Aggregation Bias in the Measurement of Diffusion through Production Networks

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Aggregation bias refers to the systematic differences in the changes in target variables estimated by inputâ€“output models under the same exogenous shock and the same inputâ€“output table, arising from different levels of sectoral or spatial aggregation. Building on an inter-country inputâ€“output (ICIO) framework, this paper systematically examines the bias in the propagation of exogenous shocks across different levels of sectoral and spatial aggregation in global production networks, and investigates its underlying mechanisms.

Tariff wars provide a typical setting for exogenous shocks across countries. Taking the China-U.S. tariff wars as the empirical setting, this paper examines whether aggregation bias arises in the measurement of tariff shock effectsâ€”specifically in their regional distribution, sectoral distribution, and joint region-sector distributionâ€”when computed using the ICIO model under different levels of aggregation. The number of sectors defined in the input-output table (the level of sectoral aggregation) and the number of regions included in the model (the level of spatial aggregation) must be specified for the problem under consideration.

Our empirical strategy proceeds as follows. Using the WIOD, we construct three sectoral aggregation levels (56, 19, and 3 sectors). Along the country dimension, we consider three aggregation levels: (i) the original WIOD country classification (43 countries plus ROW), (ii) an aggregation into China, the United States, the European Union, Japanâ€“Korea, and ROW, and (iii) a simplified three-region structure consisting of China, the United States, and ROW. Aggregation bias in measuring the diffusion effects of production networks is quantified by comparing two types of results: (i) results obtained from the most disaggregated model and subsequently aggregated to higher levels, and (ii) results obtained directly from models constructed using aggregated data. To construct the exogenous shock, we apply an elasticity-based approach to estimate the changes in Chinese exports to the United States and U.S. exports to China resulting from mutual tariff increases. We compute the value-added losses of each countryâ€“sector under different aggregation levels induced by this shock.

The results reveal several key findings. First, significant aggregation bias exists when measuring the effects of exogenous shocks using inter-country inputâ€“output models, both in the country and sector dimensions. Second, aggregation bias exhibits nonlinear characteristics. Moderate aggregation has little impact on the estimates, whereas further increases in aggregation lead to a substantial rise in aggregation bias. Along the country dimension, the difference in estimated global GDP loss between the original WIOD country classification and the six-country aggregation is relatively small. However, when the model is further aggregated into a three-country framework, aggregation bias increases significantly. Along the sector dimension, the difference in estimated global GDP loss between the 56-sector and 19-sector classifications is substantial, whereas further aggregation from 19 sectors to 6 sectors produces only a small additional bias. Third, aggregation bias in total effects is significantly smaller than aggregation bias in structural effects. The aggregation bias in global GDP loss is smaller than that in country-level GDP losses and sector-level value-added losses. Moreover, the biases at the country and sector levels are smaller than those observed under the joint countryâ€“sector classification. Fourth, the aggregation bias affecting entities that are not directly targeted by the shock may be larger than that for directly affected entities. At the country level, ROW, whose exports are not directly subject to tariff increases, exhibits the largest bias. At the sectoral level, the service sector, which is not directly affected by tariff changes, shows the most pronounced aggregation bias.

To further identify the sources of aggregation bias, we introduce a Shapley value decomposition to

attribute the overall bias to individual sectors. By explicitly accounting for nonlinear interactions across sectors, this approach decomposes the total bias into the average marginal contributions of each sector, thereby providing a systematic attribution of the sources of aggregation bias. Furthermore, we construct a homogeneity-splitting experiment, in which an aggregated sector is decomposed into multiple identical â€œvirtualâ€• sectors under a constant total constraint. This procedure effectively removes within-sector heterogeneity, allowing us to isolate its role in shaping shock propagation. By comparing outcomes across different structural configurations, we identify the mechanisms through which internal heterogeneity influences the transmission of shocks in production networks.The results show that, under a given exogenous shock, a small number of key sectors contribute disproporti