

Long-term Implications of Aligning Spanish Household Consumption with the 2Â°C Paris Target: Combining EE-MRIO and Integrated Assessment

Topic: Input-Output Modelling: Income distribution policies

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Households are central actors in national and global decarbonisation efforts, as their consumption drives a large share of final energy use and associated greenhouse gas emissions. Yet household environmental impacts are far from homogeneous. They vary with income, demographic structure, and residential context, factors that profoundly shape differentiated lifestyles, which in turn generate unequal carbon footprints. Understanding this heterogeneity is essential for designing climate policies that are both environmentally effective and socially equitable. This paper develops an integrated micro-to-macro analytical framework that links detailed household-level consumption profiles with long-term economy-wide dynamics, allowing for a novel assessment of which household types align with Paris-compatible trajectories and how mitigation efforts among high-emitting groups shape macroeconomic outcomes over time.

We combine Environmentally Extended Multiregional Input-Output (EE-MRIO) modelling with microdata from the Spanish Household Budget Survey to compute the total (direct and indirect) carbon footprints of Spanish households. Households are grouped into 60 representative typologies defined by income, family composition, and urbanâ€“rural location, facilitating comparability within groups. Using a Paris-aligned per capita carbon budget consistent with a 2Â°C pathway by 2050, households within each group are classified as â€œgreenâ€• (within the budget) or â€œbrownâ€• (exceeding it). This classification provides an intuitive, policy-relevant lens to identify both climate-compatible lifestyles and structural vulnerabilities that make carbon reduction more challenging.

Our results show that 64% of Spanish households currently exceed their Paris-compliance carbon budgets, indicating that overshooting is widespread rather than exceptional. Patterns of overshooting follow clear structural lines. Large households, families with children, and households living in low-density rural or semi-urban areas are consistently more likely to be â€œbrownâ€•. These groups face structural constraints such as larger dwelling sizes, greater mobility needs, and limited access to low-carbon alternatives. In contrast, single-person households in dense urban areas, including many medium- and high-income individuals, are more likely to remain within the carbon budget despite higher purchasing power. These findings underscore that carbon-intensive consumption is not only a function of income, but also of demographic needs, spatial configurations, infrastructures, and the distribution of services and opportunities.

A decomposition by consumption categories reveals that food, housing services (including imputed rents), private mobility, and catering services are the main contributors to excess emissions among â€œbrownâ€• households. These domains constitute the key pressure points for household-level mitigation and highlight where policy interventions may face the strongest social and territorial trade-offs. Importantly, these categories reflect structural consumption patterns rather than marginal discretionary choices, calling for systemic rather than purely behavioural policy approaches.

To explore long-term implications, the household-level results are linked to the Within Limits Integrated Assessment Model (WILIAM), an IAM with a multiregional input-output core and endogenous macroeconomic dynamics. We simulate transition scenarios in which the consumption of high-emitting households is progressively adjusted to fall within their Paris-compatible budgets. The combined MRIO-IAM approach captures not only the direct emissions reductions but also the indirect and induced effects operating through production, prices, labour markets, income distribution, and feedbacks in final demand.

This integration of heterogeneous household footprints into a dynamic IAM framework constitutes a

methodological innovation in the study of distributional and macroeconomic effects of climate mitigation. To our knowledge, this is the first attempt to connect the identification of “green” and “brown” household lifestyles with a detailed simulation of the consequences of bringing high-emitting groups in line with Paris targets. The results demonstrate that effective and socially resilient climate policy cannot rely on uniform measures. Instead, differentiated policy packages—targeted energy-efficiency programmes, mobility system reforms, food system transitions, and redistributive measures—are necessary to address the structural sources of overshooting.

Overall, the paper offers a robust analytical framework that bridges micro-level household heterogeneity with macro-level transition dynamics. By doing so, it provides new evidence for designing climate strategies that are distributionally sensitive, territorially aware, and fully aligned with the IIOA conference emphasis on advancing policy resilience through input-output methods.