Climate Change and Potential GDP: Far from Neutral, Tentatively Positive if Managed Well[1]

Under policy inaction, climate change is expected to operate as a negative supply-side shock to potential output. However, with effective adaptation and an orderly clean transition, it can become a long-run tailwind. Nevertheless, the balance between headwinds and tailwinds is highly uncertain and scenario-dependent.

Why climate change matters for potential GDP[2]. Climate change affects potential GDP through all three production-function inputs: capital, labour, and Total Factor Productivity (TFP). Chronic changes in temperature, precipitation, and sea levels, together with more frequent extreme events, act as a negative supply-side shock by raising capital depreciation, reducing effective labour force, and lowering productivity. At the same time, climate policies, adaptation measures reshape investment, labour allocation, and innovation incentives (**Table 1**).

Headwinds dominate under inaction. There is a broad consensus that unmitigated climate change lowers potential output. Estimates for global GDP losses typically cluster around a few percent by mid-century, with much larger losses by 2100 (under high-emissions scenarios and very fat downside tail risks). Results vary widely depending on whether climate is modelled as a level or growth-rate shock and on the treatment of extreme events and tipping points.

Well-managed transitions can turn into tailwinds. Well-designed, early, and credible mitigation and adaptation strategies can partly offset, and in some scenarios slightly outweigh, climate damages in the long run. Integrated climate-growth strategies work through higher green investment, faster capital renewal, reduced exposure to fossil-fuel shocks, and innovation spillovers, namely crowding in private investment and fostering economy-wide productivity. However, the positive long-run gap relative to baseline would typically be smaller and more uncertain than the negative gap associated with unmanaged climate change (**Figure 1**).[3]

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[1]: This brief is based on a review of the academic literature on climate change and potential GDP. The referenced sources can be consulted here: Climate_Lit_Review.

[2]: Potential GDP is the level of real output that an economy can sustain over the medium to long term when productive factors (labour, capital, and technology) are used at non-inflationary, structurally sustainable rates, abstracting from cyclical demand fluctuations. It is determined by structural supply-side factors—labour supply and human capital, the productive capital stock, total factor productivity (TFP), and institutional/technological conditions—and evolves gradually over time. For reference: The OECD potential output estimation methodology. OECD August 2019.

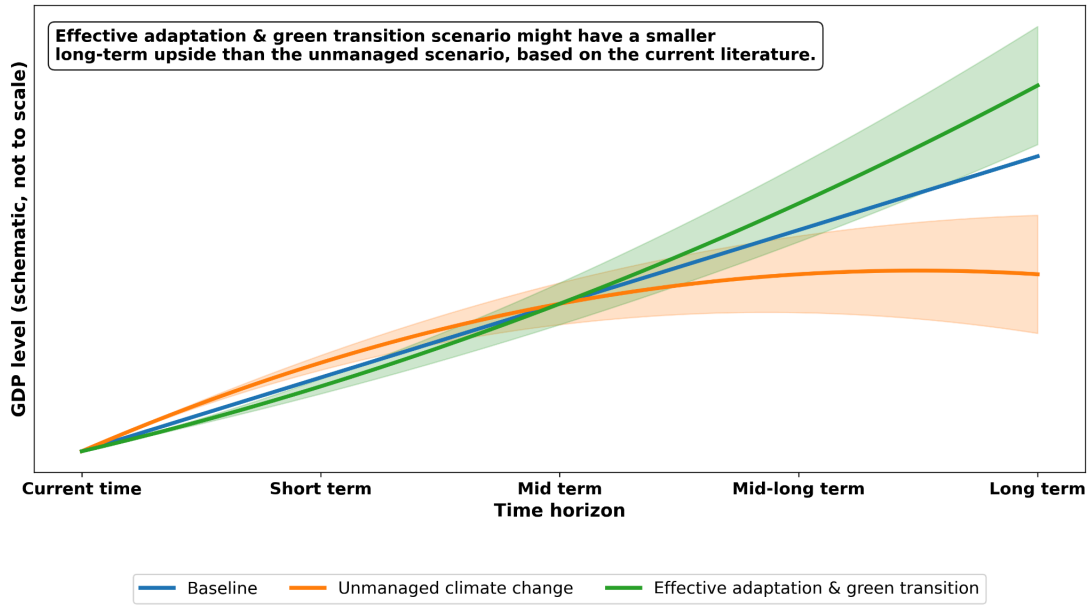
[3]: See **Box 1. Climate damages and potential gains from policy action** for details from selected literature on quantitative negative impacts of climate change, as well as the improvements under appropriate policies.

Table 1. Climate Change and Potential GDP. Drivers, Channels and Impacts

DRIVERS ---> CHANNELS	Long term climate change (chronic risks) (higher temperatures, changes to precipitation, rising sea levels and adaptation measures)	Extreme weather and climate events (acute risks) (droughts, heat waves, wildfires, storms, floods)	Climate policies and green transition (impact of policies such as carbon taxes and regulation)	CHANNELS Aggregate Impacts on Potential GDP (productive factors and TFP)
Capital Stock	Shifts in tourism flows; loss of agricultural land; water stress; coastal disruptions; biodiversity loss.	Destruction of capital stock; opportunity for rebuilding with newer capital; heightened uncertainty discouraging investment.	Stranded assets; higher energy costs from carbon taxes.	Climate change reduces effective capital through **destruction, obsolescence, and stranded assets**, though **rebuilding and green investment can partly offset.**
Labour Supply	Higher mortality and sickness; structural unemployment (e.g., tourism); climate-induced migration.	Higher mortality and sickness; disaster-induced migration; skill and education loss.	Skills mismatches; rising structural unemployment in carbon-intensive regions.	Labour supply is pressured by **mortality, sickness, and migration**, with risks of structural unemployment, but **mobility and retraining policies can ease the transition.**
Total Factor Productivity	Reduced efficiency from higher temperatures; adaptation investments less productive; resources diverted from innovation.	Bankruptcies and misallocation of finance; disrupted management and innovation; lower long-term productivity.	Output reallocation may reduce or increase efficiency; regulation may hinder or stimulate innovation (Porter hypothesis); less exposure to fossil fuel shocks.	**TFP generally declines** due to heat stress, disasters, and adjustment costs, though **green innovation and regulation may boost long-run productivity if transitions are orderly.**
HEADWINDS-TAILWINDS for climate change drivers	Long-run climate change mostly **erodes potential output** but creates **some opportunities** through **adaptation** and sectoral shifts.	Extreme weather brings **immediate destruction** but can also trigger **renewal and reallocation.**	Climate policies impose **near-term costs** but, **if managed well**, can generate **strong long-term tailwinds** through **innovation, investment, and resilience**	**Climate change creates headwinds for potential output** through capital losses, labour pressures, and productivity declines. But with effective adaptation and a well-managed green transition,they can become **long-run tailwinds** through the same channels.

Source: BBVA Research from How climate change affects potential output. ECB Economic Bulletin, Issue 6/2023

Figure 1. Conceptual Illustration of Alternative Long-Term GDP Pathways under Different Climate Change Management Strategies



Uncertainty bands widen over time, reflecting climate sensitivity, modelling choices and scenario assumptions.
Source: BBVA Research

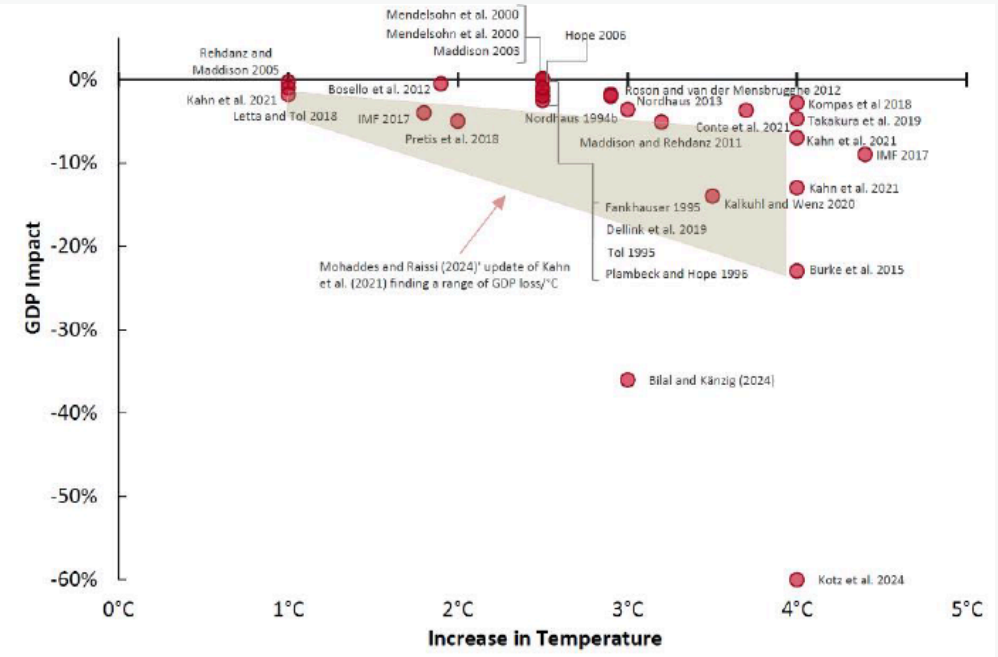
Box 1. Climate damages and potential gains from policy action

- **Central quantitative benchmarks for long-run GDP losses cluster around "a few percent" – but with very fat tails.**

  - i) OECD's 2015 "Economic Consequences of Climate Change" report suggests **global GDP losses of 1.0–3.3% by 2060 and 2–10% by 2100 in a high-emissions, limited-adaptation baseline**.[4]

  - ii) IMF's 2025 review[5] highlights that macro-damage estimates differ by an order of magnitude across studies, mainly because some treat climate as a level shock while others treat it as a growth-rate shock, and because extreme events and tipping points are often omitted. In fact, the meta-analysis of climate damage functions (**Figure B.1**) shows a statistically significant relationship between rising temperatures and GDP losses relative to a baseline scenario, although the range of estimates is also substantial.

Figure B.1 GDP Impact of Increases in Temperature. Meta-Analysis of Economic Literature(*)

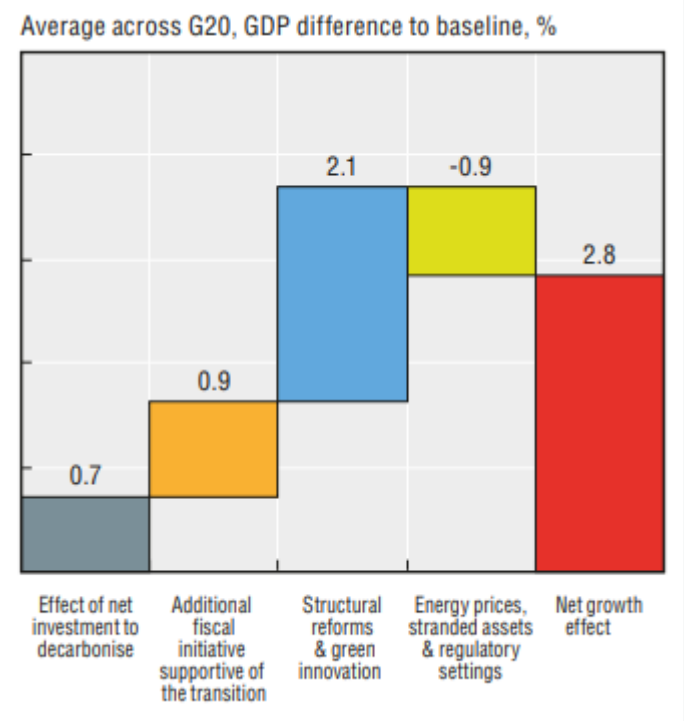


(*) Projected GDP per capita impact is for some future year, typically 2100. The shaded area represents the income losses from Mohaddes and Raissi (2024) with upper/lower bound assuming adaptation/no adaptation.
Sources: Kahn et al. (2021), Mohaddes and Raissi (2024), Tol (2024), and IPCC AR6 WGII Chapter 16, 2022.
Source: Pritha Mitra et al Integrating Climate Change into Macroeconomic Analysis: A Review of Impact Channels, Data, Models, and Scenarios. IMF, August 2025.

[4]: A later OECD technical paper refines this to 0.7–2.5% global GDP loss by 2060 for a plausible range of climate sensitivity – still excluding some non-market damages and tipping points.
[5]: Pritha Mitra et al Integrating Climate Change into Macroeconomic Analysis: A Review of Impact Channels, Data, Models, and Scenarios. IMF, August 2025.

- **Well-managed transitions can be (slightly) positive for long-run potential output.**
  - OECD (2017) finds that integrated climate-growth strategies can raise G20 GDP by up to ~2.8% by 2050 (**Figure B.2**) and nearly 5% including avoided damages, with even short-run gains (~1% of GDP by 2021) when policies boost green investment and recycle carbon revenues efficiently.

Figure B.2 Contribution of selected pro-growth and mitigation policies in the G20



Source: Investing in Climate, Investing in Growth | OECD. 2017

- IMF and NGFS reviews confirm that in most IAM/CGE/DSGE studies, long-run GDP is higher under early and ambitious mitigation than under delayed or insufficient action, even if near-term growth is slightly lower because of mitigation costs and reallocation.

Scenario dependence and asymmetries. Potential output paths diverge sharply across climate and transition scenarios. Faster transitions usually entail modest medium-term costs but deliver higher long-run output once avoided damages are accounted for. Regional impacts are highly asymmetric: low-income and climate-exposed economies face much larger losses, while some higher-latitude economies may see limited or temporary gains.

Policy framework implications. For central banks and policymakers, an important challenge is the incorporation of climate risks and transition scenarios into the estimation and forecasting of potential output. The literature provides methodological building blocks rather than a unified approach, reinforcing the case for scenario-based analysis instead of point estimates of climate-adjusted long-run GDP.

Overall, unmanaged climate change is likely to result in a large and widening negative gap in potential GDP relative to baseline, whereas early, ambitious, and well-managed mitigation and adaptation strategies may generate a more gradual positive uplift in the long run, with economy-wide spillovers through innovation and private capital investment. The specific quantification of both negative and positive effects is subject to considerable uncertainty.

Highlights of the Week

Global	State of the climate: 2025 in top-three hottest years on record as ocean heat surges - Carbon Brief. The year 2025 was in the top-three warmest years on record, with average surface temperatures reaching around 1.44C above pre-industrial levels across eight independent datasets.
Global	Climate Variability Emerges as Both Risk and Opportunity for the Global Energy Transition. Extreme heat is driving rapid growth in energy demand, increasing system stress. Hydropower is particularly exposed to rainfall variability. Climate-informed planning and forecasting are essential.
Global	The Economics of Climate Innovation: Technology, Climate Policy, and the Clean Energy Transition | NBER. "... the direction of innovation evolves endogenously, responding to economic and political incentives that may or may not push technology toward developing cheap renewable energy or new tools for climate adaptation…".
Europe	Enhancing climate analysis: new insights through data. The ESCB has strengthened its climate indicators, introducing new breakdowns of sustainable bonds, data on how inflation affects banks' carbon intensity metrics, and improved data and models assessing physical risks.
USA	• Fact Sheet: President Donald J. Trump Withdraws the United States from International Organizations that Are Contrary to the Interests of the United States – The White House. • STATEMENT: The United States Withdraws from the UNFCCC | World Resources Institute.

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