Input-Output Analysis

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Session 3.1

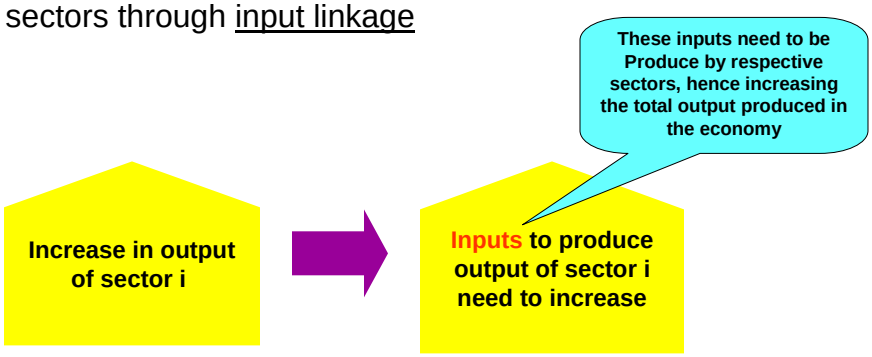
Linkage Analysis

Types of linkage analysis

- If output of sector *i* increases, it will also increase outputs of other sectors in two ways
- First, additional output of sector *i* will increase the demand of intermediate inputs (to produce that additional output of sector *i*)
  ➔ Backward Linkage
- Second, additional output of sector *i* will increase the output distributed to other sectors (and will be used to produce outputs of other sectors)
  ➔ Forward Linkage
- Several extensions using BL and FL concepts:
  - Multiplier product matrix (MPM) analysis
  - Extraction method

Backward linkage

Additional output of sector *i* will increase outputs of other sectors through input linkage



Measures of backward linkage

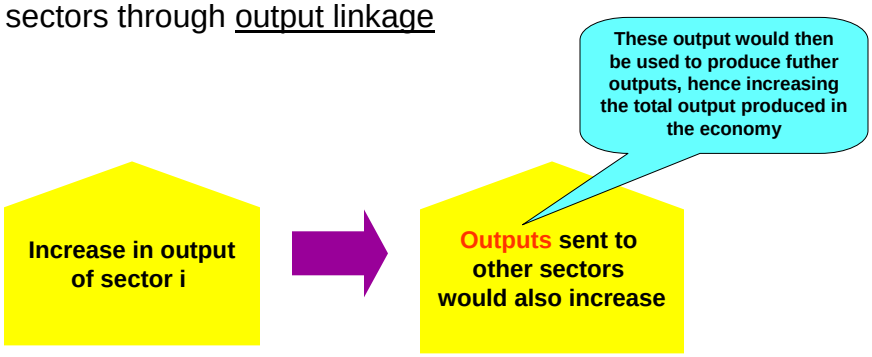
- *Direct backward linkage* $B(d)_j = \sum_{i=1}^{n} a_{ij}$

- *Total backward linkage* $B(d+i)_j = \sum_{i=1}^{n} b_{ij}$

  Comprising direct and indirect effects. In the above formula, *b* is the elements of Leontief inverse

Forward linkage

Additional output of sector *i* will increase outputs of other sectors through output linkage



Measures of forward linkage

- *Direct forward linkage* $F(d)_i = \sum_{j=1}^{n} a_{ij}$

- *Total forward linkage* $F(d+i)_i = \sum_{j=1}^{n} b_{ij}$

  Comprising direct and indirect effects. In the above formula, *b* is the elements of Leontief inverse

BL dan FL, once more …

PyIO Computes These

- *Power dispersion for the backward linkage*

$$BL_j = \frac{\frac{1}{n}\sum_i b_{ij}}{\frac{1}{n^2}\sum_i \sum_j b_{ij}} = \frac{\frac{1}{n} B_i(d+i)}{\frac{1}{n^2} V} = \frac{B_i(d+i)}{\frac{1}{n} V}$$

- *Indices of sensitivity of dispersion for forward linkage*

$$FL_i = \frac{\frac{1}{n}\sum_j b_{ij}}{\frac{1}{n^2}\sum_i \sum_j b_{ij}} = \frac{\frac{1}{n} F_i(d+i)}{\frac{1}{n^2} V} = \frac{F_i(d+i)}{\frac{1}{n} V}$$

Earlier measures normalized by the average of Leontief Inverse average

Hypothetical example

Intersectoral transactions year 1

10	30	40	90
3	2	2	4
12	19	12	13
9	2	1	4
160	70	90	130

Intersectoral transactions year 2

15	37	45	95
13	22	25	8
14	13	21	32
9	22	15	15
150	170	190	230

Intersectoral transactions year 3

25	30	40	95
23	32	35	38
24	33	31	22
19	32	25	15
155	190	200	250

BL

Sector	Year 1	Year 2	Year 3
1	0.7083	0.8347	0.9430
2	1.1406	1.0358	1.0262
3	0.9879	1.0340	1.0094
4	1.1632	1.0954	1.0215

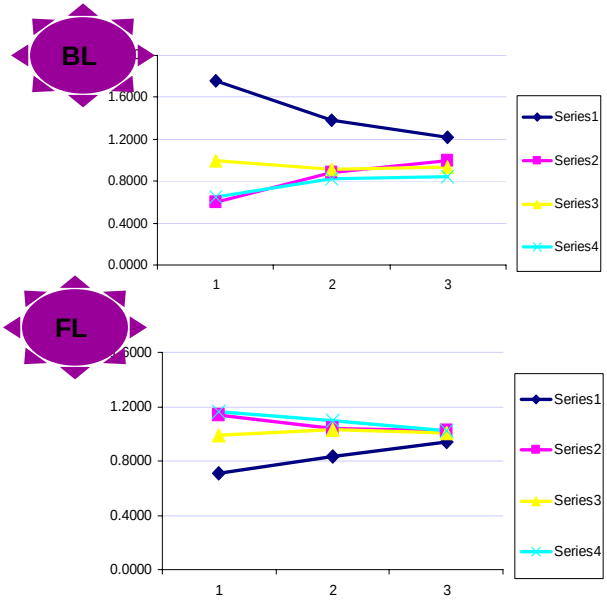
FL

Sector	Year 1	Year 2	Year 3
1	1.7603	1.3850	1.2195
2	0.5952	0.8819	0.9987
3	0.9943	0.9110	0.9391
4	0.6502	0.8220	0.8427

Key sector

- If a sector has BL and FL greater than 1, then that sector is a key sector in that particular year
  - Hypothetical case shows no key sector – but sector 3 is the closest in all years
- FL and BL analysis can also be conducted over time.

- Sectors are getting similar in terms of production capability
- Better?



Multiplier Product Matrix

Multiplier Product Matrix (MPM)

- MPM uses the backward and forward linkage at the same time
- In principle, MPM is a technique to present sectors' rank according to BL and FL values. Formally the formula is

$$M = \frac{1}{V} \times F(d+i) \times B(d+i) = \left[m_{ij} \right]$$

Characteristics of MPM

- Matrix **M** has features identical to the Leontief inverse
- According to its column summation

$$\sum_j m_{ij} = \frac{1}{V}\sum_j \left(F_i(d+i) \times B_j(d+i)\right) = F_i(d+i)$$

- According to its row summation

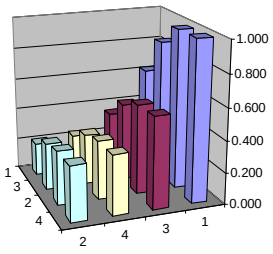
$$\sum_i m_{ij} = \frac{1}{V}\sum_i \left(F_i(d+i) \times B_j(d+i)\right) = B_j(d+i)$$

Presentation technique

- Columns and rows of M can be ranked according to the backward linkage values (for column) and forward linkage values (for rows)
- We therefore obtain the hierarchy of sectors in the economy, from the backward and forward linkage persepectives
- Freeze the ranks at the time we want to base the analysis (usually the initial year). Use the sectoral rank structure in later years
- Observe if there are changes in the economic landscape

From the hypothetical case

tahun 1



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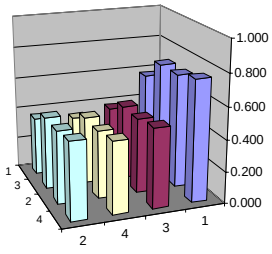

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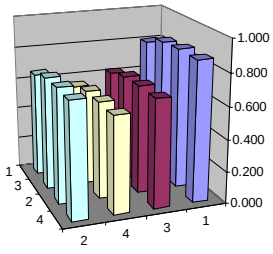
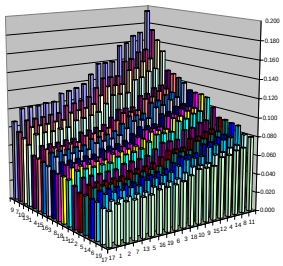
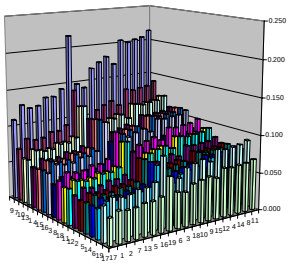


MPM Indonesia - 19 sectors

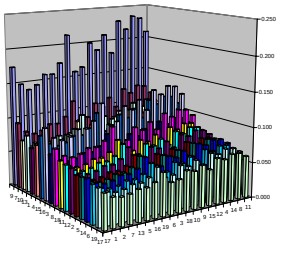
1985



1990



1995



MPM - quantification

- How to quantify that there are acually changes in the economic structure
- Are two matrices similar?

Extraction Method

Extraction method

- In its early days, this method is used to find out the importance of a sector in the economy
- By asking the following question:

  How big is the output impact if a particular sector is extracted out of the economy?

- A sector gone? How to make sense that notion?

Extraction: sector vs. region

- The vanishing of a sector may take place:
  - Evolution in the sectoral definition
  - Long-term evolution of the economic structure
- The vanishing of a region
  - Independence, split, etc.: Ceko-Slovenia, Rusia, East Timor, etc.
- In the short term – from trade to autarchy situation
  In the long term?

Region 1 is out of the economy

- The coefficient input matrix (A) and the Leontief inverse (L) can be written as:

$$\mathbf{A} = \begin{bmatrix} \mathbf{A}^{11} & \mathbf{A}^{1R} \\ \mathbf{A}^{R1} & \mathbf{A}^{RR} \end{bmatrix} \qquad \mathbf{L} = \begin{bmatrix} \mathbf{L}^{11} & \mathbf{L}^{1R} \\ \mathbf{L}^{R1} & \mathbf{L}^{RR} \end{bmatrix}$$

- Extraction means A^{1R} and A^{R1} are forced to be Zero. Output in this system would become

$$\bar{\mathbf{x}} = \begin{bmatrix} (\mathbf{I} - \mathbf{A}^{11})^{-1} & 0 \\ 0 & (\mathbf{I} - \mathbf{A}^{RR})^{-1} \end{bmatrix} \begin{pmatrix} \mathbf{f}^1 \\ \mathbf{f}^R \end{pmatrix}$$

- The difference with the pre-extracted output is

$$\mathbf{x} - \bar{\mathbf{x}} = \begin{pmatrix} \mathbf{x}^1 - \bar{\mathbf{x}}^1 \\ \mathbf{x}^R - \bar{\mathbf{x}}^R \end{pmatrix} = \left\{ \begin{bmatrix} \mathbf{L}^{11} & \mathbf{L}^{1R} \\ \mathbf{L}^{R1} & \mathbf{L}^{RR} \end{bmatrix} - \begin{bmatrix} (\mathbf{I} - \mathbf{A}^{11})^{-1} & 0 \\ 0 & (\mathbf{I} - \mathbf{A}^{RR})^{-1} \end{bmatrix} \right\} \begin{pmatrix} \mathbf{f}^1 \\ \mathbf{f}^R \end{pmatrix}$$

Missing output in region 1: two impacts

- Foregone output in region 1 because it no longer connected (economically) with R

$$\mathbf{x}^1 - \bar{\mathbf{x}}^1 = \left[(\mathbf{L}^{11} - (\mathbf{I} - \mathbf{A}^{11})^{-1}) \mathbf{f}^1 \right] + \left[\mathbf{L}^{1R} \mathbf{f}^R \right]$$

- Local or direct impact is reflected by the first component.
  This is the amount of foregone output in the context of final demand in region 1.

- Indirect impact if reflected by the second component.
  This is the foregone output in the context of final demand from R.

Missing output in region R: two impacts

- Foregone output in R because it no longer connected (economically) with region 1

$$\mathbf{x}^R - \bar{\mathbf{x}}^R = \left[(\mathbf{L}^{RR} - (\mathbf{I} - \mathbf{A}^{RR})^{-1})\mathbf{f}^R \right] + \left[\mathbf{L}^{R1}\mathbf{f}^1 \right]$$

- Local or direct impact is reflected by the first component.
  This is the amount of foregone output in the context of final demand in region R

- Indirect impact if reflected by the second component.
  This is the foregone output in the context of final demand from 1.

Effect of East Timor out of Indonesian system

Total impact	Rp 4241.52 billion
Interregional impact	Rp 4154.92 billion (97.9% dari total)
Interregional distribution	Sumatra 4.5% Jawa-Bali 54.4% Kalimantan 30% Sulawesi 9.0% East Island 1.8%