Network for Greening the Financial System

Occasional Paper

Two Lenses on Climate Risk: A Dual Macroeconomic Reading of the NGFS Short-Term Scenarios

January 2026

About this report

In May 2025, the NGFS released its first vintage of short-term climate scenarios. Since the models used to generate these scenarios were new to most of its membership, the NGFS commissioned a second team to reproduce some of the narratives using a more familiar model (the NiGEM model, already used in the NGFS long-term scenarios) to provide an additional assessment of the macrofinancial dynamics of the official results.

This Occasional Paper presents the main results of the exercise conducted by this second team and its main takeaways. The paper is accompanied by the complete set of results produced by the NiGEM model.

Acknowledgment

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The results published and this note were produced by Claudio Baccianti (Bundesbank) Paul Champey (Banque de France), Pietro Cova (Banca d'Italia), Stéphane Dees (Banque de France), Annabelle de Gaye (Banque de France), Léopold Gosset (Banque de France & NGFS Secretariat), Ian Hurst (NIESR) Lukasz Krebel (Bank of England), Iana Liadze (NIESR), Tess Teulière (Banque de France & NGFS Secretariat).

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Disclaimer

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1. Introduction

The integration of climate-related risks into macroeconomic modelling is an area of growing importance for central banks and financial supervisors seeking to incorporate such risks into policy frameworks and financial stability assessments. While the NGFS long-term climate scenarios have laid a valuable foundation for forward-looking climate risk analysis, the short-term macroeconomic impacts of transition and physical risks remain comparatively underexplored. The NGFS Short-Term Scenarios (STS), released on 7th May 2025, address this gap by offering a stylised framework to assess the near-term macro-financial implications of climate-related shocks.

As interest in assessing short-horizon climate-related risks grows, it becomes increasingly important to understand how different modelling frameworks represent near-term economic dynamics, particularly around monetary and financial transmission channels. In this context, the NGFS tasked a Second Modelling Team (SMT) to conduct an assessment of its STS by running the same narratives and assumptions with a different model. The objective was not only to improve the credibility of scenario outputs through quality assurance, but also to enhance understanding of how different macroeconomic models capture the transmission of climate-related shocks. This paper presents the results of that exercise and draws lessons from comparing two alternative approaches to modelling the short-term macroeconomic dimension of climate scenarios.

Climate-related scenario modelling remains subject to significant uncertainty, including in the short term, given the complex interplay between economic, climatic, and policy variables. This uncertainty stems not only from the nature of the shocks but also from structural differences in how macroeconomic models represent expectations, policy responses, and sectoral adjustments. Recognising this, the NGFS has previously adopted a multi-model approach in its long-term scenario framework—using three integrated assessment models (IAMs)—to better capture the range of plausible outcomes. The use of a different macroeconomic model for this STS exercise follows a similar logic: by comparing results across distinct modelling frameworks, the NGFS aims to highlight key areas of uncertainty and improve the robustness and interpretability of scenario outputs for central banking and supervisory purposes.

The SMT used the NiGEM model developed by the National Institute of Economic and Social Research (NIESR), a global macroeconometric model focusing on macroeconomic and financial dynamics within and between countries. It is already part of the NGFS long-term scenario framework. The First Modelling Team (FMT), in contrast, used a suite-of-models framework that combines a real economy model with highly granular representations of climate and transition impacts (GEM-E3) with other two models that quantify the effects on the monetary and financial variables (EIRIN and CLIMACRED).

While the FMT's approach allows for more disaggregated sectoral impacts and is tailored to stress-testing applications, the SMT's framework provides a unified, internally consistent treatment of macroeconomic aggregates.

In addition to the diverging areas of focus between the different models considered, it is also worth noting that each model relies a on different theoretical underpinning: GEM-E3 is a Computable General Equilibrium (CGE) model focusing on sectoral dynamics. It builds on a neoclassical approach while incorporating some market imperfections (especially in the labour market). Within this framework, supply and demand permanently adjust through flexible relative prices as economic agents individually optimize. EIRIN, in contrast, draws from post-Keynesian theories and follows a stock-flow consistent and balance sheet accounting approach and is demand-driven. Finally, NiGEM is also different from the two previous models: it relies on a new-Keynesian framework, where demand dynamics prevail in the short-term, before converging toward production trend while accounting for various frictions in the return to equilibrium. While conceptual, these differences have direct consequences on the transmission channels specified in each model. Divergences in response to similar shocks are to be expected as an outcome of this exercise.

This paper compares results from both modelling approaches across three NGFS STS narratives: two scenarios – Highway to Paris (HWTP) and Sudden Wake-up Call (SWUC) – focus on the effects of transition risks, while one physical risk scenario – Disasters and Policy Stagnation (DAPS) – delves into the consequences of extreme but plausible regional weather events. The analysis assesses the consistency and plausibility of key macro-financial variables[1]—such as GDP, inflation, interest rates, investment, international trade and unemployment—and explores the sources of divergence in economic dynamics across the two frameworks. The calibration of shocks for the NiGEM simulations followed, as closely as possible, those developed by the FMT, allowing for a meaningful cross-model comparison.

Several key differences emerge from the comparison. Notably, NiGEM simulations exhibit more gradual inflation dynamics and monetary policy responses, partly due to a different representation of pricing mechanisms compared to EIRIN. The comparison also underscores deeper structural divergences. In the NiGEM framework, the anticipated transition (HWTP scenario) triggers a rapid and adverse adjustment, consistent with forward-looking behaviour under rational expectations. Conversely, the response to an unanticipated transition (SWUC scenario) is more muted and more delayed. This pattern is reversed in the FMT results, where the unexpected shock generates stronger and more immediate impacts. These differences reflect both expectation mechanisms and broader modelling architecture.

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[1] NiGEM's framework focuses on macro-financial dynamics. Therefore, this exercise could not extend the comparison to sectoral or financial outputs produced by the FMT.

This work contributes to the growing literature comparing outputs of alternative modelling frameworks applied to climate scenario analysis. While much of the existing work focuses on long-term transition pathways and the energy-economy nexus[2], less attention has been paid to short-term macroeconomic modelling of climate-related shocks. By focusing on a consistent set of narratives over a 3–5 year horizon, our comparison sheds light on how assumptions about expectations, policy rules, and supply–demand interactions shape near-term economic outcomes.

The exercise also underscores the value of cross-model validation when applying climate scenarios in central banking and supervisory contexts. A single-model framework like NiGEM ensures internal coherence and facilitates interpretation of macro-financial results, but may lack the sectoral resolution needed for detailed risk assessments. Conversely, a suite-of-models approach offers greater granularity but can face challenges in maintaining internal consistency across economic aggregates.

The remainder of this paper is structured as follows. Section 2 presents the NGFS STS, including a brief description of the narratives and modelling framework. Section 3 outlines the methodology used in NiGEM, explains its key features, and contrasts it with the FMT approach. Section 4 provides a comparative analysis of the results across both modelling frameworks, focusing on real GDP, inflation, policy rates, unemployment, investment, and trade. This section includes separate discussions of the HWTP, SWUC and DAPS scenarios, each under rational and adaptive expectations. Section 5 concludes.

2. The NGFS short-term scenarios

The NGFS STS aim to support policymakers, regulators, and financial institutions in assessing the near-term macro-financial implications of climate change and associated mitigation policies. Unlike long-term scenarios, which focus on the structural transformations needed to achieve climate objectives over decades, the STS framework emphasizes the macroeconomic and financial dynamics unfolding over a five-year horizon.

To achieve this, the STS modelling framework integrates both transition and physical risks within a coherent structure of interlinked models. It captures not only the direct economic consequences of climate-related shocks but also the transmission channels across sectors, geographies, and financial systems. Specifically:

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[2] See, for instance, NGFS (2022), "Running the NGFS Scenarios in G-Cubed: A Tale of Two Modelling Frameworks", NGFS Occasional Paper or Warwick J McKibbin, Adele C Morris, Peter J Wilcoxen, Augustus J Panton, 2020. "Climate change and monetary policy: issues for policy design and modelling," Oxford Review of Economic Policy, vol. 36(3), pages 579-603.

- **Transition risks** are modelled by accounting for the timing, scale, and stringency of climate mitigation policies, their effects on technological deployment, and the resulting macro-financial feedback loops.
- **Physical risks** are assessed through georeferenced exposures and sector-specific vulnerabilities, capturing direct damages, supply chain disruptions, and productivity losses.

Importantly, due to the short time horizon, transition policies are assumed to have negligible effects on physical risks within the five-year window, as climate impacts in that timeframe are largely locked in by past emissions. Thus, while both risk types are modelled, their interplay is asymmetric in the short term.

2.1 Narratives

The NGFS STS narratives are designed to explore the near-term macro-financial consequences of various climate-related shocks, focusing on both transition and physical risks. A baseline scenario is also provided, where economic variables are aligned with the IMF's World Economic Outlook (dated October 2023), and climate policies follow a 'current policies' pathway (i.e. where only legislated climate policies are implemented). This paper concentrates on three NGFS STS:

- The **Highway to Paris** (HWTP) scenario describes a gradual and orderly transition to a low-carbon economy, driven by technological change and policy support. Here, rising carbon prices are accompanied by reinvestment into green subsidies and infrastructure, supporting economic activity and facilitating a smooth reallocation of capital.
- In contrast, the **Sudden Wake-Up Call** (SWUC) scenario envisions an abrupt shift in policy and market sentiment, with a rapid increase in carbon prices triggering supply-side disruptions and sharp asset repricing, resulting in financial instability—a so-called "Climate Minsky Moment."
- Finally, the **Disasters and Policy Stagnation** (DAPS) scenario focuses on physical risk, with a sequence of extreme weather events in 2026–2027 leading to capital destruction, productivity losses, and cascading impacts across global trade and financial networks. These shocks generate broader macroeconomic and financial instability in the absence of meaningful policy responses. This scenario is composed of five regional variants, where each variant explores the impact of the simultaneous occurrence of extreme weather on one macro-region (continent scale). Physical shocks are calibrated using global climate models, using 50-years return period. This methodology allows capturing each region's historical vulnerability to weather events and tailor the shocks to their own specificities and global propagation mechanisms.

A fourth scenario, **Diverging Realities**, which explores asymmetric global transition and physical shocks, is part of the NGFS STS but is not considered in this paper.

2.2 Modelling Framework Overview[3]

The STS framework adopts a multi-model architecture, logically coupling highly granular and structurally diverse tools to reflect the complexity of climate-related shocks. Three core models are integrated:

- **GEM-E3**: A large-scale applied computable general equilibrium (CGE) model that captures technological and economic dynamics across 50 sectors and 46 countries/regions. It models both the impacts of transition policies (e.g. ETS markets, carbon pricing, RES and energy efficiency targets) and physical damages through supply chain propagation. It features a detailed representation of the energy system and its interaction with the economy capturing all critical aspects including fuel mix per agent, capital costs of technologies, investments, production costs and competitiveness, bilateral trade, employment etc.
- **EIRIN**: A macro-financial Stock-Flow Consistent (SFC) model that simulates macroeconomic, monetary, fiscal, and financial dynamics under climate scenarios. EIRIN accounts for substitution between high- and low-carbon capital, the macro-financial effects of transition and physical risk shocks (notably in terms of GDP and inflation), and the monetary policy responses they trigger.
- **CLIMACRED**: A credit risk model that estimates changes in firms' financial positions and sectoral risk metrics based on GEM-E3 and EIRIN outputs and additional climate-related shocks. It computes changes in default probabilities, asset valuations, and the cost of capital at the sectoral level.

The models exchange information iteratively to reflect feedback effects:

- GEM-E3 determines carbon prices and sectoral output trajectories in response to transition policies and acute physical shocks.
- EIRIN uses GEM-E3's carbon prices to derive inflation and policy rates.
- CLIMACRED computes sector-specific financial risks and cost of capital, using GEM-E3's sectoral trajectories and EIRIN's policy rates.
- Sectoral Weighted Average Cost of Capital (WACC), capital stock loss and interest rate spread are computed by CLIMACRED and are reintegrated into GEM-E3 for a second simulation round, capturing macro-financial feedbacks.

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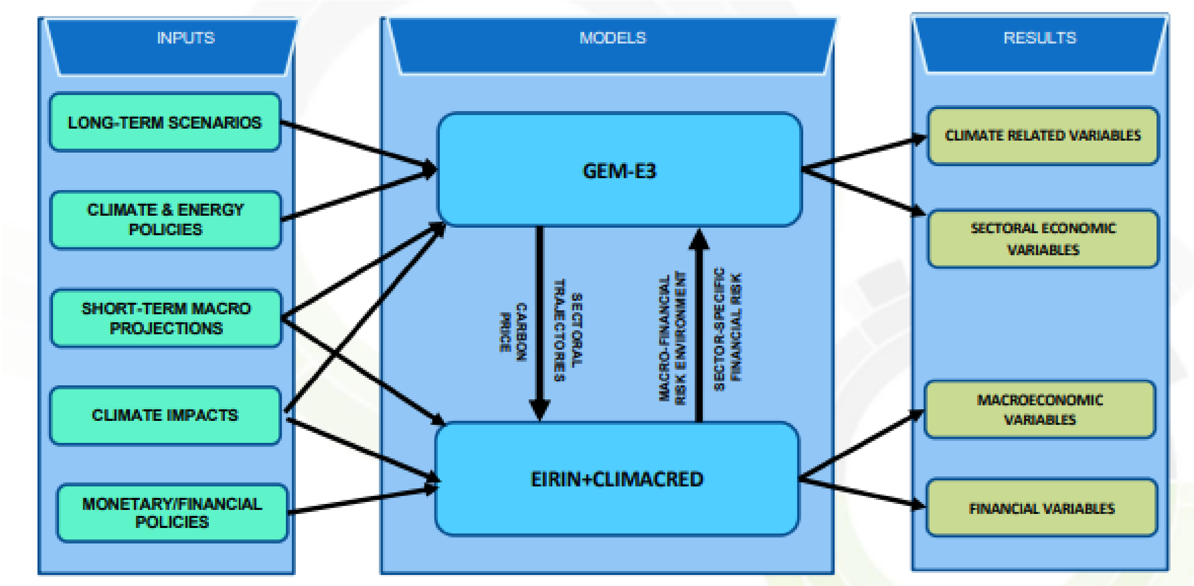
[3] A more comprehensive presentation of each model is available in the NGFS STS technical documentation

Figure 1. Model interaction within the Main Modelling Team



The framework also enables a consistent assessment across different domains:

- **Sectoral granularity**: Detailed outputs for economic activity, investment, and financial risks across 50 sectors.
- **Geographical disaggregation**: Country- and macro-region-specific impacts.
- **Financial indicators**: Probabilities of default, value-at-risk, interest rate dynamics.
- **Macroeconomic aggregates**: GDP, inflation, policy rates, trade, investment and unemployment.

3. Methodology of the model comparison exercise

The aim of this paper is to evaluate how alternative macroeconomic models capture the near-term impacts of climate-related shocks using the set of NGFS STS narratives described above. By comparing the responses generated by two contrasting modelling approaches—NiGEM and the FMT suite—the paper seeks to highlight how structural assumptions about expectations, monetary and fiscal transmission, and sectoral adjustment shape macro-financial outcomes. This comparative exercise serves both as a peer-review of the NGFS short-term scenarios and as a broader contribution to methodological transparency and model development in climate-related macroeconomic analysis.

As with the NGFS long-term scenarios, the decision to explore short-term risks using more than one modelling framework also reflects a broader awareness of model uncertainty. Different macroeconomic models embed alternative assumptions about behavioural responses and market adjustment mechanisms, which can lead to divergent outcomes even under the same narrative. Acknowledging these uncertainties is essential for designing robust stress-testing frameworks and interpreting scenario results with appropriate caution.

3.1 The NiGEM model

The NiGEM model is a global econometric model that has been developed and refined over more than 30 years. NiGEM serves as a comprehensive tool for economic forecasting, scenario analysis, and policy simulation, widely used by policymakers, central banks, international organisations, and private sector institutions around the world. The model is supported by a user-friendly interface designed to facilitate both straightforward forecasting and advanced simulation experiments.

NiGEM integrates detailed individual country models for the major economies, linking them through trade and financial flows to capture global economic interdependencies. It combines econometric estimation with strong theoretical foundations, embedding long-run economic relationships alongside flexible short-run dynamics. NiGEM’s structure reflects modern macroeconomic theory, including features such as sticky prices, forward-looking expectations, and monetary policy rules, making it suitable for analyzing a wide range of macroeconomic policies and shocks.

The model’s flexibility allows users to customize assumptions on monetary policy regimes, households, companies and financial sectors' expectation formation, which enables nuanced exploration of various economic scenarios. NiGEM is also notable for its quarterly frequency, which improves the capture of economic dynamics compared to annual models.

The NiGEM climate model extension integrates a carbon tax mechanism that affects domestic and global energy prices by incorporating the additional cost of carbon emissions into fuel prices. The model captures how a carbon tax increases the effective price of fossil fuels—oil, gas, and coal—thereby reducing their consumption gradually over time as producers and consumers adjust. Energy intensity is explicitly modeled, allowing the simulation of shifts in energy use and substitution effects in production and consumption. The model also includes feedback loops whereby changes in energy demand affect world fuel prices, which in turn influence import and export prices.

Beyond carbon pricing, the climate extension in NiGEM incorporates the broader economic implications of climate-related physical risks. These physical risks include damage to productive capital, disruptions in international trade and adverse effects on labour productivity caused by extreme weather events such as floods, storms, heatwaves, and droughts. The model allows these physical shocks to reduce potential output and raise inflationary (but also deflationary) pressures through supply-side constraints.

Overall, the NiGEM climate extension offers a comprehensive framework to analyse the macroeconomic impacts of both climate policy and physical risks. By capturing interactions across energy markets, production, and climate-driven shocks, it provides valuable insights into how economies may transition toward a low-carbon future while managing the physical consequences of climate change.

3.2 Key differences with the FMT

The FMT follows a modular approach; the SMT relies only on NiGEM, representing the economy as a single internally consistent system, ensuring coherence across macroeconomic aggregates. However, this comes at the expense of granularity: NiGEM lacks the detailed sectoral resolution of GEM-E3 and does not explicitly model financial frictions or climate-specific credit risks as in CLIMACRED and EIRIN. Furthermore, NiGEM relies on more stylised representations of the green transition propagation mechanisms, while GEM-E3 and EIRIN, which have been natively developed for the purpose of climate scenario design, tend to have more details on green technologies diffusion (see Table 1). These structural differences influence both the magnitude and timing of macroeconomic responses to climate-related shocks.

Finally, macroeconomic models used by both teams diverge in their economic theoretical underpinning:

On the FMT side:

- GEM-E3 is a Computable General Equilibrium (CGE) model, where demand and supply equalize at each iteration, and features many components of the neoclassical theory (but GEM-E3 also includes some frictions and labour market imperfections);
- EIRIN is a post-Keynesian, demand-led model, not underpinned by a general equilibrium framework (supply and demand adjust through quantities rather than prices, allowing the existence of shortages or unsold products)

NiGEM, on the SMT side, is based on a New Keynesian structure and shares many characteristics with Dynamic Stochastic General Equilibrium (DGSE) models such as rational expectations or nominal rigidities. Moreover, NiGEM uses econometric techniques to allow short-term dynamics diverging temporarily from the theoretical pathway to ensure a better empirical fit.

These differences in calibration and structural representation of economic phenomena can lead to diverging dynamics in response to similar shocks (it is however important to note that models can hardly implement the exact same shocks due to their different framework and structure).

Model	**GEM-E3**	**EIRIN**	**NiGEM**
Model type	Computable General Equilibrium	Macrofinancial Stock-Flow Consistent	Macroeconometric (semi-structural)
Agents' behaviour	Myopic	Adaptive	Rational or adaptive
Economic sector(s)	50	7	1
Production function (production factors)	Nested CES function embedded into a Leontief production function (Labour, Capital, Energy, Materials)	Leontief production function (Labour, Capital, Raw Materials)	CES function embedded into a Cobb-Douglas production function (Labour, Capital, Energy)
Monetary Policy	Exogenous (provided by EIRIN)	Taylor Rule calibrated on Coenen et al. (2023)	Two-pillar rule (default NiGEM rule)
Representation of transition-relevant sectors	Comprehensive bottom-up representation of the electricity sector (including electricity distribution) with additional details on the energy sector to represent explicitly all CO2 emissions from the sector. Other GHG emissions (eg from industrial processes) are implicitly covered and are abated through marginal abatement cost functions	One Oil & Gas sector, a green and a brown capital goods sector, a green and a brown utility sector.	The aggregated production function distinguishes between oil, gas, coal, and non-carbon inputs for the energy factor.
Model interaction	Two-way coupling: For transition shocks, EIRIN receives the carbon price computed by GEM-E3 in a first run, then, for all types of shocks (transition & physical), GEM-E3 receives a sectoral WACC encompassing the monetary policy rate computed by EIRIN for a second run.		One-way coupling: NiGEM takes GEM-E3's carbon price, revenues, and energy consumption to align on transition assumptions. No inputs from GEM-E3 or EIRIN are needed for physical shocks.

Table 1: key features and setting of GEM-E3, EIRIN, and NiGEM in the context of the NGFS STS project[4]

[4] Several information provided here are only valid for this exercise and may vary in other papers using the same models.

3.3 Comparison exercise

For results to be comparable, a common set of shocks have been taken from GEM-E3 and CLIMACRED[5], reflecting the quantified narrative of the scenarios, and plugged into NiGEM. NiGEM's baseline has also been aligned on GEM-E3's by taking its energy consumption per energy source. Table 2 in the annex presents the inputs used by NiGEM to perform its comparative exercise. The goal of the exercise was to produce macroeconomic results that could be compared with those produced by the FMT models, i.e. GDP and trade coming from GEM-E3 as well as inflation and interest rates coming from the EIRIN model.

4. Results

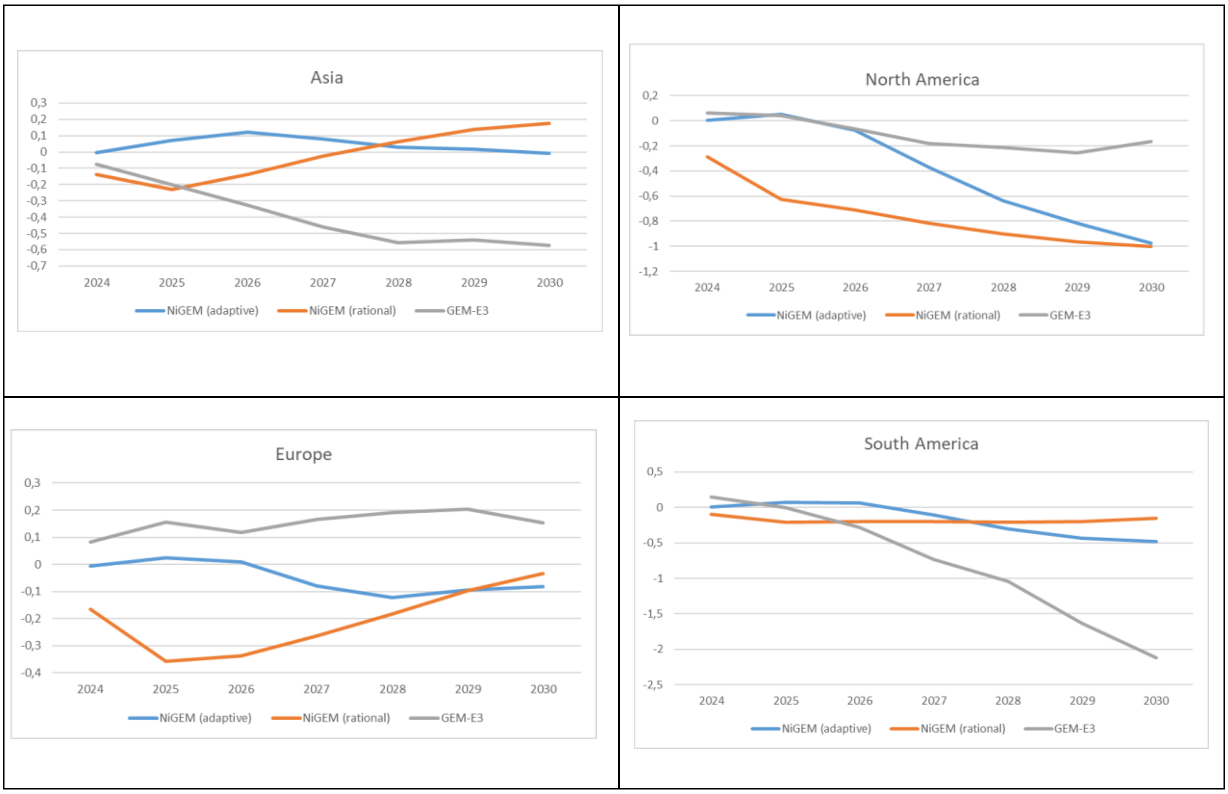
This section compares published STS outcomes with NiGEM results for key macroeconomic variables. We highlight similarities and explain notable differences. Results are presented by scenario (HWTP, SWUC and DAPS) under both rational and adaptive expectations for the NiGEM simulations.

4.1 Highway to Paris (HWTP)

The HWTP scenario refers to a gradual and orderly transition to a low-carbon economy. However, in the short term, such a transition could generate costs due to the increase in carbon prices, which could trigger macroeconomic disturbances stemming, among other things, from frictions in market adjustments. Figure 4 shows that the cost in terms of GDP is quite heterogeneous across regions and models. For the FMT, the GDP loss is moderate in North America and relatively larger in Asia, while the scenario leads to some gains in Europe (that has already improved carbon intensity already in the baseline – hence more resilient to carbon pricing). On the contrary, with NiGEM, the GDP impacts are muted in Asia while close to a 1% loss of GDP in 2030 in North America. Europe does not gain in this scenario and suffers a small loss. The GDP losses with NiGEM are larger with rational than adaptive expectations, in particular in North America and Europe.

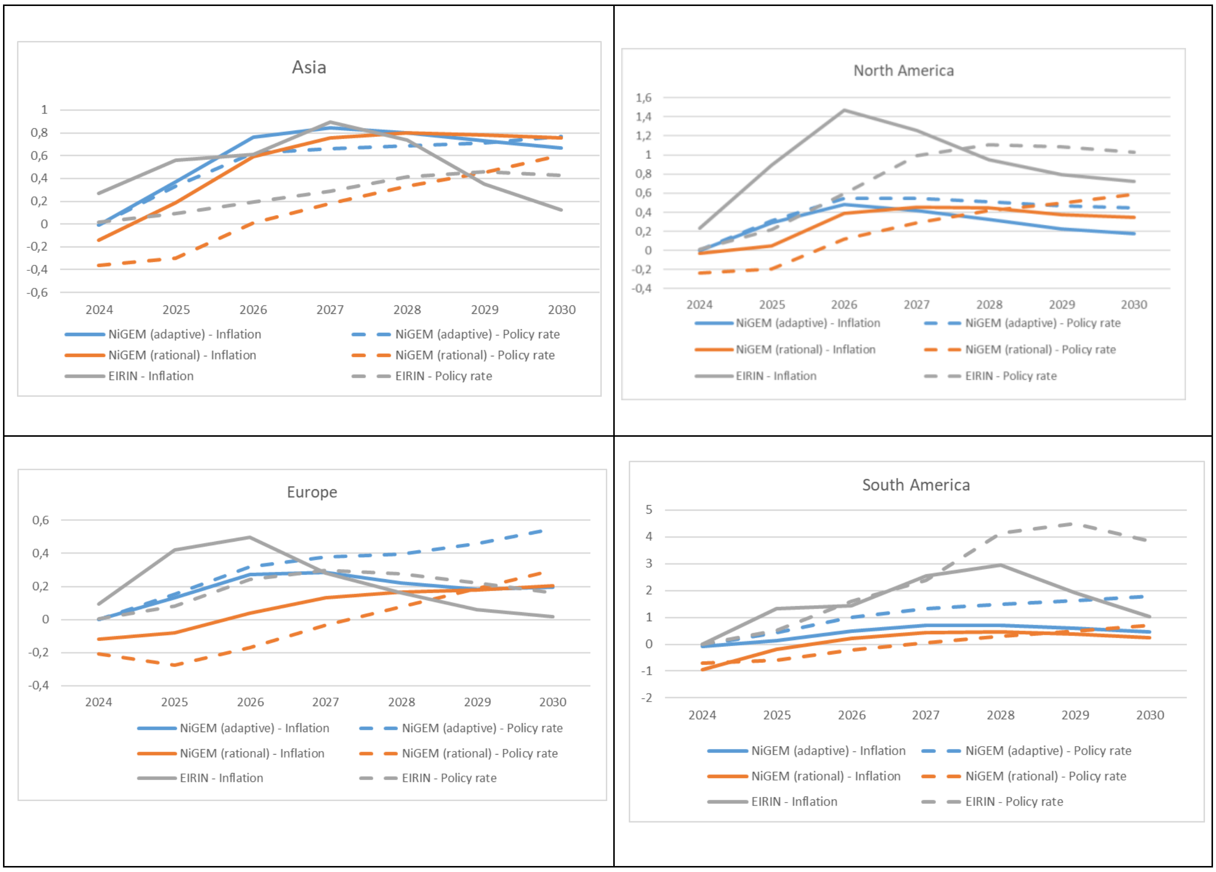
[5] While the governance and work of the two teams was kept separated, in few occasions the two teams had to collaborate on exchange of variables and information

Figure 4. Real GDP in the HWTP scenario (% deviation from baseline)



Inflation responses are broadly similar across models for Asia, showing a moderate increase of up to 1 percentage point. In contrast, inflation reacts more strongly and rapidly in North America—and to a lesser extent in Europe—under the EIRIN model, particularly when NiGEM runs under rational expectations (Figure 5). These differences in inflation dynamics also drive varying monetary policy responses. In North America, the monetary tightening is more pronounced in EIRIN, reflecting the sharper inflationary pressures. For Europe and Asia, the interest rate response under EIRIN falls between the two NiGEM simulations, with the mildest tightening observed under NiGEM with rational expectations.

Figure 5. Inflation and policy interest rates (dashed) in the HWTP scenario (absolute deviation from baseline)



Overall, NiGEM produces a more front-loaded decline in GDP, particularly under rational expectations, reflecting stronger anticipatory responses to the transition shock[6]. The associated weakening in demand leads to relatively moderate inflationary pressures and mild monetary policy reactions. In contrast, the FMT results show a more gradual GDP contraction, alongside a sharper initial increase in inflation that diminishes over time. These results, based on adaptive expectations, seem to be more driven by supply-side constraints compared to those from NiGEM.

[6] These results are in line with those coming from Environmental Dynamic Stochastic General Equilibrium models, like Ferrari and Nispi-Landi (2022).

4.2 Sudden Wake-Up Call (SWUC)

In the SWUC scenario, the disorderly implementation of the transition triggers larger GDP losses compared to HWTP (Figure 6). In Asia, the decline is sudden and pronounced for GEM-E3 (around -1.7%), whereas in NiGEM the output decline occurs much more gradually especially under rational expectations. Similar patterns are observed for North America, except that the GDP decline is more muted in GEM-E3 compared to NiGEM. In all regions, the disorderly transition in 2027 translates in both models into lower domestic demand, resulting almost always into negative GDP impacts. However, in Europe, under rational expectations NiGEM foresees first a slightly positive GDP impact, before turning negative in the later years. This result is driven by a temporary increase in exports, which is sufficient to offset the decline in demand and boost economic activity for two years.

Figure 6. Real GDP in the SWUC scenario (% deviation from baseline)

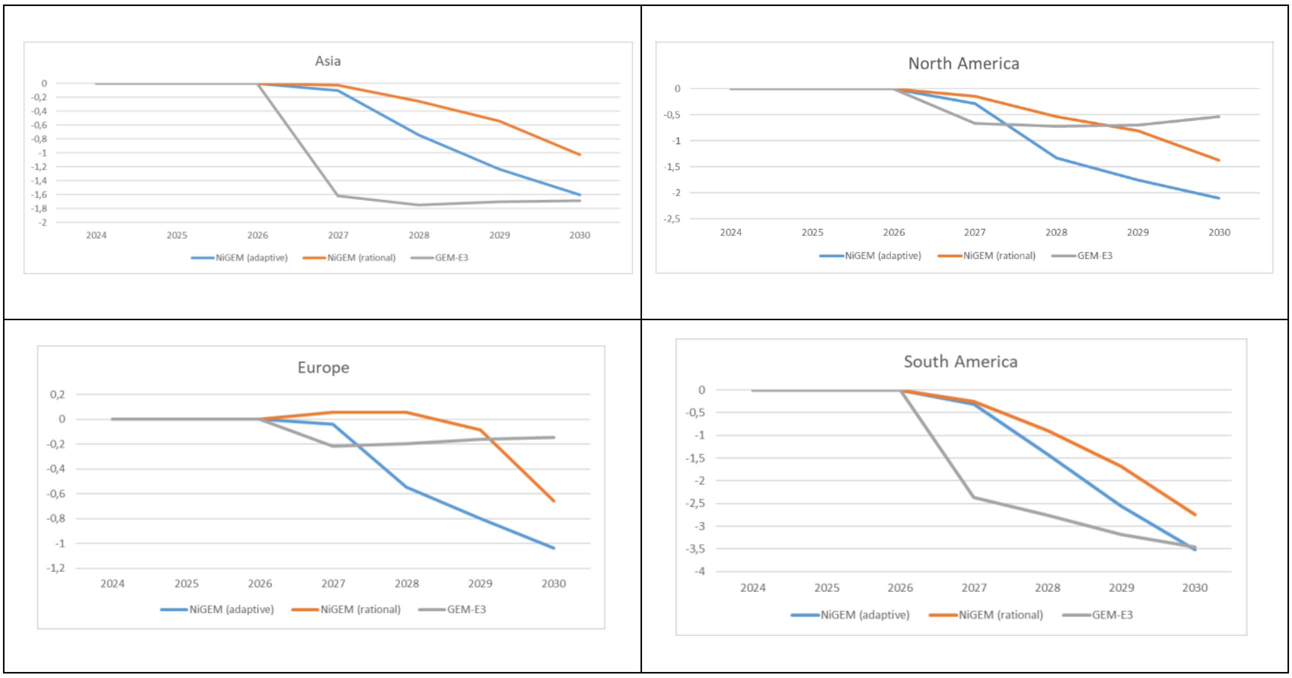
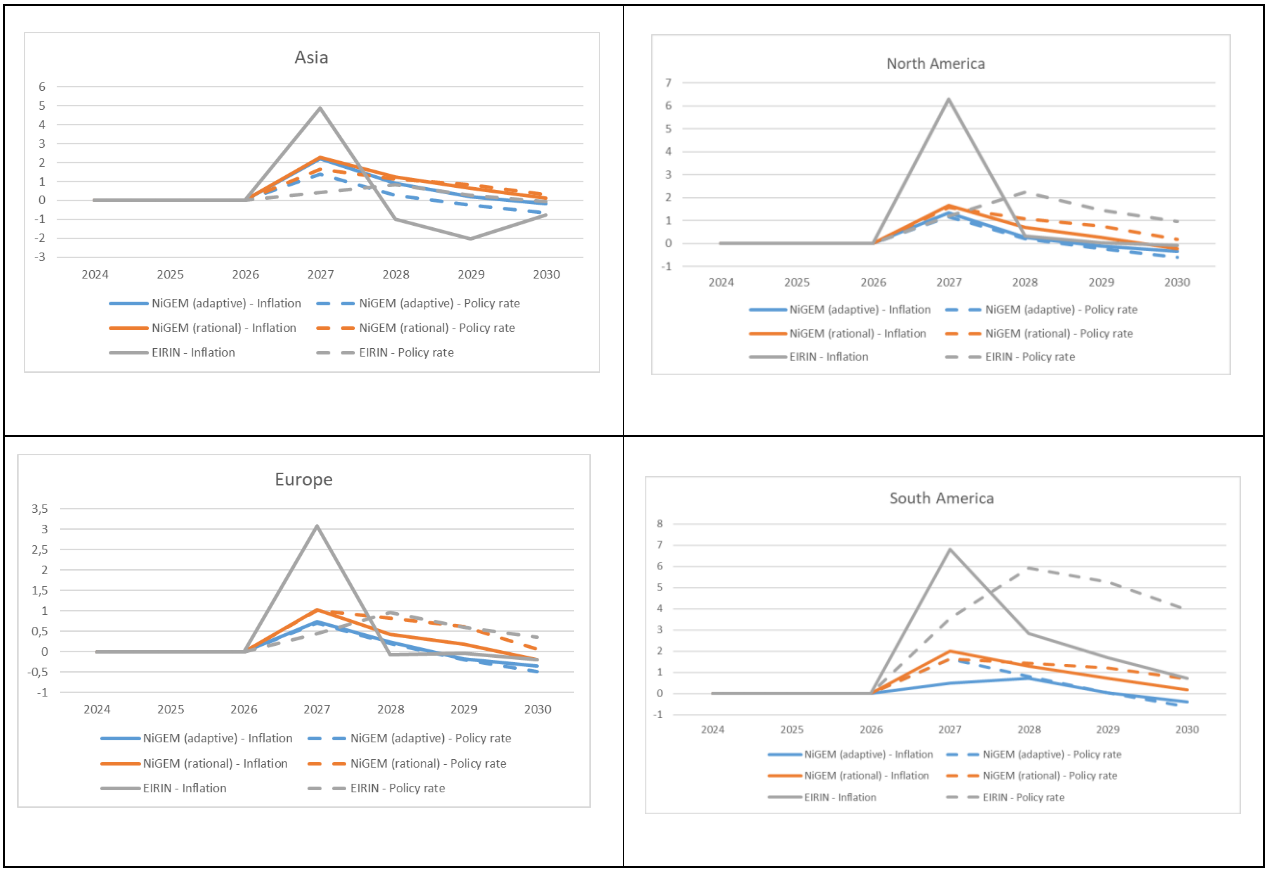


Figure 7. Inflation & policy interest rates (dashed) in the SWUC scenario (absolute deviation from baseline)



The inflation trajectories differ markedly between NiGEM and EIRIN (Figure 7). In NiGEM, nominal rigidities and subdued demand contribute to a gradual rise in inflation—reaching around 2 percentage points in Asia and North America, and about 1 percentage point in Europe. The response is slightly more pronounced under rational expectations. In contrast, EIRIN displays a faster and stronger inflationary response, with prices peaking in the first year following the shock, particularly in North America where inflation rises by up to 6 percentage points. However, this spike is short-lived: inflation returns to baseline within two years in North America and Europe. In Asia, price dynamics are more volatile, with inflation falling below baseline levels by 2029, reaching –2 percentage points. Despite the differences in inflation dynamics, the monetary policy response is relatively similar across models for Europe and Asia, with a modest tightening of up to 1 percentage point. The main divergences appear in North, and particularly, in South America, where EIRIN produces significantly stronger monetary policy responses, with policy rates rising by up to 2 and 6 percentage points respectively. Note that monetary policy responses appear generally more delayed in EIRIN compared to NiGEM.

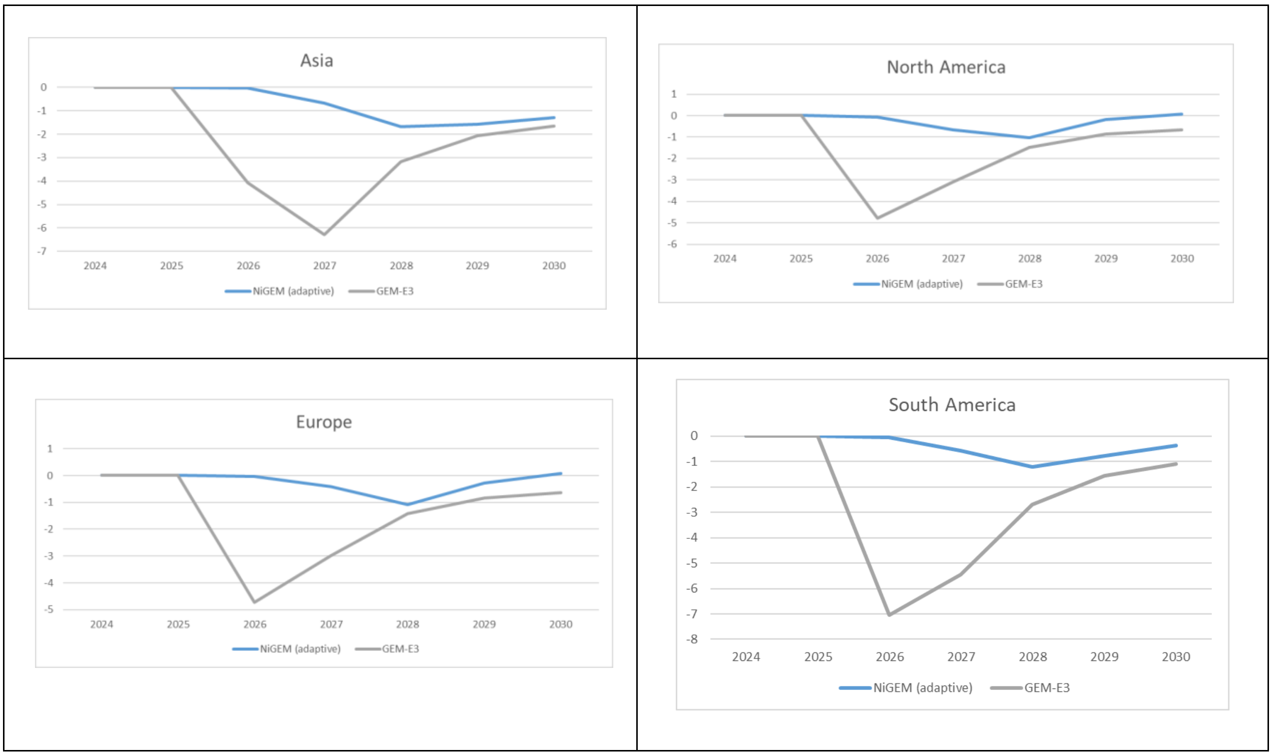
Overall, in the SWUC scenario, NiGEM and FMT show similar overall GDP losses by 2030 but differ in timing—NiGEM's decline is more gradual, while FMT's is sharper, especially in Asia. Inflation rises more quickly and sharply in FMT's EIRIN model, leading to stronger monetary tightening in North and South America compared to NiGEM. These differences highlight once more how model structure and expectations influence the assessment of short-term climate transition impacts.

4.3 Disasters and Policy Stagnation (DAPS)[7]

In the Disasters and Policy Stagnation (DAPS), the loss in GDP is much stronger under the FMT than in NiGEM. NiGEM shows a more muted and delayed GDP response to physical shocks, with the largest impacts materializing two years after the shock. In contrast, the FMT models show sharper GDP declines followed by faster recovery (Figure 8).

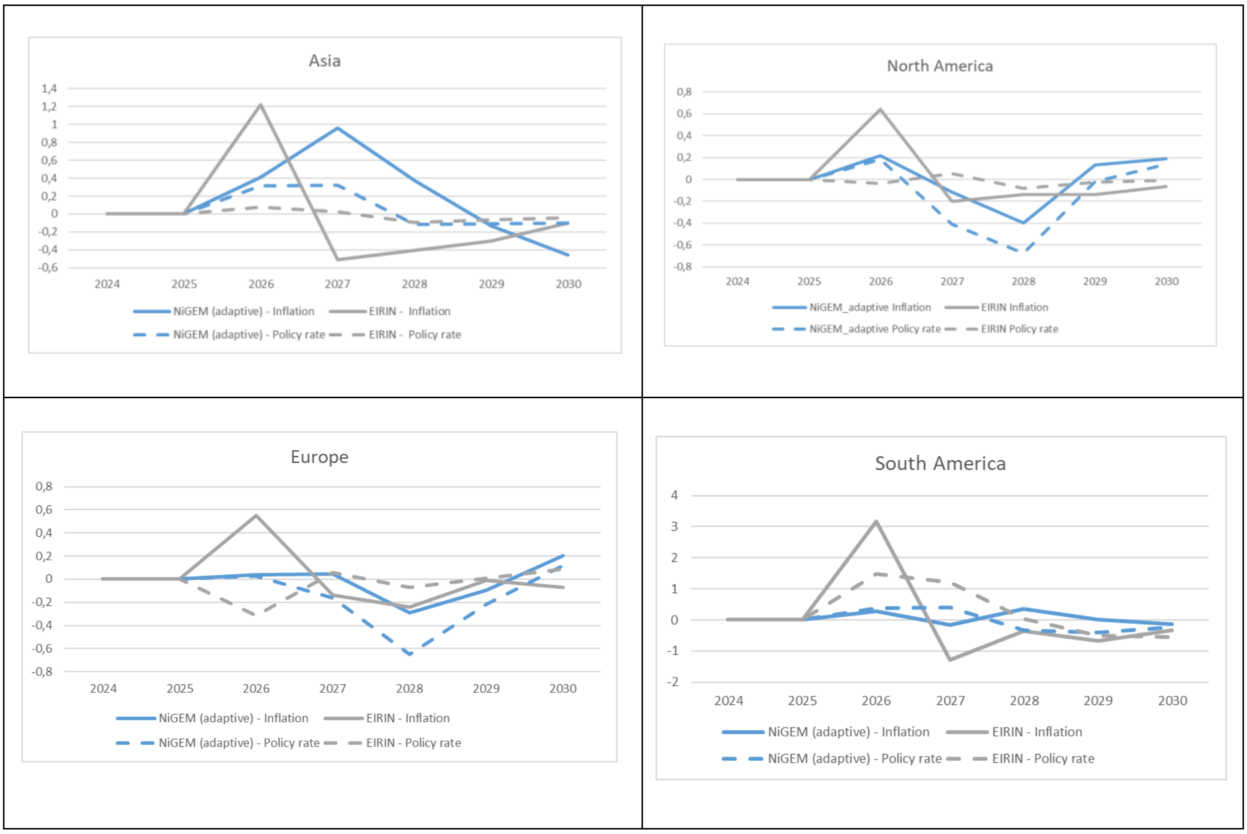
[7] For the Disaster and Policy Stagnation, NiGEM was run with adaptive expectations only given the exogenous nature of physical shocks.

Figure 8. Real GDP in the DAPS scenario (% deviation from baseline)



The timing of the inflation response follows a similar pattern across models but differs in magnitude and persistence (Figure 9). In NiGEM, inflation increases are generally more muted and delayed, with inflationary effects primarily observed in Asia, while the GDP decline tends to exert downward pressure on prices by 2028 in North America and Europe. In contrast, EIRIN shows a more immediate but relatively modest price reaction—up to 1 percentage point in Asia—that is short-lived, with inflation also declining over the horizon in some regions. Monetary policy responses diverge as well: EIRIN exhibits a shallow reaction characterized by slight rate increases followed by small decreases, whereas NiGEM produces more pronounced adjustments, including a marked reduction in policy rates after GDP contracts post-shock in North America and Europe.

Figure 9. Inflation & policy interest rates (dashed) in the DAPS scenario (absolute deviation from baseline)



Overall, in the DAPS scenario, the FMT models capture sharper and more immediate GDP declines followed by quicker recoveries, while NiGEM shows a more muted and delayed response to physical shocks. Inflation dynamics also differ, with NiGEM exhibiting more gradual and regionally varied effects, contrasted by EIRIN's faster but modest price changes. These differences extend to monetary policy, where NiGEM's responses are more pronounced, reflecting the models' distinct treatment of shock transmission and monetary policy reaction function.

4.4 Lessons from the comparison exercises

The comparison exercise between NiGEM and the models used by the FMT (notably EIRIN and GEM-E3) reveals important qualitative differences in model dynamics, particularly in how macroeconomic variables respond to transition scenarios. These divergences are relevant for interpreting results and for accounting for model uncertainty in any model-based analysis of climate-related shocks.

Expectations assumptions and GDP dynamics

A striking finding is the role of expectations in shaping GDP responses across scenarios. Under rational expectations, NiGEM shows a faster and more pronounced negative impact on GDP in the HWTP scenario compared to GEM-E3. An important consideration with regard to this scenario is the recycling of revenues generated by carbon pricing, which can have a sizeable impact on the macroeconomic impact of the transition. In this exercise, the very different frameworks only allow limited alignment between the recycling strategies adopted: in GEM-E3, carbon revenues subsidize the R&D of renewables technologies, reducing production costs for these sectors. As such, carbon revenues mainly impact the supply side. Since NiGEM represents the economy at an aggregated level, carbon revenues are recycled through additional government investment, boosting aggregate demand. Another modelling divergence (relevant here for all transition scenarios) is that GEM-E3 can endogenously compute the total additional investment needed for the green transition, while NiGEM can only explicitly account for those allowed by the recycling of carbon revenues. This in turn leads to different aggregate investment results between models (see Figure 11 in annex), directly translating into diverging GDP dynamics.

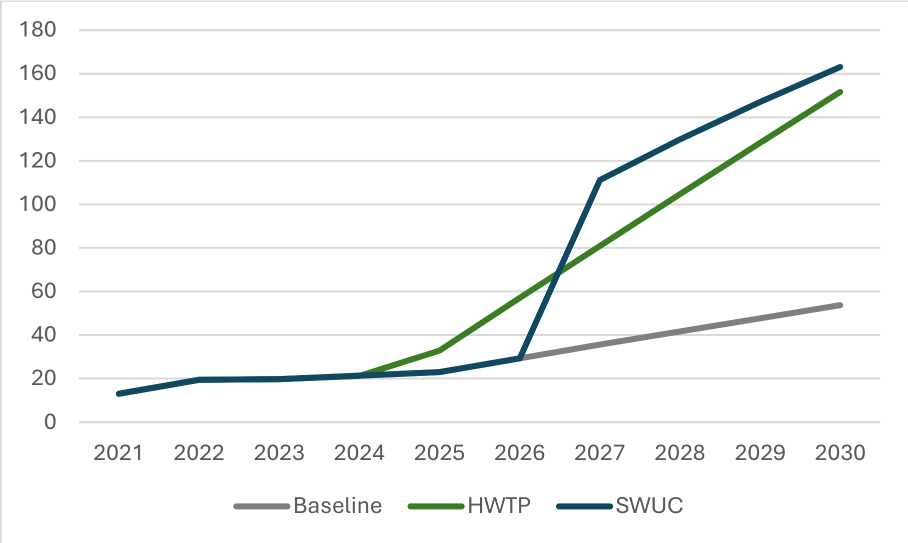
Trade patterns (discussed below) which directly affect each model's GDP dynamics also exhibit strong divergences between GEM-E3 and NiGEM.

These differences can result in diverging dynamics between models. Conversely, in the SWUC scenario, NiGEM produces a more gradual GDP decline, in contrast with the sharper and earlier downturns observed in the FMT models. This pattern reverses when NiGEM is run with adaptive expectations: GDP responses become more aligned with those of GEM-E3, underscoring the sensitivity of results to expectation assumptions.

Differences in inflation and policy rate responses

In both EIRIN and NiGEM, the inflation reaction for the HWTP and SWUC scenarios is primarily driven by the implementation of carbon taxes, taken in both cases from GEM-E3 (see Figure 10). As such, the inflationary spikes in 2027 observed in EIRIN and NiGEM for the SWUC scenario are consistent with the steep increase of carbon price provided by GEM-E3. Likewise, inflation dynamics are overall more staggered in the HWTP scenario, which is expected given the smooth and gradual increase of carbon price in line with the scenario's narrative.

Figure 10. World weighted carbon price from the GEM-E3 model for the baseline, Highway to Paris, and Sudden Wake-Up Call scenarios (in US$2017/t CO2)



Inflation dynamics vary across models for the same scenario. In EIRIN, inflation is more abrupt during both inflation spikes and subsequent declines. NiGEM, by contrast, displays smoother and more gradual adjustments over time.

Relatedly, the response of policy rates is also model-dependent. In EIRIN, the return to normal of inflation is particularly fast—especially when considering that the Taylor rule implemented by EIRIN aligns with most calibrated or estimated models used by central banks (e.g., the NAWM of the European Central Bank).

These differences are most likely a consequence of the respective price formation mechanisms encompassed in both models:

- In EIRIN, consumption prices are modelled as a mark-up on companies' unit production costs. Unit production costs in EIRIN include wages, energy and material costs, carbon taxes and depreciation costs. Therefore, an increase in carbon taxes will directly translate into inflationary pressures.
- In NiGEM, consumer prices follow a different approach: they also depend on unit total costs, but also consider the price of imports, and VAT effects. The transition effect on prices is obtained by computing an energy tax rate using carbon tax and revenues provided by GEM-E3, which then mimic a VAT impact (cfr. Table 2 in the Annex). Importantly, the change in consumer prices in NiGEM is also impacted, in the short- to medium-term, by the level of capacity utilization (or output gap) of the economy.

Hence, while both models share some similarities in their price formation mechanisms (such as wages, which are accounted into unit production costs, and follow in both models a Philips curve), different channels can also affect NiGEM and EIRIN's price dynamics. NiGEM's prices are sensitive to endogenous exchange rates through import prices under forward-looking expectations, while EIRIN's exchange rates are kept constant in the NGFS STS (as in NiGEM with adaptive expectations). The mechanisms modelled here are different and could explain diverging results.

As a final point of discussion on the inflation dynamics, we can take a step back and try to look for real-life examples of energy-driven inflation and broadly assess its unfolding compared to the simulation given by the models. In 2021, the European economies experienced a surge in energy prices (further exacerbated in 2022 following the war in Ukraine and the ban on Russian fossil fuels). Even though this is not a disorderly transition shock *per se* as in the Sudden Wake-Up Call scenario, in both cases, we see a sudden and unexpected rise in fossil fuel prices that passed through consumer price.

Both situations have otherwise very limited comparability (energy price increase in Europe was driven by multiple independent factors), but one can observe that during this episode, inflation surged steeply, moving for the Euro Area from 0.9% in January 2021 to 10.6% in October 2022, before quickly falling back below 3% as of October 2023 (source: Eurostat). These steep up and down dynamics are somewhat closer to the EIRIN results than to those of NiGEM[8].

Trade and sectoral effects

Trade responses (imports and exports) also diverge considerably (see Figure 12 in the Annex), with frequent differences in both magnitude and sign between the NiGEM and FMT results. One striking difference concerns the dynamics of imports and exports. In GEM-E3, the effects of the transition are more severe for exports than for imports, resulting in generally negative contributions from trade to GDP. This may reflect supply-side constraints that reduce the volume of goods available for export. By contrast, in NiGEM, imports are generally more affected by the shocks than exports, leading to some positive contributions from trade. This effect mainly stems from a decline in domestic demand, which reduces import volumes.

Additionally, the broader sectoral structure—more granular in GEM-E3—may further explain the stronger supply-side impacts on exports, contributing to the variations in GDP impacts, particularly in the SWUC scenario.

Finally, differences in expectation assumptions also play a role: when NiGEM adopts adaptive expectations, its results tend to align more with those of GEM-E3. This seems consistent with the fact that both EIRIN and GEM-E3 have backward-looking structures (cfr. also Table 1).

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[8] NiGEM can however also display steep increase in inflation in case of sudden oil and gas price increase, see for example Liadze et al. (2022)

Physical risk impacts

Several factors could explain the striking GDP and inflation differences in both timing and magnitude to physical shocks between the FMT's models and NiGEM:

First, the supply-nature of the physical shocks implemented can explain the delay observed between both modelling frameworks. In GEM-E3, demand and supply equalize permanently to comply with the computable general equilibrium framework, while in NiGEM, demand dynamics prevail in the short-run, and then converge toward output trend, explaining the lag observed in NiGEM for the physical risk impact.

Second, with regard to the magnitude of impacts, since NiGEM has no sectoral representation, it can only capture the direct effect of sectoral shocks after aggregating them. In contrast, GEM-E3 is able, with its Social Accounting Matrix (SAM) framework, to capture the indirect effects of physical shocks stemming from sectors' interdependence.

These differences highlight the importance of considering each modelling framework's particularities when calibrating climate shocks. The physical shocks used by both teams were designed to match GEM-E3's sectoral granularity and framework. Further refinements, rather than a simple weighted aggregation of shocks as done for imposing the shocks in NiGEM, could yield additional interesting comparisons of the macroeconomic transmission of these shocks across the two models.

Model uncertainty

These findings underscore the importance of expectation assumptions, monetary policy calibration, and sectoral granularity in shaping model results. They illustrate how quantitative outcomes can vary significantly depending on these modelling choices. Moreover, this exercise highlights the value of conducting model comparison exercises to better account for model uncertainty in the analysis of climate-related shocks. Given the complexity and novelty of these shocks, relying on a single modelling framework may lead to incomplete or potentially misleading conclusions. Cross-model assessments can help identify robust insights and inform more resilient policy design.

5. Conclusions

This comparative exercise between NiGEM and the FMT suite used for the NGFS STS highlights the importance of model architecture, expectation formation, and sectoral granularity in shaping the macroeconomic assessment of climate-related risks. While both modelling frameworks are capable of producing internally consistent narratives for a range of transition and physical risk scenarios, their structural differences lead to important divergences in timing, magnitude, and transmission channels of economic impacts.

Several key differences emerge from the comparison. First, the assumption about expectations formation strongly influences the GDP trajectories, with rational expectations in NiGEM producing more front-loaded declines than the FMT models, and adaptive expectations yielding to more similar dynamics. Second, inflation and monetary policy responses diverge significantly: EIRIN tends to produce more abrupt and short-lived inflation shocks, with interest rate paths, while NiGEM exhibits smoother, demand-driven inflation and generally a more gradual and timely policy tightening / loosening. Third, sectoral granularity in GEM-E3 and CLIMACRED captures complex transition and physical risk transmission mechanisms—particularly through supply chains and trade—which NiGEM's aggregated structure cannot fully reflect. In the case of physical risks, these modelling differences—particularly in sectoral resolution and demand versus supply-driven dynamics—lead to diverging estimates of both timing and severity of GDP impacts, emphasizing the importance of calibrating shocks to model structure.

As central banks and financial supervisors expand their use of climate scenarios, this type of model comparison will become increasingly important. Transparent assessments of model capabilities and limitations can strengthen the credibility of scenario analyses and support more informed policymaking. Going forward, greater collaboration across modelling teams, enhanced documentation of assumptions, and continued investment in methodological innovation will be essential to advance the field and ensure that climate-related risks are adequately captured in macroeconomic and financial frameworks. Future modelling efforts could for example improve macroeconomic models' ability to capture local heterogeneity and dynamics in the low-carbon transition and the economic impact of climate change.

Annex

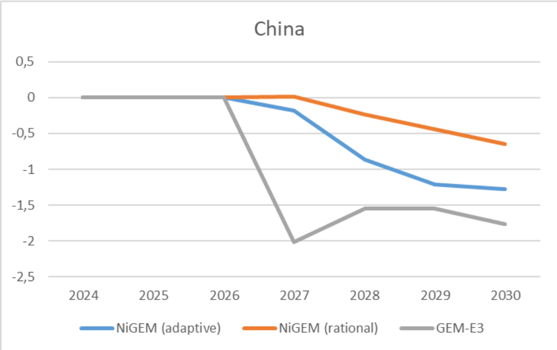
Table 2: Inputs from the Main Modelling Team used to produce comparable simulations with the NiGEM model

	Input used from main modelling team (model providing the input)	Variables shocked in NiGEM (variable acronym)	Additional detail
Baseline alignement	Energy consumption growth rate (GEM-E3)	Energy consumption growth rate applied to the v1.24 NiGEM forecast (OILC, GASC, COLC, RNWC)	Energy country-level consumption in GEM-E3 is proxied by calculating the following: $Consumption^{fuel\ type} = Production^{fuel\ type} - Exports^{fuel\ type} + Imports^{fuel\ type}$
Transition shocks	Energy consumption change compared to baseline (GEM-E3)	Fossil fuel & renewables consumption (OILC, GASC, COLC, RNWC)	The change in energy consumption between scenarios is calculated by: $Consumption^{fuel}_{\%\ change} = \frac{Consumption^{fuel\ type}_{scenario}}{Consumption^{fuel\ type}_{baseline}}$
	Carbon price (GEM-E3)	Carbon price (CBTAX)	Imported in absolute difference from baseline
	Carbon tax revenues (GEM-E3)	Energy tax (ETAX)	Energy tax rate is calculated endogenously within NiGEM using the GEM-E3 carbon tax revenue for the purposes of calculating the inflationary impact of the carbon price where $Total\ carbon\ tax\ revenue = emissions_{scenario} * carbon\ price_{scenario} - emissions_{baseline} * carbon\ price_{baseline}$ NB: To align assumptions with GEM-E3, 40% of total GEM-E3 revenue is considered available for recycling it back into the economy.
Confidence shock	Cost of capital (CLIMACRED)	Investment Premium (IPREM)	Input data is only available at GEM-3 sector's level. Hence, an aggregation was made using GEM-E3's capital stock as a weighting factor.
Uncertainty shock	Equity adjustment (CLIMACRED)	Equity price shock (EQP)	Input data is only available at GEM-3 sector's level. Hence, an aggregation was made using GEM-E3's capital stock as a weighting factor.
	Sovereign bond adjustment (CLIMADRED)	Bond spread shock (TPREM)	
Physical shocks	Capital destruction (for all sectors and hazards)	Investment Premium (IPREM)	Input data is only available at GEM-3 sector's level. Hence, an aggregation was made using GEM-E3's capital stock as a weighting factor.
	Labour productivity loss (for all sectors and hazards)	Labour augmenting technology (TECHL)	Input data is only available at GEM-3 sector's level. Hence, an aggregation was made using GEM-E3's sectoral production as a weighting factor.
	Production lost (for all sectors and hazards)	Trend productivity (YCAP)	Input data is only available at GEM-3 sector's level. Hence, an aggregation was made using GEM-E3's sectoral production as a weighting factor.

Figure 11. Real investment in the HWTP and SWUC scenarios for selected countries (% deviation from baseline)

HWTP

SWUC


China
0,5
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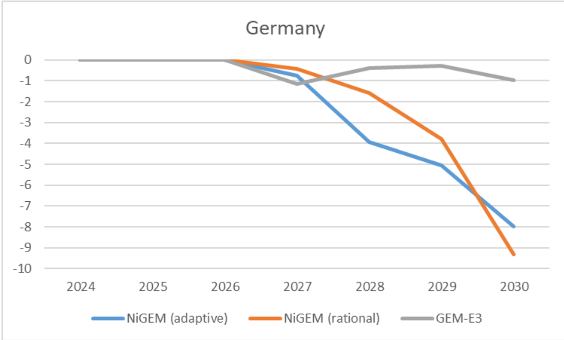
2024 2025 2026 2027 2028 2029 2030
NiGEM (adaptive) NiGEM (rational) GEM-E3


Germany
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-2
-3
-4
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-6
-7
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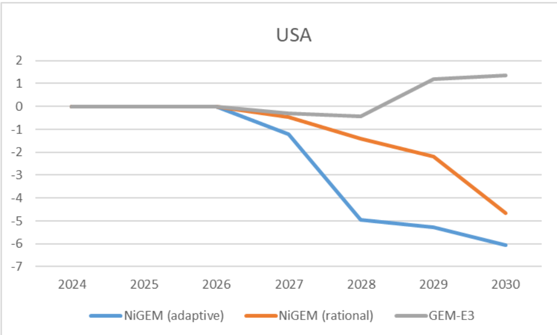
-9
-10
2024 2025 2026 2027 2028 2029 2030
NiGEM (adaptive) NiGEM (rational) GEM-E3


USA
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-1
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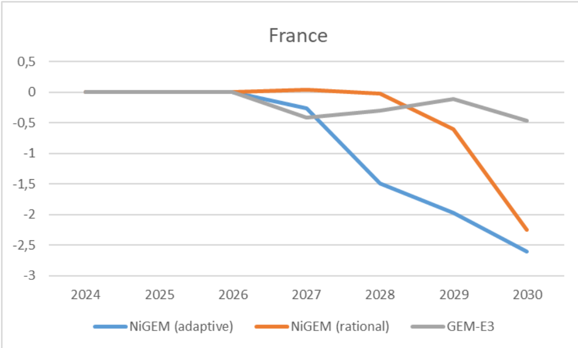
2024 2025 2026 2027 2028 2029 2030
NiGEM (adaptive) NiGEM (rational) GEM-E3


France
0,5
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-0,5
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-2
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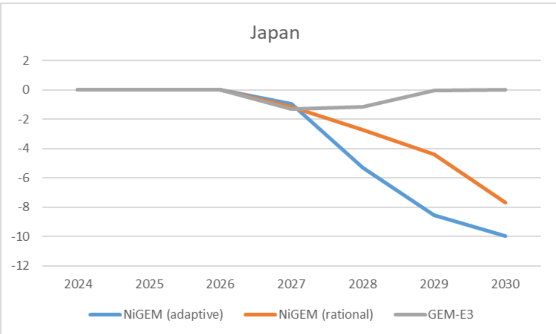
-3
2024 2025 2026 2027 2028 2029 2030
NiGEM (adaptive) NiGEM (rational) GEM-E3


Japan
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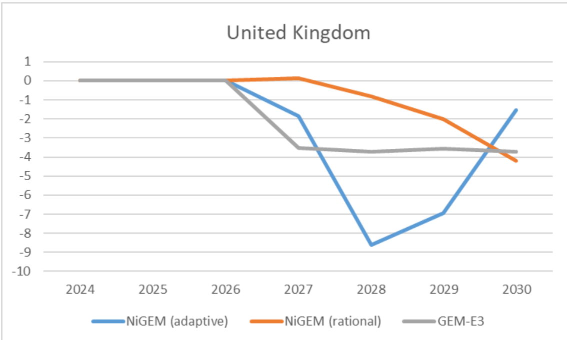
-12
2024 2025 2026 2027 2028 2029 2030
NiGEM (adaptive) NiGEM (rational) GEM-E3


United Kingdom
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-7
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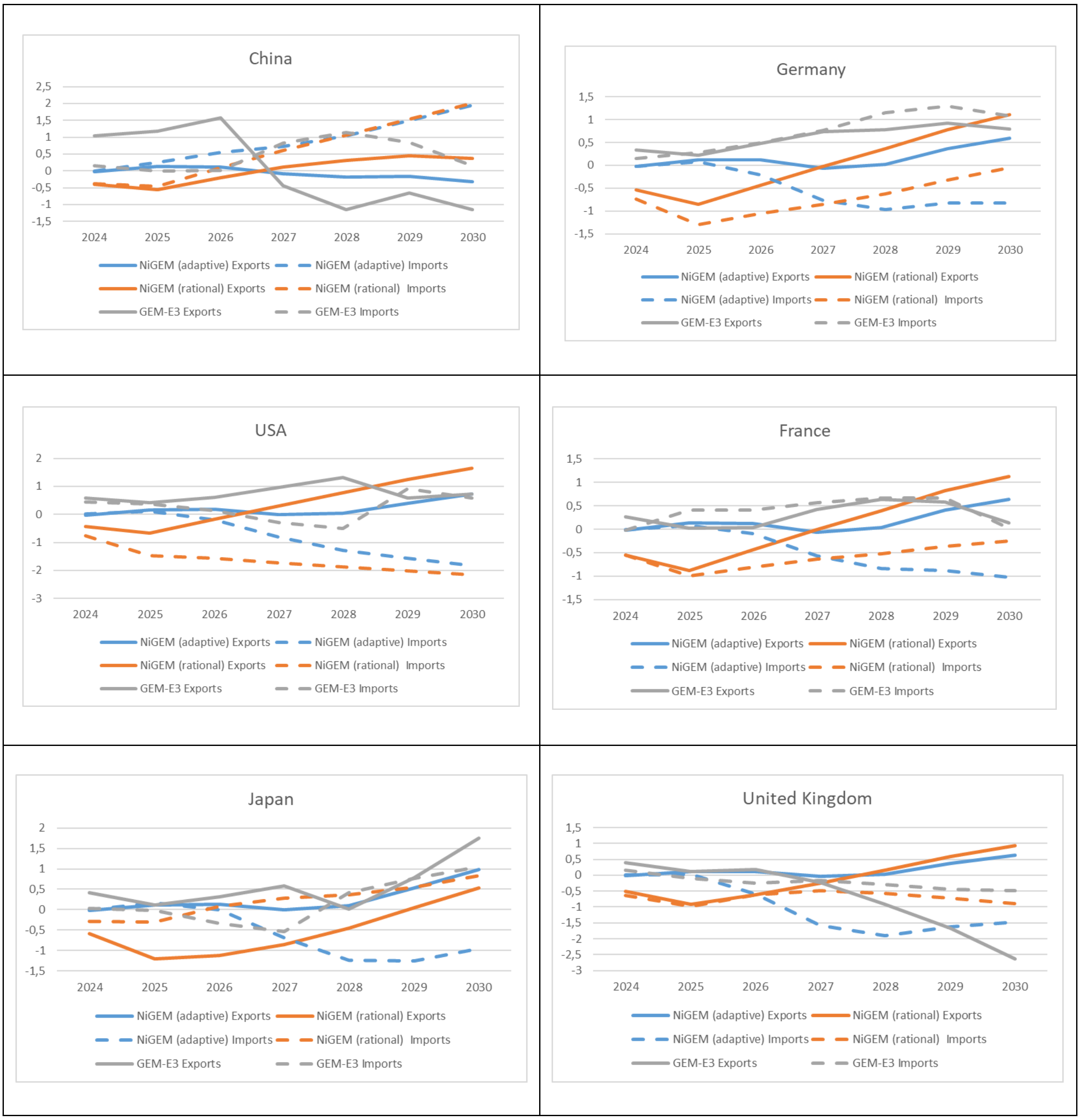
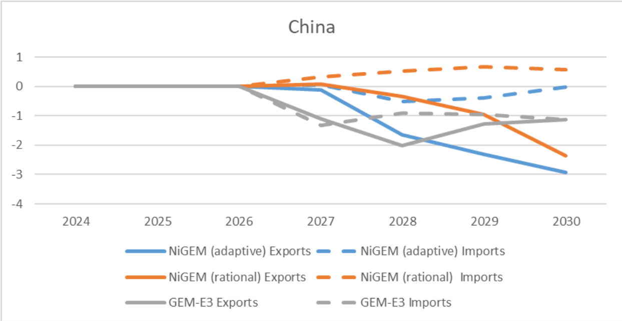
-10
2024 2025 2026 2027 2028 2029 2030
NiGEM (adaptive) NiGEM (rational) GEM-E3

Figure 12. International trade in the HWTP and SWUC scenarios for selected countries (in % deviation from baseline)

HWTP



SWUC


China
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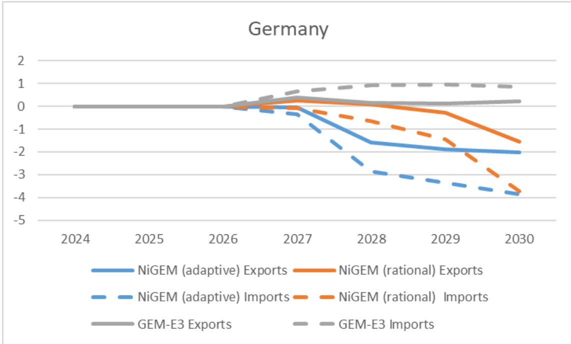
2030
NiGEM (adaptive) Exports
NiGEM (adaptive) Imports
NiGEM (rational) Exports
NiGEM (rational) Imports
GEM-E3 Exports
GEM-E3 Imports


Germany
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-1
-2
-3
-4
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2024
2025
2026
2027
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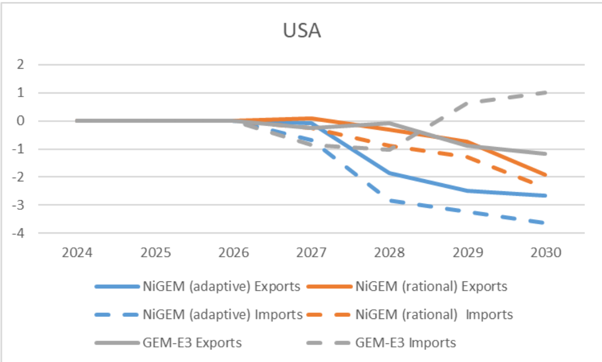
2030
NiGEM (adaptive) Exports
NiGEM (rational) Exports
NiGEM (adaptive) Imports
NiGEM (rational) Imports
GEM-E3 Exports
GEM-E3 Imports


USA
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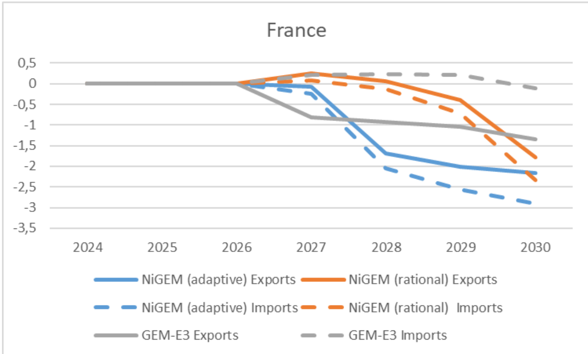
2030
NiGEM (adaptive) Exports
NiGEM (rational) Exports
NiGEM (adaptive) Imports
NiGEM (rational) Imports
GEM-E3 Exports
GEM-E3 Imports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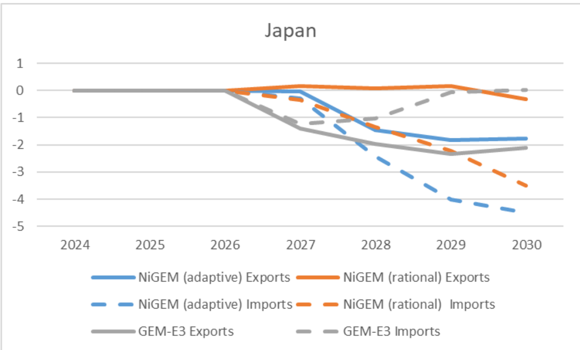
NiGEM (adaptive) Exports
NiGEM (rational) Exports
NiGEM (adaptive) Imports
NiGEM (rational) Imports
GEM-E3 Exports
GEM-E3 Imports


Japan
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NiGEM (adaptive) Exports
NiGEM (rational) Exports
NiGEM (adaptive) Imports
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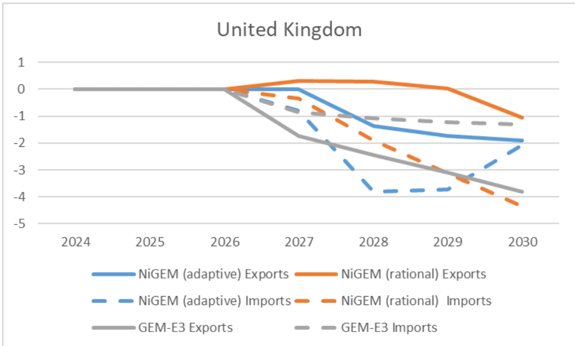
GEM-E3 Exports
GEM-E3 Imports


United Kingdom
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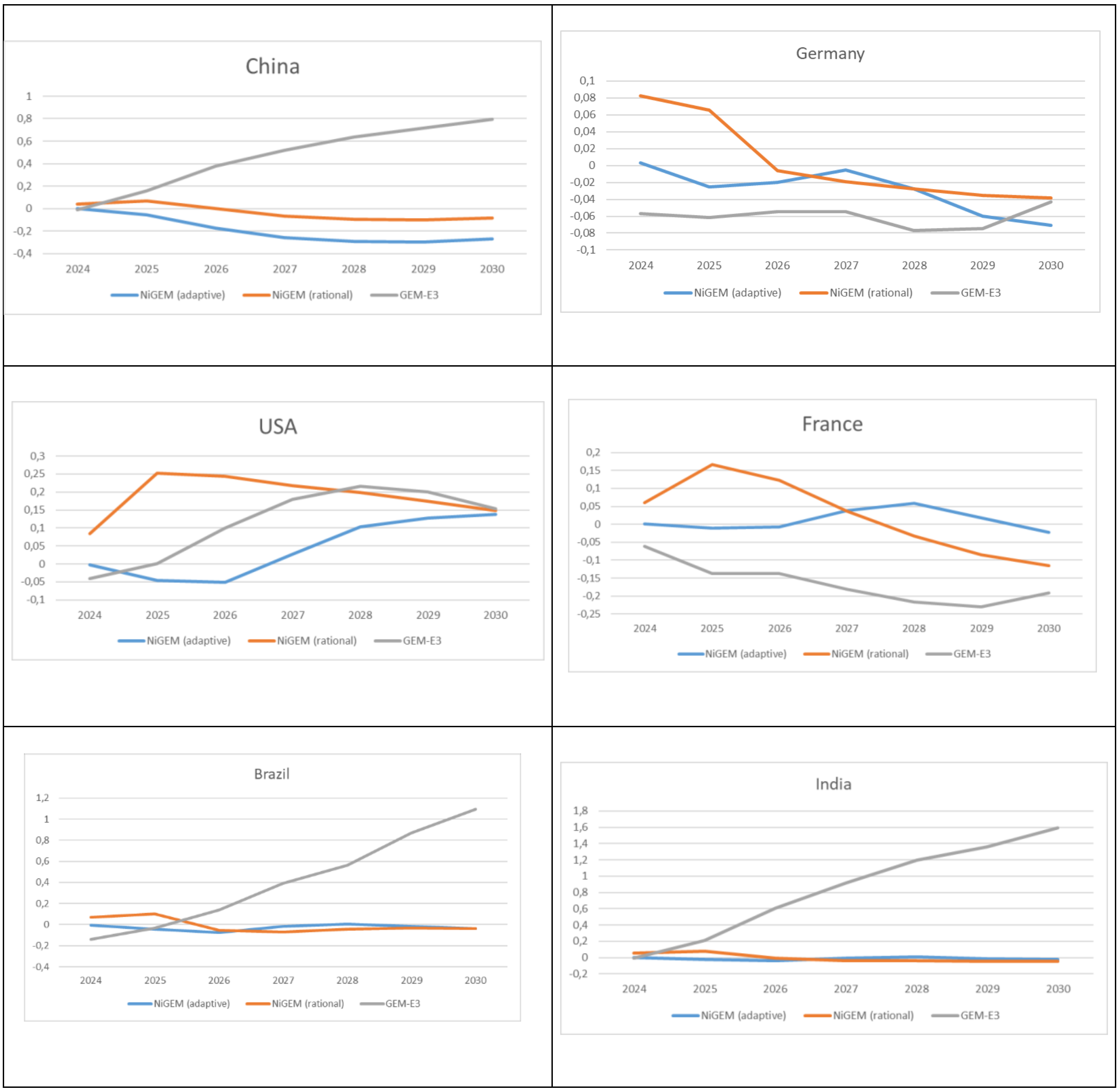
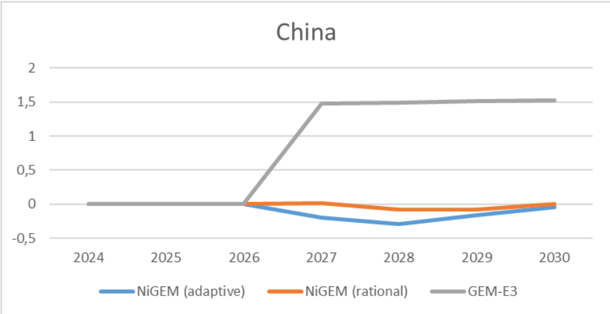
NiGEM (adaptive) Exports
NiGEM (rational) Exports
NiGEM (adaptive) Imports
NiGEM (rational) Imports
GEM-E3 Exports
GEM-E3 Imports

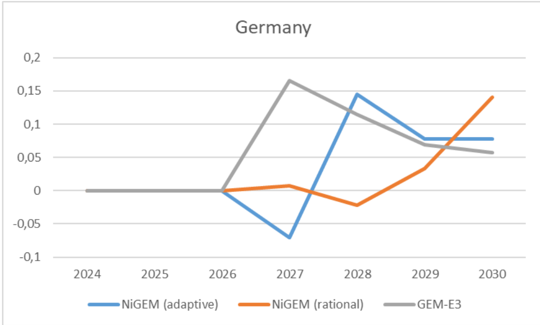
Figure 13. Unemployment rate in the HWTP and SWUC scenarios for selected countries (in percentage point deviation from baseline)

HWTP



SWUC


China
2
1,5
1
0,5
0
-0,5
2024 2025 2026 2027 2028 2029 2030
NiGEM (adaptive)
NiGEM (rational)
GEM-E3


Germany
0,2
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0,05
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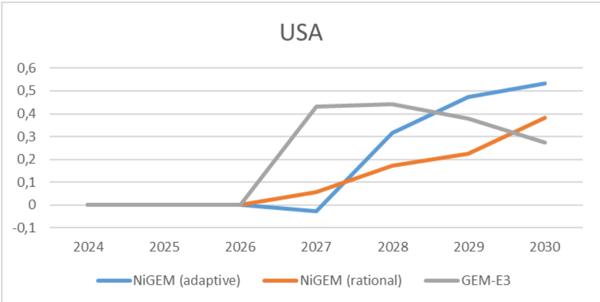
-0,05
-0,1
2024 2025 2026 2027 2028 2029 2030
NiGEM (adaptive)
NiGEM (rational)
GEM-E3


USA
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0,4
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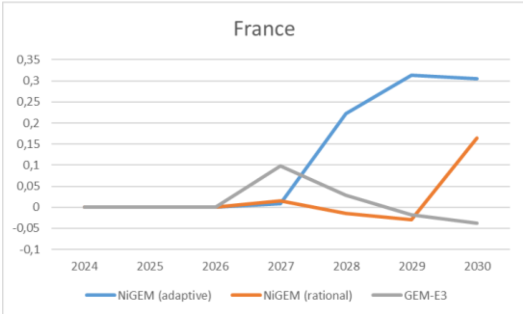
2024 2025 2026 2027 2028 2029 2030
NiGEM (adaptive)
NiGEM (rational)
GEM-E3


France
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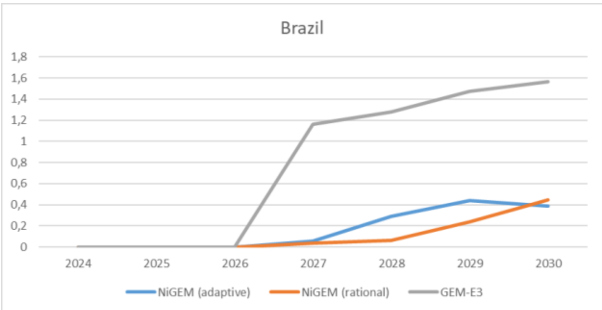
2024 2025 2026 2027 2028 2029 2030
NiGEM (adaptive)
NiGEM (rational)
GEM-E3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1,2
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0
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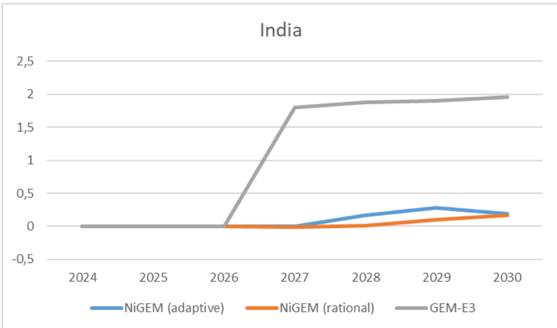
NiGEM (adaptive)
NiGEM (rational)
GEM-E3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1
0,5
0
-0,5
2024 2025 2026 2027 2028 2029 2030
NiGEM (adaptive)
NiGEM (rational)
GEM-E3