GATE
MACRO CLIMATE

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The Macro of *Climate Change*

Implications for Investors and Financial Markets

Part 1: Physical Risk

This report examines the macroeconomic implications of climate change and their significance for financial markets and investors. This report focuses on physical climate risk. A second report will examine transition risk.

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Why now?

Climate change has been discussed for decades. Its physical consequences are now becoming a more immediate force shaping growth, inflation and investment returns. **In our view, financial markets are underpricing both the scale of the damage and the speed at which it can materialise.** Four developments explain why investors should reassess these risks now:

1. **The physical reality is becoming impossible to ignore.** The impacts of a changing climate are intensifying, and increasingly materializing with an horizon that matters for financial markets. This summer's painful European heatwaves brought home how directly a changing climate can affect households and businesses. The strengthening El Niño adds urgency, increasing the prospect of further heat and disruption to rainfall patterns. The economic consequences are already substantial: according to the EEA[1], weather- and climate-related extremes caused €822 billion in EU asset losses between 1980 and 2024, *with one quarter occurring in the last four years alone*. In our view, treating climate change as a separate, distant consideration is increasingly untenable. It belongs directly in forecasts of growth, inflation, earnings and interest rates.

2. **New research suggests that the economic costs are large and could become worse.** Bilal and Känzig (2026)[2] estimate that a permanent additional 1°C of warming reduces the long-run level of world GDP per capita by more than 20%. Their analysis also suggests that GDP per capita in 2019 would have been more than 20% higher without the warming experienced since 1960. By examining global temperature changes, their approach captures damaging weather patterns that earlier studies focused on local temperatures could miss. In our view, this may be a lower bound on the damage ahead, as temperatures cross physical thresholds and increasingly simultaneous disruptions strain the capacity to recover, triggering non-linear and potentially highly disruptive dynamics.

3. **Insurance premia are sending a financial warning.** US homeowners' premiums rose by approximately 70% between 2019 and 2025, reflecting greater disaster risk and higher construction costs. Insurance professionals are themselves warning about the consequences of growing numbers of uninsured properties for mortgage markets. We think investors should take that warning seriously. When protection becomes unaffordable or unavailable, the exposure passes to property owners, companies, lenders and governments. In our view, a much broader repricing of physical risk lies ahead across property, credit and equity markets.

4. **Climate shocks materialise as negative supply shocks and challenge cross-asset relationships.** COVID revealed a combination of macroeconomic shocks that uncannily resembles what climate change could repeatedly generate: supply-chain disruptions and expansionary fiscal policy triggering large inflationary surges. In our view, markets still underprice the risk of climate shocks repeatedly combining supply disruption with a substantial fiscal response. Climate shocks weaken production, while the spending needed to cushion their consequences and rebuild can intensify pressure on scarce resources and tight supply chains. The inflationary effect will depend on the scale, timing and financing of that response, but the combination deserves a more prominent place in macroeconomic and investment analysis

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Climate change is a major macroeconomic risk

Climate change affects the three key macro variables, namely growth, inflation and interest rates together. Heat stress reduces labour productivity, drought constrains agricultural and energy output, and disasters destroy capital and disrupt supply chains. The resulting loss of productive capacity weighs on growth, while higher unit costs and scarcer inputs put upward pressure on prices. Wealth and income losses weaken consumption, while greater uncertainty encourages precautionary saving and weighs on investment. Central banks then face a trade-off between stabilising inflation and supporting activity, while persistent changes in productivity, saving and investment affect the underlying real interest rate. Public finances can also come under strain through reconstruction spending, support for affected households and businesses, and weaker tax revenues. Climate change is therefore a multidimensional macroeconomic shock, affecting aggregate supply and demand, inflation, interest rates and public finances simultaneously.

Some key macro mechanisms:

- **Gradual warming reduces the productivity of labour and capital.** Heat reduces the hours people can work and how much they produce per hour. Crops become less productive, equipment requires more cooling and maintenance, and water shortages constrain industrial activity. Businesses must spend more to maintain the same output. The ILO's 2019 projection put heat-related working-hour losses in 2030 at **2.2% globally, equivalent to 80 million full-time jobs**. ILO[3]

- **Acute disasters destroy capital and interrupt production, with recovery depending on access to finance.** Floods, storms and fires damage factories, buildings and infrastructure. Lost output continues until businesses can restore operations, and reconstruction absorbs resources that could otherwise expand productive capacity. Research published in the ECB's Working Paper Series, covering several thousand disasters across **47 countries**, estimates that damage equivalent to **1% of GDP reduces GDP growth by around 0.2 percentage points in the quarter of impact**. Greater insurance coverage substantially reduces the initial loss. Declining coverage therefore threatens to increase the economic damage from future disasters. Giuzio et al.[4].

- **Inflation rises when essential goods become harder and more expensive to supply.** Smaller harvests raise food prices, drought can restrict hydropower while heat increases electricity demand, and disrupted transport raises delivery costs. Lower productivity also increases the cost of each unit produced. Kotz et al. (2024) estimate that warming projected for 2035 could add **0.9–3.2 percentage points to annual food inflation and 0.3–1.2 percentage points to headline inflation**, averaged globally, before a targeted monetary-policy response or additional adaptation. Higher food and energy bills simultaneously leave households with less money for other purchases. That combination of higher prices and weaker demand creates a difficult policy trade-off. Kotz et al.[5].

- **Supply chains transmit local losses globally and can amplify them non-linearly.** A factory can withstand rising temperatures until its water supply, electricity connection or transport route fails. Once a critical input becomes unavailable, production can stop at customers far beyond the affected region. Sun et al. (2024) estimate that indirect supply-chain losses from heat stress reach **0.5% of global GDP around 2060 under an intermediate warming scenario and 1.5% under a very high warming scenario**. Their modelling shows indirect losses increasing disproportionately as heat stress intensifies. In our view, these networks are a major reason why investors should expect disruption to spread beyond the assets directly exposed to a disaster. Sun et al.[6].

- **Preparing for disruption also has an economic cost.** Firms may hold larger inventories, maintain backup capacity, diversify suppliers or pay for more reliable transport. These measures reduce vulnerability but require capital and can increase operating costs even in years without a disaster. Protection and reconstruction also redirect investment towards keeping existing activity viable. We think this creates a persistent drag on the resources available for expansion, alongside the acute losses when shocks occur. OECD Supply Chain Resilience Review[7].
- **Interest rates adjust through both monetary policy and longer-term financing needs.** Over the cycle, markets reprice the central bank's response to weaker activity and higher inflation. Over longer horizons, changes in productivity, saving and investment alter the underlying real rate around which policy operates. Reconstruction and adaptation also increase financing needs, while weaker tax receipts and public support put pressure on government budgets. Investors therefore need to distinguish changes in expected policy rates from changes in the underlying real rate and the compensation required to hold exposed borrowers' debt. NGFS[8].

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Climate as an underpriced financial risk

Because climate change affects growth, inflation and interest rates, its financial impact extends beyond companies whose assets are directly damaged. Exposure varies across countries and industries, and with firm-specific characteristics. Assessing these dimensions together helps quantify how a common macroeconomic shock affects individual companies' earnings, financing costs and valuations, and where risks are concentrated within a portfolio.

- **We think physical climate risk is underpriced.** Insurance provides, in our view, an interesting case study and an early warning. Many property policies renew annually, allowing insurers to reassess premiums, deductibles and coverage far more frequently than the lifetime of the assets being insured. US Treasury data for 2018–2022 show that premiums in the highest-risk fifth of ZIP codes were **82% higher** than in the lowest-risk fifth, while nonrenewal rates were approximately **80% higher**. The warning concerns both the cost of protection and the willingness to provide it. We think deteriorating insurance terms are an important early indicator of pressure on property values, business cash flows and collateral. US Treasury[9].
- **Insurance withdrawal transfers losses to households, companies, lenders and governments.** Some locations and properties become effectively uninsurable as insurers simply walk away or offer cover only at prices owners cannot afford. Senior UK and European insurance and reinsurance professionals have warned that growing numbers of uninsured, high-risk properties could undermine mortgage markets and create broader financial instability. Inside Track[10]. Insurers reduce their own exposure by leaving, but the physical risk remains. Losing insurance concentrates potential losses on households and firms less able to absorb them, increasing financial vulnerability. Owners may be unable to finance repairs, property values can fall and lenders face weaker collateral and greater default risk. Tighter lending can then delay recovery, while public finances face pressure to support affected communities. Higher premiums can cause distress even before a disaster occurs: Dallas Fed research finds that premium increases raise mortgage delinquency and reliance on credit cards, particularly among financially constrained households. We think the withdrawal of protection can therefore amplify losses and accelerate repricing across the assets and loans that depend on it. Dallas Fed[11], Bank of England staff analysis[12].

- **Equity-market research provides evidence of underreaction and corroborates our view.** Hong, Li and Xu (2019) examine publicly traded food companies in **31 countries**. Worsening long-term drought trends predict weaker profit growth and weaker subsequent stock returns, consistent with investors failing to incorporate the available information fully into prices. The implication for our analysis is clear: identifying a physical exposure does not mean that its earnings consequences are already reflected in valuations. This is why quantifying exposure matters: investors need to estimate its effect on future profits and compare that with the assumptions embedded in market prices. Hong, Li and Xu[13].
- **Property research provides further evidence of mispricing.** Gourevitch et al. (2023) estimate that US residential properties exposed to flooding were overvalued by **$121–237 billion**, depending on the discount rate, relative to a benchmark incorporating modelled flood losses over 2020–2050. The estimated flood risk was therefore insufficiently reflected in property prices. Overvaluation was concentrated in areas with weaker disclosure requirements and less concern about climate risk, linking mispricing to the information and beliefs of market participants. A correction would affect household wealth, mortgage collateral and the property-tax revenues of exposed municipalities. Gourevitch et al.[14].
- **We expect broader repricing as the financial consequences become impossible to ignore.** Repricing in one sector can have important spillovers: deteriorating insurance terms can affect property valuations, bank credit quality and local public finances, while tighter credit and weaker spending transmit those effects to the wider economy. Investors therefore need to quantify both direct exposures and the links through which losses can spread across their portfolios.

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Climate change and the new macro regime

Across climate scenarios, we expect negative supply shocks to become more frequent as physical climate risks intensify. By weakening growth while putting upward pressure on inflation, these shocks complicate monetary policy and challenge cross-asset relationships. In our view, climate change is therefore an increasingly important driver of the new macro regime, with consequences for bond diversification, term premia and the cost of capital.

- **More frequent negative supply shocks weaken the diversification properties of nominal bonds.** In a demand-led downturn, weaker growth and inflation allow the central bank to cut rates, helping bonds rally as equities fall. A physical supply shock can instead reduce earnings while raising inflation and expected policy rates. Equities and bonds can then fall together. In our view, a climate that generates more frequent inflationary disruptions makes this an increasingly important portfolio risk: the bond allocation may provide less protection precisely when equity earnings come under pressure. ECB analysis of stock–bond correlations[15].
- **We think that environment warrants higher term premia.** Investors holding long-dated nominal bonds bear uncertainty about future inflation and interest rates. If bonds also become a less reliable hedge against losses elsewhere in the portfolio, investors have a further reason to demand compensation for holding them. Additional government borrowing to finance reconstruction can reinforce upward pressure on yields. This creates a route to higher long-term borrowing costs even when climate damage weakens the growth outlook. Federal Reserve discussion of inflation risk and term premia[16], Kansas City Fed research on Treasury supply[17].

- **Central banks cannot indefinitely look through supply shocks that keep inflation elevated.** An individual heatwave or flood may end, but successive disruptions can maintain pressure on food, energy and transport prices. If that pressure feeds into wages and broader price-setting, monetary policy has to restrain demand. By restraining demand, monetary tightening can deepen the slowdown caused by the initial supply shock. We think more frequent climate disruptions will therefore make the trade-off between stabilising inflation and supporting growth more acute. NGFS assessment of climate change and monetary policy[18].
- **Uninsurability increases the incentive to save for losses that households and businesses must bear themselves.** When reliable coverage disappears, precautionary cash buffers become more valuable. Households have a reason to reduce current spending, and firms may postpone expansion to preserve liquidity. Weaker expected productivity can further reduce the appeal of new investment. Together, greater desired saving and weaker investment demand put downward pressure on the underlying real rate. Following a disaster, those buffers are drawn down to fund repairs and replace lost income. ECB research survey[19].
- **Reconstruction and adaptation simultaneously increase the demand for capital.** Replacing damaged assets, protecting infrastructure and relocating activity require substantial financing. These needs pull against the downward pressure on real rates from precautionary saving and weaker productivity. The balance between those forces will shape longer-term interest rates. In our view, the important regime change is that a growing share of saving and investment must be devoted to absorbing and preventing physical losses, tying the availability and cost of finance more closely to climate exposure. ECB research survey[19].
- **A growing divergence can emerge between safe yields and the borrowing costs of exposed households and businesses.** Investors seeking safety can support demand for government bonds while banks and credit investors demand higher spreads from vulnerable borrowers. Falling collateral values and weaker cash flows can also restrict access to lending. A lower benchmark interest rate can therefore coexist with more expensive or unavailable credit where reconstruction is most needed. We think this divergence between demand for safe assets and the financing needs of exposed borrowers is an important way physical risk can reshape the financial system. NGFS analysis of financial transmission[8].

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Implications for investors: an illustration

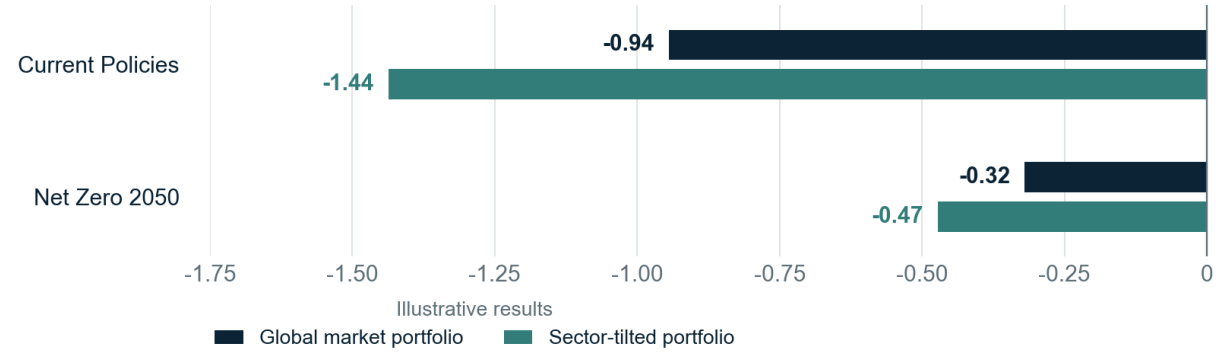
Physical climate risk deserves a more explicit place in investment and risk analysis. The challenge is to understand how it affects earnings, financing conditions and portfolio diversification across scenarios. The GATE Macro Climate Risk Model connects these effects through a common macro-financial framework, translating growth, inflation and monetary policy into financial impacts that reflect differences in country and industry exposure.

An illustration: increasing the weight of sectors exposed to physical risk in a 60/40 portfolio

We start with a global portfolio of 60% equities and 40% corporate bonds. We then increase the weights of conventional utilities, water, agriculture and food, property and transport, while keeping the overall 60/40 allocation unchanged.

Same 60/40 allocation, different physical-risk sensitivity

Average annual real-return impact, 2027–2050 (percentage points versus baseline)



Assumptions: Physical risk only, using NGFS-based model scenarios over 2027–2050. Results are average annual real-return deviations from baseline, not total-return forecasts. Selected sectors' initial weights are multiplied by five, then normalised within each sleeve; holdings and durations remain fixed over time. Adaptation remains as represented in the scenario inputs and exposure calibration. Source: GATE Macro Climate Risk Model.

Under Current Policies, the sector tilt adds approximately **0.49 percentage points to the average annual real-return drag**, mostly through earnings sensitivity. The model's interest-rate response partly cushions equity losses. The climate scenario also matters: Net Zero 2050 carries lower physical risk, resulting in a smaller drag on returns for both portfolios.

Investors need to understand where their portfolios are exposed to physical risk and how changes in growth, inflation and interest rates can amplify or offset the losses.

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