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Stress testing equity markets with higher carbon prices

Comparing the impact on traditional and ESG equity indices

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European insurance supervisors[1] have been highlighting the vulnerability of insurers to physical and transition climate risks, underscoring the need to strengthen consideration of climate risks and opportunities into insurers' governance and strategies.

Carbon prices are a key transition risk for public equities, as countries are increasingly implementing carbon tax or trading policies[2], driven in part by the European Union's carbon border tax.

This paper applies carbon price stress test scenarios to traditional and ESG equity indices.

Our analysis concludes that higher carbon prices could significantly impact company equity value by -10% to -15% for the MSCI World index, based on a carbon price of USD 150/tCO_2 or USD 300/tCO_2.

While this impact is consistently negative across indices, it is less pronounced on ESG indices.

Another approach to hedge against carbon price equity risk is to consider investing in European carbon allowances.

[1] Bank of England 2021; EIOPA 2022; APCR 2023-24
[2] HSBC (October 2023) – Carbon tax or trading policies are being created or strengthened in countries such as Australia, Brazil, China, India, Indonesia, Taiwan, Turkey, UK, and Vietnam. Some US Democrats & Republicans have separately proposed a carbon border tax.

1 / Introduction

The heightened vulnerability of insurers to climate change necessitates urgent and strategic actions to integrate climate risks into their governance and strategies.

Specifically, reform of the EU Solvency II Directive has created a new requirement[3] for insurers to identify and assess any significant exposure to climate change risks and use climate scenarios within their Own Risk and Solvency Assessment (ORSA), which will be closely monitored by the European Insurance and Occupational Pensions Authority (EIOPA)[4].

Against this backdrop, this paper presents a possible approach for assessing the implications of higher carbon prices on the value of equities globally, through the following structure:

1. Vulnerability of insurers to climate change: we remind why insurers are particularly vulnerable to climate change. This section examines the specific risks posed by climate events to insurers' financial health, and the implications for underwriting and investment portfolios.

2. Official climate scenarios may underestimate materiality of climate risks: we summarise the results of official climate scenarios that find limited risks for insurers. However, the UK actuarial professional industry body concludes that current climate scenarios underestimate climate risks.

3. Deriving a carbon price from a new short-term climate scenario narrative: we use a new, short-term climate scenario narrative developed by the United Nations Environment Finance Initiative (UNEP FI) and the National Institute of Economic and Social Research (NIESR) leading to higher carbon prices globally. This scenario incorporates more extreme assumptions to better reflect the potential adverse impacts on financial stability and to provoke the necessary strategic changes and awareness among investors.

4. Measuring the potential impact of higher carbon prices on the value of global equities: we analyse how the imposition of a more stringent carbon price could affect the value of global equities. This section also provides a comparative analysis between traditional and ESG equity indices for various regions, highlighting the financial implications of transitioning to a low-carbon economy.

Based on our proprietary analysis, we show that the impact of a higher carbon price on company equity value is significant, ranging from -10% to -15% for the MSCI World index, with a carbon price of USD 150/tCO_2 and USD 300/tCO_2. While this impact is consistently negative, it is less pronounced on ESG indices, which could encourage investors, particularly in Europe, to consider shifting their exposure from traditional indices to ESG indices in a capital preservation strategy.

By providing an in-depth analysis, this paper aims at guiding European insurers as they transition towards a more sustainable economy while ensuring their financial robustness in the face of future climate challenges. This analysis can also be seen as a useful guide for helping European insurers assess the impact of a given short-term climate scenario, in their ORSA, on the value of their portfolio invested in global equities.

[3] European Parliament, April 2024 Resolution on the proposal for amending the Solvency II Directive
[4] EIOPA June 2024 Financial Stability Report

2 / How climate risks affect insurers

2.1 Brief overview of physical and transition risks for insurance companies

1. Physical risks arising from changes in weather and climate, including:
    a. Acute risks such as floods, droughts, heatwaves, and wildfires;
    b. Chronic risks such as rising temperatures and sea levels.

The realization of climate risks can significantly affect households and businesses, thereby impacting insurance companies through their investments and policy liabilities. Without stronger efforts to reduce emissions and policies like higher carbon prices, the physical impacts of climate will be even more extreme in future. Reducing emissions now will only reduce the severity/frequency of physical impacts from being even larger in coming decades. This is why our report focuses on transition risks.

Higher-than-expected claims can increase underwriting and liquidity risks and exert pressure on capital levels. However, as most of insurance contracts in non-life are underwritten on an annual basis, this allows insurers to adjust terms and conditions and product offering to address the impact of climate change on their key liability portfolios that are exposed to physical risk.

2. Transition risks stemming from:
    a. Changes in climate regulation and policies leading to a shift away from emission-intensive production and consumption;
    b. The emergence of disruptive and cost-competitive low-carbon technologies;
    c. Shifts in consumer/business sentiment and societal preferences.

On a short-to-medium term perspective, we expect transition risks and their effects on equities and credit to be the main contributors to increased risk for insurers. Carbon prices are one of the main transmission channels and is the focus for our analysis.

2.2 Asset owners' response to climate risks and opportunities

Multiple major insurance companies and pension funds are members of the Net Zero Asset Owner Alliance[5]. The members of the Alliance manage over USD 9.5 trillion.

The Alliance's 'Theory of Change'[6] is that asset owners have a unique and active role to address the climate crisis. Asset owners can influence incentive shifts and contribute to the transition to a sustainable, net zero economy through the actions shown in Figure 1.

No assurance can be given that any forecast, target, or opinion will materialize.
Forecasts are based on assumptions, estimates, views and or analyses, which might prove inaccurate or incorrect.

[5] Net Zero Asset Owner Alliance
[6] NZAOA April 2024. Target Setting Protocol – Background document

Figure 1: Potential climate actions by insurers and other asset owners

Capital allocation	Engagement / Stewardship
▪ Strategic Asset Allocation (SAA) ▪ Targets for climate solutions and decarbonisation ▪ Index/fund selection within an asset class ▪ Company/asset selection	▪ Asset manager engagement ▪ Corporate engagement ▪ Policy maker engagement

Source: DWS summary of NZAOA 2024

Regarding capital allocation, the Alliance states:

"*While portfolio decarbonisation approaches do not in and of themselves lead to emissions reduction in the real economy, the two efforts are linked. To meet long-term obligation of safeguarding investment portfolios, investors will ultimately reallocate capital towards investments with lower carbon intensities in consideration of long-term portfolio risk-return optimisation (and may also invest in high-emitting industries to decarbonise them). In doing so, investors make capital available for the kind of new and promising low-carbon business models that are needed for the transformation of the economy [...].*

However, investment in transitioning companies may result in increased portfolio emissions in the short term [...] the likelihood of allocation strategies alone contributing to emissions reductions in the real economy remains uncertain as the empirical evidence is still limited[7]*. Thus, the Alliance places significant emphasis on engagement [...]*"

Separate DWS research reports have been published on liability-aware Strategic Asset Allocation (SAA)[8] and ESG in SAA[9].

Regarding engagement, the Alliance published expectations for asset managers on proxy voting, public policy engagement, engagement best practices and private markets. These expectations are summarised in a one-page call to action: "*Serving asset owner clients is only possible through climate stewardship*"[10].

Even if an insurance company is not (yet) a member of the Alliance, the Engagement and Stewardship guidance could be used in different ways.

The rest of our paper supports investor consideration of analysing carbon price risk on equity indices and how changing indices could provide potential downside risk mitigation.

[7] NZAOA 2023. "Understanding the drivers of investment portfolio decarbonisation"
[8] DWS May 2024. "Liability-aware Strategic Asset Allocation"
[9] DWS July 2023. "ESG in Strategic Asset Allocation: The 2023 Update"
[10] NZAOA February 2024. "Serving Asset Owner Clients through Climate Stewardship: a call to action to the asset management industry"

3 / Official climate scenarios may underestimate materiality of climate risks

Regulators' climate stress tests generally show small impacts on insurers, but professional actuaries have issued a 'Risk Alert' about the suitability of current climate scenarios[11]

The financial regulators and central bank members of the Network for Greening the Financial Sector (NGFS) have developed official climate scenarios[12] which are increasingly used by financial institutions and regulators to examine portfolio level and financial system climate risk resilience[13].

The European Central Bank (ECB) and the European Systemic Risk Board (ESRB) concluded[14] that climate risks may have limited impact on insurers due to their diversified portfolios and small proportion of carbon-intensive holdings (~3.1% of the insurer portfolios, excluding real estate and agriculture).

The International Association of Insurance Supervisors (IAIS) estimates[15] that ~35% of global insurers' investments are in climate-risk sensitive industries, including real estate and agriculture. IAIS reports that a disorderly transition scenario[16] could lead to financial losses of ~1% of total assets (similar to the ECB and ESRB findings) and that insurers' capital reserves should provide sufficient protection.

However, the French insurance supervisory authority concluded[17] that the most disorderly NGFS scenario, does not appear sufficiently negative to prompt strategic changes or adequate awareness among insurers. The potential impact of climate change on financial stability is underestimated.

The Institute and Faculty of Actuaries (IFoA) is the UK's professional body for educating and regulating 32,000+ actuaries in the UK and internationally. A 2023 report in cooperation with climate scientists critically examined scenario models. They concluded that climate scenarios "*model the Titanic hitting an iceberg but exclude the possibility that the ship could sink*"[18]

A diagram in the Appendix 1 summarises the limitations of climate scenarios.

The NGFS is working to develop shorter term scenarios that may incorporate some of these criticisms.

[11] IFoA, June 2024. IFoA "Risk Alert on climate change scenario analysis"
[12] NGFS 2024 "Climate Scenarios portal"
[13] FSB and NGFS, 2022. "Climate scenario analysis by jurisdictions"
[14] ECB and ESRB, July 2021. "Climate-related risk financial stability report"
[15] IAIS Global Insurance Market Report, September 2021. The impact of climate change on the financial stability of the insurance sector
[16] A disorderly scenario assumes that climate policies are not introduced quickly enough to minimise macroeconomic disruptions. As a result of late action, emissions reductions need to be sharper and more sudden or, alternatively, exhibit costly heterogeneity across sectors increasing the overall costs associated with the transition.
[17] ACPR May 2024. Main results of the climate exercise for the insurance sector
[18] IFoA, July 2023. "Emperor's New Climate Scenarios – a warning for financial services"

4 / Equity risk & carbon prices: The results

Analysing risks from higher carbon prices

4.1 Short-term carbon risk scenario

The use of climate scenario analysis has become widespread, but in our view there remains a notable deficiency in short-term scenarios that evaluate immediate risks, economic volatility, and potential systemic vulnerabilities. Recently, the demand for short-term scenarios in climate analysis has increased as financial institutions recognize the necessity of integrating climate commitments into their short-term strategic planning and addressing imminent climate risks. Despite this, most existing climate scenarios focus on long-term perspectives for exploring climate risks, with few addressing short-term considerations. Appendix 2 in our paper summarises carbon pricing policy developments globally.

In July 2024, the United Nations Environment Programme Finance Initiative (UNEP FI) and the National Institute of Economic Social Research released a report[19] aimed at closing the gap in climate scenario analysis by identifying short-term scenario narratives for financial use. This report serves as a guide to help financial institutions comprehend the implications and drivers of various short-term scenarios.

We have chosen to consider the transition risk shock detailed in the report, where the narrative involves the abrupt implementation of government policies, leading to a significant increase in the carbon price. Carbon pricing places a cost on greenhouse gas emissions, either through a carbon tax or cap-and-trade system, to encourage reductions. It is slowly expanding globally and raises costs for companies emitting high levels of carbon, measured either by scope 1 emissions (direct emissions from company-owned sources) or scope 1+2 (which also included indirect emissions from purchased energy). Carbon price is typically measured in cost per ton of CO_2 equivalent, with prices varying based on region and policy.

The narrative for the transition risk shock in the report entails that the carbon price gradually rises over five years, reaching an average of about USD 325/tCO_2 by 2027 in advanced economies. This carbon price shock is predicated on a coordinated global policy effort to combat climate change.

Accordingly, we will assume a carbon price level of USD 300/tCO_2 across all countries to assess its impact on the equity value of traditional and ESG indices. In the following section, we will describe how higher carbon prices can affect global companies' equity value using our proprietary CROCI analysis. We examine the results by assuming a carbon price of USD 150/tCO_2, and then USD 300/tCO_2.

4.2 CROCI equity analysis: a "genuine" comparability of companies

We aim at estimating the potential decline in the equity value of various traditional and ESG equity indices following an increase in the carbon price. This estimation is conducted through our CROCI (Cash Return on Cash Invested) analysis.

CROCI is a proprietary equity valuation model of DWS and around EUR 6bn of assets follow its CROCI investment strategies The CROCI model was created in 1996 in the context of equity research with the main objective of analysing and calculating a meaningful and comparable return on capital and price/earnings ratios for each stock under coverage.

[19] UNEP FI July 2024 "Scenarios for assessing climate related risks: new short-term scenario narratives"

Dedicated sector analysts perform deep due diligence on each stock to reach the genuine economic asset base and cash flows that reflect the company's specific business models and its economic situation, starting from the pro-forma financial statements of each company. The approach follows a set of rules designed to ensure consistency of company analysis, regardless of their sector or country[20].

CROCI covers 885 companies globally (or 830 excluding financials and real estate sectors) allowing a significant representation of the main regional market indices ex financials & real estate, globally and at sector level (above 75% of each relevant benchmark's market capitalisation). For most of those 885 companies there are more than twenty years of historical financial metrics including cash return and valuation ratios, as well as two years of forecasts derived from the consensus of analysts' estimates.

Over the last five years, CROCI has assessed the best approach and methodology for integrating various ESG aspects into companies' financials and valuation, contributing to DWS research. Recent publications by the CROCI team include reports on "*Carbon allowances and financial accounts*"[21] and "*Price of climate risk*"[22] (which is summarised in the next section).

4.3 Are equity markets pricing climate risk?

We see no evidence of an increase in equity climate risk premia over the last two years

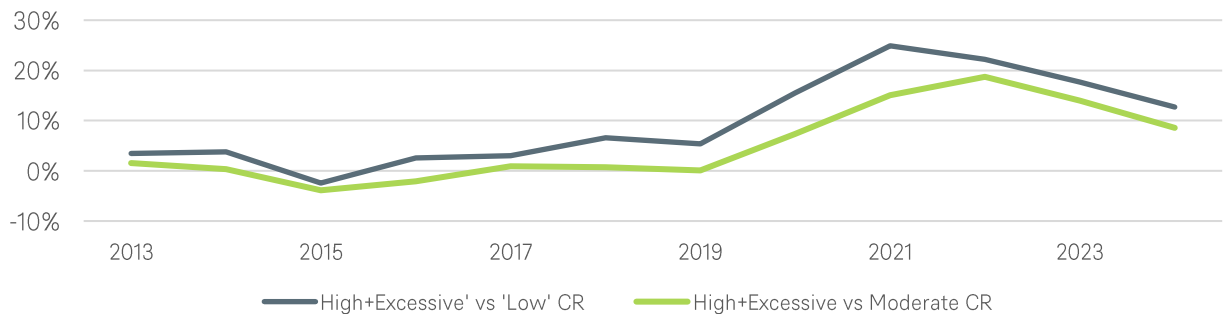
In addition to the limitations of climate scenarios, a parallel DWS CROCI report[23] examined whether equity values have been pricing climate risks. In summary, we concluded that the willingness or capacity of equity investors to anticipate and integrate climate risks in stock prices is not linear.

With every missed emission reduction target, the consequences of the climate transition become even higher. It is inevitable that humanity accelerates its efforts to cut emissions. In the meantime, investors tend to price risks as they are perceived and as they materialise.

Figure 2 shows the discount in valuation multiple of companies with high/excessive climate transition risk compared to the valuation multiple of companies with low and moderate transition risk.

This discount increased from 3% in 2013 to 13% in 2024E. The current discount is close to the ten-year average, though it has receded from its peak of 25% in 2021, 22% in 2022 and 18% in 2023.

Figure 2: Discount in the median economic P/E of the 'High & Excessive' vs 'Low' and 'Moderate' climate risk categories



Source: DWS CROCI June 2024 The Price of Climate Risk

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[20] https://www.dws.com/capabilities/active-investments/croci/
[21] DWS, April 2023; "Carbon Allowances and Financial Accounts: CROCI's approach and the need for an international accounting standard"
[22] DWS, June 2024. "The Price of Climate Risk"
[23] DWS CROCI, June 2024 "The Price of Climate Risk"

4.4 Equity value sensitivity to higher carbon prices

The CROCI database is also used to perform sensitivity analysis on companies' profitability and valuation based on various external or internal ESG related shocks. These include the strengthening of a carbon framework where companies will increasingly have to pay for some or all their carbon emissions.

Concretely, the CROCI team calculates the cost that companies would bear if paying for their Scope 1+2 carbon emissions at a certain carbon price ranging from USD 150/tCO_2 to USD 300/tCO_2 and the impact of this cost on their operating cash flow, cash return and ultimately fundamental value.

The valuation of equities is measured by the Economic P/E, which is defined in Figure 3, along with two other key metrics that we will use subsequently.

Figure 3: CROCI metrics

CROCI Economic P/E	Calculated as (EV/NCI) / CROCI, Economic P/E is a measure of valuation, calculated according to the CROCI methodology, that seeks to allow a fair comparison of the market valuation of companies regardless of industry or sector
CROCI EV/ NCI	Used as the economic version of an asset multiple, e.g. Price-to-Book Value. Over time, this ratio should converge to 1x, according to economic theory (Tobin) — CROCI Enterprise Value (EV) A measure of the market value of the firm, which includes not only financial liabilities (eg debt) but also operational liabilities (e.g. warranties, pension funding, specific provisions, etc.) — CROCI Net Capital Invested (NCI) An approximation of the replacement value (at current costs) of net assets
CROCI	Cash Return On Capital Invested, the economic version of Return on Equity. A measure of cash earnings yield, standardised for all companies, regardless of their business or location. Also described as the Cash IRR

Source: DWS CROCI analysis

The selected equity indices included in our CROCI analysis are as follows:

- **Traditional Equity Indices:** MSCI World, Europe, and USA
- ESG Equity Indices:
  - **MSCI Low Carbon SRI Leaders:** World, Europe, and USA versions of this index
  - **Paris Aligned Benchmark (PAB):** Developed Markets, Europe, and US version of Solactive ISS ESG Net Zero Pathway
  - **Climate Transition Benchmark (CTB):** World, Europe & USA versions of MSCI Select Sustainability Screened CTB.

To start with, the proportion of companies covered by the CROCI analysis is verified (defined as the "coverage ratio") at the level of equity benchmark indices, followed by the sectors that comprise these indices. The coverage ratio ranges between 69% and 78% for traditional equity indices as shown in Figure 4. This is primarily due to low CROCI coverage in the Financials' sector and the absence of

coverage in the Real Estate sector. Therefore, these two sectors will be excluded from our carbon price sensitivity analysis. For the other sectors, the coverage ratio is satisfactory, averaging around 85%.

Figure 4: CROCI Coverage ratio for our analysis

CROCI Coverage	MSCI World	MSCI Europe	MSCI USA	Low carbon World	Low carbon Europe	Low carbon USA	PAB World	PAB Europe	PAB USA	CTB World	CTB Europe	CTB USA
Total	73%	69%	78%	72%	62%	78%	67%	63%	76%	67%	63%	74%
Excluding Financials and Real Estate	85%	85%	88%	83%	79%	87%	81%	79%	88%	83%	81%	87%

Source: DWS CROCI analysis 2024.

For the ESG indices, we observe slightly lower coverage compared to traditional indices, with a difference of up to 6 percentage points. Nevertheless, the coverage remains satisfactory in absolute terms. The same observation applies at the sectoral level.

Furthermore, the overall consistency in coverage ratios across indices from the same region or sector appears to be adequate. As a result, the conclusions we may later draw from our CROCI analysis will not be skewed by similar index-level coverage ratios that could have masked significant disparities at the sectoral level.

In Figure 5, we show the sensitivity for the world equity indices in scope (MSCI World, Low Carbon, PAB and CTB) to a global carbon cost of USD 150/tCO_2. This assumption corresponds to a 2030 price forecasted by BloombergNEF[24].

For the sake of simplification, we assume a spot impact: we 'tax' Scope 1+2 CO_2 emissions and analyse the financial data of the underlying companies (as of September 17th, 2024). The long-term direction of the carbon price will depend on the speed and cost of decarbonising industry. For instance, technologies to capture and permanently store carbon underground, become viable at USD 150/tCO_2+.

In the absence of government intervention companies face a choice of:

1) increasing capex for the transition to lower carbon intensity of their operating models;

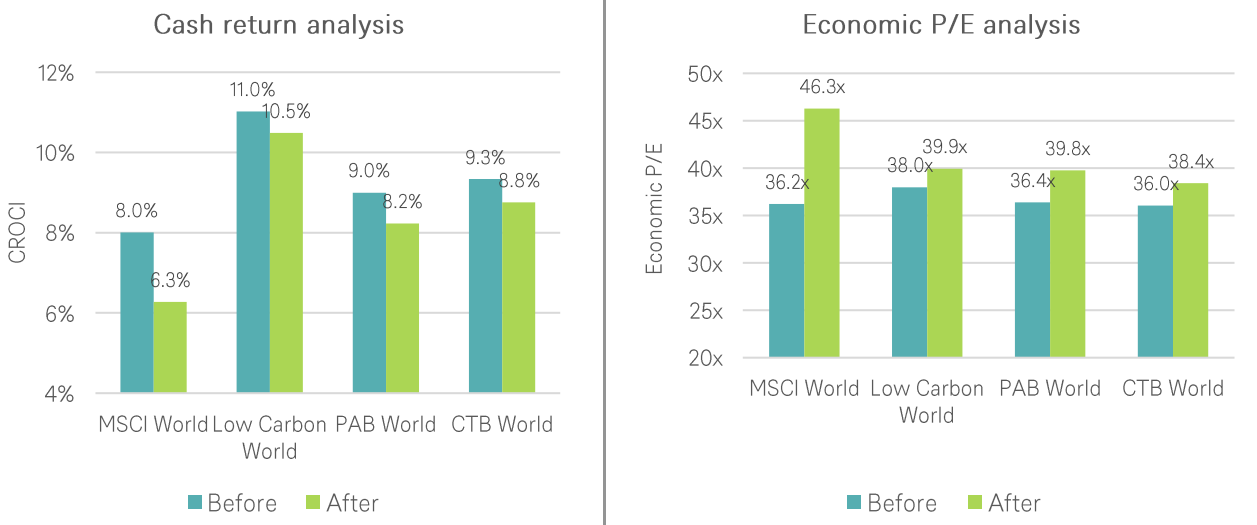
2) internalising higher carbon costs (which could be significantly detrimental to profitability);

3) passing on a large chunk of rising carbon costs to the end customer (which would put structural pressure on inflation).

While it is too early to predict which mix of these three responses will happen on balance, all three channels would put further pressure on already high market equity values: (1) & (2) through lower profitability, (3) through potentially higher interest rates and higher risk premia.

[24] BloombergNEF 2024 "Carbon market outlook"

Figure 5: Carbon price sensitivity analysis with USD150/tCO_2 carbon price



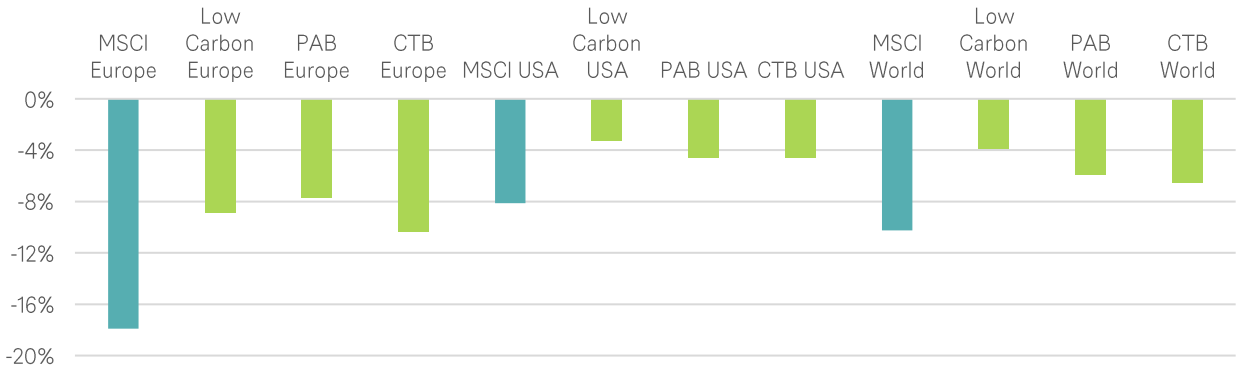
Source: DWS CROCI analysis as of September, 17th 2024

Based on the cash return and Economic Earnings[25] of individual companies after the carbon price shock, we can estimate the likely decline in their respective equity value assuming their valuation ratio would return to the equilibrium level, which we assume to be the Economic P/E level before the shock.

We observe a stronger resilience of the ESG indices compared to the MSCI World in the event of a market normalization.

Figure 6 shows the potential equity market value loss across the different indices in the USD 150/tCO_2 scenario. In other words, in a capital preservation perspective, it seems increasingly attractive to shift equity exposure to ESG indices as the carbon price rises. Indeed, the Economic P/E increases by +10x for the traditional index compared to +2x to +3x for the ESG indices.

Figure 6: Estimated loss in equity market value under a USD 150/tCO_2 carbon price scenario – by regions



Source: DWS CROCI analysis as of September, 17th 2024

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[25] In CROCI, Economic Earnings = CROCI x Net Capital Invested

4.5 The higher carbon price scenario

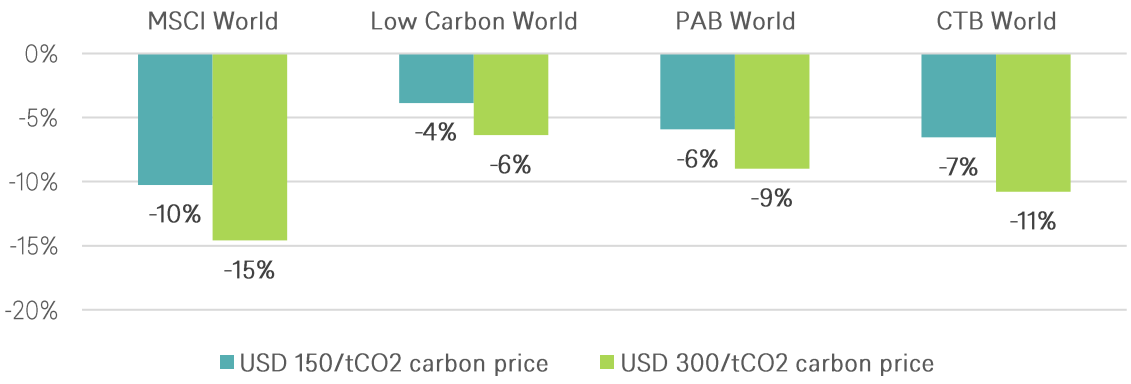
In the event of a significant increase in the carbon price to USD 300/tCO_2 (which experts from the United Nations suggest could happen as early as 2027), the decline in the MSCI World could be very pronounced (-15%) in a return-to-equilibrium scenario; considering we 'tax' only Scope 1+2 CO_2 emissions (requiring companies to buy carbon allowances) and only consider direct impact on companies, excluding indirect impact on the global economy and any feedback loops. Figure 7 shows the gap between the MSCI World index and its ESG counterparts ranges from +4% to +9%.

This confirms that as the carbon price increases, the equity value of traditional indices is at greater risk compared to ESG indices.

While such a scenario may seem far from current reality, the fact is that the planet is heating faster than scientists previously predicted and that this is likely to strengthen physical climate impacts. We believe it is inevitable that policymakers will respond – the question is the timing.

Appendix 2 summarises carbon pricing policy developments in countries around the world.

Figure 7: Estimated loss in equity market value under a USD 150/tCO_2 and a USD 300/tCO_2 carbon price scenario



Source: DWS CROCI analysis as of September, 17th 2024

4.5 Sector sensitivity to a carbon price scenario

The differences in exposure to the various sectors primarily explain the differences in the potential loss in the indices' equity market value under the carbon price stress test. For example, the Low Carbon Transition and Paris Aligned Benchmark indices have no Energy sector securities by design.

In some other sectors like Utilities and Materials, the various global indices have roughly the same weights, as shown in Figure 8. But the specific exposure to individual securities mainly explains the differences in sensitivity of the respective indexes market value to the carbon price scenario.

Figure 8: World indices sector breakdown by value in %

Portfolio \ Sector	Communication	Consumer Discretionary	Consumer Staples	Energy	Financials	Health Care	Industrials	Information Technology	Materials	Real Estate	Utilities
MSCI World	8%	10%	7%	4%	15%	12%	11%	24%	4%	2%	3%
Low Carbon World	10%	10%	3%	0%	17%	14%	10%	30%	3%	2%	1%
PAB World	9%	8%	7%	0%	15%	15%	8%	29%	4%	4%	1%
CTB World	8%	10%	5%	3%	17%	13%	11%	25%	3%	4%	2%

Source: DWS CROCI analysis as of September 17th 2024

It should be noted that we assumed unchanged business models. Companies are likely to seek to adapt to the transition. Therefore, the modelled market cap declines should be viewed with caution, particularly for sectors expected to be most affected by the cost of the transition. Nevertheless, the ranking should remain, with more pronounced declines in carbon-intensive sectors compared to others.

We note that Scope 1 and 2 emissions of publicly listed companies cover an estimated 40% of global emissions[26]. In a world of rising carbon prices for listed companies, climate policies will affect the entire economy. Therefore, the cost of climate policies in the rest of the economy could be passed on to listed companies such as through their supply chains.

[26] Generation Investment Management 2021. "Listed companies account for 40% of climate warming emissions"

5 / Conclusion: potentially protecting downside risk thanks to ESG indices

This paper has laid the foundation by focusing on the value of equities under a more severe climate scenario, deriving a carbon price, and assessing its impact on global equity value.

The impact of a higher carbon price on company equity value appears significant, ranging from -10% to -15% for the MSCI World index, with a carbon price of USD 150/tCO_2 and USD 300/tCO_2. While this impact is consistently negative, it is less pronounced on ESG indices, which could potentially encourage investors, particularly in Europe, to consider shifting their exposure from traditional indices to ESG indices seeking additional potential for risk mitigation. Figure 9 shows the potential downside risk mitigation in market value.

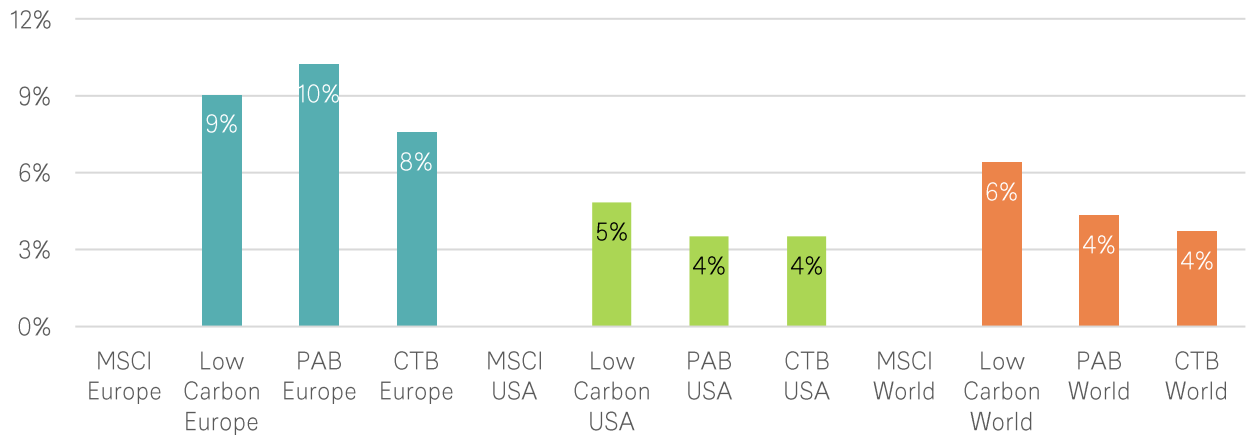
Another approach to hedge against carbon price risk is to consider investing in carbon allowances, a strategy which we explored in our report[27] "*Investing in carbon: a new asset class*".

Our approach to evaluating climate transition risks at the sector level, through CROCI analysis, could be leveraged within the ORSA framework in anticipation of the Solvency II reform, which is expected to require a deeper analysis of the transition's impact on insurers' balance sheets and business models.

We also note that nature and biodiversity are increasingly seen as a critical part of climate analysis and investing. DWS is publishing a series of reports on biodiversity and natural systems like freshwater[28].

As an extension of this analysis, we plan to delve deeper into the broader implications of this adverse scenario. It will extend the analysis to fixed income and strive to measure the consequences of such a scenario on the balance sheet and solvency of insurers. This future research aims to provide a comprehensive view of the financial stability challenges faced by insurers in the context of a climate transition and to offer further guidance on mitigating these risks.

Figure 9: Shifting to ESG indices could provide potential downside risk mitigation (USD 150/tCO_2 carbon price scenario)



Source: DWS CROCI analysis, data as of September 17, 2024

[27] DWS Research Institute, December 2023. "Investing in carbon: a new asset class"
[28] DWS Research Institute April 2024. "Why companies are waking up to nature's value"; DWS Research Institute December 2023 "Nature-focused regulations start to get serious"

Appendix 1 – Limitations of climate scenarios

Key limitations of official climate scenarios

Disconnect between economic and climate science models	▪ Positive and negative climate tipping points, sea level rise and involuntary mass migration are largely excluded from climate economic models ▪ Some economic models implausibly show that extreme climate impacts would be economically positive
Climate impacts could be higher than anticipated	▪ Scientists may have underestimated how quickly the planet will heat with the current level of emissions. The rate of heating accelerated in 2023 and scientists are not yet sure of the cause ▪ Faster global heating will result in more severe/acute physical impacts ▪ Carbon budgets to keep global temperatures from exceeding Paris Agreement goals, would therefore be much smaller - faster emission reductions (and thus stronger policies) will be needed
Risk of 'group think' regarding climate scenarios	▪ Key model limitations, judgements and assumptions are not widely understood ▪ Risk of undue reliance on models results that show relatively benign climate impacts on financial institutions

Source: DWS analysis of IFoA 2023 and IFoA 2024

A follow-up 2024 report[29], "*Climate Scorpion: the sting is in the tail*" analyses the latest climate science (global temperatures increasing at a faster rate than scientists have anticipated) and the relevance to actuaries. This report is also relevant to insurers.

Appendix 2 - Developments in carbon pricing policies

Since 2005, emissions in industries covered by the EU Emissions Trading Scheme (ETS) have declined by close to fifty percent. Currently, 40% of the greenhouse gas emissions in Europe are covered by the EU ETS.[30] Companies regulated by the EU ETS are on track to achieve the 2030 target of a 62% percent reduction, showing the effectiveness of the emissions cap.[31] With the planned expansion of the EU ETS to other industries like shipping, road transportation, and buildings, the coverage is expected to increase to 75%. Prior DWS reports examined carbon pricing and the ETS in depth.[32]

While EU ETS sector coverage is increasing, the financial impact is currently limited given the free allocation of allowances for many industrial sectors. However, the total number of allowances in circulation will be reduced by a so-called "linear reduction factor". The EU agreed that the linear reduction factor will be increased (i.e., available allowances will be reduced) from the current 2.2% to 4.3% for the period 2024-2027 and to 4.4% for the period 2028-2030. The EU will also gradually phase out free emission allowances and phase in the Carbon Border Adjustment Mechanism (CBAM) between 2026 and 2034 for the sectors in scope.

Globally, 24% of global emissions across 40 countries are covered by a carbon tax and/or a regulated carbon market, which is an increase from 2005 when only 5% of emissions faced a price on carbon. However, only 1% of emissions (primarily in Europe) face a carbon price that is high enough to encourage change by companies[33].

[29] IFoA March 2024 "Climate Scorpion: the sting is in the tail"
[30] DWS, April 2023; "Carbon Allowances and Financial Accounts: CROCI's approach and the need for an international accounting standard"
[31] European Commission, April 2024. "Record reduction of 2023 ETS emissions due largely to boost to renewable energy"
[32] DWS, Dec 2023; "Investing in carbon: a new asset class"
[33] World Bank May 2023 State and Trends of Carbon Pricing

Starting in 2026, the EU's CBAM will force imports of select Iron, Steel, Aluminium, Cement, Fertilisers, Hydrogen, and Electricity to pay the EU's carbon price for their embedded emissions. The carbon border tax is encouraging more governments to strengthen or create carbon pricing policies, such as Australia, Brazil, China, India, Indonesia, Taiwan, Turkey, UK, and Vietnam[34]. Carbon border taxes are also proposed in the U.S. by some Republicans and Democrats.

For the sake of simplicity (and to provide a longer-term view of the impact) we assume a similar ETS framework which covers 100% of GHG emissions of companies which are constituents of the four market indices and part of the CROCI universe as a starting point for unravelling the potential impact of carbon prices on the underlying cash returns, especially should companies not be able to pass on carbon costs to the end customers.

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[34] HSBC (October 2023) European Green Deal: CBAM country and sector impacts start to emerge.

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Notes on Carbon Terms:
Carbon Neutrality: the point in time when the net emissions of carbon are balanced by net removals. So, ultimately, either an entity or the planet as a whole has net carbon emissions. But that's only referencing one greenhouse gas, carbon dioxide.

Net Zero: it extends it to look at all types of greenhouse gases. So, that is beyond simply carbon dioxide, but also then into emissions like methane, nitrous oxide, which are very important emissions from, like, the food and land sector, for example. So, Net Zero is the more encompassing term.

Decarbonization: Any mechanism that we can do to prevent the release of carbon into the atmosphere. So, essentially what we talk about with company decarbonization is what the actions companies are taking to prevent and reduce their emissions.

Scope 1 and 2: refer to the emissions that are directly from their operations, either through direct emission sources or through the electricity that they purchase to run their manufacturing sites, for example.

Scope 3: actually looks beyond the business boundaries into their supply chain. So, their upstream supply chains and also the downstream use phase and waste management of the products they produce.

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