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Allianz Research

Long-run capital market returns in times of climate change

Lessons from the American playbook

Executive Summary

Bjoern Griesbach
Senior Investment Strategist &
Eurozone Economist
bjoern.griesbach@allianz.com

Pablo Espinosa Uriel
Investment Strategist, Emerging
Markets & Alternative Assets
pablo.espinosa-uriel@allianz.com

Jordi Basco Carrera
Lead Investment Strategist
jordi.basco_carrera@allianz.com

- **The materialization of physical climate risks is driving up disaster-related costs, which will ultimately translate into increased economic volatility, higher average inflation and lower real growth. What will this mean for investors?** In this report, we try to answer the three biggest questions by looking at US markets. First, through which channels will climate change affect your portfolio? Second, what will it mean for expected returns in different asset classes? Third, how do correlations and volatility expectations affect the optimal composition of your portfolio? The inputs for our financial analysis are drawn from the "Below 2°C" and "Current Policies" scenarios from NGFS[1], with the latter "Hot House" scenario having more severe outcomes on the economy and financial markets. Both scenarios also take into account other structural trends in particular the demographic slow-down.

- **Interest rates are set to fall and even become negative in real terms in the 2040s.** Long-term interest rates are projected to decline, averaging around 2.5% until 2050 with only minor differences across different climate scenarios. Higher inflation will gradually push real yields into negative territory reaching -0.5% (Below 2°C) and -0.7% (Current Policies), respectively, by 2050.

- **Equity investors will face a future of higher risks and lower returns amid rising risk premia and lower dividend growth.** Investors are likely to discount future returns at a higher rate due to increased physical and transition risks, which would compound the slowdown of economic growth. Annual total equity returns are set to fall on average to 5.4% until 2050 (Below 2°C) and 4.7% (Current Policies), yielding still slightly positive real returns at the end of the forecast horizon. In the credit space we expect spreads to widen to 140bps in the Below 2°C scenario and to 170bps in the Current Policies scenario by 2050.

- **From 60/40 to 40/60 – the optimal portfolio allocation could shift in the future.** An increase in negative supply shocks amid climate change will reduce the effectiveness of bonds as a hedge against equity volatility while at the same time reducing the risk-return profile of equities. Optimizing risk-adjusted returns would call for more bond-heavy portfolios. Nevertheless, the average projected total returns of such a portfolio until 2050 will drop to around 4.1% (Below 2°C) or 3.8% (Current Policies) compared to the 10.4% returns of the past, while volatility is increasing.

- **25% higher equity prices in 2050 – the reward for keeping temperature rise Below 2°C.** On top of all the other positive effects, prioritizing the fight against climate change would also pay off financially. In this context, it is essential to raise awareness and prepare monetary policy accordingly. Institutional investors will need to adjust their strategies to account for lower returns and higher volatility both in their portfolios but also in their communication to customers – in particular to future pensioners.

[1] Network for Greening the Financial System

The structural challenges for financial markets

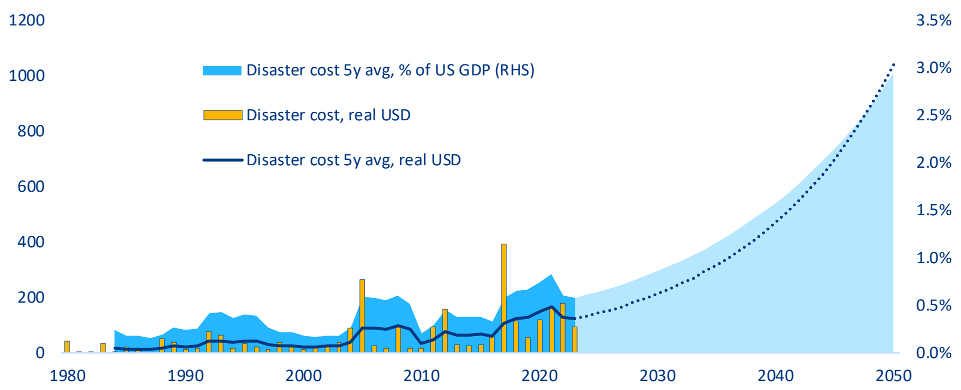
Climate change needs to be incorporated not only in macroeconomic outlooks but also in financial market forecasts. Not long ago, we looked into how the 5Ds – i.e. demographics, decarbonization, deglobalization, debt and digitalization – will structurally affect inflation in particular, and the whole macro-financial landscape in general[2]. In this report, we focus on the implications for capital markets and at the same time broaden our view on different aspects of climate change. We do not only look at decarbonization but also at the increasingly tangible physical risks posed by climate change. We aim to answer the three most relevant questions for asset owners. First, through which channels will climate change affect your portfolio? Second, what will it mean for expected returns in different asset classes? Third, how do correlations and volatility expectations affect the optimal composition of your portfolio?

Physical climate risks are already materializing, with disaster costs from storms, floods and droughts rising strongly. Climate change typically affects the macro-financial outlook through two channels: physical risks and transition risks. Physical risks emerge due to the tangible impacts of climate change, such as extreme weather events, rising sea levels and natural disasters, which can directly damage assets and disrupt operations. Physical risks have become increasingly evident especially after recent climate anomalies surprised even pessimistic climate change forecasters.[3] This trend translates into rising physical damages. The five-year rolling average real cost of US climate disaster events has amounted to more than USD120bn per year in 2023 (equivalent to around 0.5% of GDP or 0.2% of the fixed capital stock) and is rising by +8.2% per year on a 20-year average. Extrapolating these losses would lead to a significant destruction on a macro level, affecting

[2] See our report: The five Ds of structurally higher inflation
[3] The world is warming faster than scientists expected (ft.com)

economic output each year. By 2050, the annual costs would rise to more than USD1trn in today's prices (Figure 1). If homes, factories, bridges and other parts of the fixed capital stock used for economic production are destroyed at this rate, potential output would significantly decelerate.

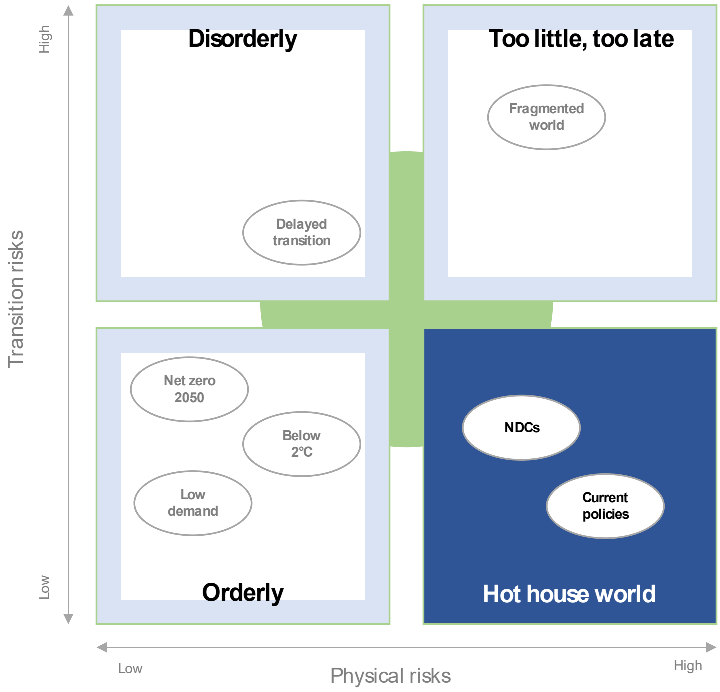
Figure 1: US climate disaster costs extrapolated with 20y historic growth rate



Sources: NOAA, Oxford Economics, LSEG Datastream, Allianz Research
Note: The forecasted values for % of GDP are based on the baseline long-term Oxford Economic US growth forecast averaging +1.8% until 2050.

Physical risks or transition risks or both? Besides the materialization of physical risks, there are downside effects on growth stemming from transition risks towards mitigating climate change. Transition risks arise from the shift towards a low-carbon economy, encompassing regulatory changes, carbon taxes, technological advancements and shifting consumer preferences. These risks can lead to asset devaluation, increased operational costs or stranded assets. For example, if countries impose a carbon tax to incentivize the reduction of carbon emissions, this would at least temporarily move an economy from the current optimal equilibrium to a sub-optimal, lower growth setting. The Network for Greening the Financial System (NGFS) structured potential future outcomes with respect to climate change in a transition vs. physical risk matrix (Figure 2). If for example governments globally do not speed up the fight against climate change and stick to "Current Policies" this would keep transition risks rather low but therefore we would steer towards a hot house world with large physical risks. Contrary, if governments increase their efforts in order to keep temperatures "Below 2°C" we would have less physical risks but higher transition risks. The later these ambitions kick in, the higher will be the transition risks, as indicated by the "Delayed Transition" scenario.

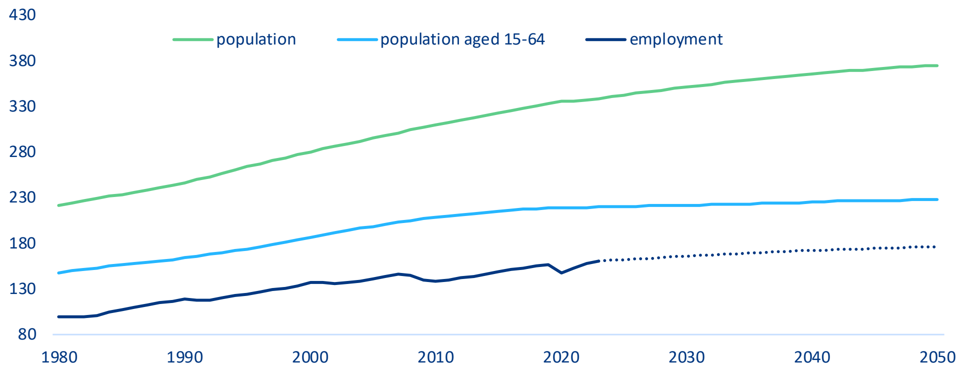
Figure 2: NGFS climate scenarios



Source: https://www.ngfs.net/ngfs-scenarios-portal/

Next to climate change, other structural trends impacting long-term economic and financial outlooks must not be forgotten with the demographic slow-down still the most dominant one. Next to physical and transition risks from climate change, declining population growth remains among the key drivers of slowing economic growth in the years to come. Figure 3 shows that since 1980 the US working-age population (aged 15-65) has risen from less than 150mn to 220mn today – an average growth of +0.9% per year. Going forward, the working-age population is set to stagnate. The growth boost of almost 1pp from the past will therefore be no longer applicable to the future as more people produce more output and vice versa. There are some structural changes that might dampen that effect, such as people working longer in their life times or more women entering the labor force, but they might only be able to soften the dynamic, not stop it altogether.

Figure 3: NGFS climate scenarios



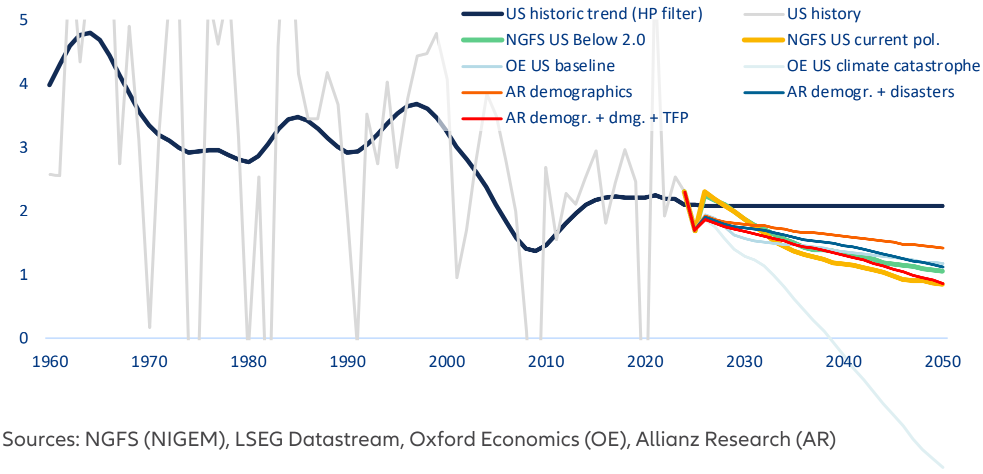
Sources: UN population database, LSEG Datastream, Allianz Research
Note: Employment forecast is estimated based on the working-age population and a rising participation rate.

Digitalization and AI could compensate for the growth deceleration from climate change and demographics to a certain extent. Technological progress translating into higher total factor productivity and thereby growth has always been a key driver for potential growth. Whether Generative AI is another quantum step ahead in this spectrum remains to be seen. Goldman Sachs has been among the most optimistic, predicting in 2023 that Generative AI could increase global GDP by +7% and add 1.5% in annual productivity gains in the US over the next decade. However, they have recently backpedaled, admitting slower-than-expected AI adoption among firms.[4]

"Prediction is very difficult, especially if it's about the future". Agreeing with Niels Bohr, we use official NGFS long-term macro forecasts as an input to our capital market analysis. Predicting economic outcomes over a long time horizon is inherently difficult and even more so when the above mentioned structural changes with different severity are taken into account. Figure 4 shows historic and potential future growth paths for the US. Despite the large dispersion, all forecasts have in common that future growth is much lower than in the past. However the range is quite large, with growth becoming negative from 2039 in the climate catastrophe scenario of Oxford Economics to a constant +2.1% growth rate if we simply extrapolate recent trend growth forward. Judging which scenario is the most likely outcome goes beyond the scope of this analysis. We therefore base our capital market analysis on official NGFS forecasts, selecting two scenarios as an input: the "Below 2°C" scenario with medium transition risks and low physical risks and the "Current Policies" scenario with low transition risks but higher physical risks ahead. Notably, the latter is in line with our own proprietary potential growth model for the US, which takes into account rising physical damages laid out in Figure 1, demographic change in Figure 3 and an additional slowdown of total factor productivity, with each of these drivers contributing about a similar drag on growth.

[4] AI is showing "very positive" signs of eventually boosting GDP and productivity | Goldman Sachs

Figure 4: US GDP growth and selected forecasts, %

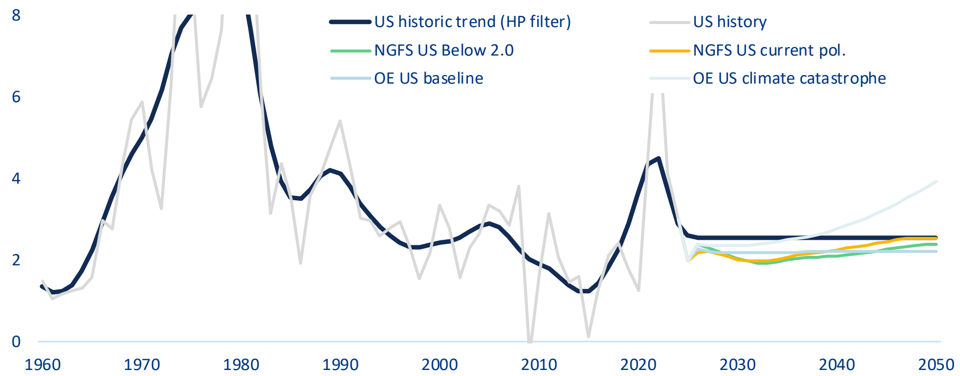


Sources: NGFS (NIGEM), LSEG Datastream, Oxford Economics (OE), Allianz Research (AR)

The US serves as a blueprint, but Europe or Asia could fare even worse. Geographically, we focus on the US in our analysis as it is a large economy whose capital markets are driven by domestic conditions and for which long historical time series data exist. The latter part is crucial in calibrating our models for long-run forecasts and is the main reason for us focusing on this market. From a qualitative perspective, Europe or Asia, would not look any better – potentially even the opposite. Demographic change is hitting Europe more forcefully than the US while climate change will impact Asia at least as a badly as the US. Moreover, positive structural shocks from technological advances have proven to be adapted most quickly in the US in the recent history.

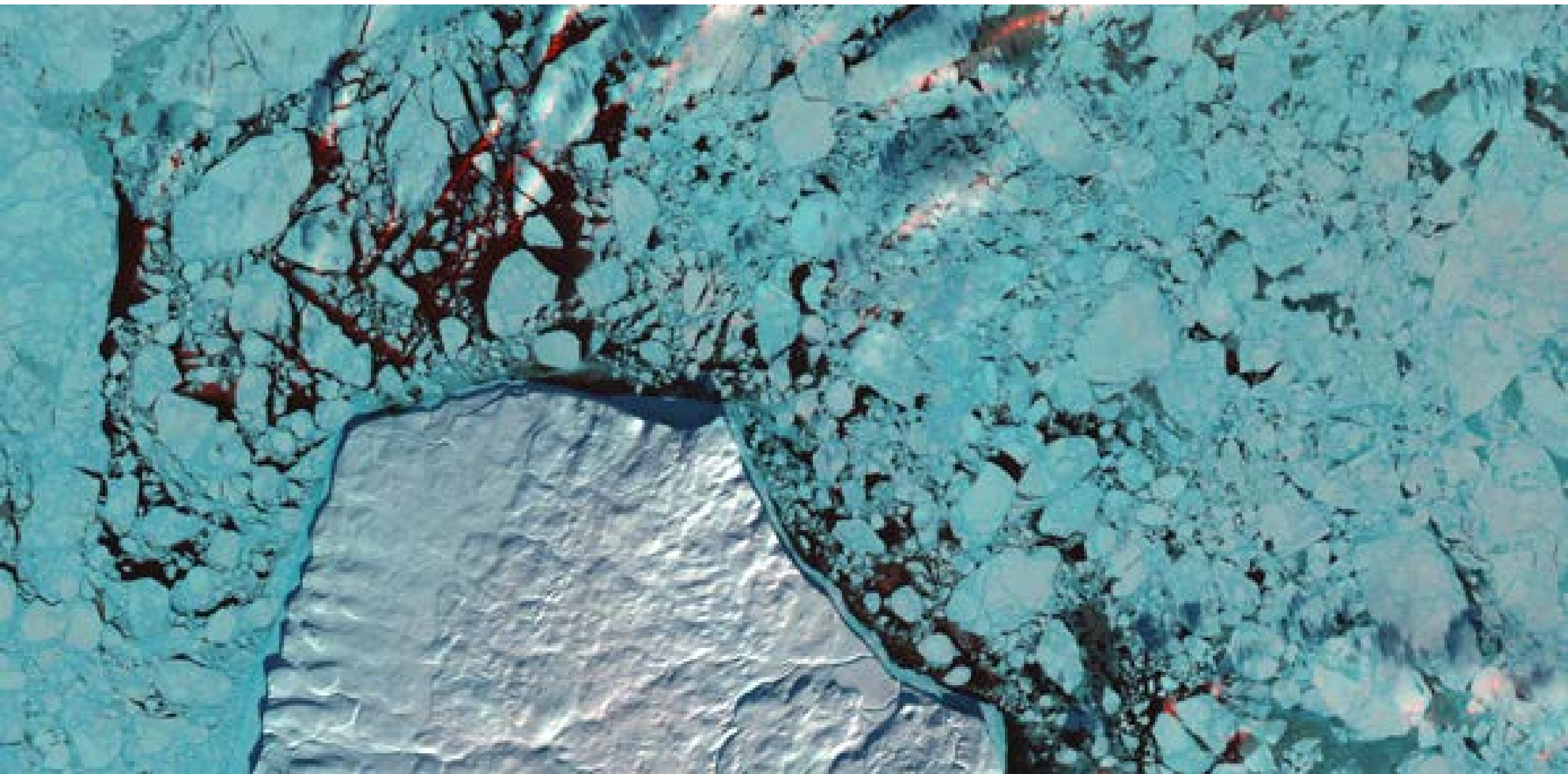
Physical climate risks will lead to an increase in negative supply-side economic shocks, contributing to higher macroeconomic volatility and higher inflation on average. Supply-side shocks often result in higher economic output volatility and higher inflation on average. Central banks can more easily cope with demand-side shocks by adjusting policy rates, thereby stimulating demand-side components like investment, consumption and net exports. Supply-side shocks typically result in a temporary spike in inflation as lower economic production increases price pressures when it meets unchanged demand. Also, supply shocks tend to last longer as by committing to price stability, central banks are by definition forced to slow down the demand side of the economy to bring demand and supply back into balance. Therefore, despite the structural downside drivers to inflation ahead, we anticipate higher inflation rates on average than the 2010s. For our capital market scenarios, we rely again on the official forecasts from NGFS that are in line with this view (Figure 5).

Figure 5: US inflation and selected forecasts, %



Sources: NGFS (NIGEM), LSEG Datastream, Oxford Economics (OE), Allianz Research

Our long-term outlook is not affected by any particular fiscal or monetary policy assumption. Long-term economic forecasts typically ignore demand stimulations (or restrictions) from central banks or governments as these are short-term demand drivers and do not impact structural trends or potential growth. Consequently, our asset performance expectations are not influenced by any particular assumption on quantitative easing or fiscal stimulus, for example. However, as noted, these policy tools will continue to be applied to mitigate cyclical fluctuations, which are likely to increase due to the additional volatility from the materializing physical risks of climate change.



Why we expect returns to halve through 2050

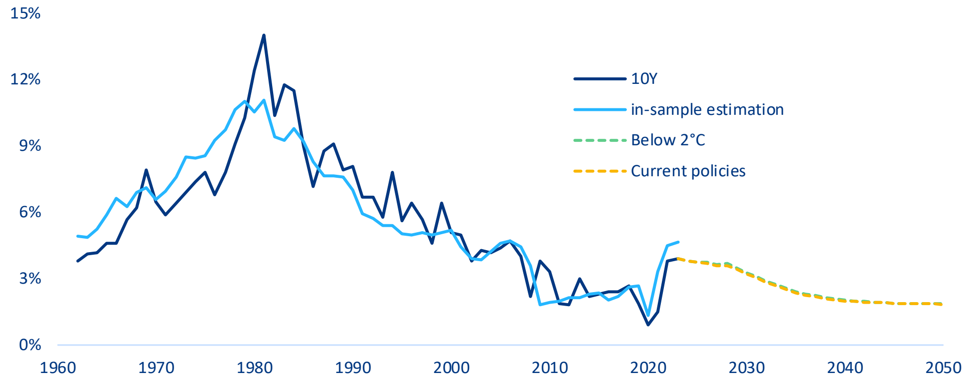
As the realities of climate change unfold with increasing intensity, it is indisputable that market returns will face profound disruptions. The economic consequences of climate change – as projected by the NGFS scenarios – will reverberate across global markets. Drawing on these scenarios, we model market returns with a focus on long-term impacts, extending our horizon to 2050. Given the broad trends and extended time frame, we will employ a simplified version of the models we typically use to calculate market returns. Additionally, for modelling US equity returns, we will assume a closed economy framework to isolate domestic impacts, acknowledging the limitations and caveats this approach entails. Overall, investors and institutions can no longer ignore the escalating risks to asset valuations, sectoral performance and overall market stability.

Interest rates are set for a decline, with minor differences in nominal terms among the climate scenarios. We apply a straightforward estimation technique for long-term rates based on nominal GDP growth – a technique widely accepted in the literature on long-term government bond-yield forecasting. Given the cointegrated relationship between yields and economic growth, we use a simplified version of Poghosyan (2014)[5] and find that $i=-0.03+1.3(g+p)$ where i denotes US 10y nominal yields, g real GDP growth and p inflation. Figure 6 shows the historic fit as well as the forecast based on the macro inputs from NGFS. It is apparent that the forecasts do not differ much on a nominal level as lower real growth is balanced out by higher inflation in the Current Policies scenario compared to the Below 2°C scenario. Nominal yields are set to gradually fall to 1.8% in the Current Policies and 1.9% in the Below 2°C scenario by 2050. Real yields, differ slightly more, reaching -0.7% compared to -0.5% in 2050 given the higher inflation rate in the Current Policies scenario. Total returns look slightly

[5] See Long-run and short-run determinants of sovereign bond yields in advanced economies - ScienceDirect

more promising. A straightforward approach suggests an additional average annual return of around 0.6pp until 2050 as the gradual decline in interest rates boosts bond prices and, consequently, their returns.[6] However, as the decline in yields slows toward the end of the forecast horizon, this additional benefit is expected to diminish by 2050. Overall, average annual total returns from investing in 10y government bonds are set to decline to 3.2% in nominal terms and 1.0% in real terms until 2050 in the "Below 2°C" scenario (Current Policies: 3.1% and 1.0%) – less than half the returns seen in previous decades.

Figure 6: 10y US rates forecast and history



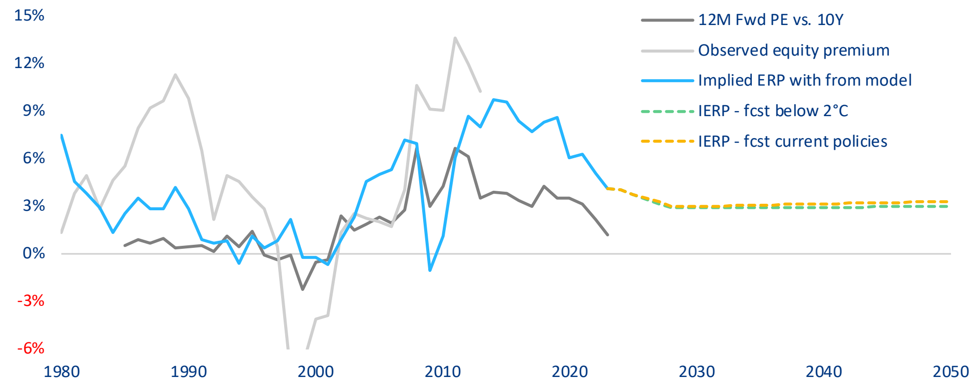
Sources: LSEG Datastream, Allianz Research

Investors are likely to discount future returns using a higher implied Equity Risk Premium (ERP) in a climate-adverse scenario due to both physical and transition risks moving forward. This premium reflects the additional returns required to compensate for the increased risks associated with equity investments over risk-free investments such as government bonds. The potential for more frequent and extreme weather events, regulatory shifts, evolving consumer preferences and direct physical impacts on businesses all contribute to a more volatile and uncertain investment landscape, prompting investors to seek higher returns. In such an environment, the implied ERP used to discount future returns is thus expected to rise as investors account for the added risks and uncertainties. In our version of the Gordon Growth model – explained more in detail later in the text – this effect amplifies the impact on current prices of decreasing dividend growth by further reducing the present value of future cash flows.

A higher implied ERP translates into a lower observed ERP. Precisely because a higher implied ERP constrains current pricing, and given that price returns have historically been a significant component of overall equity returns, we should not expect this to result in an observed equity premium that exceeds the historical average. In fact, in this context it is even more important to distinguish between the implied ERP and observed equity premium. The observed equity premium is backward-looking, derived from historical data on the returns that equities have provided over risk-free assets. In contrast, the implied ERP is forward looking and acts more as amplifier of the discount rate, calculated based on current market prices, expected future dividends and growth rates. Figure 7 suggests that, under the assumptions used in our model (i.e. adaptative expectations), the implied ERP has been a reliable predictor of at least the direction of observed equity premium.

[6] In both climate scenarios, yields are set for an average annual decline by 7.5bps which, with a current duration of roughly eight years, results in 60bps of additional annual performance from rising bond prices. Other factors influencing carry and roll are excluded in this simple calculation. For example, we implicitly assume that yield curves on average are not inverted in the forecasting horizon.

Figure 7: Equity risk premia in the US: different approximations and values used in the forecasts.



Source: LSEG Datastream, Allianz Research. Note: observed equity premium calculated as the differential between the annualized equity total returns of the following 10 years minus the total returns of the 10Y sovereign bond of the following 10 years.

Significantly lower equity returns are expected, even in the baseline scenario, due to the combined impact of an aging population and the varying severity of climate change on the economy. Our model for forecasting equity returns is grounded in the Gordon Growth Model framework, which values equities based on expected future dividends and the discount rate (see Equation 1). This approach offers a straightforward yet robust method for estimating the intrinsic value of equities by focusing on the key drivers of long-term returns: dividend growth and the rate at which future cash flows are discounted.

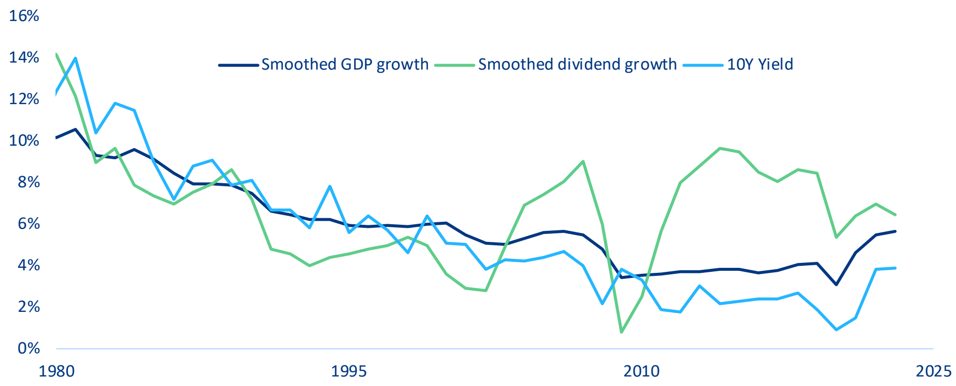
Equation 1. Simplified Gordon Growth Model framework used in equity price forecasts

$$\text{Equity price index}_t = \frac{\text{Dividends}_t * (1 + \text{expected long term dividend growth rate}_t)}{\text{risk free rate}_t + \text{implied ERP}_t - \text{expected long term dividend growth rate}_t}$$

To approximate dividend growth within our model, we employ a straightforward approach by using smoothed nominal GDP growth as a proxy. This method relies on the assumption that, excluding changes over the next 30 years in i) the long-term distribution policy and ii) the labor vs. capital share in GDP, the growth rate of dividends is primarily determined by the country's overall economic growth.[7] By linking dividend growth to nominal GDP, our model captures the broader economic trends that drive corporate performance, ensuring that our forecasts reflect the expected long-term trajectory of economic activity. The smoothing of nominal GDP growth helps to mitigate short-term volatility, providing a more stable and reliable estimate of future dividend growth. In Figure 8 we show how this relationship was in the last 45 years. Looking forward, there are two approaches to deriving the expected future dividend growth rate: (i) using adaptive expectations, which assume that future growth will mirror perceived past growth, and (ii) employing rational expectations, which assume that economic agents can anticipate future economic conditions based on all available information and a correct understanding of the underlying economic model. After careful consideration, we opted for adaptive expectations. The unprecedented difficulty in predicting the effects of increasingly volatile weather makes rational expectations less plausible in this context.

[7] According to the Penn World Tables, the distribution aggregate income among capital and labor has varied between a maximum share for labor of 65 (capital 35) to a minimum of 59 (41) since WWII in slightly decreasing trends. Our model, however, does not capture how those shares would change in a scenario of demographic change and higher depreciation rates of capital due to physical risks.

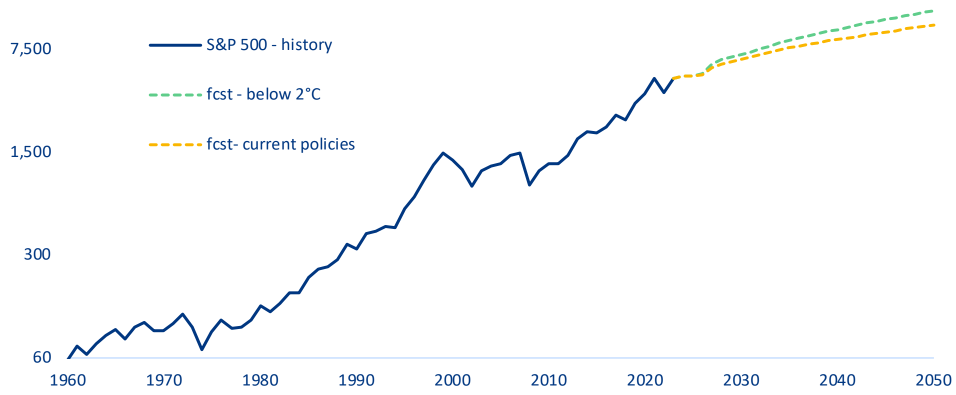
Figure 8: Dividends vs. nominal GDP vs. 10Y yields in the US



Sources: LSEG Datastream, Allianz Research. Smoothed: exponential weighted average with a weight of 0.2 to the new (yearly) value.

Last but not least, when it comes to the selection of the implied equity risk premium, we opted for the one that would make US equity prices as of end-2023 fairly valued based in our expectations framework – although that is below their average levels in the last two decades [8] Starting from that level, which is equal across scenarios, we adjust it to converge with the average implied ERP by 2050. In the climate-adverse scenario, additional adjustments are made to account for the higher risk premium required by investors, as discussed earlier in this section. That translates into a higher discount rate in the climate-adverse scenario (Current Policies), which together with lower nominal dividend growth creates an important divergence of equity prices across scenarios (see Figure 9).

Figure 9: Equity price index forecasts (log scale)

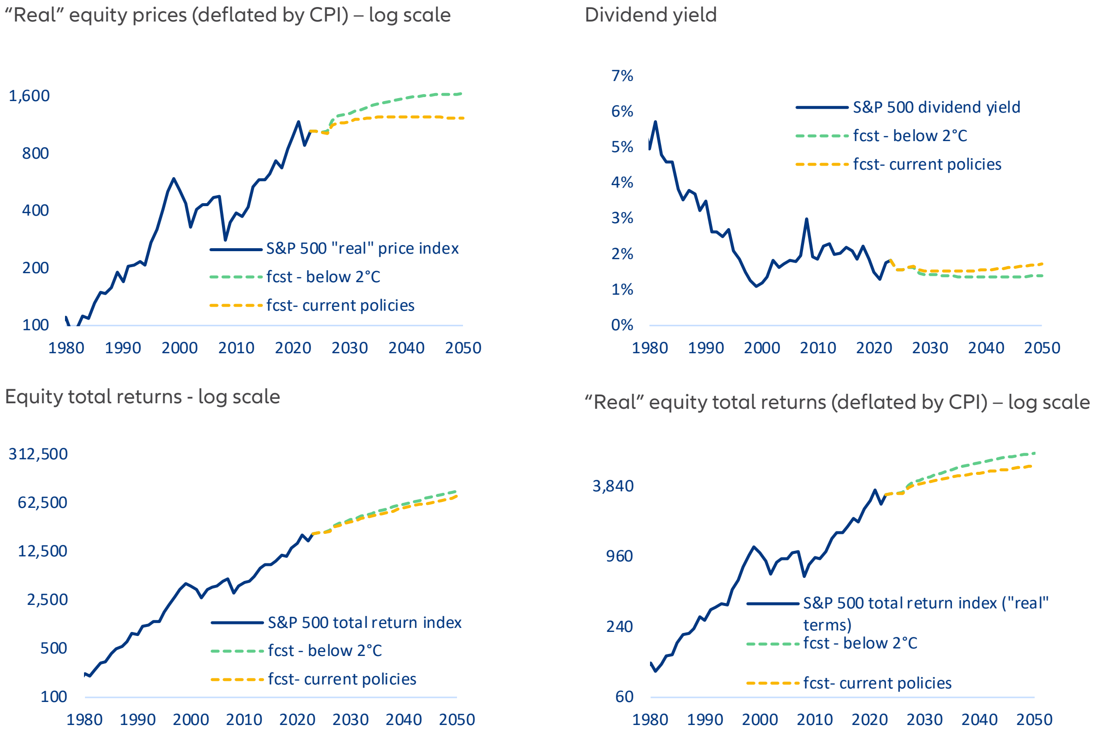


Sources: LSEG Datastream, Allianz Research

[8] From this one cannot extract that current equity prices are expensive based on those future expectations as the US equity index is made up of large multinational companies concentrated in few very specialized sectors.

More harm than meets the eye. The comparison of equity returns under the different climate scenarios reveals significant disparities: the equity price level (nominal terms) in 2050 would be 25% higher in the Below 2°C scenario than in the Current Policies scenario, with price returns in 2050 of 2.9% vs. 2.4%. But the difference in real performance between the two scenarios is wider than that. In the adverse climate scenario under Current Policies, higher inflation boosts nominal returns partially masking the underlying weakness in real terms. When adjusted by inflation (Figure 10, upper left), the contrast is starker: the "real" equity price level in 2050 would be 35% higher in the Below 2°C scenario than in the adverse, with the annual real price return turning slightly negative from 2038 onwards (-0.15% in 2050). Additionally, while dividends also show a different degree of impact between nominal and real terms (the nominal dividends would be 1% higher in the Below 2°C scenario, and 9% higher in case of the "real" dividends), the gap is smaller, as equity prices inherently reflect future expectations (worsening) while dividends reflect the past. This dynamic also explains why (as shown in Figure 10, upper right) the dividend yields are higher in the adverse scenario. All in all, the total return of equities would remain positive (Figure 10, lower half) for the whole time horizon (~1.5% real total returns in 2050 in the Current Policies scenarios) in contrast with the negative real returns observed in sovereign bonds after 2040. Nevertheless, the average annual total return of equities until 2050 would drop to 5.4% in the Below 2°C scenario and 4.7% in the Current Policies scenario whereas real returns would fall to 3.2% and 2.5%, respectively. Similar to sovereign bonds the returns would more than half compared to previous decades.

Figure 10: Equity price forecasts – additional results.

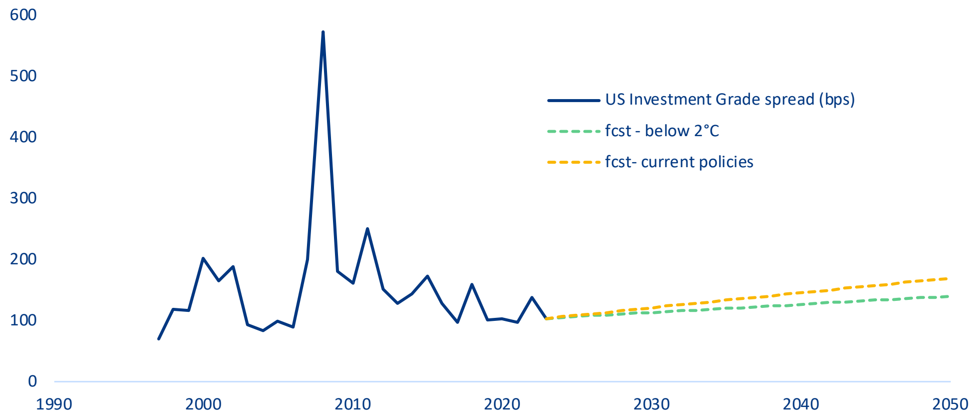


Sources: LSEG Datastream, Allianz Research. Note: The initially below-average equity returns are attributed to a downward adjustment in adaptive expectations as the outperformance of top US companies relative to GDP gradually diminishes within a closed economy framework, and not to adaptation costs.

Corporate credit risk to be structurally higher due to climate change. Climate change is set to significantly impact how corporate credit risk is assessed as several new endogenous and exogenous factors emerge, including physical risks such as asset damage and supply-chain disruptions but also transition risks such as stricter regulations and shifts towards low-carbon markets. The latter in particular could see companies facing legal and reputational consequences for their contributions to climate change or for failing to properly disclose climate-related risks adhering to established reporting standards. This could lead to investors demanding higher risk premiums for certain corporate fixed-income instruments. Ultimately it seems fair to assume that companies and/or sectors that manage and disclose their climate-related risks effectively will be better positioned to mitigate these impacts, while those that do not may experience higher borrowing costs and reduced access to capital, ultimately increasing their credit risk. Irrespective of the climate scenario, it is fair to assume that there will be a higher dispersion of returns within the corporate credit universe moving forward, with a high likelihood of green corporates outpacing brown companies.

However, calculating the impact of climate change on corporate credit risk is a difficult task as macro-based modelling for corporate spreads remains relatively scarce. For this reason, and to cross check our results, we use two different methodologies to estimate the most plausible path for corporate credit risk across climate scenarios. The first approach consists of treating corporate risk and equity risk as two sides of the same coin, using our equity estimation to forecast corporate spreads under the different climate paths by means of a direct linear regression. The second choice is to take a macro-based approach to the topic and use the ISM purchasing manager index as a middle estimator between real growth and credit spreads by means of a double linear regression. Both approaches provide similar results, suggesting that under a climate-adverse scenario investors might ask for an additional 60-70bps for investment-grade corporate credit risk in the long run. This would increase the long-term average expectations for investment-grade corporate spreads from 100bps to 170bps, a level currently perceived as quite high and that would signify an overall erosion of the market's average credit quality. In our Current Policies scenario, however, some structurally higher spreads will also be required as investors transition towards a 140bps target, a tad higher than historical averages (Figure 11).

Figure 11: US corporate bond spreads forecast and history



Sources: LSEG Datastream, Allianz Research

Comparison with other publications and history

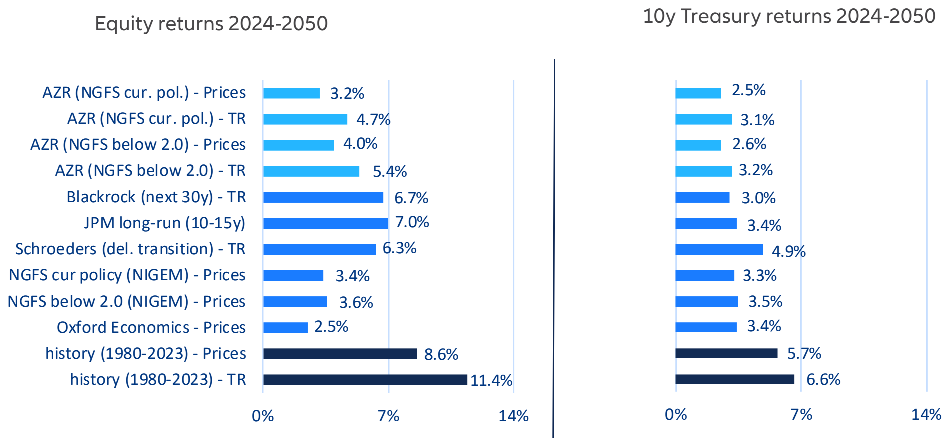
Our forecasts suggest a greater variability of returns across scenarios and returns in the lower range of the forecasts compared to those of other financial and research institutions. In reviewing the existing literature on the financial impacts of climate change, we found that previous analyses often produced outcomes that appeared somewhat limited in scope, particularly when considering the magnitude of the climate challenge. Specifically, two key issues prompted us to develop our own analysis: first, and as we explain earlier in the text, the differential in outcomes between benign and severe climate change scenarios was often relatively narrow, which seemed inconsistent with the substantial risks posed by climate change. Second, when reflecting on the historical performance of US equity markets from 1980 to 2023 – a period marked by exceptionally strong returns – we had the impression that previous studies may not fully capture the potential for significant deviations in future performance under varying climate scenarios.

25% higher equity prices in 2050, the reward for keeping the temperature rise below 2°C[9]. Figure 12 is the result of this analysis in perspective. With regards to our first concern, NGFS (NIGEM) scenarios show a delta between the Current Policies and the Below 2°C scenarios of just 0.13pps of annual nominal price growth and non-existent in the case of sovereign bond returns. Although we also have virtually no difference in nominal bond returns (0.03pp annually), this is not the case in equity prices. Thanks to the introduction of a varying implied equity risk premium, consistent with variation of uncertainty and volatility across scenarios, we find a nominal price return difference of 0.85pp annually, which means that by 2050 the equity price index would be 25% higher in a scenario where we implement the necessary policies to keep the temperature increase below 2°C. Regarding the other forecasts shown in Figure 12, we obtain total returns from equities of 5.4% and 4.7% in each of the scenarios. While these figures reflect slight

[9] As explained in the first section, by the selection of scenarios used, this figure cannot account for some of the transition costs.

differences in underlying assumptions, the return for the Below 2°C scenario is 1.3pp lower than the average of the BlackRock, JP Morgan and Schroders scenarios. Nevertheless, these results align with the broader industry consensus in that the exceptional trends observed during 1980-2023 are unlikely to continue into the future.

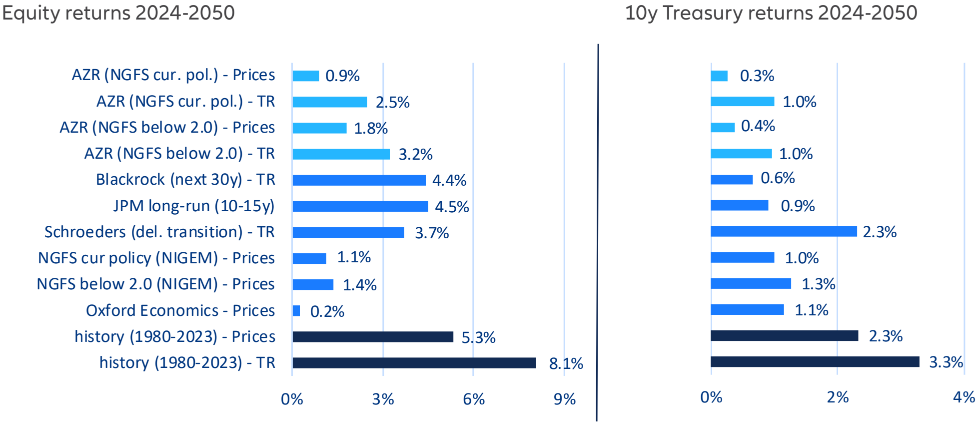
Figure 12: Selected long-term nominal capital market forecasts for the US



Source: Allianz Research. AZR = Allianz Research. "TR" refers to total returns. "Prices" refers to price returns for equities and yields for treasuries. Note: The selection of the 1980-2023 time span for the historical data is somewhat arbitrary, chosen mainly to ensure a sufficiently long period where the equity cycle's starting point has minimal influence on the results. However, if a shorter time horizon were used, treasury returns would be smaller (approximately -1.5pps per decade since 1980), while equity returns could vary by +/- 2pps from 10.5%.

The picture is similar when we look at returns in real terms, as depicted in Figure 13, where we deduct expected inflation from expected nominal returns. In our calculations, the "real" equity price in the Below 2°C scenarios would be 35% higher than in the Current Policies scenario. From all the forecasts included, Schroeders and JP Morgan are the ones using a higher average inflation rate (2.6% and 2.5% on average respectively), while we, together with NGFS (NIGEM) and Oxford Economics are around 2.2%-2.3%. That difference explains the difference in bond returns that we see in Figure 12, on the one hand, and reduces the performance differential of Allianz Research proprietary forecasts in real terms vs. other financial institutions (Figure 13) on the other. In historical terms, we project real returns in both equities and bonds to halve in the next quarter of century vs. what US equities experienced in the previous 43 years.

Figure 13: Selected long-term real capital market forecasts for the US



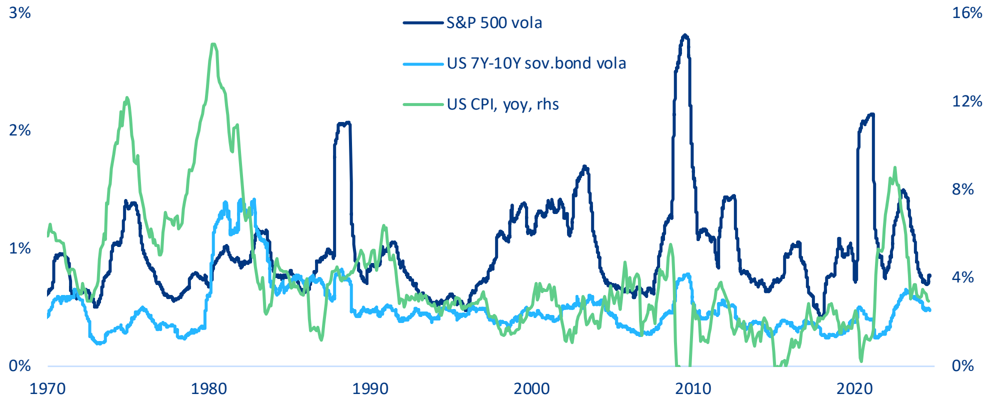
Source: Allianz Research. AZR = Allianz Research. "TR" refers to total returns. "Prices" refers to price returns for equities and yields for treasuries.

A higher implied ERP negatively affects the observed equity premium due to the diminishing effect on price returns (future dividends are discounted at a higher rate). The nominal equity premium over bonds (that is, observed equity premium) will decrease from close to 5% on average in the period 1980-2023 to 3% on average until 2050 in the Below 2°C scenario, and to merely 2.2% in the Current Policies scenario. This difference of 200bps and almost 300bps of excess equity returns, respectively, can be mainly explained by the larger decrease in equity returns (more particularly, in price returns). One has to keep in mind the exceptionality of the past decade in terms of excess returns as observed equity premium benefited from historically low interest rates and strong price returns driven, also in part, by low discounting rates. Going forward, heightened risks from climate change and other global uncertainties are expected to constrain future equity price growth, limiting the potential for an observed equity premium.

Volatility, correlation and asset allocation

By introducing volatility-adjustments in this analysis, we can better assess the risk-return profile of bonds and equities, allowing us to answer the critical question of what would be the optimal portfolio allocation going forward. Although realized volatility is always higher in equities, an analysis of volatility of the last 50+ years (Figure 14) for both bonds and equities shows that the biggest spikes in terms of bond volatility have often been accompanied by relatively higher inflation caused by supply-side shocks (1970s oil embargo, 2020s Covid/Ukraine war). Major equity volatility spikes have also occurred during demand-side shocks originating from financial-market speculation (e.g. 2008 GFC, dotcom bubble). This is crucial in our analysis: although we do not include in our forecasts a demand-side-driven capital market crisis, the evolution of inflation and supply-side shocks in general is a key differentiating element across scenarios.

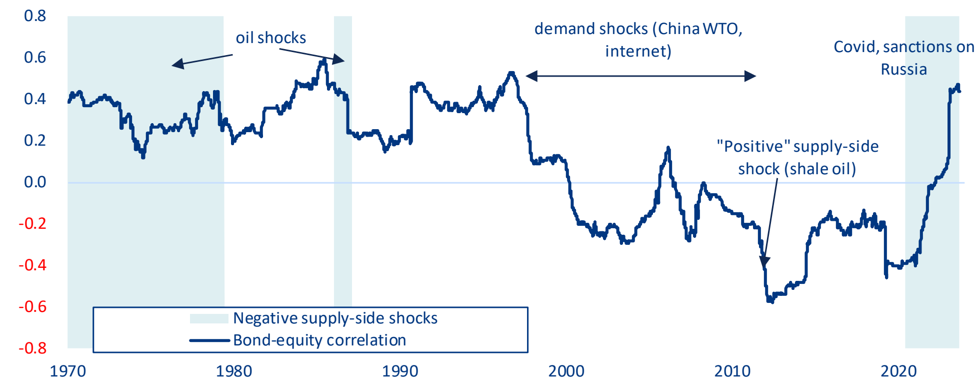
Figure 14: Realized volatility of US 10Y bonds and US equities



Sources: LSEG Refinitiv, Allianz Research. Volatility calculated as the rolling standard deviation over 1Y of daily price returns.

It is not only about volatility, but also about correlations. As Figure 15 shows, supply shocks also play a vital role in the definition of positive and negative cross-asset correlation regimes. The "negative" oil shocks in 1973 and 1979, but also the Covid-19 crisis and the Russian attack on Ukraine in the early 2020s, which lead to a spike in oil and gas prices in Europe, marked high-inflation periods characterized by a positive correlation among bonds and equities. On the other hand, the "positive" supply shock of the first two decades of this millennium, induced by the introduction of the internet, China entering the WTO and shale oil, marks a long period of low inflation, with negative bond-equity correlation.

Figure 15: Equity-bonds correlation: how it relates to demand- vs. supply-side shocks

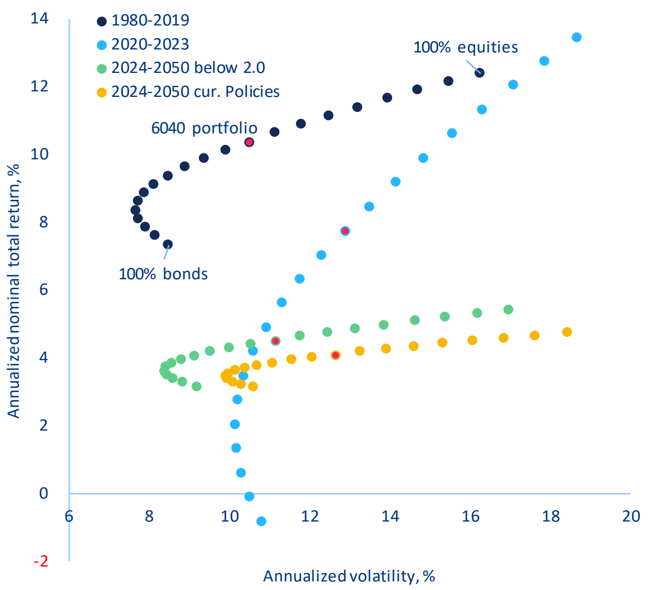


Sources: LSEG Refinitiv, Allianz Research. Correlation calculated on a rolling basis over 2Y of monthly price returns. There were smaller supply-side shocks during those periods (e.g. 2008 oil price spike), but offset by the general deflationary conditions.

In the past, sudden negative supply shocks led to increased volatility (in both bonds and equities) and turned the bond-equity correlation positive. We use these findings and the latest supply shock from the 2020s as a blueprint for our future projections for these variables. However, with only three occurrences of significant negative supply shocks over the past 50 years, the application of econometric models is impractical due to the limited number of observations. As a result, we must rely on informed assumptions. Hence, it is crucial to approach our forthcoming optimal portfolio discussions with caution. In the Below 2°C scenario, where negative supply shocks from physical climate risks are comparatively lower (though still increasing compared to past decades), we slightly raise future correlation and volatility from historical levels towards those observed during the negative supply shocks of the 2020s. In contrast, under the Current Policies scenario, which could lead to a hothouse world with more frequent natural disasters causing negative supply shocks, we push the pendulum of correlation and volatility even further toward the conditions seen in the 2020s.[10]

During economic supply shocks, the 60/40 portfolio will provide less risk hedging than it used to, complicating the job of asset managers. Combining our insights from expected returns, volatility and correlation gives us a glimpse of the optimal portfolio of the future (Figure 16). Between 1980 and 2019, adding equities to a bond portfolio improved the return and even lowered the risk until a level of 20% equity and 80% bonds. Adding more equities delivered higher returns at considerably little extra risk as the frontier curve had a steep slope in its upper part in this time period. The traditional 60/40 portfolio consisting of 60% equities and 40% bonds delivered an impressive average return above 10% annually, with much lower volatility compared to a 100% equity portfolio. However, the past three years are a good blueprint of how such a portfolio performs when the economy is hit by a negative supply shock, first from the Covid-19 pandemic and then from the war in Ukraine. These events changed the shape of the efficient frontier significantly. First of all, the curve moved to the right, implying higher volatility for both bonds and equities. Second, the positive correlation between bonds and equities lowered the curvature of the efficient frontier with no easy picks any more. With the bond hedge almost gone, more equities simply meant higher returns came at a higher risk. Third, the total return of a pure bond portfolio yielded a negative level as yields were increasing strongly during this period, causing large price declines. A full equity portfolio on the other hand was doing well in terms of performance but that came at the price of higher volatility. Moreover, the exceptionally high equity returns in that period were largely the result of significant fiscal stimulus, translating into excess savings that were put in capital markets, inflating stock prices probably a little too much (see our discussion above on the unusual high realized equity premium). Hence, while volatility and correlation could be a good indicator for negative supply shocks in general, the returns are not.

Figure 16: Nominal risk return profiles of portfolio compositions, 1990-2019, 2020-2023, future



Source: LSEG Datastream, Allianz Research.
Note: Each dot resembles a mixed portfolio of stocks and 10y treasury bonds with 100% equities on the top right corner and 100% bonds and the lower left part. Mixed portfolios in 5pp steps are in between with the 6040 portfolio highlighted in purple..

[10] Volatility for each asset class σ and bond-equity correlation ρ in the future is calculated as follows $\sigma_{(2024\text{-}2050)}=\omega\ \sigma_{(1980\text{-}2019)}+(1\text{-}\omega)\ \sigma_{-(2020\text{-}2023)}$ and $\rho_{(2024\text{-}2050)}=\omega\rho_{(1980\text{-}2019)}+(1\text{-}\omega)\ \rho_{-(2020\text{-}2023)}$ with the weight w being 0.7 in case of the Below 2°C scenario and 0.1 in case of the Current Policies scenario.

With more supply shocks to come from physical risks amid climate change, investors face a future of higher risk and lower returns. Given the less favorable risk-return ratios of stocks, the optimal portfolio will have to increase the weight of bonds. The shape of the efficient frontier for our future scenarios becomes much less attractive to what investors were used to in the past (Figure D5). Lower returns shift the curve downwards both for the Below 2°C scenario and the Current Policies scenario. An increase in supply shocks stemming from materializing physical risks amid climate change will lead to less negative correlations of bonds and stocks in the future and thereby reduce the curvature. This means adding stocks to a bond portfolio provides less of a hedge than it used to. Most notably, with volatility increasing and returns dropping the upper part of the efficient frontiers becomes flatter, meaning additional risk is compensated with much less additional returns. As a consequence, the optimal portfolio for an average risk-averse investor would likely have to increase the bond share. The 60/40 portfolio could become a 40/60 portfolio in the future – at least this would be the combination offering the highest Sharpe ratio (a measure for risk-adjusted returns) in our forecast. This is the case in both the Below 2°C and Current Policies scenarios. But with this adjusted portfolio setting, investors have to brace for lower returns and higher volatility.[11]

Nevertheless, portfolio diversification will still be advisable as demand-side shocks will still prevail. Even in a world dominated by structural changes such as climate change and demographics, demand-side shocks will continue to occur. Losses in consumer or investment confidence, as seen during the Great Financial Crisis or the dotcom bubble will still happen. Such shocks will continue to be mitigated through aggressive monetary easing, which will lower yields and thereby raise the price of bonds during times when stocks typically take a hit. Consequently, negative bond-equity correlations will continue to exist albeit at a lower frequency just like the share of demand side induced shocks will fall compared to supply-side induced shocks. The bottom line: blending bonds and stocks will remain essential for long-term investors to improve their risk-return profiles.

[11] Bear in mind that these numbers refer to nominal returns and the average over the coming decades until 2050. With falling returns and rising inflation, real returns in 2050 are very low and even negative for bonds (see discussion further above). Hence hedging a portfolio with bonds will be costly in 2050, and the optimal portfolio allocation for the subsequent decades from 2050 onwards might again look different.

Policy recommendations

Institutional investors need to rethink their investment strategies in light of the changing landscape. In this challenging environment, the first priority should be education and awareness. Investors must understand that the past is unlikely to repeat itself. The well-known example of investing USD10,000 in a 60/40 portfolio in 1980, which would now be worth over USD600,000 (USD170,000 in real terms), is unlikely to recur. Raising awareness is particularly important for countries with large pension fund systems because pensions effectively depend on the long-term returns achieved. If these turn out to be much lower than expected, this could eventually lead to social imbalances. Secondly, large institutional investors, such as insurance companies, pension funds and sovereign wealth funds, should exercise caution with stock investments. The risk-return profile of equities is expected to deteriorate more than that of bonds, thereby affecting the optimal portfolio allocation as outlined above. Lastly, with lower macro-level returns, micro investments will regain appeal. There will always be opportunities to outperform, while some investments, such as stranded assets, will struggle. However, these opportunities will be tapped by some, while others lose. What seems clear is that return dispersion across single names and sectors is likely to increase, with green companies expected to outpace brown companies and with companies adhering to ESG and climate reporting standards outperforming those that fail in ESG transparency. In the long-run and on an aggregate level, this is a zero-sum game and the aggregate asset management industry will have to cope with lower returns and higher volatility.

Given the bleak investment outlook, largely driven by weaker economic growth, governments should prioritize efforts to combat climate change. While slower economic growth can partly be attributed to lower population growth, this is less concerning than the impact of climate change on growth. This becomes clearer when focusing on per capita income and wealth, which better reflects aggregate human well-being. As long as individual prosperity continues to rise, slower population growth could still support a high standard of living and quality of life, even if total economic expansion moderates. However, climate change threatens individual well-being regardless of population size or growth. Natural catastrophes will harm people, growth and financial assets irrespective of how many people there are. And the impact of climate change will get worse over time if it is not stopped. While our analysis extends "only" to 2050, the situation becomes much more dire when we consider the potential impacts on a longer time frame. Extrapolating rising disaster costs, declining growth and accelerating inflation until 2100, the damage to financial assets may pale in comparison to the broader challenges future generations will be confronted with.

Central banks will need to determine how to respond to future negative supply-side shocks stemming from natural catastrophes. For instance, a major storm that destroys critical infrastructure would likely lead to a combination of low growth and high inflation. This presents a significant dilemma for central bankers: should they raise interest rates to curb demand and align it with the reduced supply to lower price pressures, or should they support economic reconstruction – potentially fostering a greener economy – by keeping rates lower, even at the risk of de-anchoring inflation expectations? Balancing these conflicting priorities will be one of the most challenging tasks for central banks in the coming decades.

Our team

Chief Economist
Allianz SE

Ludovic Subran
ludovic.subran@allianz.com

Head of Economic Research
Allianz Trade

Ana Boata
ana.boata@allianz-trade.com

Head of Insurance, Wealth & ESG Research
Allianz SE

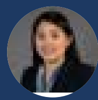
Arne Holzhausen
arne.holzhausen@allianz.com

Macroeconomic Research

Lluis Dalmau
Economist for Africa & Middle East
lluis.dalmau@allianz-trade.com

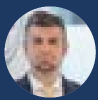
Maxime Darmet Cucchiarini
Senior Economist for US & France
maxime.darmet@allianz-trade.com

Jasmin Gröschl
Senior Economist for Europe
jasmin.groeschl@allianz.com



Françoise Huang
Senior Economist for Asia Pacific
francoise.huang@allianz-trade.com

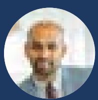
Maddalena Martini
Senior Economist for Italy, Greece & Benelux
maddalena.martini@allianz.com



Luca Moneta
Senior Economist for Emerging Markets
luca.moneta@allianz-trade.com

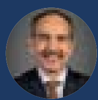
Manfred Stamer
Senior Economist for Middle East & Emerging Europe
manfred.stamer@allianz-trade.com

Corporate Research

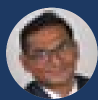


Ano Kuhanathan
Head of Corporate Research
ano.kuhanathan@allianz-trade.com

Maria Latorre
Sector Advisor, B2B
maria.latorre@allianz-trade.com

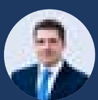


Maxime Lemerle
Lead Advisor, Insolvency Research
maxime.lemerle@allianz-trade.com

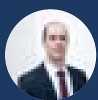


Sivagaminathan Sivasubramanian
ESG and Data Analyst
sivagaminathan.sivasubramanian@allianz-trade.com

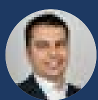
Capital Markets Research



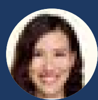
Jordi Basco Carrera
Lead Investment Strategist
jordi.basco_carrera@allianz.com



Bjoern Griesbach
Senior Investment Strategist & Eurozone Economist
bjoern.griesbach@allianz.com

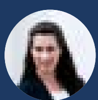


Pablo Espinosa Uriel
Investment Strategist, Emerging Markets & Alternative Assets
pablo.espinosa-uriel@allianz.com



Yao Lu
Investment Strategist
yao.lu@allianz.com

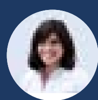
Insurance, Wealth and Trends Research



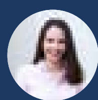
Michaela Grimm
Senior Economist, Demography & Social Protection
michaela.grimm@allianz.com

Patrick Hoffmann
Economist, ESG & AI
patrick.hoffmann@allianz.com

Hazem Krichene
Senior Economist, Climate
hazem.krichene@allianz.com



Patricia Pelayo-Romero
Senior Economist, Insurance & ESG
patricia.pelayo-romero@allianz.com



Kathrin Stoffel
Economist, Insurance & Wealth
kathrin.stoffel@allianz.com

Markus Zimmer
Senior Economist, ESG
markus.zimmer@allianz.com

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Director of Publications
Ludovic Subran, Chief Economist
Allianz Research
Phone +49 89 3800 7859

Allianz Group Economic Research
https://www.allianz.com/en/economic_research
http://www.allianz-trade.com/economic-research
Königinstraße 28 | 80802 Munich | Germany
allianz.research@allianz.com

@allianz

allianz

Allianz Trade Economic Research
http://www.allianz-trade.com/economic-research
1 Place des Saisons | 92048 Paris-La-Défense Cedex | France

@allianz-trade

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