Research on the Factors Influencing the Accuracy of Heterogeneous Input-Output Models

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The input-output model, as a general equilibrium model, plays an irreplaceable role in simulating economic shocks, evaluating economic policies, and interpreting causal relationships in macroeconomic changes by depicting the structural impacts of economic shocks through clear inter-sectoral production networks. However, traditional input-output models only differentiate industries or products, while the assumption of intra-sectoral homogeneity obscures the reality where different types of enterprises within the same sector employ diversified production technologies, possess different consumption structures, and target different markets. Scholars have innovated and improved heterogeneous input-output models to capture intra-sectoral technological differences, thereby enhancing the model's ability to delve into the internal dynamics of economic sectors from a more micro perspective, analyzing variations in production technologies, and inter-industry linkages within the same sector.

Nevertheless, existing research on heterogeneous input-output models is limited to empirical applications, lacking theoretical analyses on the accuracy and reliability of these models. Compared to traditional input-output models, the absence of uncertainty analysis in heterogeneous input-output models has a more severe impact on the scientific rigor of research findings. This is because the increased dimensions of input-output models entail a surge in the demand for inter-sectoral flow data, which existing statistical data struggle to accurately account for. The construction of heterogeneous input-output models thus relies on proportion assumptions and mathematical optimization methods to fill in missing data. The numerous assumptions made during model construction lead to a hidden paradox: while increasing model dimensions enriches the information depicted by the model and enhances its ability to explain differentiated production technologies of enterprises in reality, the massive inter-sectoral flow data required for constructing heterogeneous models mainly come from estimations, inevitably introducing significant errors compared to actual inter-sectoral flows, severely affecting the reliability of heterogeneous input-output models.

Therefore, there is a need for in-depth and systematic research on the accuracy of heterogeneous input-output models, to clarify the factors influencing the accuracy of heterogeneous input-output models. Based on this studies, methods to improve the accuracy of heterogeneous input-output models could be proposed.

This paper is a further study on the measurement methods and case analysis of the accuracy of heterogeneous input-output models presented at last year's Alghero Conference. It improves the methods for measuring the accuracy of heterogeneous input-output models based on Monte Carlo simulation and TRAS, effectively addressing the challenge of the lack of a comparative basis for studying the accuracy of heterogeneous input-output models. Building on this, using the Input-Output Framework for Foreign and Domestic Firms (ICIO-DF) released by OECD as research materials, this paper explores the forms of errors in intermediate flow matrices, the scale of economies or economic sectors, the granularity of sectoral divisions, the relevant characteristics and structures of input-output matrices, and the impact of key sectors or elements of input-output matrices on the accuracy of heterogeneous input-output models.

The results show that: (1) The uncertainty of heterogeneous input-output models increases with the growth of errors in intermediate flow matrices, but the magnitude of error expansion exhibits a gradually convergent feature. This characteristic is guaranteed by the specific structure of heterogeneous input-output models and the precision of larger elements in input-output matrices. (2) There is a positive relationship between the scale of economies or sectors and accuracy. Larger economies or sectors are more accurate in heterogeneous input-output models. (3) The finer the

sectoral divisions, the more accurate the overall results of the model. Using as detailed data as possible in model construction helps improve accuracy, even if these data are contradictory. (4) The higher the proportion of non-zero elements in the intermediate flow matrix, the more accurate the heterogeneous input-output model. The rich inter-sectoral input relationships enhance the complexity of the model, increase the constraints of the input-output matrix, and thus improve the overall accuracy of the model.

Heterogeneous input-output models have been widely applied in trade value-added and environmental economics. Research on the accuracy of heterogeneous input-output models can provide information on quantifying the uncertainty of research conclusions, helping decision-makers understand the assumptions and limitations behind the data, and enabling them to make informed decisions under full information.