NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

Institute of Catastrophe Risk Management

Pearl River Delta (PRD) Intercity Risk Study: Economic Interdependency Using Input-Output Modelling

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Summary

As an established economic zone consisting of nine cities, Pearl River Delta (PRD) region has not only seen rapid urbanization and economic growth but also forged a strong internal network for regional cooperation and development. To determine economic interdependency among PRD cities, a Multi-Regional Input Output (MRIO) model can be constructed, which is based on both intraregional and interregional trade flow relationship among studied cities and can be used to estimate overall impact to the whole system resulted from an initial impact (e.g. direct disaster losses) that has occurred in a certain city within the PRD region.

Multi-Regional Input Output (MRIO) Model

Gross Output of Sector *i* :

$$x_i = z_{i1} + z_{i2} + z_{i3} + \cdots + z_{in} + f_i$$

z_{ij}: intermediate sales by sector *i* to sector *j*
f_i: final demand for sector *i* (amount of output consumed by purchasers)

Leontief Technical Coefficient:

$$a_{ij} = \frac{z_{ij}}{x_j}$$

Regional Coefficient Matrix:

$$\boldsymbol{A} = \begin{pmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{pmatrix}$$

Proportion of Inflow Amount of Sector *i* into Region *s* from Region *r* :

$$c_i^{rs} = \frac{z_i^{rs}}{x_i^{Os}}$$

z_i^{rs}: inflow of sector *i* into region *s* from region *r*
x_i^{Os}: total inflow of sector *i* into region *s* from all regions

Inter-regional proportion matrix:

$$\boldsymbol{C^{rs}} = \begin{pmatrix} c_1^{rs} & 0 & \dots & 0 \\ 0 & c_2^{rs} & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & c_n^{rs} \end{pmatrix}$$

Intra-regional proportion matrix:

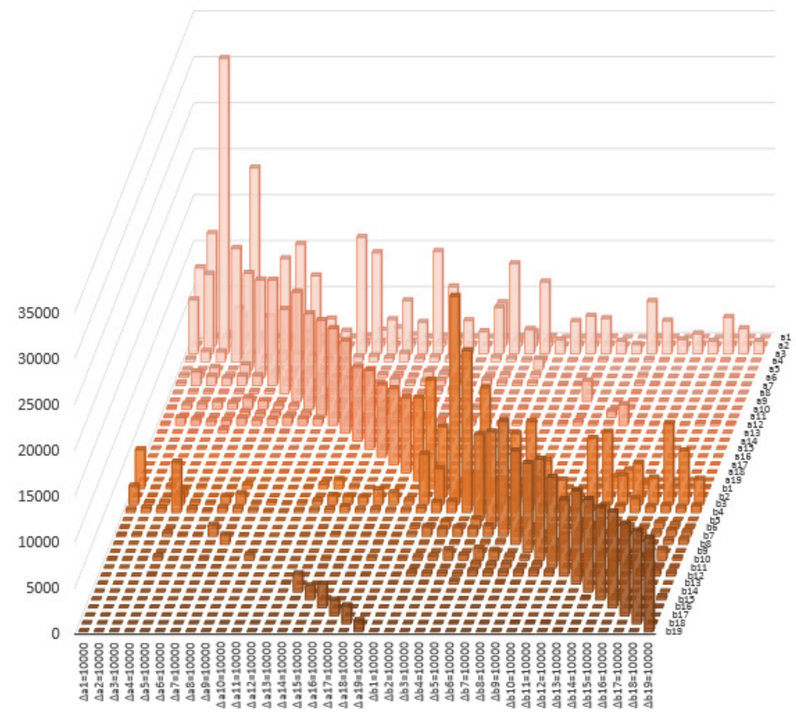
$$\boldsymbol{C^{rr}} = \begin{pmatrix} c_1^{rr} & 0 & \dots & 0 \\ 0 & c_2^{rr} & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & c_n^{rr} \end{pmatrix}$$

Application of MRIO Model In Impact Analysis

Impact Analysis:

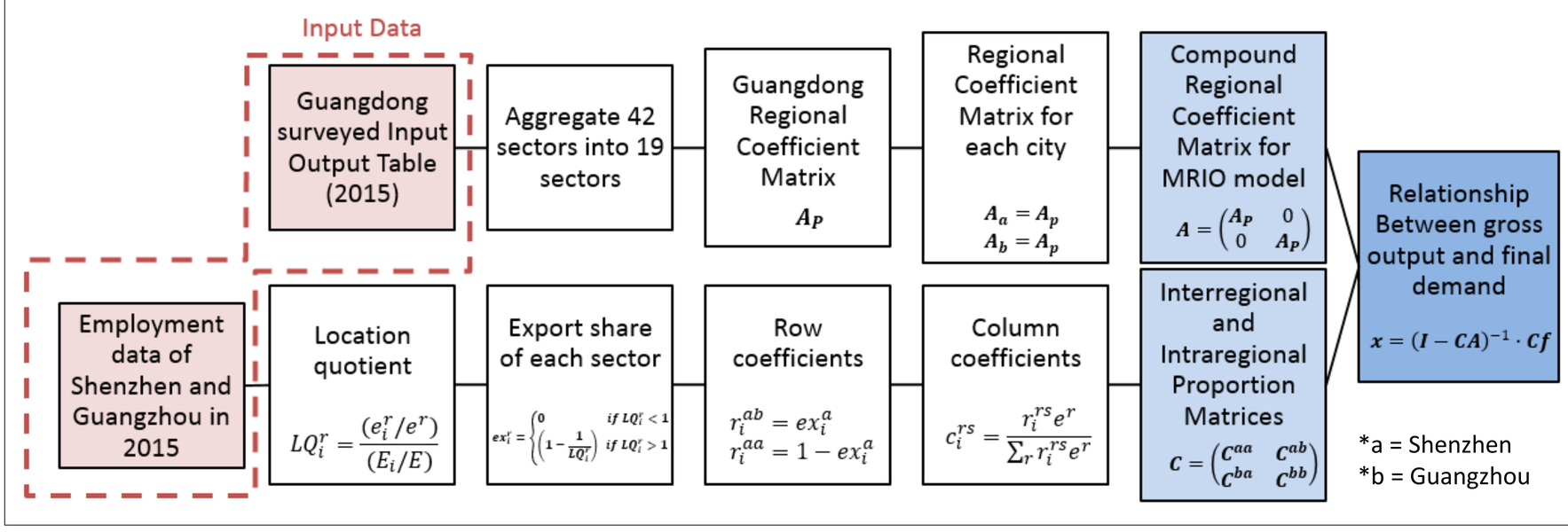
$$\Delta \boldsymbol{x} = [(\boldsymbol{I} - \boldsymbol{CA})^{-1} \cdot \boldsymbol{C}]\Delta \boldsymbol{f}$$

$\Delta \boldsymbol{f}$: Initial Loss/Direct Loss
$\Delta \boldsymbol{x}$: Total Loss
$(\Delta \boldsymbol{x} - \Delta \boldsymbol{f})$: Cascading Loss



Total Loss in All Sectors of Shenzhen and Guangzhou due to 10,000-Yuan Direct Loss in Each Sector

Flow of MRIO Model Establishment (Shenzhen and Guangzhou)



Conclusions:

- The established MRIO model can be employed to gauge total loss and cascading loss based on a known initial loss.
- It appears that the cascading loss can be comparable to or even bigger than initial loss.
- The resultant total loss varies when initial loss occurs in different sectors or same sector but in different cities.

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