

# It takes two to tango. Dichotomous principles in regional economic models

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# Content

1. Aim of this paper and “why should you care”?
2. Regional economic models – how to tango in Denmark
3. Theoretical understanding of the 2 by 2 by 2 principle
4. Discussion regarding the size and types of multipliers
5. Setup of hypothesis and experiment

# Aim and scope

- **Aim of this paper:** To analyse the size and types of multipliers based on the multiplier experiment in Leontief's input-output and Miyazawa's extended demographic model.
- **“Why should you care”?** This study should contribute to analyse how local economies function and its linkages to other areas of economy and geography.
  - E.G. if we argue that the export jobs are attractive for local communities then our question should be
    - How attractive are they?
    - What are the spillover and feed-back effects on other localities?
    - How much the local economic structure and its geography actually matters?

# Regional economic models

## How to tango in Denmark?

- 2 by 2 by 2 principle is the basic data and model-structure in SAM-K and LINE (interregional general equilibrium model)

### History:

- 1995 to 2010 - developed model and theory based upon the 2 by 2 by 2-principle (B. Madsen, C. Jensen-Butler, P. Dam)
- 2006 to 2018 - SAM-K and LINE was implemented in practice (B. Madsen, J. Zhang)
- <2018 – different versions of SAM-K/LINE:
  - Basis version (5 regions, The Danish Agency for Labour Market and Recruitment)
  - Tourism version (Visit Denmark)
  - Harbour version (Danish Harbours)
  - Building version (The Danish Construction Association)

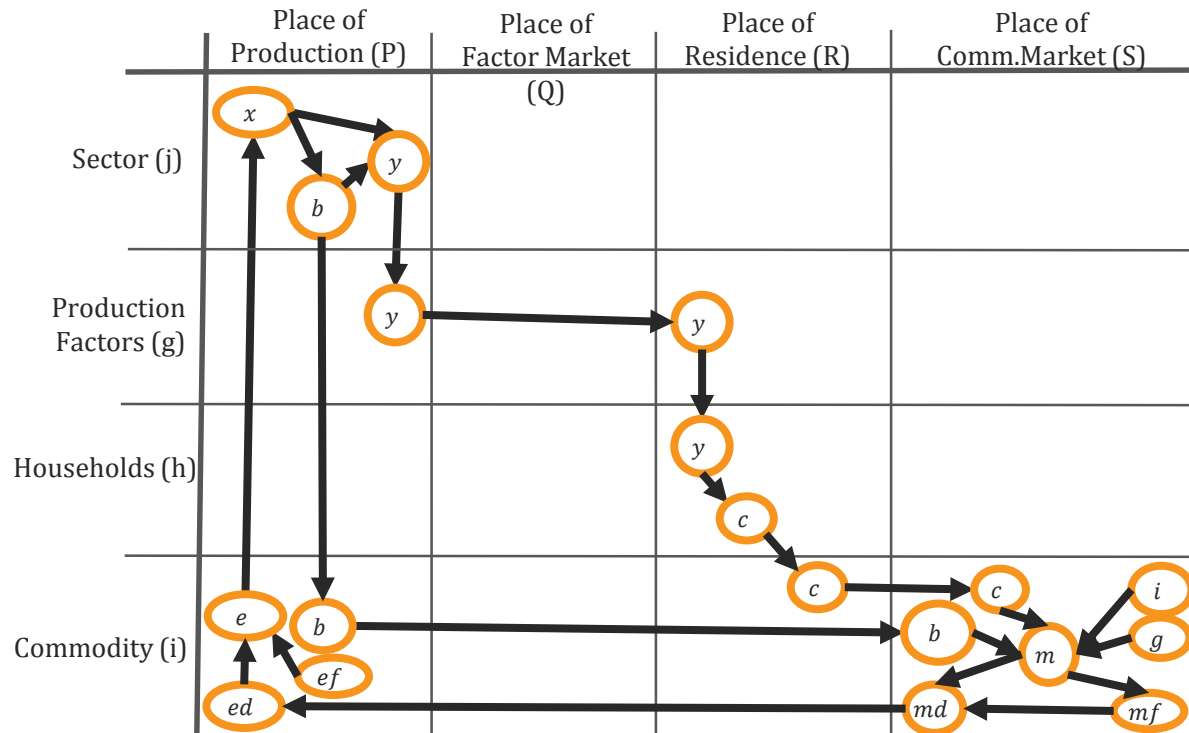
2018 <

- Health Economic version...under development (Region Greater Copenhagen)
- Environmental Economic version ...under development (CRT, Aarhus University and Copenhagen University)

# It takes two to tango

## From the National Quantity model to the Inter-Regional 2 by 2 by 2-model

Figure 3.2.c The circular flow  
 With income/expenditure flows  
 With detailed social accounting and geography



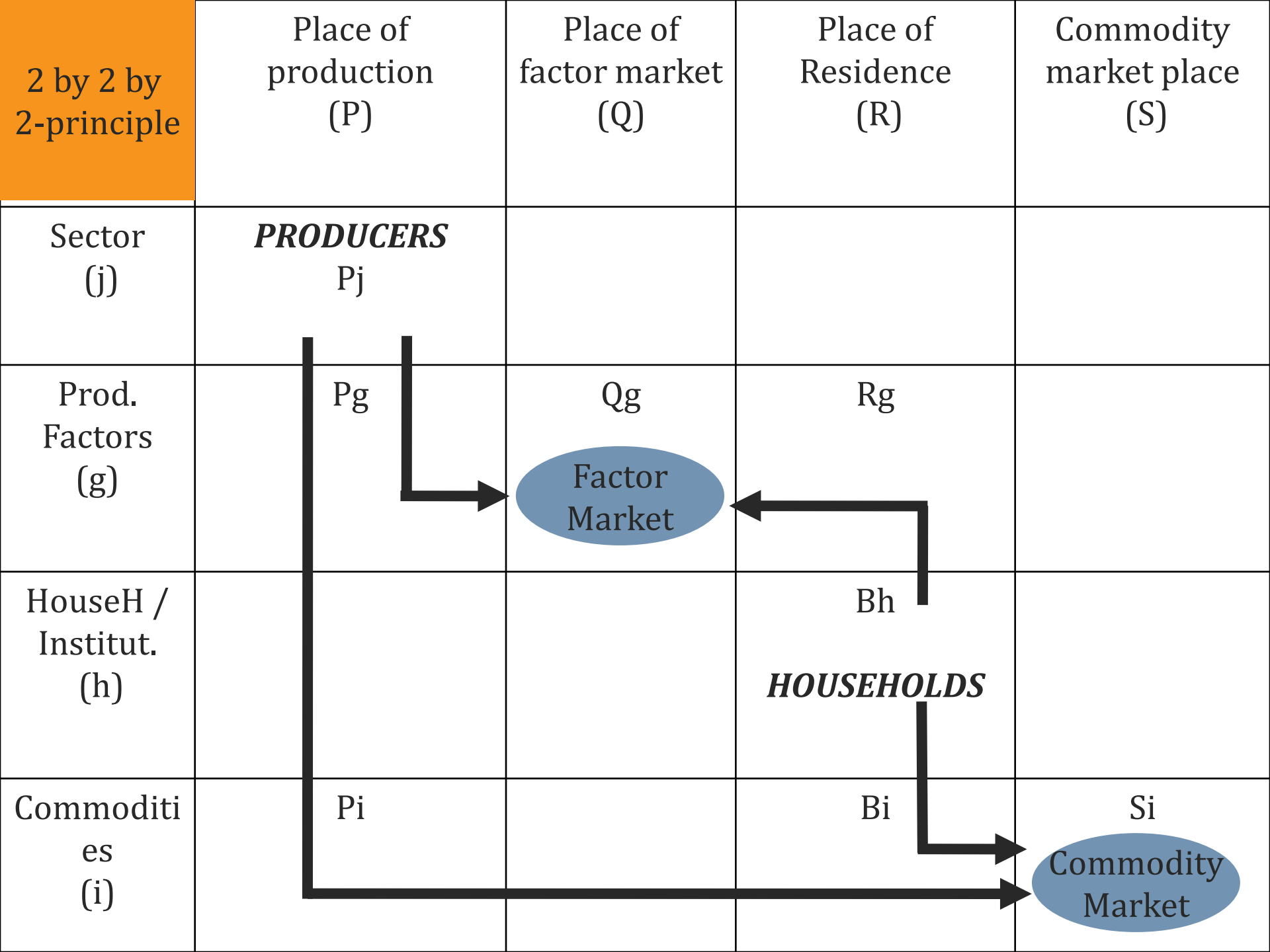
# SAM-K/LINE based on 2 by 2 by 2-principles:

SAM-K refers to Social Accounting Matrix for K-municipalities

LINE refers to Interregional General Equilibrium Model

- **2x2x2 – Geography:**
  - ✓ Place of production
  - ✓ (Place of factor market)
  - ✓ Place of residence
  - ✓ Place of commodity market
- **2x2x2 – Actors:**
  - ✓ Sectors
  - ✓ Production factors
  - ✓ (Household types)
  - ✓ Commodities
- **2x2x2 – Interactions:**
  - ✓ Trade
  - ✓ Commuting
  - ✓ Shopping
  - ✓ Tourism





# The Leontief – Miyazawa interregional Input-output & Income Multiplier Model

First, in the Miyazawa extended demographic model the production is determined in the following way:

$$x = Ax + CVx + f \dots \dots \dots (1)$$

where

$x$ : gross output by sector

$A$ : intermediate consumption by sector of origin as share of gross output, by purchasing sector

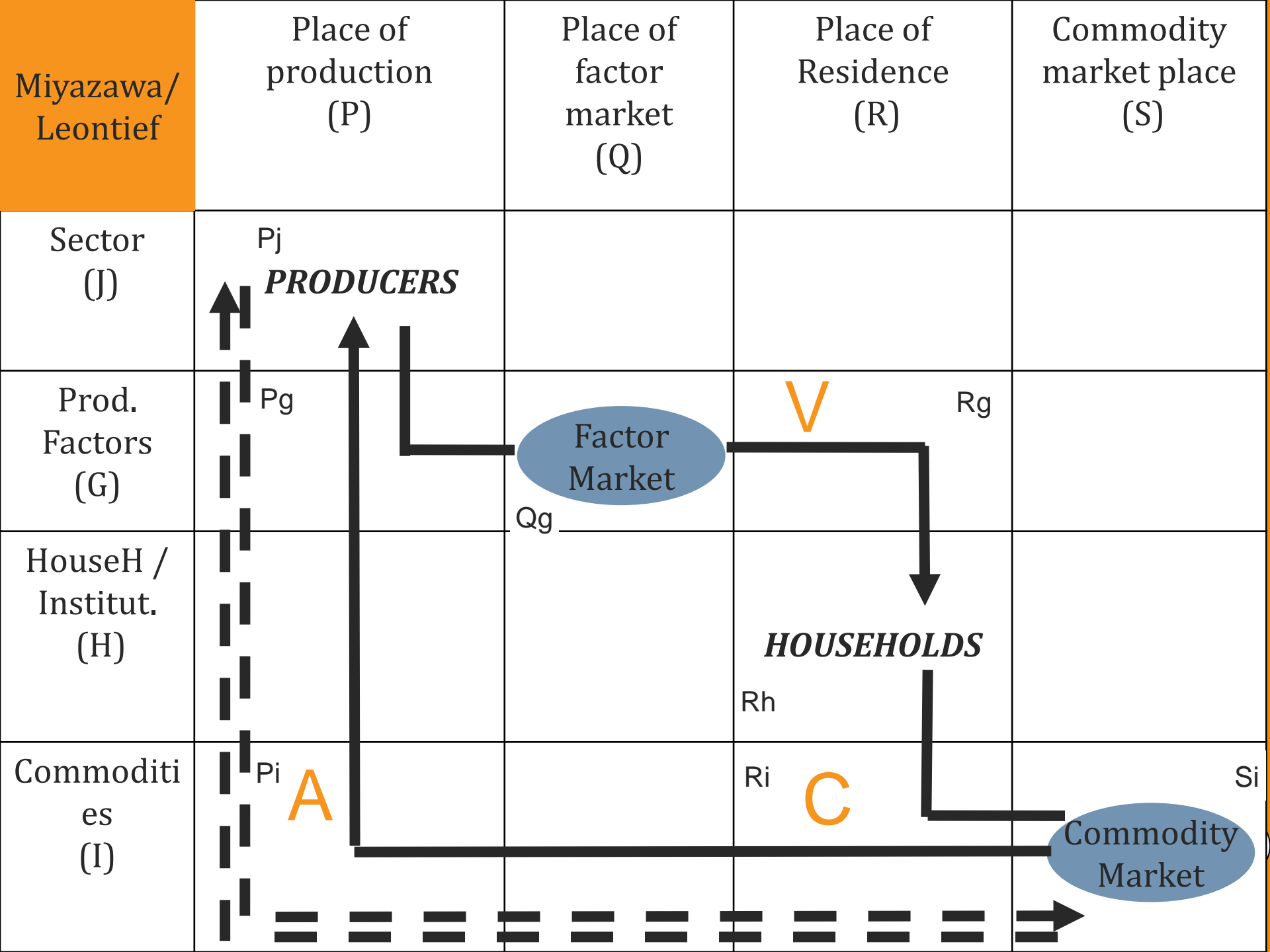
$C$ : Private consumption by sector and place of production as share of private consumption, by type of household and by place of residence

$f$ : final demand, by sector

The simple solution to the model is:

$$x = (I - Ax - CV)^{-1}f \dots \dots \dots (1a)$$





# From the "A- and CV-model" to the "2 x 2 x 2"-principle-model

The Leontief and Miyazawa model can be decomposed into the following expression:

$$\begin{aligned}
 \overset{\text{A}}{\underbrace{DTS_{ic}B_{ic}}_A}x + \overset{\text{CV}}{\underbrace{DTS_{cp}B_{cp}HJ_{sup}J_{dem}G}_{CV}}x \\
 + DTf_{dem} \dots \dots \dots (2) \\
 \underset{\text{C}}{\quad} \quad \quad \quad \underset{\text{V}}{\quad}
 \end{aligned}$$

From this the solution to the model can be established:

$$\begin{aligned}
 \overset{\text{A}}{\underbrace{I - DTS_{ic}B_{ic}}_A} - \overset{\text{CV}}{\underbrace{DTS_{cp}B_{cp}HJ_{sup}J_{dem}G}_{CV}} \text{ )}^{-1} DTf_{dem} \dots \dots \dots (3)
 \end{aligned}$$

# The Leontief – Miyazawa interregional Input-output & Income Multiplier Model Decomposition in to 2x2 elements (C)

Further the consumption matrix  $C$  can also be divided into four sub-matrices:

$B_{cp} = b_{h,i}^R$ : Private consumption by commodity  $i$  as share of income, by type of household by place of residence  $R$  (USE-table)

$S_{cp} = s_i^{R,S}$ : Private consumption by place of commodity market  $S$  as share of total private income, by place of residence  $R$  and by commodity  $i$

$T = t_i^{S,P}$ : Trade by place of production  $P$  share of total trade, by place of commodity market  $S$  and by commodity  $i$

$D = x_{i,j}^P$ : Production by sector  $j$  as share of total production, by place of production  $P$  and by commodity  $i$  (MAKE/SUPPLY-table)

# The Leontief – Miyazawa interregional Input-output & Income Multiplier Model Decomposition in to 2x2 elements (V)

Following the figure the  $V$ -matrix can be divided into 4 sub-matrices:

$G = j_{j,g}^P$  : Factor income/labour demand by type of labour  $g$  as share of gross output, by sector  $j$  and by place of production  $P$

$J_{dem} = j_g^{P,Q}$  : Income/labour demand by place of factor market  $Q$  as share of total employment demand, by place of production  $P$  and by type of labour  $g$

$J_{sup} = j_g^{Q,R}$  Income/labour demand by place of residence  $R$  as share of total employment demand, by place of factor market  $Q$  and by type of labour  $g$

$H = h_{g,h}^R$  Income/labour demand by place of factor market  $q$  as share of total employment demand, by place of residence  $R$  and by type of labour  $g$

# The Leontief – Miyazawa interregional Input-output & Income Multiplier Model Decomposition in to 2x2 elements (A)

The Leontief interaction between sectors  $A$  can be sub-divided into 4 components:

$B_{ic} = b_{IC,j,i}^P$ : Intermediate consumption by place of production  $P$  as share of production, by place of production  $P$ , by sector  $j$  and by commodity  $i$  (USE-table)

$S_{ic} = s_{IC,i}^{P,S}$ : Intermediate consumption by place of commodity market  $S$  as share of intermediate consumption, by place of production  $P$  and by commodity  $i$

$T = t_i^{S,P}$ : see definition of trade above

$D = x_{i,j}^P$ : see definition of supply reverse matrix above

# The size and types of multipliers

## Vertical (SAM-elements, multiplicative)

- Intermediate consumption shares
- Private consumption shares
- GVA-shares

## Horizontal (redistribution, non-multiplicative)

- Commuting
- Shopping
- Trade

# From the "A- and CV-model" to the "2 x 2 x 2"- principle -model

From this the solution to the model can be established:

$$x = \left( \overbrace{I - DTS_{ic}B_{ic}}^A - \overbrace{DTS_{cp}B_{cp}HJ_{sup}J_{dem}G}^{CV} \right)^{-1} DTf_{dem} \dots \dots \dots (3)$$

Vertical multiplicative effects

# From the "A- and CV-model" to the "2 x 2 x 2"-principle-model

From this the solution to the model can be established:

$$x = \left( I - \overbrace{DTS_{ic} B_{ic}}^A - \overbrace{DTS_{cp} B_{cp} H J_{sup} J_{dem} G}^{CV} \right)^{-1} DT f_{dem} \dots \dots \dots (3)$$

Horizontal regional redistributive effects



# The size of multipliers – hypothesis 1

## (Horizontal : regional redistribution)

The size of multipliers can now be explained by the characteristics of 98 municipalities of Denmark:

- The **size** of municipality (Copenhagen, Aarhus ect.):
  - Lower the leakages the larger the municipality = high local multiplier
- The **peripherality** (islands):
  - both – lower leakages commuting and shopping, but higher leakages interreg. trade = multipliers above average for the induced effects, but smaller for indirect effects
- **Suburban** areas of great cities (metropolises)
  - High commuting, shopping and trade, i.e. higher leakages = small local multiplier

# The size of multipliers – hypothesis 2

## (Vertical – SAM multiplicative effects)

The size of multipliers can now be explained by the characteristics of 98 municipalities:

- Municipalities with high share of sectors with higher intermediate consumption, e.g. **Manufacturing industry**
  - = high multiplier and impacts of changes in the final demand
- Big municipalities with ability **to supply local markets** with a goods and labour
  - = higher local multiplier
- Municipalities with high **private consumption** shares
  - = higher impacts of changes in the final demand

# Types of multipliers

- Both Horizontal and Vertical multipliers can be sub-divided by:
  - Local multipliers – i.e. intra-municipality impact
    - Higher is the intra-municipality leakages – higher is local multiplier and lower is national multiplier
  - National multipliers – i.e. inter-municipality impact
    - Higher is the inter-municipality leakages – higher is the national multiplier and lower is the local multiplier

# Multiplier experiments with LINE

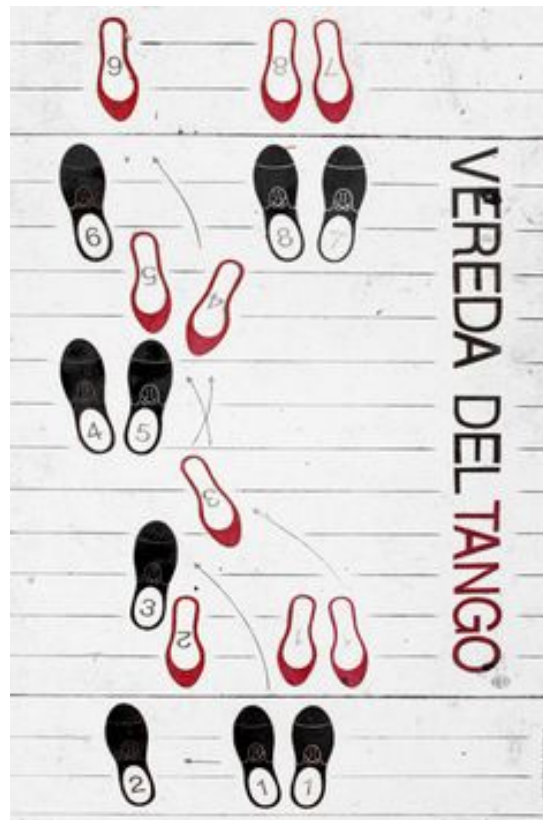
(=Local INterregional Economic model for Denmark)

- Type of experiment:
  - 100 jobs within manufacturing industry
- Direct effects
  - Employment (Place of residence (R) by age, gender and education (g))
  - local demand (Place of commodity market (S) by commodity (i))
  - Jobs (place of production (P) by sectors (j))
- Multipliers
  - Local multipliers = direct local impacts/total local impact
  - National multipliers=direct national impacts/total national impacts

# Future plan.....to complete the experiment and elaborate the results

## **To summarise:**

- A-CV model based on Leontief and Miyazawa
- Distinction between the vertical and horizontal multipliers
- Discussion /hypothesis regarding size of multipliers
- The types of multipliers based on the spillover effects – i.e. local and national
- We plan experiment by increasing 100 industry jobs in each municipality of Denmark to see the differences in size and types of multipliers vs. municipality characteristics



*Thank you for your attention*