Compensatory mechanism of tourism activities on fishery sector under climate change impact: A mixed Input-Output model for Northern Ireland

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Author: Alberto Roca Florido
Co-Authors: Simon Mair

Climate change is increasingly reshaping marine ecosystems, with significant implications for fisheries, coastal economies, and regional development strategies. Rising sea temperatures, ocean acidification, and shifts in species distributions are already altering the productivity and spatial viability of commercial fisheries, particularly in regions highly dependent on marine resources. Marine spatial planning has therefore become a key governance instrument to reconcile ecological protection with economic activity. However, climate adaptation and conservation measures often generate uneven socioeconomic impacts across sectors, creating a need for mechanisms capable of mitigating economic losses while maintaining environmental objectives.

This study examines whether tourism activities can function as an effective compensatory mechanism for climate induced impacts on the fishery sector, using Northern Ireland as a case study. The analysis is based on an integrated modelling framework that combines original spatial climate data with a novel mixed endogenous exogenous input output model. Both components rely on primary data generated within the research programme, ensuring a consistent linkage between ecological change and economic outcomes rather than relying on secondary or generic datasets.

The spatial climate information is produced within the MSPACE project, where ecosystem level indicators are generated through a meta analytical approach to detect climate change signals across marine environments. This process identifies climate change hotspots, defined as areas experiencing ecosystem shifts beyond historical variability, and climate refugia, where ecological conditions remain comparatively stable and may partially buffer climate impacts. These spatial outputs are directly linked to sectoral exposure in fisheries, allowing climate signals to be translated into economically meaningful supply constraints.

On the economic side, the study employs a newly developed input output model specifically designed for the Northern Ireland economy, with an explicit focus on marine industries and tourism activities. The model provides a detailed representation of fishery fleet segments, marine related industries, and tourism sectors, allowing climate driven supply shocks in fisheries to be analysed alongside demand driven dynamics in tourism. Unlike standard input output tables, this purpose built structure explicitly incorporates marine spatial planning measures and climate induced constraints on production, offering a tailored representation of the regionâ€™s coastal economy.

The mixed endogenous exogenous structure allows fisheries output to be treated as exogenously constrained by climate impacts, while tourism output remains responsive to changes in final demand. This approach is particularly suited to climate change analysis, where shocks originate from ecological processes rather than market demand. The model captures direct impacts on fisheries, indirect effects across interconnected sectors, and induced effects associated with changes in income and employment.

Four stylised scenarios are analysed. A business as usual baseline provides a reference against which climate impacts are evaluated. The first climate scenario assesses the economic consequences of reduced fish catches associated with climate change hotspots. The second scenario incorporates the mitigating role of climate refugia, allowing for partial buffering of fishery losses. Two additional scenarios explore the conditions under which increased tourism activity can

compensate for these losses, identifying threshold levels of tourism output required to stabilise wages, gross value added, employment, and greenhouse gas emissions.

The results indicate that climate induced reductions in fisheries generate substantial negative effects not only within the fishery sector but also across the wider regional economy, reflecting strong intersectoral linkages. Employment and income losses extend beyond fisheries, highlighting the vulnerability of coastal economies to climate driven supply shocks. At the same time, tourism exhibits a strong compensatory potential. Employment responds at relatively low increases in tourism demand, followed by wages and value added as tourism activity expands. Accommodation, food and beverage, and related hospitality services emerge as the main drivers of this mechanism.

Importantly, the inclusion of climate refugia reduces the scale of tourism expansion required to offset fishery losses, underscoring the economic value of ecosystem resilience and climate smart marine spatial planning. Overall, the study demonstrates the value of integrating primary spatial climate data with a purpose built input output model to assess cross sectoral climate adaptation strategies.