Can EU Cohesion Policy Prevent Climate-Induced Regional Divergence? Evaluating Climate-Adjusted Fiscal Transfers in a Dynamic Multi-Regional CGE Model.

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Extended Abstract

Climate change is increasingly recognised not only as an environmental threat but as a structural risk to macroeconomic development (Tol, 2024). Recent research demonstrates that physical climate damages may propagate through highly interconnected inter-sectoral and inter-regional trade networks, generating substantial indirect effects that extend beyond the localized direct asset losses and exceed their scale substantially (Cortés Arbués et al., 2024; Knittel et al., 2024). Nowhere is this risk more institutionally consequential than in Europe. The European Union (EU) combines deep economic integration with an explicit commitment to territorial cohesion. Yet the continent is also the world's fastest-warming region, and climate hazards are spatially concentrated, with uneven consequences for different EU regions. This raises a fundamental question: can Europe's fiscal architecture prevent physical climate risk from becoming a permanent driver of regional divergence?

In prior work, we developed a dynamic multi-regional computable general equilibrium (CGE) model disaggregated to 234 NUTS-2 regions to quantify the economy-wide effects of two major hydrological hazards: sea-level rise (SLR) and river flooding. In this regional model, bottom-up estimates of local direct capital destruction propagated through interregional trade networks, capital mobility, and sectoral linkages to other regions, generating recursive-dynamic projections till 2100 for EU as a whole as well as for each of its 234 regions. We found that climate-induced flooding acts as a strongly divergent force. Under a 3°C warming scenario, damages from the two studied climate-induced hazards to some regions approached 51% of regional GDP by the end of the century. Lower-income regions were projected to be disproportionately affected, leading to rising inequality both between and within member states. River flooding, in particular, emerges as the dominant driver of divergence, with interior and less-developed regions facing escalating relative decline.

These findings pose a direct challenge to the EU's regional convergence objectives. Cohesion Policy—implemented primarily through the European Regional Development Fund (ERDF) and the Cohesion Fund—constitutes one of the largest supranational redistributive frameworks in the world. For the 2021–2027 programming period, significant resources are earmarked for climate resilience and green transition objectives. However, the allocation framework remains largely based on GDP per capita thresholds and thematic concentration rules, rather than forward-looking physical climate risk metrics. Funding mechanisms are often reactive, emphasising reconstruction and co-financed projects, and may insufficiently target regions facing compounding exposure to long-run climate damages from multiple hazards.

International studies have shown that climate-related damages curb long-run economic growth, especially in poor countries(Diffenbaugh & Burke, 2019; Kahn et al., 2021), while literature has also highlighted climate-induced economic damages as a potential driver of fiscal strain (Jerch et al., 2023; Parrado et al., 2020). However in the European context, little attention has been paid to how cross-national transfers in the form of EU cohesion funds can be optimally designed to avert fiscal strain and regional divergence driven by climate-induced economic damages.

To address this gap, we extend our previous CGE framework to explicitly evaluate the macroeconomic role of EU fiscal transfers under escalating climate hazards. We introduce a fiscal module that incorporates regionally differentiated transfers calibrated to observed Cohesion Policy allocations, alongside alternative allocation rules that explicitly condition transfers on projected climate exposure. The central contribution of this study is to quantify how different fiscal architectures alter the long-run distributional consequences of physical climate risk across Europe.

Modelling Framework

We augment the dynamic CGE model with an explicit representation of interregional fiscal transfers financed at the EU level. The model preserves its core structure: regionally differentiated production sectors, interregional trade flows, capital accumulation dynamics, labour mobility constraints, and endogenous price adjustments. Direct damages from SLR and river flooding enter as shocks to productive capital and sector-specific productivity. These shocks propagate through trade networks and factor markets, generating indirect spillovers and long-term structural shifts.

The fiscal extension introduces three key components to the standard regional CGE analysis:

1. **Baseline Cohesion Allocation Rule**
   Transfers follow the allocation principles of the 2021–2027 EU Cohesion Policy, implemented primarily through the European Regional Development Fund (ERDF) and the Cohesion Fund. Funding intensity depends predominantly on regional GDP per capita relative to the EU average, with higher support rates for less developed regions and additional eligibility at the member-state level under the Cohesion Fund.

   The baseline modelling reflects the thematic concentration requirements of the current programming period, including minimum spending shares directed toward climate and environmental objectives. We assume that a fixed proportion of transfers finances adaptation-relevant public capital formation (e.g., flood protection infrastructure, resilient transport networks, nature-based solutions), while the remainder supports broader public investment and regional development.

Crucially, allocation does not incorporate forward-looking physical climate risk indicators. Climate damages affect transfer volumes only indirectly, through their impact on realised regional GDP and subsequent eligibility thresholds. Fiscal adjustment therefore occurs ex post, after income losses materialise, rather than ex ante on the basis of projected exposure. This structure allows us to evaluate the extent to which the current income-based allocation framework can stabilise regions facing progressively intensifying hydrological risks.

2. **Damage-Contingent Redistribution**
Transfers respond endogenously to realised climate-induced GDP losses. Regions experiencing larger direct and indirect damages receive higher fiscal inflows, mimicking an adaptive solidarity mechanism.

3. **Climate Vulnerability Multiplier (Forward-Looking Rule)**
Transfers are allocated using a composite index combining (i) GDP per capita and (ii) projected hydrological exposure (river flood probability and SLR exposure). This anticipatory rule mirrors proposals for embedding climate risk explicitly into post-2027 programming frameworks.

All transfer schemes are budget-neutral at the EU level, financed through proportional contributions from member states. The model therefore captures redistributional trade-offs, general equilibrium feedbacks, and potential crowding-out effects.

Simulation Design

We simulate combined SLR and river flooding scenarios to 2100 under high-warming conditions. For each hazard scenario, we compare four fiscal environments:

1. No interregional transfers
2. Baseline Cohesion Policy rule
3. Damage-contingent adaptive transfers
4. Forward-looking climate-adjusted allocation rule.

We evaluate impacts along three dimensions:

- Aggregate EU GDP.
- Between-country and within-country inequality (decomposed regional GDP across NUTS-2 regions).

- Capital allocation dynamics, regional investment divergence, impacts on employment and sectoral output.

Inequality metrics include the Theil index, which measures dispersion of regional GDP per capita and is decomposed into inter- and intra-member state components.

Results

1. Baseline Cohesion Policy Moderately Dampens but Does Not Reverse Divergence

Under escalating flood damages, baseline GDP-based transfers partially stabilise poorer regions. However, because allocations are not directly linked to exposure, highly climate-vulnerable regions that are not initially among the poorest receive limited compensatory support. As damages compound, regional capital stocks decline persistently in exposed areas, leading to outmigration and structural economic contraction.

The result is a sustained increase in both between-country and within-country inequality relative to a no-climate baseline. Cohesion transfers reduce the magnitude of divergence but do not prevent it.

2. Climate Damages Trigger Endogenous Capital Reallocation

Without adaptive fiscal mechanisms, capital increasingly relocates toward less-exposed, higher-productivity regions. This generates a self-reinforcing dynamic: climate-exposed regions lose productive capacity, lowering returns on investment and accelerating relative decline. In the long run, such mechanisms risk locking vulnerable regions into a climate-induced development trap.

3. Damage-Contingent Transfers Reduce Persistent Decline

When transfers are tied directly to the realised climate damages, exposed regions maintain higher investment levels and experience slower capital erosion. This mechanism significantly reduces within-country inequality, particularly in member states with high exposure heterogeneity. However, the reactive nature of transfers implies that substantial losses still occur before compensation materialises.

4. Forward-Looking Climate-Adjusted Allocation Is Most Effective

Embedding a Climate Vulnerability Multiplier in allocation rules produces the strongest stabilisation effect. By increasing funding intensity in regions where low income intersects with high hydrological exposure, anticipatory transfers support adaptation investment before capital destruction compounds. This mechanism:

- Substantially reduces long-run inequality growth
- Limits permanent capital flight from exposed regions

- Lowers the dispersion of GDP losses across NUTS-2 regions.

However, the model reveals non-trivial trade-offs. Financing such a scheme increases fiscal contributions from less-exposed, higher-income regions, generating modest aggregate output reductions due to distortionary taxation effects. The net EU-wide GDP effect remains small relative to the avoided divergence costs, but political economy constraints may arise.

Policy Implications

Our findings suggest that climate change may undermine the EU's territorial cohesion objectives unless fiscal rules evolve with the climate resilience objectives in mind. A transition from a compensatory to a preventative convergence model appears macroeconomically justified at the EU level.

These results have the following implications for the design of the EU policies:

- Post-2027 programming frameworks could embed a mandatory climate vulnerability component into allocation mechanisms to counteract the adverse effect of climate damages on regional cohesion.
- Adaptation funding intensity should be higher where exposure intersects with low fiscal capacity.
- Co-financing requirements could be relaxed for highly vulnerable low-income regions to avoid underutilisation of funds.
- Administrative simplification ("green-track" approval for nature-based solutions) may be critical for less-developed regions facing institutional bottlenecks.

By explicitly modelling general equilibrium feedbacks, our results show that climate-adjusted fiscal redistribution is not merely a solidarity instrument—it functions as a macroeconomic stabiliser in an integrated union.

Contribution to the Literature

This paper makes three contributions to the literature on the regional cohesion policy, climate resilient regional economies, and the economic costs of climate change.

First, it links physical climate risk to supranational fiscal architecture within a unified dynamic CGE framework. While prior studies assess regional climate damages or evaluate Cohesion Policy effectiveness separately, we integrate the two.

Second, we demonstrate that fiscal transfer design materially alters the long-run distributional consequences of climate change in the EU. Climate damages are not purely exogenous divergent forces; their structural effects depend critically on institutional response.

Third, we provide quantitative evidence relevant to ongoing debates about reforming EU Cohesion Policy for the 2028–2034 period. As Europe faces simultaneous pressures from demographic ageing, competitiveness challenges, and climate transition costs, understanding the macro-distributional implications of physical risk becomes essential.

Limitations and Future Research

Several limitations remain. As in our previous work, we focus on hydrological hazards (river flooding and SLR). Incorporating additional climate risks—such as droughts, heatwaves or wildfires—could amplify projected divergence, particularly in Southern Europe. Furthermore, household heterogeneity within regions is not modelled. Integrating CGE dynamics with micro-distributional data would enable welfare-based analysis beyond GDP per capita.

Finally, the political economy of fiscal reform is beyond the scope of our analysis. While climate-adjusted transfers appear economically efficient in reducing divergence, their implementation depends on member state bargaining and budget negotiations.

Conclusion

Climate-induced flooding is projected to become a structural driver of regional divergence within Europe. Without reform, existing fiscal mechanisms are unlikely to fully offset these forces. However, anticipatory, climate-adjusted transfer rules embedded within EU Cohesion Policy could substantially mitigate long-run inequality and prevent vulnerable regions from entering persistent decline.

In an integrated economic union exposed to asymmetric physical risks, fiscal architecture determines whether climate change entrenches divergence or reinforces solidarity. This paper provides quantitative evidence that institutional design will play a decisive role in shaping Europe's economic geography over the twenty-first century.

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