Weekly Summary

Economics of Climate Change

November 15, 2024

NGFS Phase V: The same scenarios, but less room for an orderly climate transition and greater impacts from chronic physical risks

The new release includes significant updates mainly focused on the chronic physical risk assessment, driven by a new damage function aligned with the latest research, resulting in greater projected output losses.

On November 5, 2024, the Network for Greening the Financial System (NGFS) released its fifth edition of long-term climate macro-financial scenarios. These scenarios are designed to assess forward-looking climate risks, considering both transition and physical impacts over extended timeframes based on varied assumptions. **While Phase V does not change the number or definitions of the scenarios, it introduces crucial updates**, particularly with a new damage function and updated historical data.

To support the application of these updated scenarios, the NGFS has made available **four key documents**:

- A high-level overview (note and presentation) summarizing the key updates.
- A detailed explanatory note on the new damage function.
- An updated technical document outlining the modeling framework and underlying assumptions.

Key enhancements in the Fifth Phase of NGFS scenarios

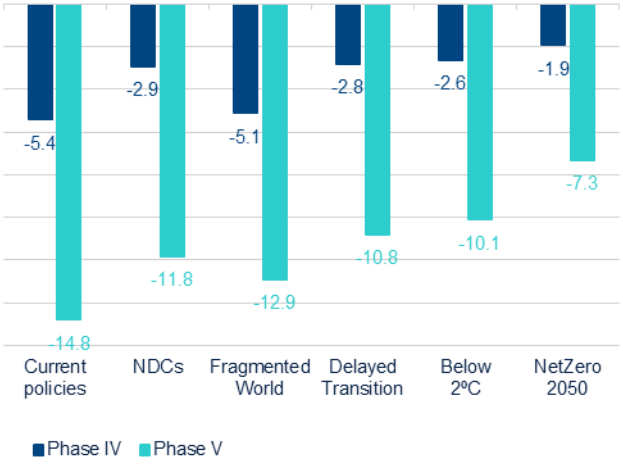
1. Introduction of a new damage function for physical risk assessment. The most notable update in this phase is the introduction of a new damage function, an econometric expression showing how tendential climatic changes impact economic output. Unlike earlier versions, which focused primarily on mean temperature increases, **this new function incorporates additional variables**, such as daily temperature variability, annual precipitation, wet-day frequency, and extreme rainfall events. This more granular approach aims to deliver a more accurate assessment of chronic physical risks (refer to **Box 1** for details). The updated function also accounts for **lagged effects**, reflecting that economic impacts from climate shocks can persist for up to a decade. **This change significantly raises projected economic damages from physical risks compared to previous estimates** (see **Figure 1**).

2. Integration of updated climate and economic data. The scenarios have been revised using the latest climate and economic projections, including:

- Adoption of the Shared Socioeconomic Pathways (SSPs, version 3.0) from the Intergovernmental Panel on Climate Change (IPCC).
- Integration of the most recent country-level policy commitments and data as of March 2024.
- Enhanced granularity in data collection, including sub-national climate data from 1979 to 2019.

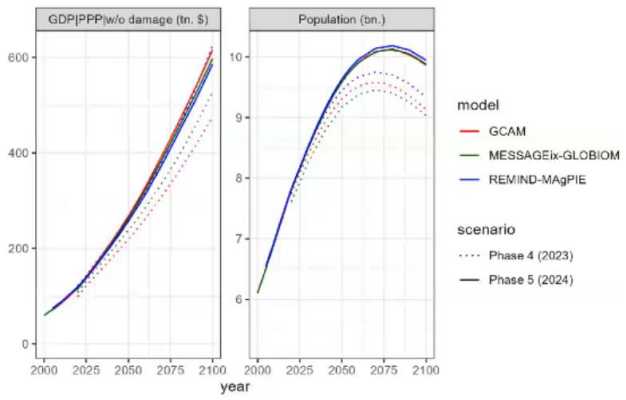
The incorporation of SSPs allows for more accurate population and GDP growth estimates that align better with the current background, improving, at the same time, the consistency across the three Integrated Assessment Models (IAMs) used by NGFS (see **Figure 2**).

Figure 1. **GLOBAL GDP IMPACT BY CLIMATE PHYSICAL RISK IN PHASE IV AND PHASE V.** 2050. % DIFFERENCE FROM BASELINE WITH NO PHYSICAL RISKS



Source: NGFS. NiGEM based on REMIND.

Figure 2. **GDP|PPP AND POPULATION PATHWAYS.** NGFS PHASE IV AND V

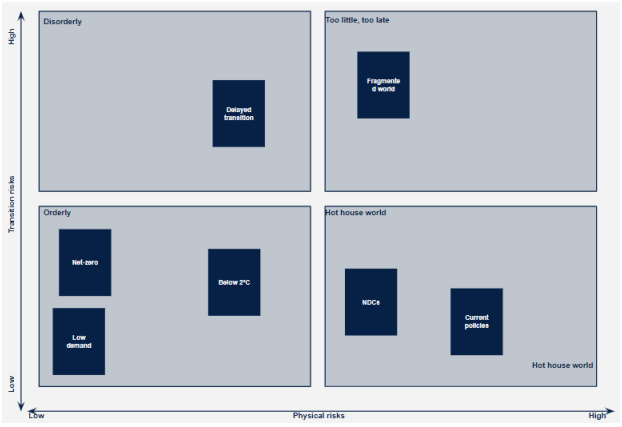


Source: NGFS.

Main findings of the updated NGFS scenarios

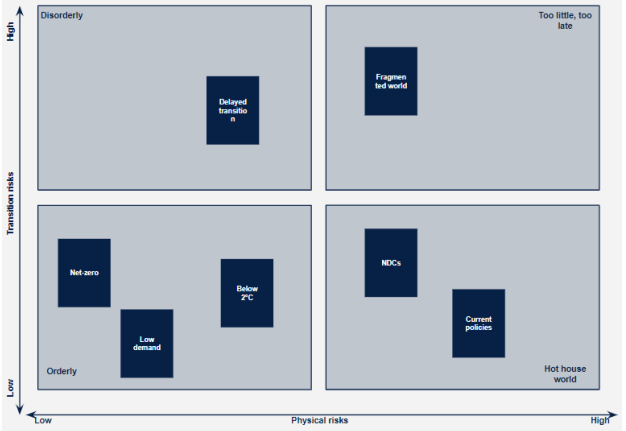
1. Limiting global warming to 1.5°C or at least 2°C remains achievable but requires an even more aggressive action. The updated scenarios reaffirm that keeping global warming within 1.5°C above pre-industrial levels is still possible but will require far more aggressive policy interventions across all sectors. **Delayed action has led to higher emissions, resulting in more disruptive transitions and steeper shadow carbon prices in the projected pathways (more disorderly transitions).** This highlights the urgent need for immediate, ambitious climate policies to mitigate severe economic disruptions from escalating physical risks.

Figure 3. **NGFS SCENARIO FRAMEWORK.** PHASE V



Source: BBVA Research from NGFS.

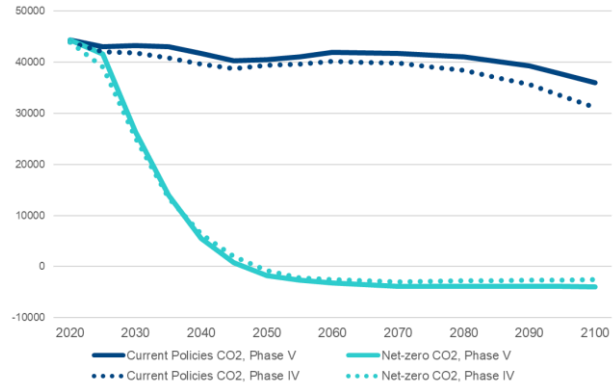
Figure 4. **NGFS SCENARIO FRAMEWORK.** PHASE IV



Source: BBVA Research from NGFS.

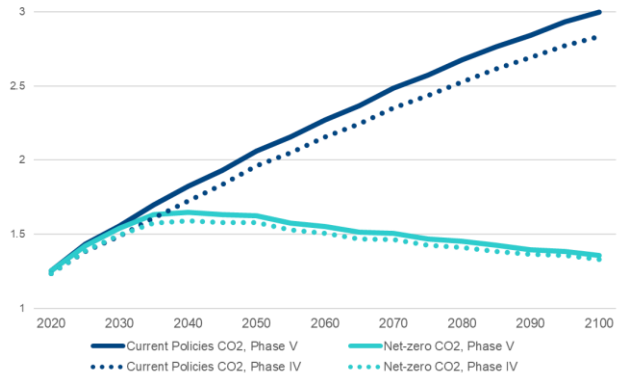
2. Higher emissions and elevated peak temperatures. Due to delayed climate actions, emissions have increased in the short term, notably impacting transition scenarios. For example, in the "Net Zero 2050" scenario, peak temperatures are now projected to reach 1.7°C, exceeding previous scenario thresholds. As a result, **stricter carbon pricing will be required to meet climate targets.** Most scenarios now project a higher peak temperature and final temperature in 2100 compared to Phase IV (see **Figures 5** and **6**). Notably, the **"Current Policies" scenario has worsened by 0.1°C** relative to the previous phase. Additionally, the **"Net Zero" scenario now requires a 3.3% additional reduction** from 2025 to 2045 -equivalent to about a 0.2% annual decrease- due to insufficient CO2 emission cuts in recent years.

Figure 5. **PHASE V VS PHASE IV. CP AND NET-ZERO SCENARIOS. CO2 EMISSIONS, WORLD.** (MT CO2/YR)



Source: BBVA Research from NGFS. REMIND-MAgPIE.

Figure 6. **PHASE V VS PHASE IV. CP AND NET-ZERO SCENARIOS. SURFACE TEMP, WORLD.** (°C ABOVE PRE-INDUSTRIAL LEVELS)

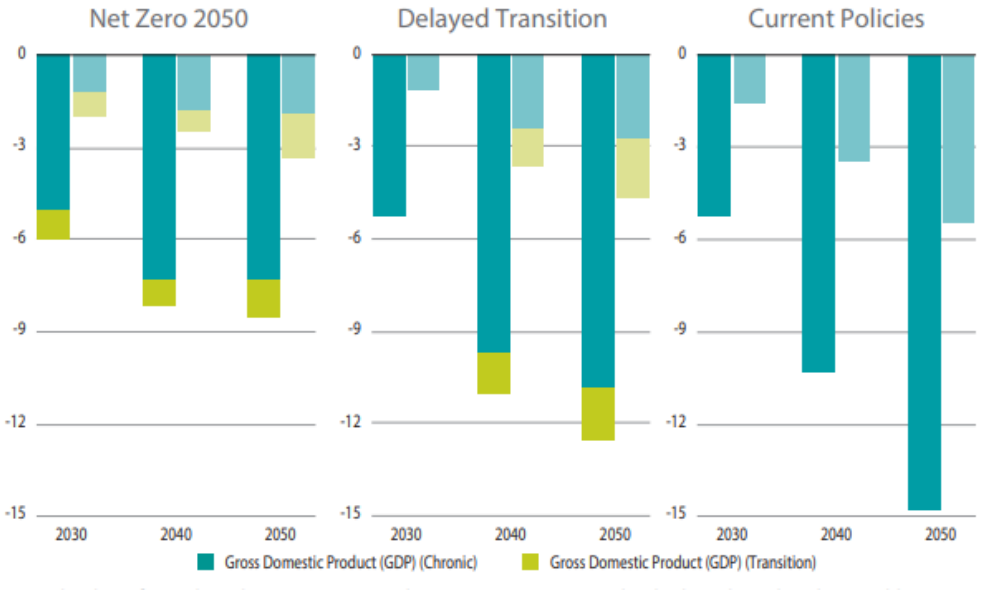


Source: BBVA Research from NGFS. REMIND-MAgPIE.

3. Physical risks now outweigh transition risks. The newly calibrated damage function reveals that the **economic impacts of physical risks are substantially higher than previously understood.** In all scenarios, the costs associated with physical risks are projected to surpass those from transition efforts (see **Figure 7**). For example, by 2050, the "Current Policies" scenario **could see economic losses** (GDP in levels) **as high as 15%, tripling the previous estimate** of 5%. This increase is largely due to the updated damage function, with only 1.5 percentage points attributed to changes in temperature projections between Phase IV and Phase V. The gap between the "Net Zero" and "Current Policies" scenarios, in terms of additional damages from chronic physical risks, has more than doubled, increasing from **3.5% to 7.5%**. With an average temperature difference of 1.6°C between the two scenarios[1], we can approximate, assuming a linear relationship, that each additional degree of warming reduces GDP level by around 4.7% due to chronic physical risks in 2050 (compared to 2.3% in Phase IV).

1: in 2100.

Figure 7. **GLOBAL GDP IMPACT BY CLIMATE RISK SOURCE IN PHASE V AND IV.**
% DIFFERENCE FROM BASELINE WITH NO PHYSICAL RISKS. PHASE V (IN FULL) VS PHASE IV (IN TRANSPARENT)



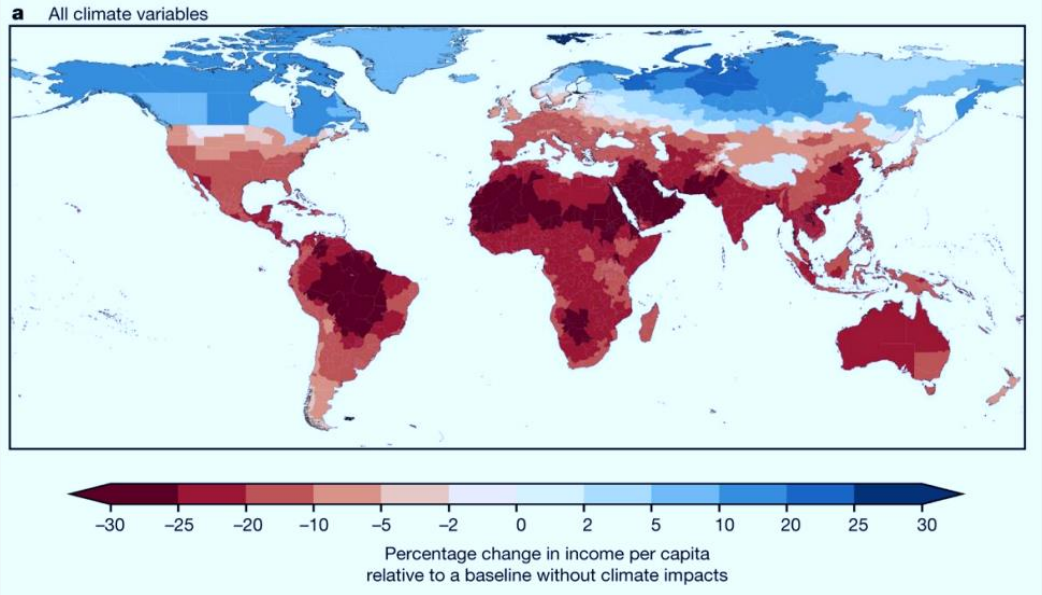
Source: NGFS. NiGEM based on REMIND.

Box 1. New Damage Function

In Phase V, a new damage function, **based on Kotz et al. (2024)**, has been introduced to better capture the physical risk impacts on the economy. This function integrates the latest scientific evidence and uses granular climate and economic data from 1979 to 2019. Unlike previous models that primarily focused on mean temperature increases, **the new function includes variables like annual temperature averages, temperature variability, precipitation, and extreme rainfall.**

One of the novel aspects of this function is its ability to catch prolonged economic impacts from climate shocks, capping persistence at a decade. Regional variations are also better accounted for, with temperature shocks affecting hot regions more severely and precipitation changes impacting dry versus wet regions differently. **However, the model's assumptions have limitations, such as equating short-term weather shocks with long-term climate impacts and using unweighted static panel regressions, which could skew results due to outlier regions.** These limitations suggest that further refinements may be necessary.[2]

Figure 8. **KOTZ ET AL. (2024). PERCENTAGE CHANGE IN INCOME PER CAPITA RELATIVE TO A BASELINE WITHOUT CLIMATE IMPACTS.** ALL CLIMATE VARIABLES.



Source: Kotz et al. (2024).

The final and preferred specification of the regression model included ten lags for both temperature variables (N) and four lags for all three precipitation variables(M). It also includes region fixed effects (μ_r), yearly fixed effects (η_y), and region-specific linear time trends (k_y). The full specification is presented below, in which $\Delta lgrp_{r,y}$ is the year-on-year growth of the log-transformed gross regional product (grp) of region r in year y.[3]

2: The first important assumption made in studies such as Kotz et al. (2024) and indeed Kalkuhl & Wenz (2020) is that short-term weather shocks are identical to climate impacts (see Howard & Sterner, 2017). While climate change certainly affects weather patterns, it is not necessarily true that long-term changes in climate have an identical effect as short-term weather variations on economic growth (Dell et al., 2014; Kolstad & Moore, 2020; Tol, 2024). Secondly, the regression is estimated using an unweighted ordinary least squares (OLS) static panel modeling approach. Since the regression is performed unweighted, all regions - large and small - are attributed the same weight. If the dataset were unbalanced, outlier regions would have the potential to skew the results. The selection of control variables poses another potential concern regarding the specification of the regression model.

$$\Delta \text{lgrp}_{r,y} = \mu_r + \eta_y + k_r y + \sum_{L=0}^{N} (\alpha_{1,L} \Delta \bar{T}_{r,y-L} + \alpha_{2,L} \Delta \bar{T}_{r,y-L} \times \bar{T}_r)$$
$$+ \sum_{L=0}^{N} (\alpha_{3,L} \Delta \tilde{T}_{r,y-L} + \alpha_{4,L} \Delta \tilde{T}_{r,y-L} \times \hat{T}_r)$$
$$+ \sum_{L=0}^{M} (\alpha_{5,L} \Delta P_{r,y-L} + \alpha_{6,L} \Delta P_{r,y-L} \times P_r)$$
$$+ \sum_{L=0}^{M} (\alpha_{7,L} \Delta \text{Pwd}_{r,y-L} + \alpha_{8,L} \Delta \text{Pwd}_{r,y-L} \times \text{Pwd}_r)$$
$$+ \sum_{L=0}^{M} (\alpha_{9,L} \Delta \text{Pext}_{r,y-L} + \alpha_{10,L} \Delta \text{Pext}_{r,y-L} \times \bar{T}_r) + \epsilon_{r,y}$$

4. Distinguishing acute from chronic physical risks becomes more uncertain. The updated NGFS scenarios emphasize the importance of differentiating acute (short-lived, extreme events) and chronic (protracted shifts) physical risks. While the new damage function theoretically addresses chronic risks, caution is advised when aggregating acute and chronic risks to avoid potential double-counting. NGFS is confident that the updated damage function effectively excludes the impact of cyclones. However, uncertainty persists regarding other acute risks, even though no changes were made to acute risk assessments in Phase V to avoid double counting **(see Table I)**. Therefore, the NGFS may currently be overestimating chronic impacts by partially including acute risks within them. As a result, we might expect an adjustment to either acute or chronic risk estimates in the next edition.

Table 1. **OVERLAP OF CHRONIC AND ACUTE RISKS**

Acute risk indicators:	Correlates with:	Bottom-up vs top-down approach:
• heat stress (impacts on labor productivity and consumption) • droughts (impacts on agricultural production) • floods (impacts on assets) • tropical cyclones (impacts on assets)	• annual mean temperature change • precipitation extremes	• empirical damage function captures dynamic effects in the whole economy to some degree already • acute risks only capture event directly ➢ complementary, not separate ➢ difficult to separate out of aggregate function, could separate drivers in the future

Source: NGFS.

In short, the fifth phase of NGFS scenarios marks a significant advancement in understanding the economic impacts of climate change. The findings[4] underscore that prompt and coordinated climate action is crucial for minimizing economic damage. Delays will only increase costs and make the transition to a low-carbon economy more disruptive. **The lessons for economic policy are clear: To design and deploy, with greater ambition, all**

3: The climate shocks included in this model are able to identify longer enduring impacts on economic output beyond the instantaneous impacts, and same time, avoid the assumption of infinite and continuously increasing climate impacts (as it is modeled in differences for both explanatory and response variables) that would come with models where the explanatory variables are in levels and the response variable in differences:
4: The findings come with the usual disclaimer of huge uncertainties around from measurement, modeling, or, last but not least, the lack of consideration of adaptation measures (unlikely), tipping points, or the compound of climate crisis.

necessary measures for a decisive and orderly climate transition. However, prospects remain uncertain, as the momentum needed for implementing global and coordinated policies aligned with ambitious decarbonization targets appears to be wavering. The outcomes of COP29, starting these days, will provide clues to confirm or dispel these expectations.

Postscript: The first edition of short-term NGFS scenarios is expected in early 2025, focusing on a 3- to 5-year horizon that combines climate risks with business cycle fluctuations (see the qualitative assessment of short-term scenarios here).

Highlights of the Week

- **Global | Analysis: Global CO2 emissions will reach new high in 2024 despite slower growth - Carbon Brief.** Carbon dioxide (CO2) emissions from fossil fuels and cement will rise around 0.8% in 2024, reaching a record 37.4bn tonnes of CO2 (GtCO2), according to the 2024 Global Carbon Budget report by the Global Carbon Project

- **Global | Global energy sector employment increased by 3.8% in 2023, outpacing the wider economy - News - IEA.** Energy sector added 2.5 million jobs worldwide last year, led by clean technology manufacturing, though skills shortages remain a key issue.

- **Global | As the climate crisis worsens, the warming outlook stagnates - News - CAT.** The combined global effect of government action on climate change has flat-lined over the last three years, underscoring a critical disconnect between the reality of climate change and the lack of urgency on policies to cut emissions.

- **Europe | Mind the gap: what it takes to finance a greener future. Christine Lagarde**. Complacency in fighting climate change and preserving biodiversity is endangering our economic survival. The longer we wait, the higher the costs will be.

- **España | Los datos evidencian la magnitud extrema de la riada: solo debía ocurrir cada 1.000 años | España | EL PAÍS.** Los registros de lluvia, caudal y área inundada recopilados por EL PAÍS describen un evento absolutamente inusual para la expectativa científica.

- **US | Lee Zeldin, Trump's EPA Pick, Brings a Moderate Face to a Radical Game Plan - News - ICN.**

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