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Title: Carbon-intensive logistics and food security: structural vulnerability in global food imports

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Abstract: Introduction – International food trade can underpin food availability, yet the carbon intensity of import logistics may signal greater exposure to disruption risks in food-import supply chains and weaken food security performance. This study examines whether transport emissions from imported food are associated with national food security and whether supply-chain structure conditions this relationship. Methods – Using bilateral food flows, we construct importer-year transport emissions through a ton-kilometer approach with mode-specific emission factors. A dynamic panel model, estimated using two-step System GMM, is applied to 169 countries to address persistence, unobserved heterogeneity, and endogeneity. Results – Higher transport emissions are negatively associated with food security outcomes, with the sign remaining stable across specifications although statistical precision varies with the treatment of import scale. This association is particularly pronounced among highly import-dependent economies and is moderated by import-source diversification. Model-implied simulations indicate substantially larger declines in highly import-dependent economies than in low-dependence economies, while diversification attenuates, but does not eliminate, the adverse association. Discussion – These heterogeneity patterns are consistent with an exposure interpretation: emissions proxy carbon-intensive import logistics that heighten exposure to cost and disruption shocks. The findings suggest that the logistics structure of food trade can constrain efforts to sustain food security under tightening decarbonization pressures. Policy priorities include developing low-carbon shipping corridors, designing carbon-pricing measures with safeguards for vulnerable importers, and strengthening sourcing diversification, route reliability, and logistics redundancy as integral components of sustainable supply-chain design.



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