Heterogeneous decoupling of economic growth and CO2 emissions across Indian states from 2011 to 2019

Topic: Input-Output Analysis: Trade and Global Value Chains policies (14)
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Against the backdrop of deepening regional specialization and rapidly expanding final demand, consumption-based carbon emissions (CBA) in Indian states are increasingly shaped not only by local production, but also by interstate supply chains that redistribute where emissions are generated and who ultimately bears responsibility for them. Existing studies have focused mainly on production-based accounting or national aggregates, leaving limited evidence on three issues at the state level: the source structure of CBA (local versus imported embodied emissions), the evolution of interstate embodied carbon transfers, and the extent to which these supply-chain dynamics condition decoupling from economic growth. Using a multi-regional inputâ€“output framework for 32 Indian states over 2010â€“2019, this study develops an integrated accounting and decomposition framework that combines source attribution, interstate carbon-flow mapping, and consumption-based decoupling analysis.

We find that Indiaâ€™s state-level CBA rose from 1,342.7 Mt COâ„‚ in 2011 to 2,021.0 Mt COâ„‚ in 2019, while the top five states accounted for 47.4% of total CBA in 2019, indicating strong spatial concentration of demand-driven emissions. Nationally, imported embodied emissions increased from 974.0 to 1,494.6 Mt COâ„‚, compared with an increase in locally generated emissions from 368.7 to 526.4 Mt COâ„‚. Imported emissions thus contributed 520.6 Mt COâ„‚, or 76.8% of total CBA growth, and raised the aggregate imported share of CBA from 72.5% to 74.0%. At the same time, state-level source structures evolved unevenly: in 21 of 32 states, local emissions grew faster than imported emissions, indicating differentiated restructuring rather than a uniform deepening of import dependence. By 2019, imported emissions still dominated CBA in most states: 26 states had imported shares above 70%, 11 exceeded 80%, and only Chhattisgarh had a local share larger than its imported share.

The interstate carbon-flow matrix further shows that embodied carbon transfers were highly concentrated along a limited set of major corridors. Odisha, Chhattisgarh, Gujarat and Madhya Pradesh repeatedly appeared as major upstream sources, while Maharashtra, Uttar Pradesh and Tamil Nadu were the main destinations. In 2019, only six states were net embodied carbon exporters, whereas all remaining states were net importers, implying that production-side carbon burdens were concentrated in a small number of upstream states. These net outflow states exhibited much higher average production-based emissions (160.1 versus 40.8 Mt COâ„‚), production emissions per capita (346.8 versus 85.7), and carbon intensity (1.69 versus 1.21) than net inflow states, confirming a systematic mismatch between consumption responsibility and production burden.

Finally, Tapio analysis shows that decoupling improved in relative terms but remained incomplete. Over 2011â€“2019, 20 states were in weak decoupling, 8 in coupling, 4 in strong coupling, and none achieved long-run strong decoupling. Structural decomposition further indicates that population, affluence and production structure consistently pushed emissions upward, whereas emission intensity and demand structure provided the main offsetting forces. Before 2015, technology- and intensity-related improvements were the dominant mitigating mechanism; after 2015, demand-structure adjustment became more important, while rising interstate embodied transfers increasingly complicated decoupling outcomes in both major input and output states. Together, these findings show that interstate supply chains do not merely relocate emissions: they reshape the

composition of CBA growth and condition the highly uneven decoupling trajectories of Indian states.