

# How vulnerable is Europe to severe climate-related natural disasters abroad?

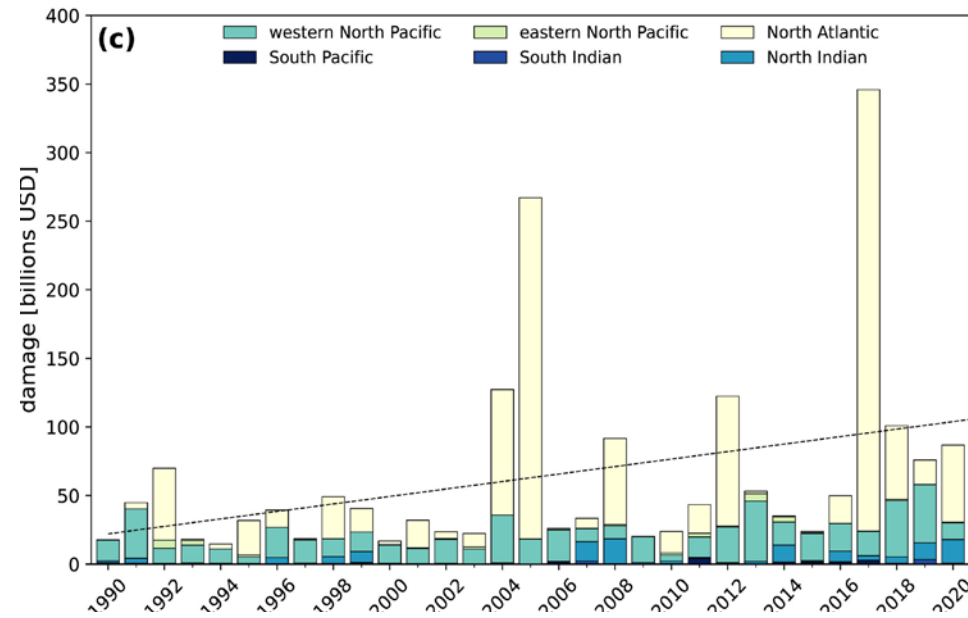
A dynamic CGE analysis of the international financial and economic impacts of a large hurricane in the southern USA.

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# Motivation

Tropical cyclones are one of the most damaging natural catastrophes, causing hundreds of fatalities and billions of US dollars in damage globally each year (Klotzbach et al. 2022).



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# Motivation

- “The proportion of intense tropical cyclones (Category 4-5) and peak wind speeds of the most intense tropical cyclones are projected to increase at the global scale with increasing global warming (*high confidence*)” IPCC 2022. WGI, Summary for Policymakers, p.16.
- “Our world today is characterized by a high degree of interconnectedness and globalization which establish pathways for the transmission of climate-related risks across sectors and borders ... [yet] only a few countries have so far integrated interregional aspects into their climate change risks assessments...” IPCC 2022. WGII, p.16-40.

# Research context

- The direct and indirect negative effects of natural disasters on the domestic economy have been extensively studied (see review of Botzen et al., 2019).
- Effects include loss of GDP due to loss of property and life, inflation in the prices of certain goods, and a deteriorating trade balance. Financial effects include the devaluation of classes of investment assets, changes in interest rates, changes in currency exchange rates and sovereign credit ratings, and bond yields (Zhou et al., 2022; Cambridge Centre for Risk Studies, 2018).
- Studies have examined regional and sectoral spillovers (USA: Hallegatte 2013; Germany: Sieg et al. 2019; Taiwan: Faturay et al. 2020; and China: Huang et al. 2021).
- Studies have assessed international spillovers on specific supply chains (Arto et al. 2015).
- Studies examined the effects of natural disasters on foreign stock markets (Valizadeh et al. 2017).
- But there are not much studies that address international financial and economic spillover effects from natural disasters in a comprehensive way.

# Research objective

This paper describes a storyline *of a cascade of events* on financial and economic markets that could be triggered by a major hurricane in the USA and assesses its financial and economic impacts on Europe with the help of a macroeconomic model.

The paper thereby aims to contribute to a better understanding of international financial and economic spillover effects from climate-related natural disasters.

# Methods and data

- We follow the climate storyline approach, where a storyline is defined as “a physically self-consistent unfolding of past events, or of plausible future events or pathways” Shepherd et al. (2018)
- Ciullo et al. (2021) proposed to build a climate storyline approach as a combination of downward counterfactual events. Downward counterfactuals are plausible alternative realizations of historic events that would have been much more impactful than the actual event (using past forecast data to ensure reasonable plausibility).
- To estimate direct economic damages from counterfactual hurricanes we use the open -source and -access CLIMADA impact model (Aznar-Siguan and Bresch , 2019).
- To assess the financial and economic impacts of the counterfactual hurricanes, we use a multi-sector, multi-region recursive dynamic computable general equilibrium (CGE) of the world economy. The model is based on the standard GDyn model (Ianchovichina and McDougall 2012), but includes a number of innovations in model stability, saving behavior and international capital mobility (Gretton 2021).

# Methods and data

- The base data of the model represent the global economy in 2014, divided into six countries and regions (EU28, USA, China, Japan, Australia and Rest of the World), six economic sectors (Agriculture, Minerals and mining, Petro-chemicals, Other manufactures, Construction, and Services), and five factors of production (Land, Skilled Labor, Unskilled Labor, Capital and Natural Resources). Projections of population, skilled and unskilled labor and economic activity (GDP) per country and region up to the year 2100 are taken from the SSP2 scenario (CEPII).
- Speed of adjustment parameters in GDyn-FS's investment function (RORGFLEX, LAMBRORG, LAMBROGE, LAMBKHAT) have been calibrated on the speed of recovery of Hurricane Katrina as described in Hallegatte (2013).
- We assumed some flexibility in the substitution between value added and intermediate goods in production (elasticity value of 1.2 for each industry), and a less-than-perfect substitution of capital and skilled labor in the domestic markets (10 and 20, resp.).
- All other parameters are as standard in GDyn.

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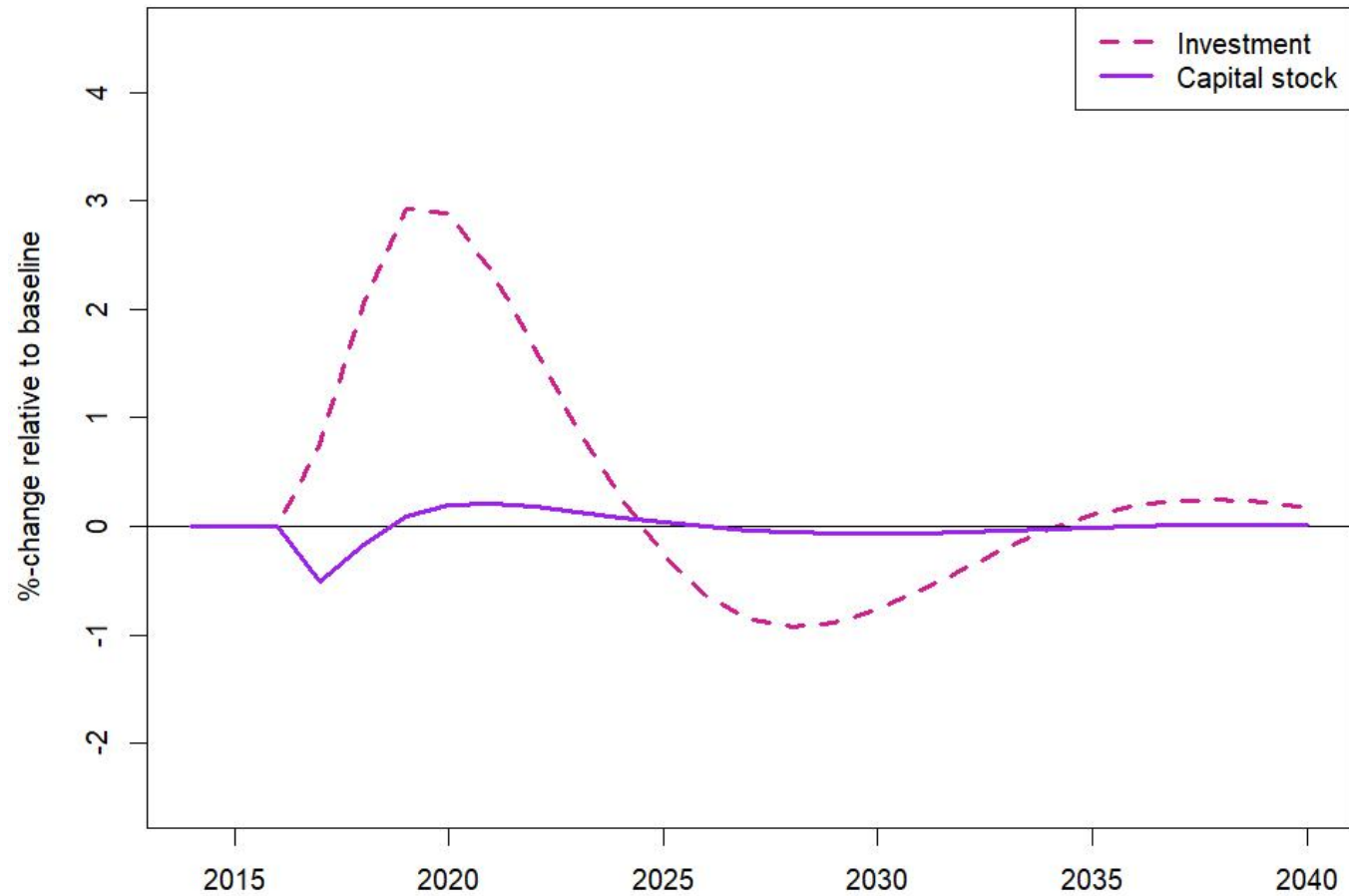
# Simulation scenario

Shocks	Variable	Value	Source/Assumption
Capital loss	sqk	-0.81	CLIMADA (direct loss is USD 548 billion)
Employment <sup>1)</sup>	qfactsup	-0.42	Employment falls to the extent that GDP loss is proportional to GDP loss of hurricane Katrina as estimated by Hallegatte (2013)

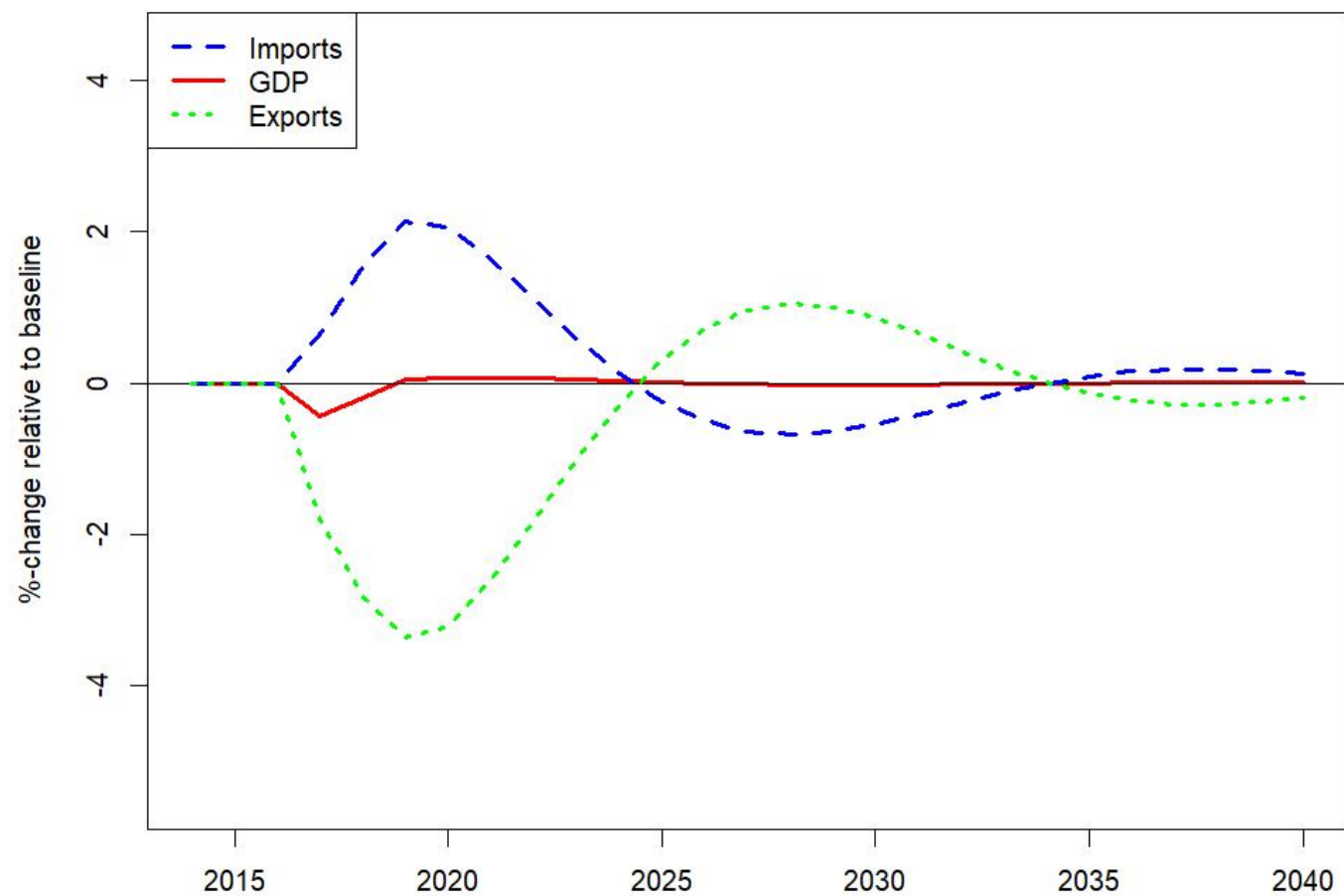
1) Employment exogenously recovers in two years



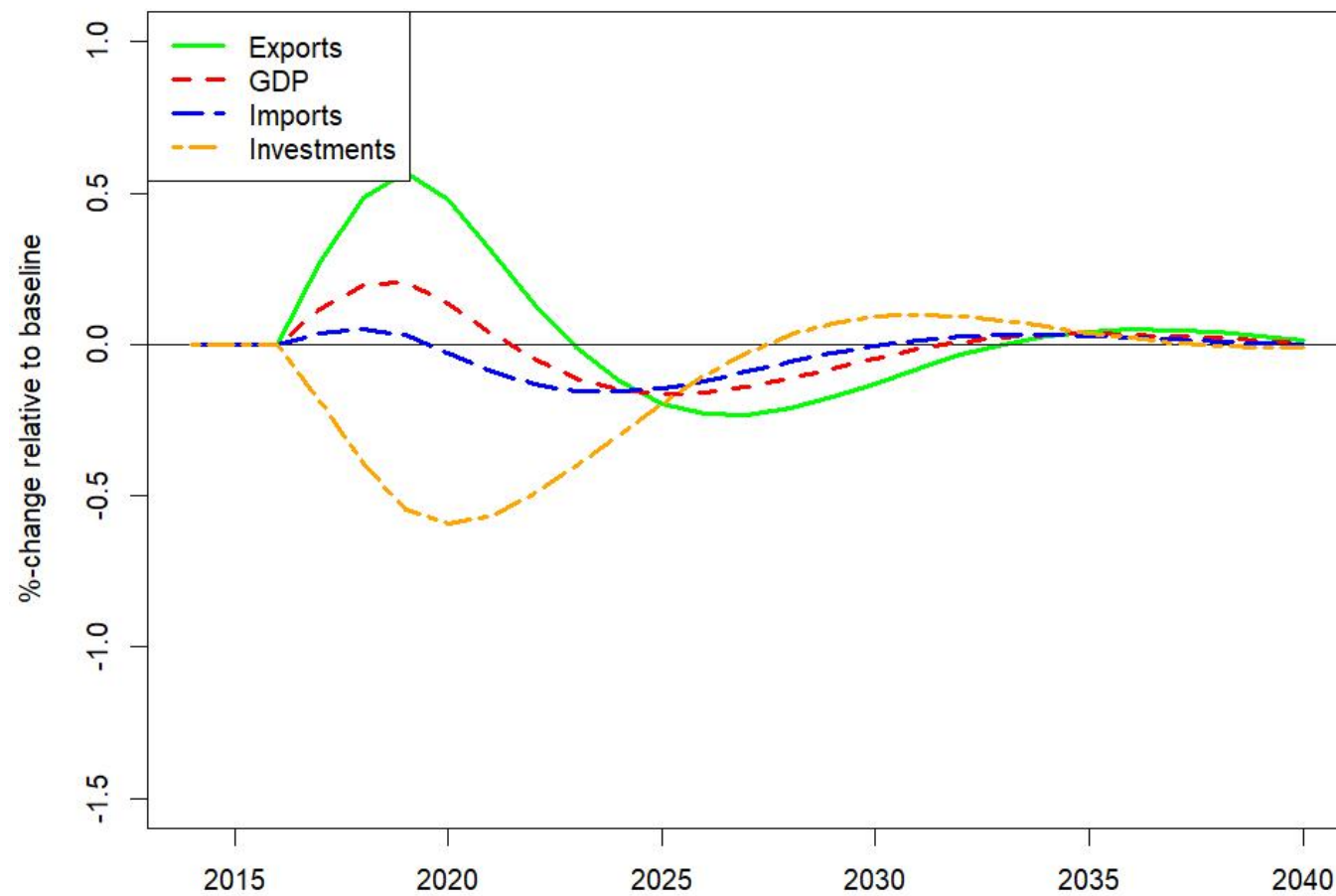
# Results USA (i)



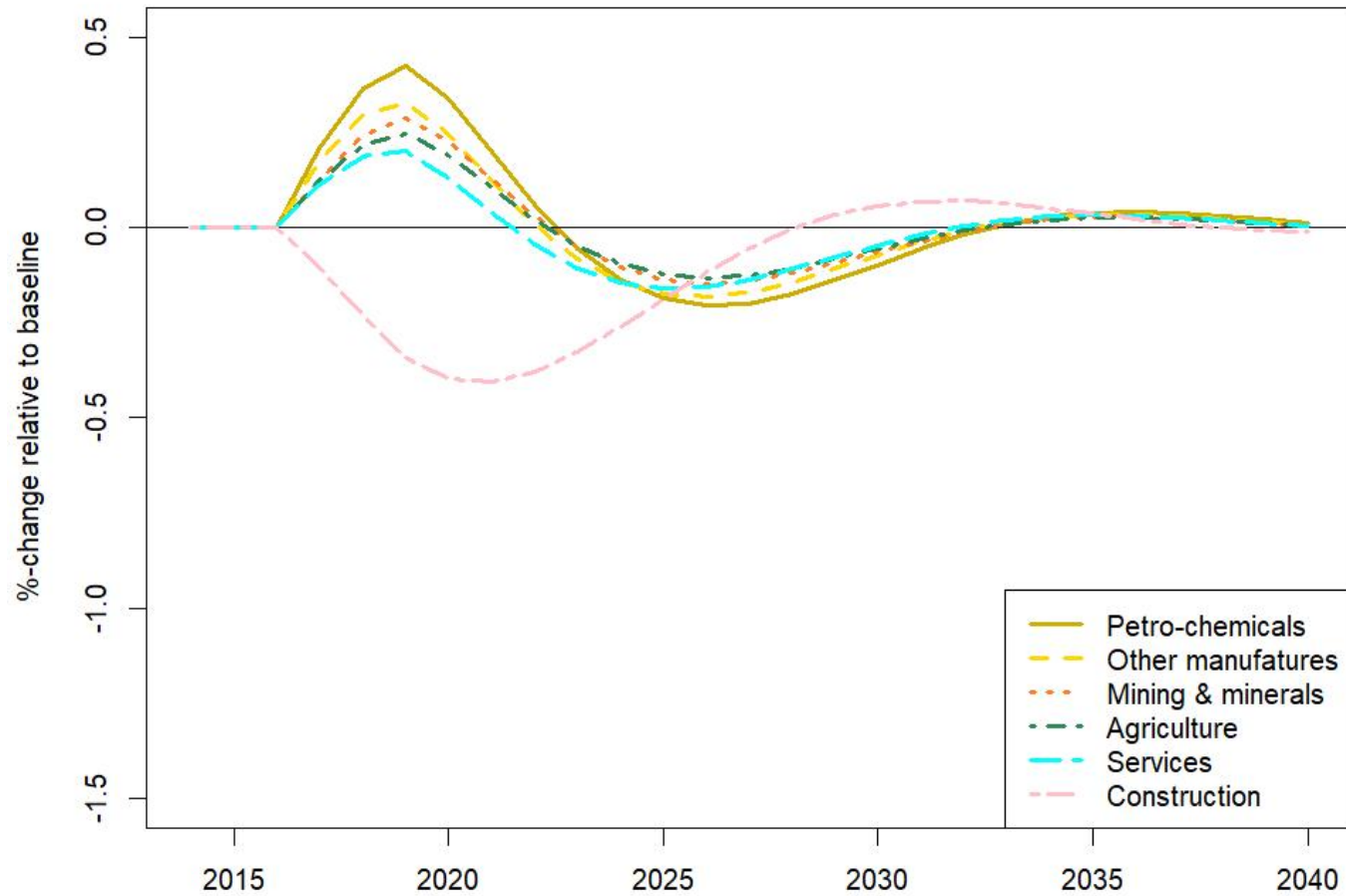
# Results USA (ii)



# Results EU (i)



# Results EU (ii)



# Discussion and conclusion

- A severe climate-related natural disaster in the USA, such as three consecutive hurricanes in one season, can have small but significant material effects on the EU economy through trade and investment flows.
- We use the dynamic computable general equilibrium model GDyn-FS to simulate the economic impacts of this disaster in the US and abroad. For the impacts in the US we use Hallegatte's analysis of Hurricane Katrina (2013) to calibrate the model.
- For the impacts abroad, we find that the disaster causes an initial increase in economic activity in the EU, followed by drop in activity later on, caused by a shift of global capital to the US for post-damage reconstruction.
- In further research we will focus on the impacts of the natural disaster on financial flows.

Thank you for your attention!

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