

China's Household Carbon Footprints: Structural Drivers and Provincial Disparities (2002–2022)

Topic: Input-Output Analysis: Sustainable Production and Consumption policies (2)

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Research question. This paper asks whether China's household carbon footprints (HCFs) have reached a structural turning point after 2017 and how the transition differs across urban vs. rural households and provinces/regions. We further identify the structural drivers behind (i) changing emission composition, (ii) urban–rural convergence/divergence, and (iii) the rising spatial decoupling between consumption and production through interprovincial supply chains.

Method. We measure HCFs as the sum of direct household energy emissions and indirect (embodied) emissions. Indirect emissions are calculated with a provincial multi-regional input–output (MRIO) model. Changes over time are explained using a multiplicative structural decomposition analysis (SDA) (Fisher index), decomposing indirect-emission changes into: carbon intensity (fuel mix), energy intensity (efficiency), production structure (Leontief inverse), consumption structure, interprovincial trade pattern, per-capita consumption level, population, and urbanization. An urban–rural decomposition highlights heterogeneous mechanisms behind aggregate trends.

Data. We use China interprovincial MRIO tables for 2002, 2007, 2012, and 2017 (30 provinces, harmonized sectors, constant prices). Direct household energy use comes from provincial energy balance tables with IPCC (2006) emission factors; sectoral CO₂ inventories are from CEADs. To extend results to 2022 (beyond the latest MRIO), we apply a transparent simulation that holds the 2017 production structure fixed while updating sectoral emission coefficients, household expenditures, and demographics with post-2017 official statistics.

Key findings. China's household emissions more than tripled from 2002 to 2017 and then plateaued and declined by 2022, suggesting a potential structural turning point. Urban per-capita HCFs peaked around 2017 and decreased thereafter, while rural per-capita HCFs continued rising, leading to rapid urban–rural convergence; notably, rural households surpassed urban households in per-capita direct emissions after 2017 in many provinces. The composition of indirect emissions shifted from basic needs to residence and transport, overtaking food and indicating a fundamental lifestyle transition. Interprovincial spillovers intensified: the share of indirect emissions generated outside the consuming province increased (e.g., 2012–2017), and affluent municipalities outsourced the vast majority of their consumption-based emissions to industrial and resource-rich provinces, raising equity concerns.

Novelty. This study contributes by combining two-dimensional heterogeneity (urban–rural – province/region) with MRIO–SDA, explicitly separating fuel-mix decarbonization from efficiency improvements, quantifying interprovincial spillovers, and providing updated 2022 estimates despite MRIO table gaps.