Triangularization of Input-Output Table and Material Flow Analysis

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Abstract

The importance of the triangularization of input-output tables, which has a long history, is increasing recently. The triangularization of input-output tables was proposed in 1950s as a method for analyzing industrial structures (Chenery and Watanabe, 1958, Econometrica). In the literature of the inter-industry material flow analysis, a novel analytical framework, waste input-output material flow analysis (WIO-MFA), was proposed (Nakamura et al., 2007, Journal of Industrial Ecology). "Materials" are theoretically defined based on the triangular structure of an input coefficient matrix in WIO-MFA. This research proposes a method to visualize an industrial structure for inter-industry material flow analysis based on the triangularization of input-output tables, and applies it to Japanese data.

Triangulation problem is defined as a combinatorial optimization problem to find a permutation of industrial sectors which minimizes the sum of upper triangular components of an input-output table. Heuristic algorithms (Simpson and Tsukui, 1965, Review of Economics and Statistics; Korte and Oberhofer, 1970, European Economic Review; Fukui, 1986, Econometrica) have been proposed because no well-established algorithms for general combinatorial optimization problems, like the simplex method for linear programming problems, are known. The mass filter in WIO-MFA being applied, however, the optimal value of the triangulation problem becomes zero. That is, the mass filter converts a standard input coefficient matrix into an input coefficient matrix for MFA, where a component of the matrix is set equal to zero if it corresponds to the input that does not physically enter the output. Therefore, algorithms for decomposition into strongly connected components, which can be run on a digital computer much more easily than any algorithm proposed for solving the triangulation problem, can reveal the hierarchy of industrial sectors.

Keywords: Hierarchy of industrial sectors, Triangularization of input-output tables, Inter-industry material flow analysis, waste input-output material flow analysis (WIO-MFA), Visualization.