# 30-year return forecasts

## How climate change will impact asset returns

### Part 1

January 2024

Foresight

Schroders

# Contents

# Long-run asset class performance:

## How climate change will impact asset returns – an update

**Schroders Economics Group produces thirty-year return forecasts on an annual basis, which incorporates the impact of climate change.**

**This is Part 1** of our paper where we outline the methodology used to incorporate climate change into our return assumptions.

**In Part 2 of our paper**, we discuss our 30-year forecasts for cash, bonds, credit, equities, and real estate, incorporating the impact of climate change and explain what has changed from our previous analysis.

Over the past year, we have been refining our climate change assumptions to align more closely with the Network for Greening the Financial System (NGFS). The NGFS is a collective of 114 central banks and supervisors, who are collaborating to enhance the role of the financial system in managing climate risks and mobilising capital for green and low-carbon investments.

The NGFS scenarios offer a robust starting point for analysing climate risks to the economy and financial system. We have increasingly embedded these scenarios into our climate assumptions, recognising their widespread acceptance and use among central banks and financial institutions worldwide.

In our latest update of the 30-year return forecasts, we have collaborated again with Oxford Economics (OE) to apply their climate-macro model to our productivity, GDP, and inflation forecasts. These factors are key inputs into our return forecasts due to their influence on interest rates and profits growth. OE has utilised integrated assessment models to derive optimal carbon prices for a given degree of climate mitigation while maximising the welfare of the economy.

Our analysis continues to capture the diverse interactions between economies, energy systems and emissions, and the impacts of economy-wide decarbonisation.

**Samar Khanna**
Environmental Economist
(44-20) 7658 2075

**Irene Lauro**
Environmental Economist
(44-20) 7658 4962

**Tina Fong, CFA**
Strategist
(44-20) 7658 3278

# Introduction

**The future is inherently uncertain, and this uncertainty is magnified when considering the impacts of climate change and policy interventions to tackle it.**

Scenario analysis is a powerful framework to explore a distribution of plausible paths, understand potential forces at play, and identify climate-related risks and opportunities for financial institutions.

We adopt three scenarios to describe a range of possible outcomes to assess the impacts of climate change on our long-term asset return assumptions.

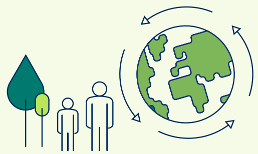
Our reference scenario, called 'Current Policies', incorporates only those policy commitments that are substantiated by credible actions and are considered sufficiently detailed. Our approach, which aligns with the International Energy Agency's Stated Policies Scenario (STEPS), does not assume that governments will reach all announced goals. Instead, it takes a more nuanced approach to review the efficacy of existing policies, as well as those under development. The scenario does not assume any further mitigation measures are put in place, apart from those announced, over our forecast horizon.

The 'Current Policies' scenario presents a future where emissions do not peak until around 2030. The global system does shift towards lower-carbon energy sources in electricity production, but demand for electricity remains a small share of total energy demand. In fact, the global energy system continues to remain heavily skewed towards high-emission energy sources like coal, oil, and gas even as we approach 2050. Although there is a downward trend in emissions over the forecast horizon, it falls considerably short of reaching the net zero target. Consequently, average global temperatures rise to 1.9°C above pre-industrial levels, as countries' current climate pledges are not ambitious enough to meet the legally binding threshold of 1.5°C established by the Paris Agreement.

The 'Current Policies' scenario serves as a benchmark scenario against which we compare the two other scenarios.

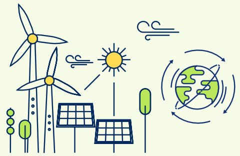
### Current Policies (reference scenario)

- Reflects policy commitments that are supported by credible measures
- A negligible rise in carbon pricing in line with stated policies
- Global warming set to reach 1.9°C by 2050



### Delayed Transition (central scenario)

- Policymakers only start to take action and increase carbon taxes in 2030
- Disorderly transition, with higher transitional impact
- Global temperatures to rise by 1.6°C by 2050



### Net Zero with innovation

- Prompt action is taken and carbon taxes start rising from 2024
- Orderly transition, with additional innovation benefits from R&D investment
- Global warming is limited to around 1.4°C by 2050

# Our transition scenarios

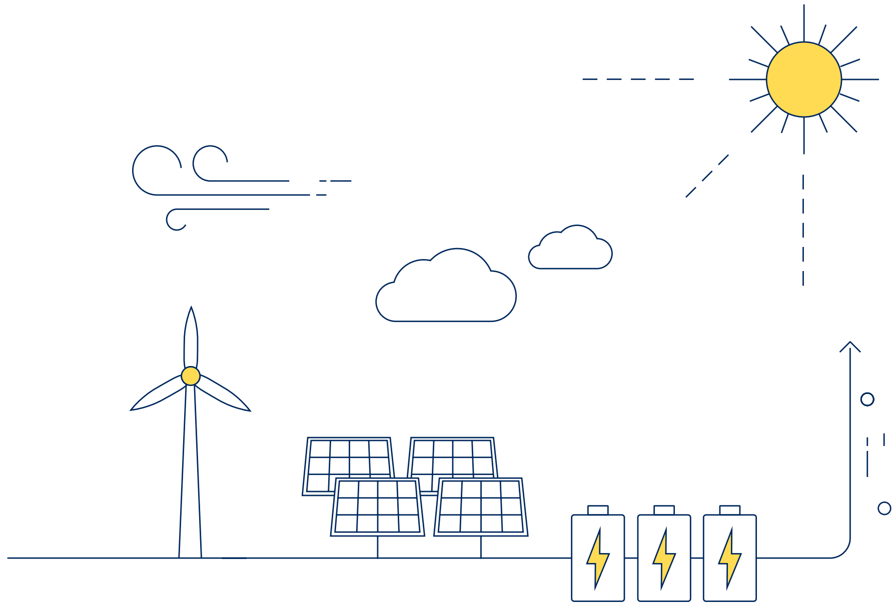
With our reference scenario established, we employ two distinct scenarios to describe plausible transition pathways to reach a low-carbon economy. Both these scenarios are catalysed by an increase in the price of carbon, leading to a lower temperature increase compared to our Current Policies scenario. The timing, pace and scope of carbon price hikes will determine whether the scenario unfolds in an orderly or disorderly manner. In any case, the transition to a low-carbon economy has the potential to transform every sector of the economy, representing both risks and opportunities for the financial industry as they decide where to reallocate their capital. Our two additional scenarios are:

- **Delayed Transition:** A disorderly transition scenario which assumes that policy makers only start to take more ambitious action and increase carbon prices from 2030 onwards. The global system manages to limit temperature increases to 1.6°C by 2050, but the aggressive policies introduced over a short span of time leads to elevated financial instability, higher inflation and more stranded assets compared to other scenarios
- **Net Zero with Innovation:** An orderly transition which assumes that climate policies are introduced early and gradually become more stringent. The economic transformation that ensues leads to greater innovation and higher productivity, with a notable rise in private sector investment. Proactive policy introduced early in our forecast horizon allows economic participants sufficient time to internalise the cost of carbon and innovate, resulting in global warming of 1.4°C by 2050

> The Delayed Transition scenario is the most likely of the three scenarios and forms our central scenario

We believe that the Delayed Transition scenario is the most likely of the three scenarios presented and forms our central scenario. The recent UN Global Stocktake report shows how the global system is notably off its decarbonisation trajectory and aggregate policies insufficient. Political headwinds continue to persist around introducing effective mitigation policies which will enable the global system to decarbonise at a faster pace.

It is also important to highlight that in the Current Policies scenario temperatures keep rising after 2050, with global warming hitting 3.1°C  by the end of the century. Meanwhile, in our Delayed Transition and Net Zero with Innovation scenarios, transition policies help stabilise global temperatures, which are expected to remain constant after 2050.



# The three-step approach

We adopt a three-step approach to incorporate climate change in our macroeconomic assumptions:

1. In the first step, we focus on the physical risk of climate change by examining the impact of temperature rises on output and productivity.

2. The second step then considers the transition risk by evaluating the economic impact of actions taken to mitigate climate change and reach net zero targets.

3. Lastly, we account for the effects of stranded assets - where we factor in losses resulting from the write-off of coal, oil and gas reserves that can no longer be exploited and hence remain in the ground.

By aggregating the physical impact, transition impact and stranded assets we can forecast productivity and economic growth, along with inflation for different economies. These are crucial for estimating long-term asset returns. Productivity is a key driver of our asset returns. In particular, our equity return assumptions use a Gordon's growth model approach, in which returns are generated through the initial dividend yield and the growth rate of dividends (via earnings growth). Earnings are assumed to grow in line with productivity, because we believe that over the long term, productivity is a good measure of how well capital is invested.

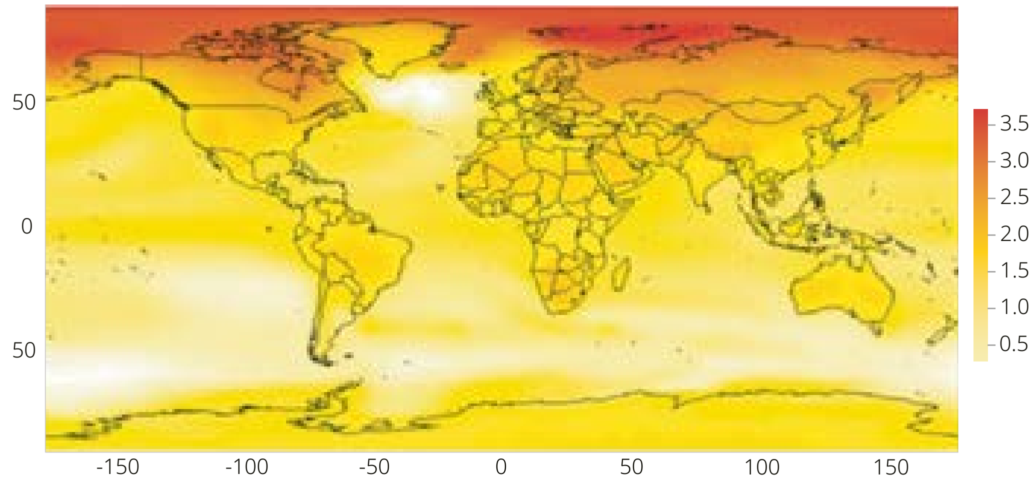
We can also assess the consequences for fixed income assets by making use of the productivity figures to modify our interest rate and bond returns. Following the framework developed by Laubach and Williams[1], long-run equilibrium interest rates move in line with changes in trend growth in the economy. Assuming that the supply of labour is not affected by climate change, then changes in productivity feed directly into changes in trend growth. In turn this directly affects the long-run or equilibrium interest rate for the economy.

### Step 1 – Physical impact

Global carbon emissions have a direct effect on global temperature. Emission estimates are determined within the model by annualised forecasts for coal, oil and gas demand. The flow of carbon dioxide emissions is then translated into a global temperature increase using a linear climate response function. Temperature is therefore endogenous as the amount of global warming is determined within the model by the amount of emissions produced in each scenario we analyse.

It is important to note that the rise in temperature that each country is likely to experience depends on its latitude. As illustrated in the chart below, more northerly latitudes warm the most. In order to scale a given level of global warming into country specific rises, we use the results from the RCP (Representative Concentration Pathways) scenario analysis. These scenarios have been modelled by the Intergovernmental Panel on Climate Change (IPCC) to understand the risk of climate change determined by the amount of greenhouse gas (GHG) emissions produced.

**Chart 1: Average temperature increase in 2050 under RCP 6.0**




IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

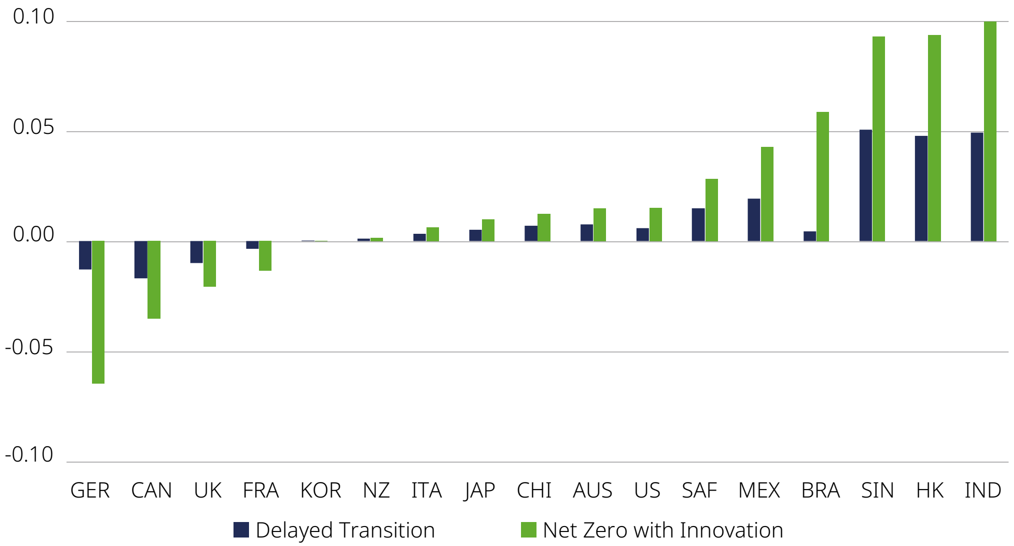
[1]Laubach and Williams, Measuring the natural rate of interest, Review of Economics and Statistics (2003).

We then employ a climate damage function to understand how temperature increases impact economic performance and productivity. Our damage functions are drawn from the research done by Burke, Hsiang and Miguel (2015), which shows a quadratic relationship between productivity growth and temperature. Put simply, those countries which have annual average temperatures below 15°C (such as cold countries in Europe and North America) will experience increased economic growth with a rise in temperature. Whereas for countries with annual temperatures above 15°C (such as hot countries in Latin America, Africa and Asia), economic growth declines as temperatures rise.

In chart 2, we compare the physical costs of global warming in the Delayed Transition and Net Zero with Innovation scenarios against the Current Policies scenario, where global warming reaches 1.9°C by 2050. For the hotter countries, a less pronounced increase in temperatures means higher productivity growth. On a 30-year horizon, India, Singapore and Hong Kong will all be better off in a scenario where global warming rises less than 1.9°C above pre-industrial levels. On the other hand, colder countries will benefit from a rise in temperatures. Hence, Canada, Germany and the UK will tend to see higher productivity in the Current Policies scenario when compared to the other scenarios.

**Chart 2: Physical impact of climate change on productivity (ppt p.a. 2024–2053)***

Percentage point difference in productivity due to physical impact; relative to 'Current Policies' scenario




*The chart shows the impact of higher temperatures measured as the difference in productivity of the Delayed Transition and Net Zero with Innovation scenarios relative to the Current Policies scenario, in which global warming reaches 1.9°C by 2050. Source: Oxford Economics, Schroders Economics Group, January 2024.

Finally, it is important to note the limitations of our methodology and identify avenues for improvement. As we mentioned before, our approach is aligned with NGFS and is widely employed within the financial services industry. Having said that, a majority of climate-economy models are unable to incorporate the non-linear impacts of climate change (such as climate tipping points) and the second-order effects of climate change (such as involuntary mass migration and civil unrest) – impacts which can be quite significant for certain economies. Additionally, these estimates do not capture adaptation, which would reduce impacts but require significant investment. We continue to research different frameworks and models which will help us assess climate risks more accurately and close the gap with what climate scientists are concluding.

## Step 2 – Transition risk

In the second step of our analysis, we examine the economic impact of mitigation policies and action. The journey to a lower-carbon economy will involve significant policy, legal, technology and market changes which will lead to substantial transformations across many sectors of the economy.

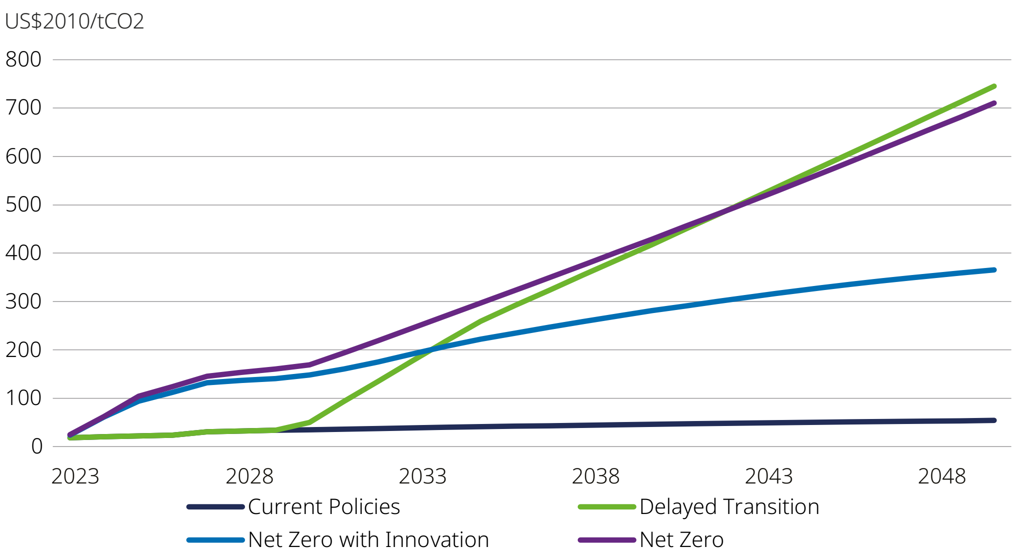
In our scenarios, policymakers induce the transition to a low-carbon economy by raising carbon prices and internalising the cost of emissions. Carbon prices can be considered as a proxy for mitigation policy ambition and effectiveness. Placing a price on carbon will increase fuel prices and disincentivise consumption of carbon-intensive fuels, shifting consumption towards low-carbon sources which will help limit global warming.

Under OE assumptions, the global price of carbon will need to rise to $710 per tonne of carbon dioxide (tCO2) in order to successfully reach net-zero by 2050. Under the Delayed Transition scenario, ambitious climate action only starts from 2030, with carbon prices rising sharply to reach $745/tCO2 by 2050. This reflects the assumption that global policy makers pursue more stringent policies in the latter half of our forecast horizon as stronger incentives are required to limit global warming. This scenario forms our central case for the purpose of calculating 30-year returns.

However, in the Net Zero with Innovation scenario, the proactive introduction of carbon prices earlier spurs higher investment, leading to greater innovation and productivity gains. This results in carbon prices rising to less than half of the levels when compared to net-zero transition (without innovation) – at around $360/tCO2 by 2050.

In our previous publication, we had assumed that carbon prices don't rise over our forecast horizon under the Current Policies scenario. However, there has been a shift in the ambition and effectiveness of mitigation policies over the past year. Notably, the European Union has introduced the Carbon Border Adjustment Mechanism (CBAM), and the United Kingdom has plans to implement a similar CBAM from 2027 onwards. In light of these developments, our current policies scenario now incorporates a carbon price of $18/tCO2 in 2023, which is projected to rise modestly to around $54/tCO2 by 2050. This adjustment is made to reflect the evolving landscape of carbon pricing and the increased commitment towards climate change mitigation.

**Chart 3: Carbon price under different scenarios**




Source: Oxford Economics, Schroders Economics Group, January 2024.

In aggregate, the carbon tax is a negative for all countries as the internalisation of the cost of greenhouse gas emissions leads to lower production and a loss in output. However, the degree of the fall in activity (and thus productivity) varies across countries and scenarios. The impact of carbon pricing across the globe will depend on a number of country-specific factors.

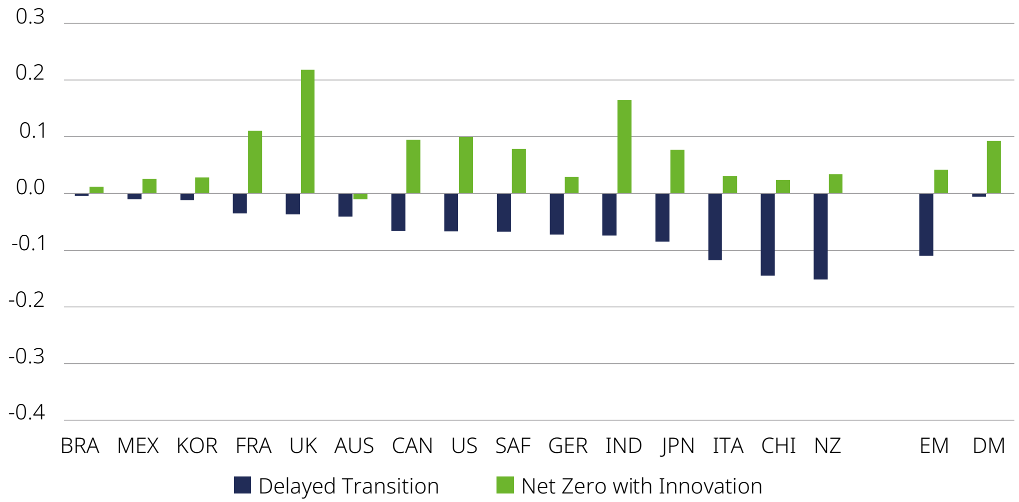
The first factor we consider in building country-specific profiles is the magnitude of carbon price increases for different economies. NGFS models carbon prices that are more severe for developed than developing economies. So emerging markets (EM) like India, Brazil and Mexico are assumed to experience the smallest increase in carbon prices over the next three decades. In addition to carbon price assumptions, the carbon dioxide intensity of economic production is also an important factor in determining a particular country's carbon pricing vulnerability. In other words, countries that are currently more reliant on fossil fuels for their energy generation will be more exposed to carbon taxes, as a higher share of fossil fuels leads to higher inflationary pressures weighing on economic activity. This is particularly applicable to countries like China and South Africa, which are highly dependent on coal – the most carbon intensive fossil fuel.

In general, most countries will experience greater economic benefits under our Net Zero with Innovation scenario. But there are a few countries which stand to experience economic pain. A case in point is Australia, a major fossil fuel exporter, which will experience a negative impact on productivity given its high reliance on coal. In comparison, fossil fuel importers like the UK, European countries and India are expected to replace fossil fuel imports with domestic low-carbon electricity generation and energy efficiency. These are likely to improve net trade and their balance of payments, helping to lift economic growth.

Combining all these factors enables us to build the productivity impact of decarbonisation for our transition scenarios, as is shown in Chart 4.

**Chart 4: Transition impact of climate change on productivity (ppt p.a. 2024–2053)***

Percentage point difference in productivity due to transition impact; relative to 'Current Policies' scenario




*The chart shows the climate change impact measured as the difference in productivity of our transition scenarios relative to the Current Policies scenario, in which there are no mitigation costs. Source: Oxford Economics, Schroders Economics Group, January 2024.

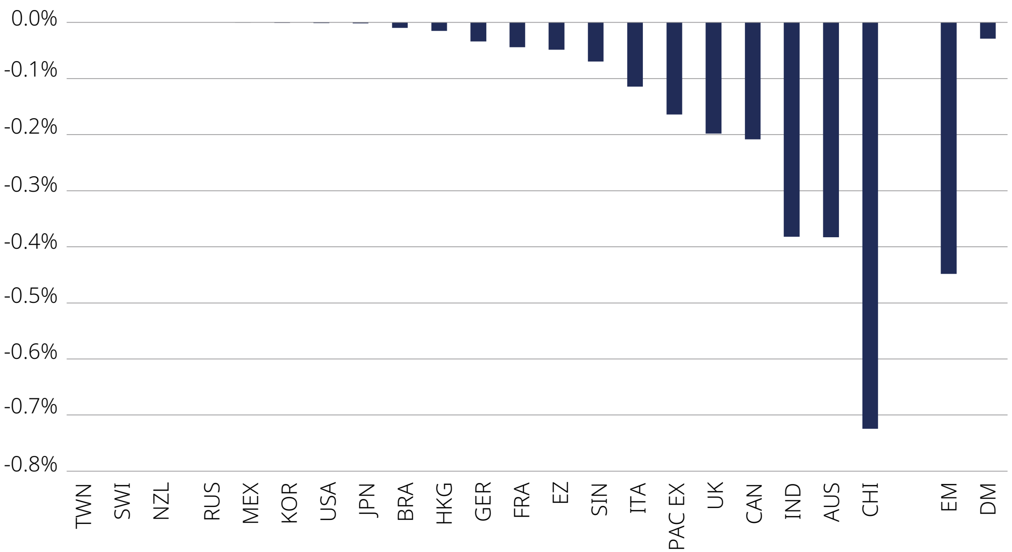
**Step 3 – Stranded assets**

Analysis from the IEA finds that almost 60% of oil and gas reserves, and over 80% of current coal reserves should remain unused in order to meet the Paris target. We use MSCI data that reports potential CO2 emissions from coal, oil and natural gas reserves owned by public companies to calculate the loss that companies' balance sheets would register given the fraction of unburnable reserves of oil, coal and gas. We do this for each equity index in the scenario where mitigation policies lead to some moderation in global temperatures. The results are shown in chart 5, highlighting the sizeable impact to EM returns, particularly in China and India. In the US, there is only a small downward adjustment to returns; a reflection of the sheer size of the equity market, even relative to its oil giants.

Almost 60% of oil and gas reserves, and over 80% of current coal reserves should remain unused in order to meet the Paris target

**Chart 5: Reduction in equity returns from stranded assets**

Reduction in equity returns from stranded assets in Delayed Transition (% p. a. 2024–2053)




Source: Refinitiv, MSCI, Schroders Economics Group. January 2024. For Russia, we use the MICEX Index instead of the MSCI Russia, given the low number of listings on the latter. We also use the NSE for India and the Shanghai Stock Exchange Composite Index for China since we have data for companies listed on their domestic stock exchange.

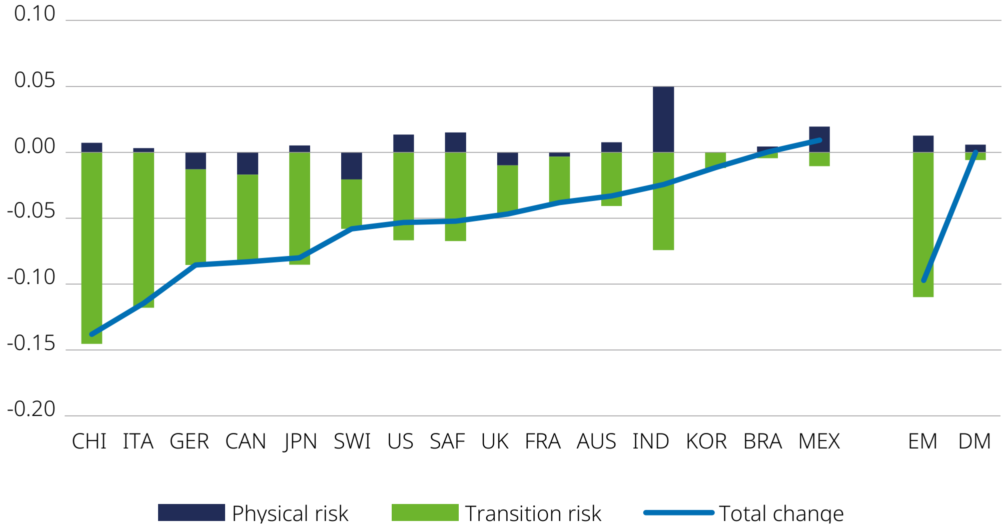
# The aggregate impact on productivity in our central case – Delayed Transition

Combining the physical and transition costs yields the final estimate for productivity that is used to calculate the long-term asset returns. Chart 6 shows the differences in productivity growth between the baseline Delayed Transition scenario and the reference Current Policies scenario.

Our modelling finds that all countries experience lower productivity in the Delayed Transition scenario, highlighting that mitigation costs will be more painful the longer it takes to internalise the negative externalities associated with climate risks. Aggressive carbon taxation policies lead to significant inflationary pressures and a higher rate of depreciation, both of which weigh on real GDP and productivity growth. The negative impact of a delayed transition largely outweighs the positive boost from mitigating global warming. Hotter countries, like India, South Africa, China, and Japan, while benefitting from a more limited temperature increase relative to the warming under current policies, will be worse off on the back of larger transition costs. Economic growth in colder countries like Canada and Germany will see lower productivity in the baseline as a result of a drag from both physical and transition costs.

**Chart 6: Changes in productivity in Delayed Transition versus Current Policies**

ppt, p.a.2024–2053




Source: Oxford Economics, Schroders Economics Group, January 2024.

Mitigation costs will be more painful the longer it takes to internalise the negative externalities associated with climate risks

# The impact on the inflation forecasts

The green energy transition also impacts the forecasts for inflation. With more stringent climate action, inflation is mainly impacted by rising carbon prices via changes in energy prices. The Oxford Economics model assumes that fossil fuel supply is slow to adjust to the change in prices. In contrast, demand is more responsive and adapts more rapidly to changes in the price of energy.

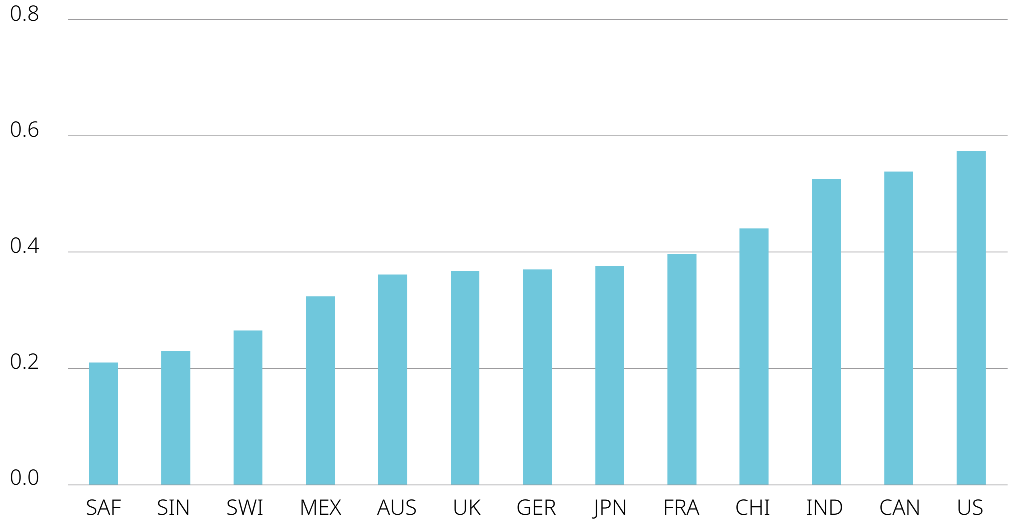
Overall, a more aggressive carbon taxation policy results in substantial inflationary pressures globally. The energy transition is also set to boost demand for key industrial metals, such as aluminium, copper, cobalt and lithium, used to generate and store renewable energy. Given the supply challenges for these metals, this is likely to add further pressure on inflation. That said, the impact of carbon pricing on energy costs is the main inflationary driver. Our inflation impact estimates differ across countries (Chart 7), with energy price increases being driven by a particular country's carbon usage and energy efficiency. Coal is expected to experience the largest price rise as it is the most carbon-intensive fuel, while natural gas is likely to have a smaller price increase. So, countries with greater reliance on coal for their energy production should experience higher inflation than economies more dependent on cleaner sources of energy.

For this reason, over the next 30 years, Mexico and Switzerland are expected to see the smallest inflation increases, as the share of coal in their current energy production mix is less than 4%. For the US, the Delayed Transition scenario is estimated to add 0.6% p.a. to headline inflation over the next 30 years.

Now that we have aggregate estimates for the impact on productivity from climate change and the costs of stranded assets, in Part 2 of our paper we outline how we use the productivity estimates for our asset return forecasts, explaining the methodology for cash, bonds, credit, equities, and real estate, along with a look at the historic evolution of most of those forecasts.

**Chart 7: The impact on inflation from incorporating more ambitious climate action (Delayed Transition versus Current Policies)**

ppt, p.a.2024–2053




Source: Oxford Economics, Schroders Economics Group, January 2024.

Overall, a more aggressive carbon taxation policy results in substantial inflationary pressures globally

EST. 1804

**Schroders plc**
**1 London Wall Place, London EC2Y 5AU, United Kingdom**
**T +44 (0) 20 7658 6000**

**schroders.com**
**@schroders**

## Important information