For professional investors only

ESG Megatrends: Climate Change

April 2022

Gertjan Medendorp
Senior Investment Strategist

Anna Czylok
Investment Strategist

Executive summary

- Although the actual pathway that the economy will follow is unknown, we know with certainty that there is no 'business as usual' scenario where climate does not play a role eventually. Transition and physical risks are relevant and will result in varying degrees of risk.
- We encourage investors to think about the risks, opportunities and investment impact associated with climate change and start communicating these with stakeholders.
- Actively managing transition risks in the years to come is crucial.
- Investors should be mindful of green-washing and highly complex approaches resembling a black box, which in fact provide limited insights into how investment(s) (portfolios) are influenced by climate change.
- An important consideration for investors when weighting up transition risk against physical risks is that physical risk resulting from climate change cannot be reversed. It will keep increasing in magnitude if the transition towards a net-zero economy is not timely and the results would be disastrous.

Understanding the potential impact of climate change and the interaction between different stakeholders, initiatives, metrics, and tools presents challenges. There is a growing need for investors to understand the risks, opportunities and the impact on investment portfolios that come with climate change. Supervisory bodies across Europe are raising the bar and expect institutional investors to assess and understand whether and to what extent they are exposed to these types of upcoming risks. As a fiduciary manager we help our clients to further integrate climate-related considerations into the investment processes. Our approach is forward looking, transparent and comes with a high degree of flexibility. We support clients by putting things into the right perspective, interpreting outputs, and designing a path to improve portfolios' resilience.

This article is part of the ESG Megatrends: Implications for Strategic Asset Allocation (SAA) series in which we discuss the consequences of key ESG developments across the global economy that we believe will affect investors' portfolios.

For more information about Aegon AM's capabilities in Fiduciary Management, please contact your usual client representative or visit **https://www.aegonam.com/en/fiduciary-management/**

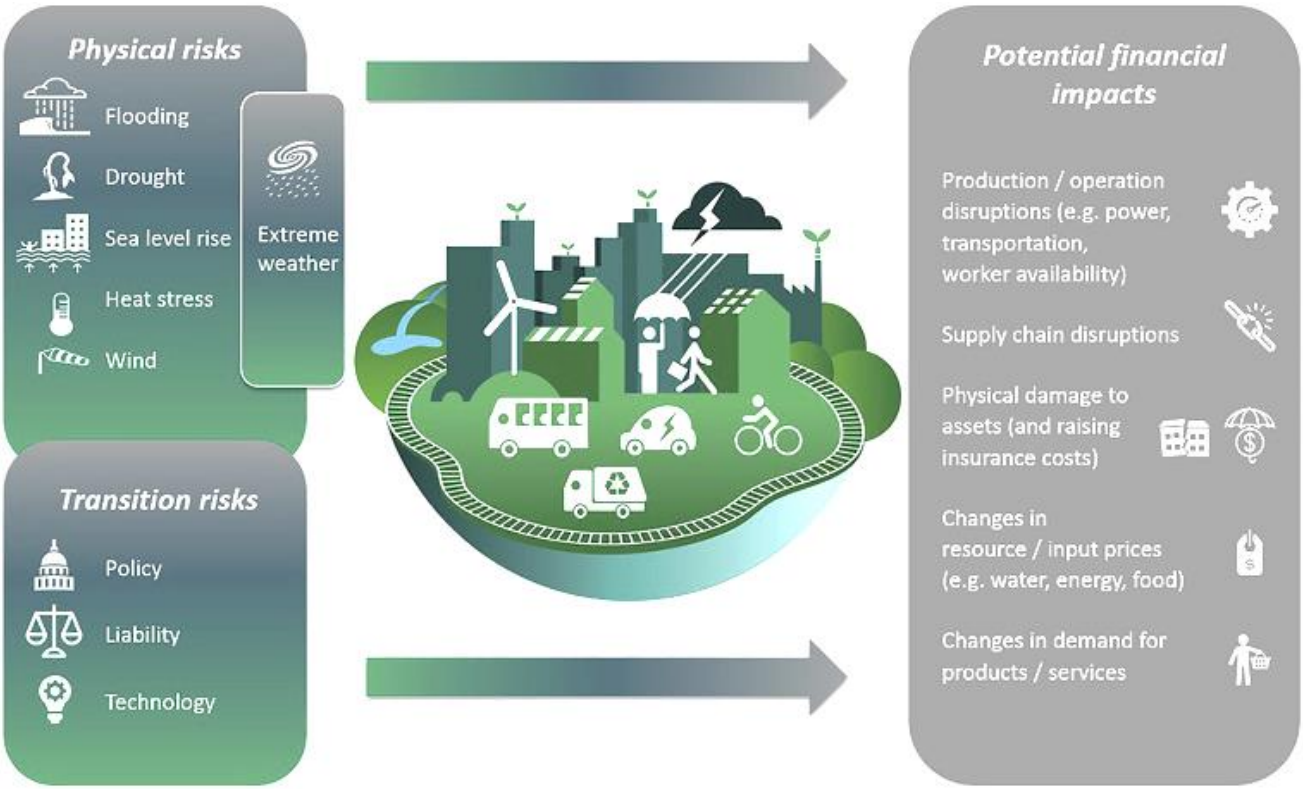
Introduction

The 2020s so far have forced a global realization that threats posed by climate change are severe, urgent, and irreversible. Research institutes, such as NASA or Copernicus Climate Change Services show that in recent years, we have been reaching record average temperatures globally. This results in changed weather patterns across the globe, including more frequent and extreme weather events, and biodiversity loss, both having increasingly more impact on human life. The need to take action to combat further temperature rise is therefore pressing. However, the years that have passed since the Paris Agreement was signed have been lost due to non-action. The latest IPCC report concludes that the concentration of greenhouse gas (GHG) in the atmosphere between 2011 and 2019 has increased, meaning that to have a reasonable chance to limit the temperature rise to 1.5°C, any measures taken must be acute. Therefore, it is increasingly important for investors to manage climate-related financial risks as these are now recognized as being systemic.

Climate change undoubtedly bears financial consequences

The financial sector is exposed to the risks of a transition to a net-zero economy and the physical risks caused by increasing climate change.

Figure 1: potential financial impacts of climate change



Source: C. Clapp, H. Francke Lund, B. Aamaas, E. Lannoo, Shades of climate risk: categorizing climate risk for investors. CICERO Report 2017:01, http://hdl.handle.net/11250/2430660

The **physical risks** caused by climate change arise due to real-world environmental hazards, such as an increase in extreme weather events. These physical risks have both real-world and financial implications due to, for example, supply chain disruptions, changes in commodity prices, and physical damage to assets. Most likely climate change is already affecting the financial sector in many ways and the effects could increase significantly. Transitioning away from fossil fuels and carbon-intensive production and consumption requires a significant shift towards zero -emission alternatives across the globe. This gives rise to **transition risks** for the economy and financial markets.

Changing attitude towards climate change, and prioritization of climate action leads to a growing number of climate-aware investment solutions and tools for climate risk assessments.

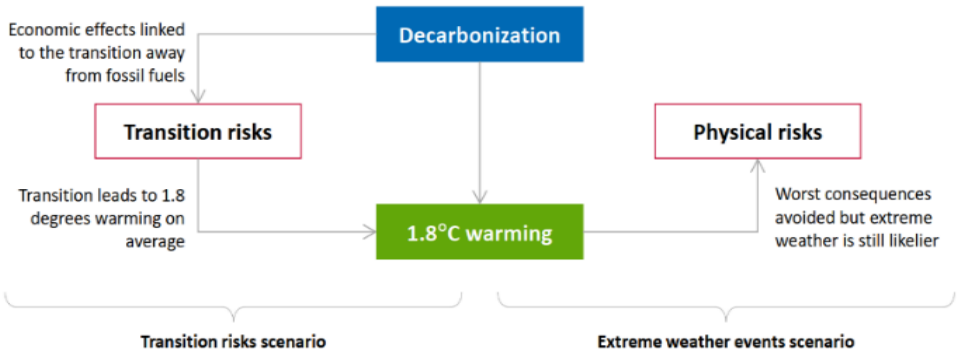
The impact of climate risk on investment portfolios

We have been servicing multiple clients in their endeavours to understand the potential impact of climate change on their investment portfolio. In this journey we have developed our own proprietary methodology supplemented with tooling from external vendors and data providers to provide useful insights.

Climate risks are complex and there are many dimensions to consider, such as time horizon and loss metrics. Besides, projecting the impact of events that are historically unknown is challenging. Scenario analysis can be helpful in gaining understanding of how different asset classes, countries and sectors are impacted by climate-related financial risk. Therefore, it is vital for investors wishing to use these techniques to clearly identify their research objectives first. This will also help to determine the breadth of analysis.

The box below provides some general observations of the potential impact of climate risk in a moderate scenario that assumes[1] immediate policy commitment, moderate pace of technological change, some use of carbon removal and a coordinated global approach. It is expected that this will limit physical risks (extreme weather events), while keeping the transition orderly.

Figure 2: Scenario that would likely limit the risks, while keeping the transition orderly



Transition risks

- The transition will likely lead to large differences across and within industries. Investors should not forget that it could bring significant opportunities too.
- The cumulative projected impact of transition risks can be significant on a 20 to 30 year horizon[2].
- Year on year, investors can still expect to earn a positive return on their investments.
- A disorderly transition could offset the expected additional return of risky assets, particularly when climate policy implementation is unanticipated. This is especially true if climate risks are not correctly priced into the financial markets.
- Expected returns from companies in high-emitting industries could be highly influenced by direct carbon cost and changes in product demand. This holds even if we assume that they'll manage to reduce their emissions to almost zero in 2050 and account for technological progress. For example, in our approach around 10% of the companies in the MSCI World will lose more than half of its market value when carbon emissions will be taxed under the assumption that carbon prices rise gradually to EUR 750 (per tonne CO_2) in 2050. To mitigate the impact of this an investor could exclude entire high-emitting

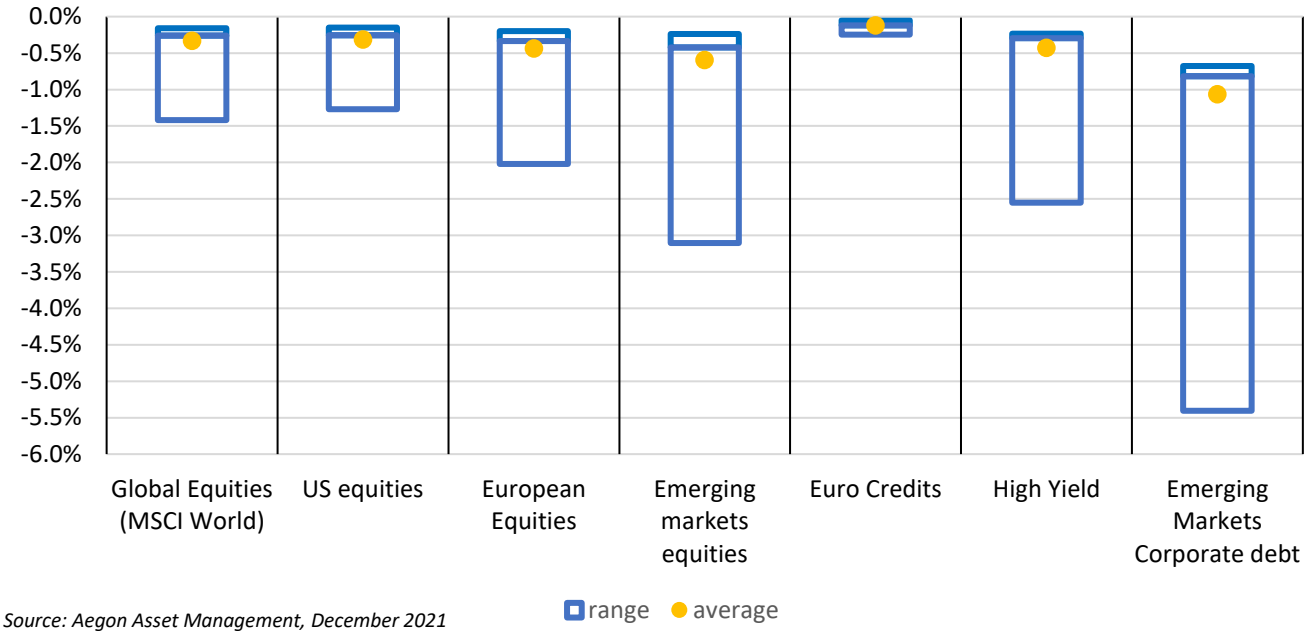
[1] The Network for Greening the Financial System (NGFS) has been working with the academic community to publish a set of standardised scenarios that can be used for financial analysis. In order to capture the impacts of climate change and build scenario's, the IPCC's climate models are combined with economic and financial models. These scenarios illustrate possible pathways based on assumptions of economic activity, technology.
[2] Next to quantifying the impact on expected future earnings of carbon pricing we estimate the economic impact on supply and demand. Furthermore, we assume that long-term interest rates are 0.3% to 0.5% higher than the reference scenario on a 30-year horizon (based on the NGFS below 2°C scenario) caused by additional demand for capital. Inflationary pressure because of pass-through, more than compensating decrease in energy prices. These assumptions are based on recent publications from NGFS.

Transition risks

industries from the investment universe. In our opinion this is not the way to go. Firstly, we think that companies from these industries (e.g. energy and utility) play a vital part in keeping the economy running (also during the transition). These are the sectors where transitioning towards sustainable energy sources can make the biggest impact. Cutting off financing sources in these industries can be pressing a brake pedal on transition in the first place. This doesn't imply that we are against exclusions altogether, but that we prefer to be selective. The ability and willingness of companies to transition is in our eyes a better criterium to judge upon.

- It seems that emerging markets are more exposed to transition risks than developed markets. On the other hand, the expected additional profit growth in emerging markets versus developed markets provides quite some room to offset the potential negative aggregated impact of transition risks. However in the short run, when the marginal impact of carbon pricing is projected to be highest and less anticipated, it seems doubtful that emerging markets will provide sufficient returns to bear the additional risks compared to developed markets.

Figure 3: Projected reduction in annual return over a 20-year time horizon versus a climate agnostic scenario



Source: Aegon Asset Management, December 2021

Physical risks

- To summarize, financial impacts from physical climate risk could arise from both an increase in the frequency and severity of extreme weather events, and gradual rising temperatures. These risks may have wide-ranging direct economic impacts on:
  - Physical capital: due to destruction of property and infrastructure (e.g., from flooding and tropical cyclones)
  - People: labour productivity, mortality, and morbidity (e.g., from changes in temperature extremes and wet bulb effect)
  - Natural capital: due to disruption to agriculture, and biodiversity loss. This could lead to significant knock-on impacts on the economy depending on the nature of the threat, the level of resilience and level of local adaptation.
- Another aspect to consider is the uncertainty that extreme weather events bring about and its effect on (real) interest rates and risk premia. Given a greater unpredictability with respect to future (economic) outcomes and depending on the risk aversion, people might increase their saving rate in anticipation of more dire conditions in the times ahead. This implies lower current consumption and demand for credit,

Physical risks	and results in a downward pressure on interest rates. The reaction is more evident the higher the level of welfare, as with higher income levels expenditure shifts from basic toward luxury goods and can therefore be postponed relatively easily. • From an investor perspective, companies' exposure to physical risk and subsequently long-term valuation will necessarily be subject to larger margins of error giving a rise to higher required compensation for risk. • Particularly at risk are those companies with locations in climate-sensitive regions, or with long-lived fixed assets. Fixed-income investors are better positioned to bear the risks of capital destruction and climate costs caused by extreme weather events based on the capital structure of the companies[3].

There are many possible pathways along which the physical and transition risks might develop as well, each driven by choices made by governments and society. Consequences vary from severe physical impact in scenarios where our behaviour does not change, to lesser physical risks in combination with a more severe transition impact in those in which drastic action is taken to counteract climate change. Nevertheless, it is of importance to investors to understand the exposure of the portfolio, as in the short and medium-run, financial markets will react to changing economic and social conditions. Analysing transition and physical risk scenario's is therefore the first step to get a grasp on risk. Scenarios play a role on portfolio level. They shouldn't, however, guide the asset allocation decisions on a standalone basis. We help clients to interpret the outcomes, and to design tailored solutions to manage the risk and, where possible, take advantage of the opportunities. Further down the road, it is also possible to analyse portfolio holdings based on policy measures that companies take to reduce the impact of the transition and possibly to contribute to a smoother transition elsewhere in the economy.

The remainder of this paper introduces several key aspects for a better understanding of the potential influence of climate change on investment portfolios.

Carbon pricing is a key concept in modelling transition risk scenarios

Transition risks will affect the profitability of businesses as well as household wealth, creating financial risks for lenders and investors. They will also affect the broader economy through investment, risk premia, productivity, and potentially stranded assets.
We use carbon pricing as a key element in modelling transition risks scenarios. Internalizing the societal costs of carbon emissions for industries can take different forms, such as a carbon trading system or a carbon tax. The global coverage and number of pricing mechanisms for carbon emissions has increased in recent years. However, there is still plenty of room for the right financial incentives to induce the transition towards a more sustainable world.

Global carbon pricing (mechanisms)[4]

According to the World Bank, the number of carbon pricing mechanisms in operation has doubled to 64 over the past 10 years. The World Bank estimates that at the end of 2021 approximately 20% of global carbon emissions are taxed. This has increased significantly last year due to the introduction of an emission trading system (ETS) for energy companies in China. This means there is now an explicit price for around a third of carbon emissions in China, which is an important step as China is the highest emitter worldwide.

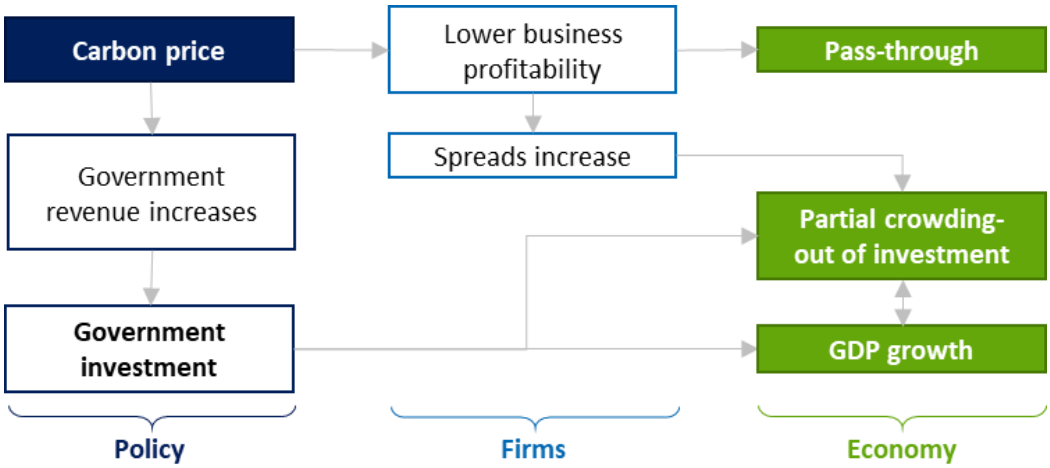
Approaching transition risks from a macro perspective seems appealing because it aims to account for the far-reaching impact of carbon pricing on the global economy. But modelling the interaction between numerous macro- economic variables, including transition-induced changes in the behaviour of economic agents, will inevitably result in high margins of uncertainty around the outcomes and difficulties in interpretation of the results. That's why we prefer to combine bottom-up and sector-level approaches to examine the broader economic impact of climate risk within a tractable framework, thus illustrating the different channels through which climate risk could affect various companies, industries, and regions.

[3] Based upon the Merton Model that assesses credit risks of a company's debt by splitting the climate costs according to the capital structure of the company.
[4] Worldbank 2021, State and Trends of Carbon Pricing 2021 and https://www.dnb.nl/en/actueel/dnb/towards-a-global-price-for-carbon-emissions/

Monetizing the impact of climate policy on the economy

Policy makers can induce the transition by increasing the implicit costs of emissions: the carbon price. The carbon price is a monetary proxy for government policy intensity, and changes in technology and consumer preferences. Carbon tax or trading system are explicit measures to internalize the cost of the emissions. More implicit options are also possible, such as reducing fossil fuels subsidies and regulations to change supply and demand dynamics or to incentivize low carbon solutions. Exhibit 3 shows some potential consequence of carbon pricing.

Figure 3: potential impact of taxing carbon emissions



Source: Aegon Asset Management

Consensus in the literature is that the impact of carbon pricing on economic growth is highly uncertain and dependent upon how orderly the transition will go. A key question is if (government) investments can stimulate technological change and offset the potential negative impact on supply and demand.

Distinct transition impact channels for companies

Carbon pricing may have positive economic impact by driving investment and spurring innovation, but across companies there will be winners and losers. While it is still debatable if a price on carbon emissions should be the same across sectors and regions, companies depending on carbon the most will undoubtedly face the highest costs, as they'll be forced to pay higher (than now) carbon prices on their emissions. To reduce these costs, they will have to invest more heavily in transition technologies and change their production processes.
The table below sets out the key transition impact channels for companies and how investors could cope with these in scenario analysis.

Carbon costs	In our methodology direct carbon costs influence companies' expected earnings. The impact on company future profitability obviously depends on the current and future emissions level. We assume that carbon costs will partly be transferred to the consumer and that companies succeed in reducing their own emissions. Probably, abatement does not come without a cost. The expected aggregated impact of these costs on annual profitability and subsequently on market value translates into yearly deviations from our climate-agnostic projections across asset classes.
Abatement (costs)	Companies will incur costs to reduce their emissions. These costs are assumed to be lower than the carbon price which would have to be paid absent the reductions. Due to the technological innovation, we expect that companies can reduce a larger share of carbon emissions for less than the carbon price over time.

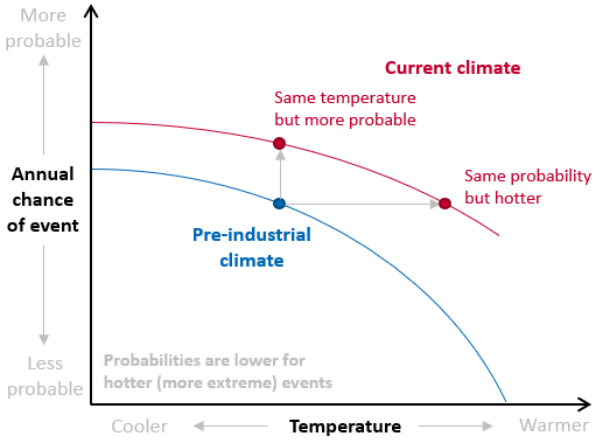
	The study by McKinsey & Company[5] (2010) showed that abatement costs tend to increase with higher levels of abatement. It can therefore be assumed that the first abatement will be (almost) costless and that the marginal costs increase with further abatement. The underlying logic is that, initially, it may be relatively cheap to reduce carbon emissions by switching to alternative production technologies. This is, however, likely to become increasingly harder and more expensive as emissions converge to zero (i.e., increasing marginal abatement costs).
Changes in demand	Reduced demand for fossil fuels pushes down prices and results in lower profit margins and stranded assets in certain industries and geographies. Increasing demand for low-carbon products and materials needed pushes up profits in certain industries.

To summarize, many financial transition risk scenarios are driven by the projected carbon price, assumptions about future emissions, technological progress and the risk of stranded assets. The transition will likely lead to large differences across and within industries. Investors should not forget that it could bring significant opportunities too.

Impact of physical risks are severe but difficult to project

The key consequence of man-made climate change has been well-known for quite some time: given the current path, temperatures will rise globally by a few degrees on average by the end of the century. While the horizon seems long, the consequences of temperature rise are much more immediate. Thanks to the developments in science, we are now able to clearly link extreme weather events to climate change. Although climate change is a slow process, it causes an increase in disequilibrium in weather patterns, leading to more extremes. There is scientific evidence that the frequency of extreme weather events has already increased, as has the severity of the damage caused by these events. NOAA National Centres for Environmental Information estimate that in the period between 1980-2021, the US experienced $7.4 billion damages from weather events on average. In the past five years however, the average reached $17.2 billion.[6] These statistics result from increased frequency of high-impact extremes on the one hand, and from asset exposure and physical vulnerability of areas hit by disasters on the other.

Figure 4: Extreme events have become more probable and more intense



Source: Aegon Asset Management, IPCC, 2021

A change in the distribution of weather events resulting from human-induced climate change causes a shift in mean temperature and larger variance, transforming the patterns of extreme weather events in the following ways:

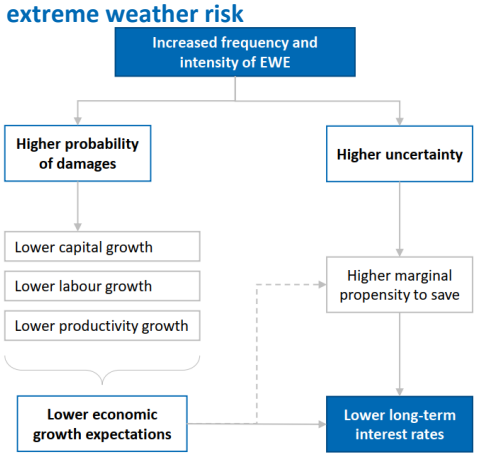
- Larger magnitude: events considered extreme in the current climate will occur with unprecedented magnitude in the future.
- Increased frequency: future extremes will occur with unprecedented frequency.
- New locations: extremes may occur in regions not previously exposed to those types of events (e.g., wildfires in the Arctic).
- Different timing: extreme events may be unprecedented in their timing (e.g., hot temperatures earlier in the year).
- New combinations: 'compound events' (multiple extremes occur simultaneously or in succession) may be more probable, dramatically increasing damage.

[5] McKinsey & Company, 2010, Pathways to a low-carbon Economy. Version 2 of the global greenhouse gas abatement cost curve
[6] https://www.climate.gov/news-features/blogs/beyond-data/2021-us-billion-dollar-weather-and-climate-disasters-historical,

Climate change increases uncertainty

Appraising the impact of specific weather events such as hurricanes or floods on the global scale is practically infeasible given the scale, complex interactions between (highly uncertain) local weather conditions, and geography/country specific exposure and levels of economic development. Such an appraisal could potentially be interesting for policymakers and investors wishing to invest in solutions in certain regions. However, this would be less the case from the portfolio risk management perspective, given the assumption of a well-diversified portfolio. Therefore, given a high degree of certainty with respect to the increase in both the frequency and severity of extreme weather events on the global scale, we assess an aggregate impact of these events on the global economy and various asset classes.

Figure 5: potential influence of increasing extreme weather risk

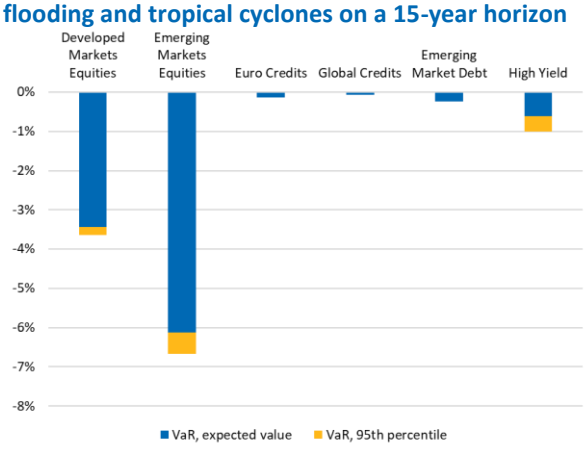


Source: Aegon Asset Management

We distinguish two channels through which these changes affect the economy: a higher probability of (physical) damages in any given year and a higher uncertainty among economic agents, resulting in lower expected economic growth and lower long-term interest rates. To understand the logic behind the conclusions it's worthwhile to look at different factors separately.

A higher probability of damages has a negative impact on all three growth components in Figure 5. First, the negative effect of extreme weather on the physical and natural capital stock is quite intuitive. Natural disasters like floods, wildfires or hurricanes lead to the destruction of infrastructure and property, and to disruption in economic activity.

Figure 6: potential aggregate impact (value-at-risk) of flooding and tropical cyclones on a 15-year horizon



Source: MSCI, Aegon Asset Management

Investors should also bear in mind that the economic effects of disasters are nonlinear. MSCI ESG Research, for example, has developed

a methodology that utilises relative concentration pathways and the projected cost distribution of asset damage for companies for certain NFGS climate scenarios.

Figure 6 shows the potential aggregate impact (value-at-risk) of flooding and tropical cyclones[7] on different asset categories on a 15-year horizon, based on MSCI methodology.

Asset damages result in the need to divert resources away from new productive investments towards reconstruction, replacement, protection, and adaptation, which in turn lower total factor productivity growth.

Second, people's willingness and ability to work is also influenced given the increase in average temperatures and more frequent heatwaves. Negative effects will be more pronounced in countries with higher exposure to heatwaves, and economies depending more heavily on activities performed outside, like agriculture or construction work. We expect that these areas will experience a lower labour force growth and productivity growth as compared to the base scenario. Both effects reduce the long-term growth rate of the economy, putting downward pressure on interest rates.

An important consideration for investors when weighting up transition risk against physical risks is that physical risk resulting from climate change cannot be reversed. It will keep increasing in magnitude if the transition towards a net-zero economy is not timely and the results would be disastrous.

[7] *Flooding:* MSCI uses a global digital elevation model to determine whether an asset will be reached and subsequently inundated by a flood event. Stage damage functions are used to translate the height of the water level at the asset site to asset damage.
Tropical Cyclones: MSCI uses a tropical cyclone generator based on an extensive set of historical storms that evaluates the distribution of winds speeds for each business location. With the help of regionally calibrated damage functions an asset damage cost is obtained.

Important information

For Professional Clients only and not to be distributed to or relied upon by retail clients.

All investments contain risk and may lose value. This document is for informational purposes only in connection with the marketing and advertising of products and services, and is not investment research, advice or a recommendation. It shall not constitute an offer to sell or the solicitation to buy any investment nor shall any offer of products or services be made to any person in any jurisdiction where unlawful or unauthorized. Any opinions, estimates, or forecasts expressed are the current views of the author(s) at the time of publication and are subject to change without notice. The research taken into account in this document may or may not have been used for or be consistent with all Aegon Asset Management investment strategies. References to securities, asset classes and financial markets are included for illustrative purposes only and should not be relied upon to assist or inform the making of any investment decisions. It has not been prepared in accordance with any legal requirements designed to promote the independence of investment research and may have been acted upon by Aegon AM and Aegon AM staff for their own purposes.

Past performance is not a guide to future performance. Outcomes, including the payment of income, are not guaranteed. Opinions and/or example trades/securities represent our understanding of markets both current and historical and are used to promote Aegon Asset Management's investment management capabilities: they are not investment recommendations, research or advice. Sources used are deemed reliable by Aegon Asset Management at the time of writing. Please note that this marketing is not prepared in accordance with legal requirements designed to promote the independence of investment research and is not subject to any prohibition on dealing by Aegon Asset Management or its employees ahead of its publication.

All data is sourced to Aegon Asset Management unless otherwise stated. The document is accurate at the time of writing but is subject to change without notice. Data attributed to a third party ("3rd Party Data") is proprietary to that third party and/or other suppliers (the "Data Owner") and is used by Aegon Investment Management B.V. under licence. 3rd Party Data: (i) may not be copied or distributed; and (ii) is not warranted to be accurate, complete or timely. None of the Data Owner, Aegon Investment Management B.V. or any other person connected to, or from whom Aegon Investment Management B.V. sources, 3rd Party Data is liable for any losses or liabilities arising from use of 3rd Party Data.

This financial promotion is issued by Aegon Asset Management UK plc in the UK and Aegon Investment Management B.V in the EU. Aegon Asset Management UK plc is authorised and regulated by the Financial Conduct Authority. Aegon Investment Management B.V. is registered with the Netherlands Authority for the Financial Markets as a licensed fund management company. On the basis of its fund management license Aegon Investment Management B.V. is also authorised to provide individual portfolio management and advisory services.