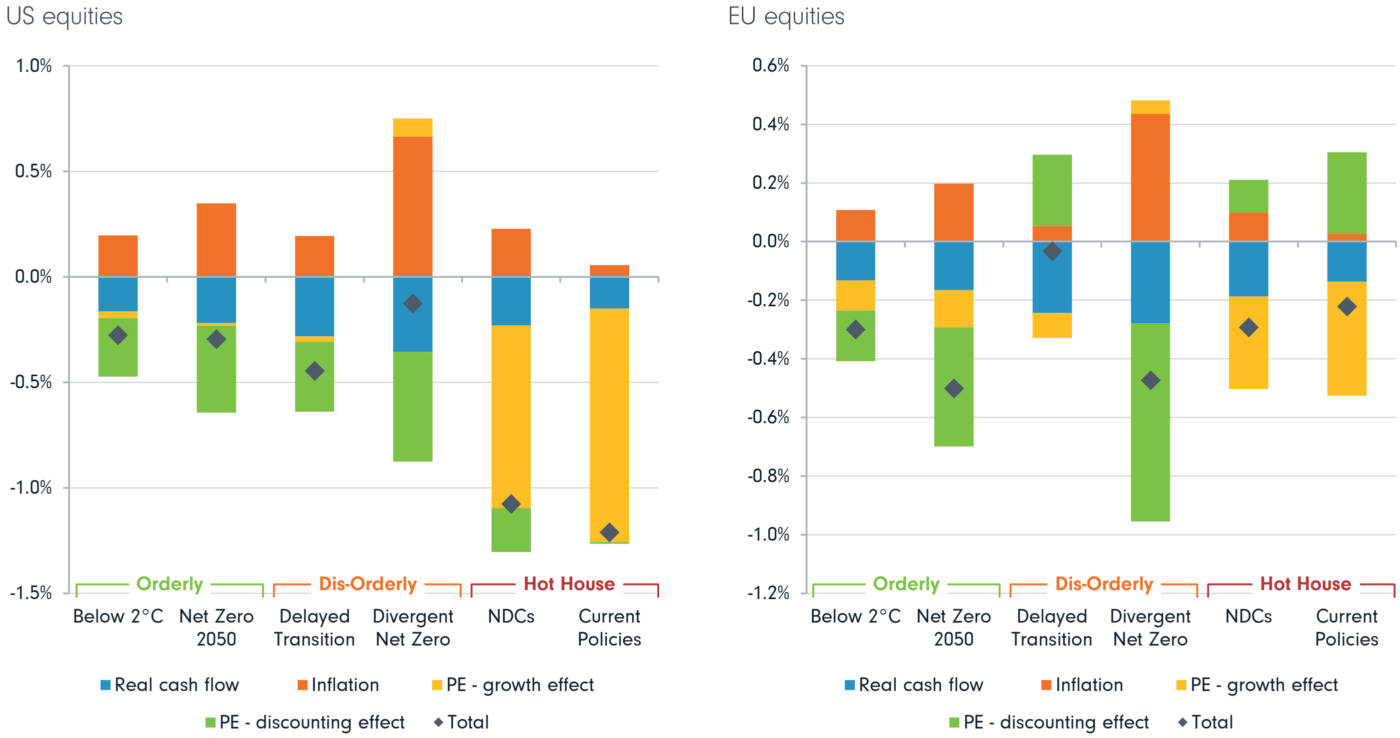


Source: Fidelity International, March 2023. Assumptions are based on proprietary CMAs modelling. They reflect the views of investment professionals at Fidelity International. EU refers to the EMU. **For illustrative purposes only**. Note: The 10-year period is from February 28, 2023, to February 27, 2033.

Equities represent a perpetual claim on company cash flows. When analysing the impact of future cash flows on valuations, it helps to divide the underlying performance drivers into "discounting" and "growth" components. The projected interest rate environment affects the "discounting" component, where higher interest rate levels imply lower price-to-earnings multiples. In contrast, the "growth" channel assumes that within the 10-year investment horizon examined, valuations will reflect the expected effect of climate risks on economic growth out to 2050.

The price-to-earnings "discounting" and "growth" effects are analysed against specific factors such as real cash flows, which we define as the combination of real revenue growth, change in margins and dividend yield. Real cash flows tend to move in a similar direction as GDP growth. Since we expect inflation to rise and GDP growth to decline when climate risks are integrated into CMAs, real cash flows are expected to decline in all scenarios. As demonstrated in Figure 12, valuation (whether due to the discounting effect or the growth effect) is a critical contributor to expected equity returns, and therefore, investment outcomes.

Figure 12: Climate effects on 10Y annualised expected returns, US vs EU equities



Source: Fidelity International, March 2023. Assumptions are based on proprietary CMAs modelling. They reflect the views of investment professionals at Fidelity International. EU refers to the EMU. **For illustrative purposes only**. Note: The 10-year period isfrom February 28, 2023, to February 27, 2033.

Global corporate bonds, which sit between government bonds and equities on the risk-return spectrum, exhibit some similar characteristics to both when climate risks are integrated into CMAs models. Higher interest rates result in capital losses and higher rates of default and downgrade. Therefore, investors demand a higher risk premium to own the assets, depressing valuations. However, the higher credit spreads also tend to deliver higher income that may at least partially offset the capital losses from a valuation perspective. Again, the return expectations depend on the inter-relationships between risk-return variables across different channels of influence and climate scenarios.

Asset allocation decisions through a climate lens

A robust strategic asset allocation should prepare an investment portfolio for a variety of futures. If investors believe climate change is an increasingly important part of that future, they must consider its impact on CMAs and SAAs. Constructing a portfolio that ignores these risks will likely result in hidden biases that may result in unexpected, negative outcomes and lost opportunities.

Investors may be tempted to simply underweight asset classes that are expected to be more negatively impacted by climate change, yet this is not advisable. Asset allocation decisions depend on a host of financial and non-financial objectives, such as performance targets, risk budgets and organisational policies. Climate risks should be incorporated into the investment process, just as investors might consider other risk-return drivers such as the expected direction of central bank monetary policies.

A careful evaluation of the climate risk taken, intentionally or unintentionally, against the underlying performance drivers through various climate scenarios can help investors optimise risk-adjusted returns. Some considerations include the following:

- A broader set of outcomes is expected when integrating climate risks into CMAs. In our view, average expected returns are likely to be lower while volatility rises, particularly in the disorderly and hot house world scenarios. Therefore, investors may require new tools and models to measure and assess risk.
- Greater dispersion and higher uncertainty at the regional, country, and sector levels due to climate risks may call for a more considered and dynamic implementation of investment strategies.
- The underlying performance drivers when climate risks are integrated into CMAs are also significant. These return components may also change significantly over time, so investors should monitor and integrate them into investment decisions. This helps minimise unintentional risk-taking when balancing between financial targets and decarbonisation commitments.

- The volatility of certain regions and asset classes is likely to increase if climate risks are integrated into CMAs, appearing more significant for fixed income than equities in a divergent net zero scenario. However, equities tend to exhibit higher volatility under a hot house scenario. Therefore, investors should recalibrate their risk-return assumptions accordingly.
- Physical and transition risks are interlinked and may follow a highly uncertain path, be irreversible and have fat-tail distributions. In what has been labelled as 'green swan' risks, the possibility of severely disruptive market events of several standard deviations due to climate risks is increasing.[7]

Cross-checking investment ideas and strategies against CMAs has always been necessary to understand performance expectations. Given the impact of climate change on risk-return characteristics, as highlighted in this paper, it is crucial to recalibrate strategic asset allocation decisions against CMAs that integrate climate risks in a forward-looking, transparent, and consistent way. Our work in modelling climate change and its impact on macroeconomic and financial risks is far from complete. We will continue to advance our modelling as new information becomes available.

Even if the exact timing, path, and magnitude remain uncertain, climate change alters the risk-return profiles of investment portfolios, both from the top-down and bottom-up perspectives. Understanding environmental risks and opportunities more granularly can help investors build more ballast into their portfolios to address climate change.

In this regard, there are several options to consider. First, investing in companies, issuers, or assets with higher environmental credentials relative to peers may help manage climate risks and add risk-adjusted return potential. For example, commercial properties with higher sustainability credentials tend to obtain higher rents, exhibit lower vacancy rates, and operate at lower costs than buildings that do not.

Second, investors can add exposure to direct climate solutions that help mitigate and adapt to climate change in areas such as renewable energy or technology. Furthermore, there are ways to mitigate the effects of global warming by influencing indirect drivers of climate change such as biodiversity. The global economy depends on natural ecosystems, which are being threatened by climate change.

Third, some regional strategies such as sustainable solutions in China may offer opportunities and diversification benefits in a climate-aware portfolio. Fourth, investors can engage with companies, particularly high emitters, to reduce carbon emissions. Engagement can encourage credible transition plans backed by concrete action, helping investors to benefit from value-creating potential as issuers improve their environmental credentials. Finally, investors might exclude or divest issuers that do not show adequate evidence to transition to a low-carbon economy. In our view, though, this should be a last resort following unsuccessful engagement efforts over a predetermined period.

Underscoring an effective strategy to manage climate-related risks and opportunities is a forward-looking assessment framework. This tracks transition pathways at the corporate level that can be mapped to the six climate scenarios and transmitted into CMAs modelling. According to Fidelity's Climate Ratings, our proprietary ratings platform covering about 2,000 issuers to assess their transition potential, most companies continue to set targets and take measures to mitigate their impact on climate change but are struggling to align their activities to a net zero path. Yet to achieve net zero, at least 90% of companies in our coverage should be either achieving or enabling net zero, or aligning to a net zero pathway by 2050. The ability to monitor transition potential at these companies improves our understanding of how corporate action influences climate scenarios. At the portfolio level, it also assists in decarbonising investment strategies.

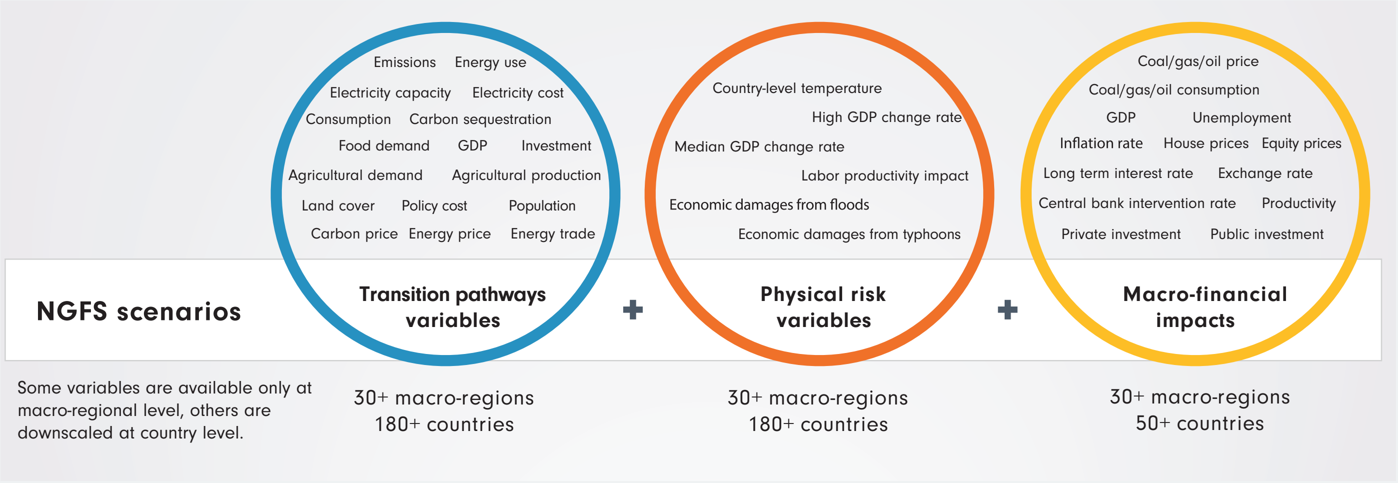
Ultimately, the consequences of climate change will depend on our collective actions. However, as demonstrated by our research, global financial markets do give us some clues about the climate risks we face. For example, we know the climate crisis will leave a profound legacy on the financial sector through physical and transition risks. We know these risks will leave their mark on asset valuations, and therefore, future risk-return potential. And we know that investors have a responsibility to help reduce climate risks through their investment decisions.

While we cannot have absolute clarity of climate change's outcomes, we can prepare for that eventuality. As the futurist Karl Schroder once said, "Foresight is not about predicting the future; it's about minimising surprise." In our view, applying portfolio optimisation practices that consider climate risks from a top-down perspective and incorporating them into capital market assumptions and strategic asset allocation decisions can help reduce the risk of negative surprises, adding resilience to an investment portfolio.

Appendix - Greening macro-financial models

In our view, using the NGFS framework can lead to climate-aware CMAs that consider science-based physical and transition risks (see Figure 13), are easily comparable, and can be systematically updated as new information and best practices are introduced to give a more forward-looking assessment. For example, when the NGFS published its third iteration of the climate risk framework in September 2022, we responded by creating a continuous feedback loop in which we re-analysed climate change factors, calibrated them within our CMAs, and assessed the related economic and financial costs. And as the NGFS continues to update its framework and new methodologies emerging from academic research become available, we will also advance our climate-aware CMAs modelling infrastructure.

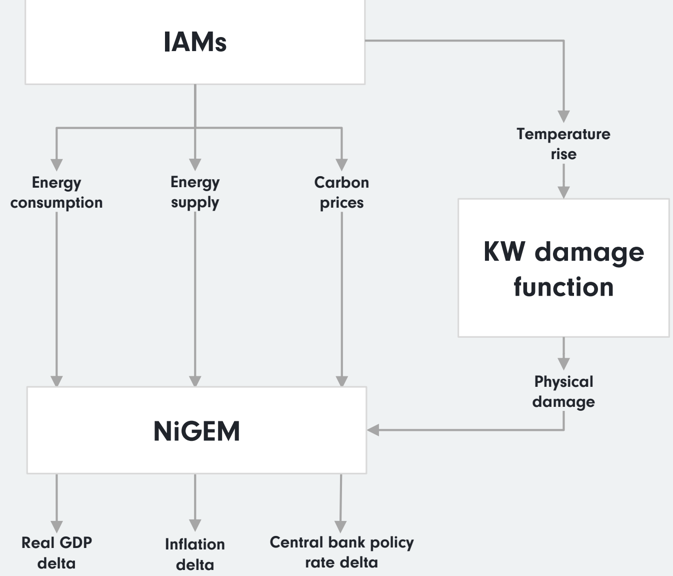
Figure 13: Risk assumptions in NGFS's climate scenarios



Source: NGFS, September 2022. This figure does not contain the full list of variables and is for illustrative purposes only. The names of the variables do not necessarily correspond to the ones used in the IIASA Portal. The number of countries/regions available varies significantly depending on the variable. Downscaled climate-related and macroeconomic financial variables are available for 180+ and 50+ countries, respectively. Physical risk variables such as labour productivity impact can be accessed on the Climate Impact Explorer.

The nature of climate risks presents significant challenges to accurately model these risks, according to BIS.[8] Managing this higher order of inherent uncertainties across multiple dimensions requires more than one model. At a simplistic level, the NGFS essentially uses three types of well-established climate-economic models: **Integrated Assessment Models (IAMs)** to generate and analyse transition pathways through assumptions on factors such as energy costs, energy efficiency, and policy; the **Kalkuhl & Wenz (KW) damage function** quantifies physical risk through the effects of a change in global mean temperature on gross domestic product (GDP); and the **National Institute Global Econometric Model (NiGEM)** uses energy, carbon price and physical damage trends to assess economic impacts from transition and physical risks under different scenarios at a more granular level. Each has its own set of advantages and limitations. Together, they address many shortcomings to present the clearest picture possible. (See Figure 14.)

Figure 14: NGFS modelling overview



Source: NGFS, Fidelity International, March 2023. **For illustration purposes only**. Note: Delta refers to the deviation from the climate-agnostic baseline.

1 '[Climate Change 2022:Impacts, Adaptation, and Vulnerabilities](#)', IPCC, 2022.

2 "Financial Markets and Climate Transition: Opportunities, Challenges and Policy Implications", OECD, 2021.

3 Egemen Eren, Floortje Merten and Niek Verhoeven, "Pricing of climate risks in financial markets: a summary of the literature", Bank of International Settlements, December 2022.

4 "NGFS climate scenarios for central banks and supervisors", NGFS, September 6, 2022.

5 Lars Peter Hansen, "Confronting Uncertainty in Climate Policy", Chicago Booth Review, July 26, 2022.

6 "NGFS climate scenarios for central banks and supervisors", NGFS, June 2021.

7 Patrick Bolton, Morgan Despres, Luiz Awazu Pereira da Silva, Frédéric Samana and Romain Svartzman, "The green swan: central banking and financial stability in the age of climate change", Banque de France, January 2020.

8 Egemen Eren, Floortje Merten and Niek Verhoeven, "Pricing of climate risks in financial markets: a summary of the literature", Bank of International Settlements, December 2022.

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