AIM/Material Model

Features, model and necessary data

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Session 4: Asia-Pacific Integrated Model (AIM):
Introduction to Component Models (Cont.)

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Coverage in this workshop

- **Summary (This session)**

  For understanding AIM/Material model

  - ***What is AIM/Material model?***
  - ***Model formulation***
  - ***Necessary data for simulation***
  - ***Future scenario***

- **Training (Session 5)**
  - ***Operation of AIM/Material model***

- **Application (Session 7)**
  - ***Application of AIM/Material model to India and Japan***

Features of AIM/Material Model

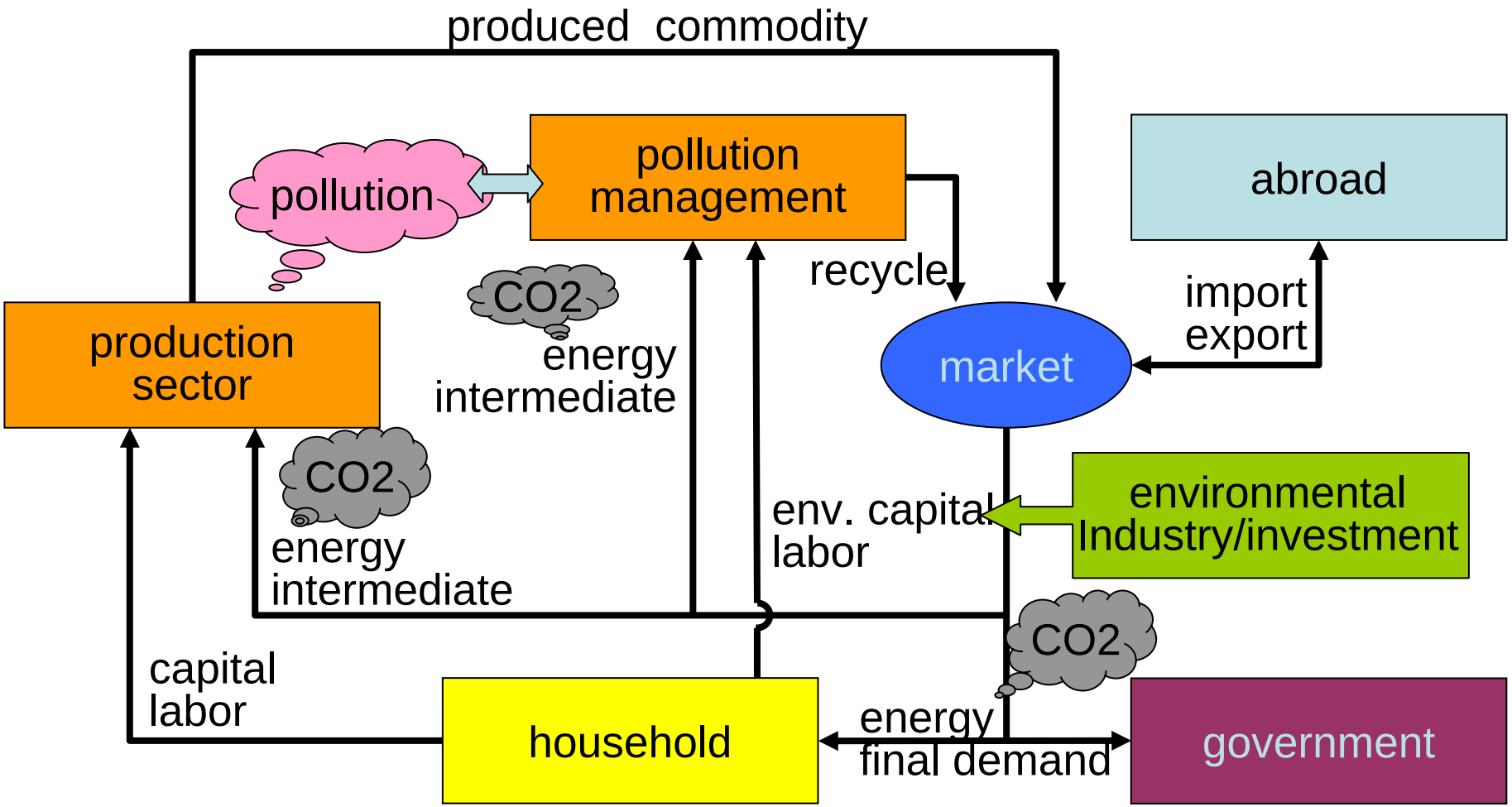
- **Top-down model**
- **Domestic model**
- **Computable General Equilibrium model**
- **Recursive dynamics**
- **Treatment of pollution generation, management and discharge**
- **Activity of environmental industry and environmental investment**
- **Consistent material balance**
- **Link with technology model such as AIM/Emission model for technology progress**

We have been developing AIM/Material for both CO2 and other environmental problems.

Structure of AIM/Material Model

- **Production sector**
  - **Input: capital, labor, energy, other intermediate input, pollution (inputs for pollution management)**
  - **Output: commodity**
- **Household**
  - **Endowment: capital, labor**
  - **Demand: household final consumption, investment**
- **Government**
  - **Revenue: tax including environmental tax**
  - **Demand: government final consumption, government investment**

Structure of AIM/Material Model



Procedure of model analysis

1. Formulation of model
2. Preparation of dataset in initial year, and calibration
3. Preparation of future scenarios
4. Simulation
    i. Reference case
    ii. Policy case

Social account matrix for AIM/Material

			Production sector			Final Consumption	Investment			Supply	Price	Endowment
			Sector 1	Sector 2	Sector 3		Sector 1	Sector 2	Sector 3			
Input	Intermediate inputs	Commodity 1	X_{11}	X_{12}	X_{13}	C_1	I_{11}	I_{12}	I_{13}	$Y_{11}+Y_{21}+Y_{31}$	P_1	
		Commodity 2	X_{21}	X_{22}	X_{23}	C_2	I_{21}	I_{22}	I_{23}	$Y_{12}+Y_{22}+Y_{32}$	P_2	
		Commodity 3	X_{31}	X_{32}	X_{33}	C_3				Y_{33}	P_3	
	Capital		K_1	K_2	K_3						P_K	K^*
	Labor		L_1	L_2	L_3						P_L	L^*
	Final disposal				W_3						P_W	W^*
Output	Commodity 1		Y_{11}	Y_{21}	Y_{31}						P_1	
	Commodity 2		Y_{12}	Y_{22}	Y_{32}						P_2	
	Commodity 3				Y_{33}						P_3	

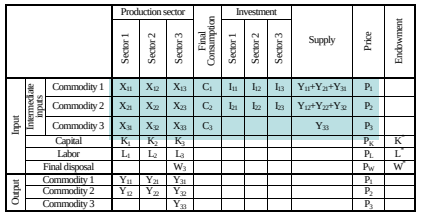
Formulation of AIM/Material

- **Market equilibrium**
  - **Produced commodity**

$$P_i \left\{ \sum_{j=1}^{3} Y_{ji} - \left(\sum_{j=1}^{3} X_{ij} + C_i + \sum_{j=1}^{3} I_{ij} \right) \right\} = 0$$

$$P_i \geq 0$$

$$\sum_{j=1}^{3} Y_{ji} - \left(\sum_{j=1}^{3} X_{ij} + C_i + \sum_{j=1}^{3} I_{ij} \right) \geq 0$$



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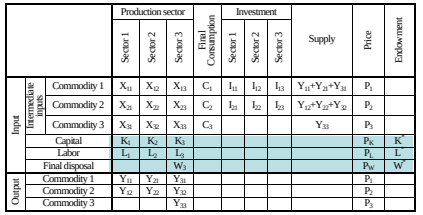
		Commodity 3			Y_{33}						P_3	

  - **production factor (capital, labor, ...)**

$$P_K \left\{ K^* - \sum_{j=1}^{3} K_j \right\} = 0,\ P_K \geq 0,\ \text{and}\ K^* - \sum_{j=1}^{3} K_j \geq 0$$

$$P_L \left\{ L^* - \sum_{j=1}^{3} L_j \right\} = 0,\ P_L \geq 0,\ \text{and}\ L^* - \sum_{j=1}^{3} L_j \geq 0$$

$$P_W \left\{ W^* - \sum_{j=1}^{3} W_j \right\} = 0,\ P_W \geq 0,\ \text{and}\ W^* - \sum_{j=1}^{3} W_j \geq 0$$



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Formulation of AIM/Material

- **Balance of production sector**

$$\sum_{i=1}^{3} P_i X_{ij} + P_K K_j + P_L L_j + P_W W_j = \sum_{i=1}^{3} P_i Y_{ij}$$

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- **Balance of final demand sector**

$$H = P_K \sum_{j=1}^{3} K_j + P_L \sum_{j=1}^{3} L_j + P_W \sum_{j=1}^{3} W_j$$

$$H = \sum_{i=1}^{3} P_i (C_i + \sum_{j=1}^{3} I_{ij})$$

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	Commodity 2		Y_{12}	Y_{22}	Y_{32}						P_2	
	Commodity 3				Y_{33}						P_3	

- **Capital stock and investment**
  - **for dynamics**

$$K_{j,t+1} = (1-\delta_j) K_{j,t} + \sum_{i=1}^{3} I_{ij}$$

Formulation of AIM/Material

- **Relationship between input and output**
  - **Production function**
  - **Demand function**

    CES, Leontief, Cobb-Douglas, Linear, ...

- **Household: Maximize utility**
- **Production sector: Maximize profit**

➔Find equilibrium solution

Dataset for AIM/Material Model

- IO table (commodity x commodity)
- U matrix (commodity x sector)
  - Disaggregate pollution management
- V matrix (sector x commodity)
- Investment by sector
  - Disaggregate pollution management
- Pollution flow by sector
  - Generation, treatment, discharge, recycle, ...
- Supply and demand of reused material

Input-Output table

household consumption, government consumption, investment, export

	commodity 1	...	commodity i	final demand	total output
commodity 1					
:					
commodity i					
value added					
total output					

Distribution of produced commodity to production of commodity and final demand is presented.

In order to produce commodity, what kind of inputs and how much of them are necessary.

- Necessary data for simulation-

U matrix (Use matrix)

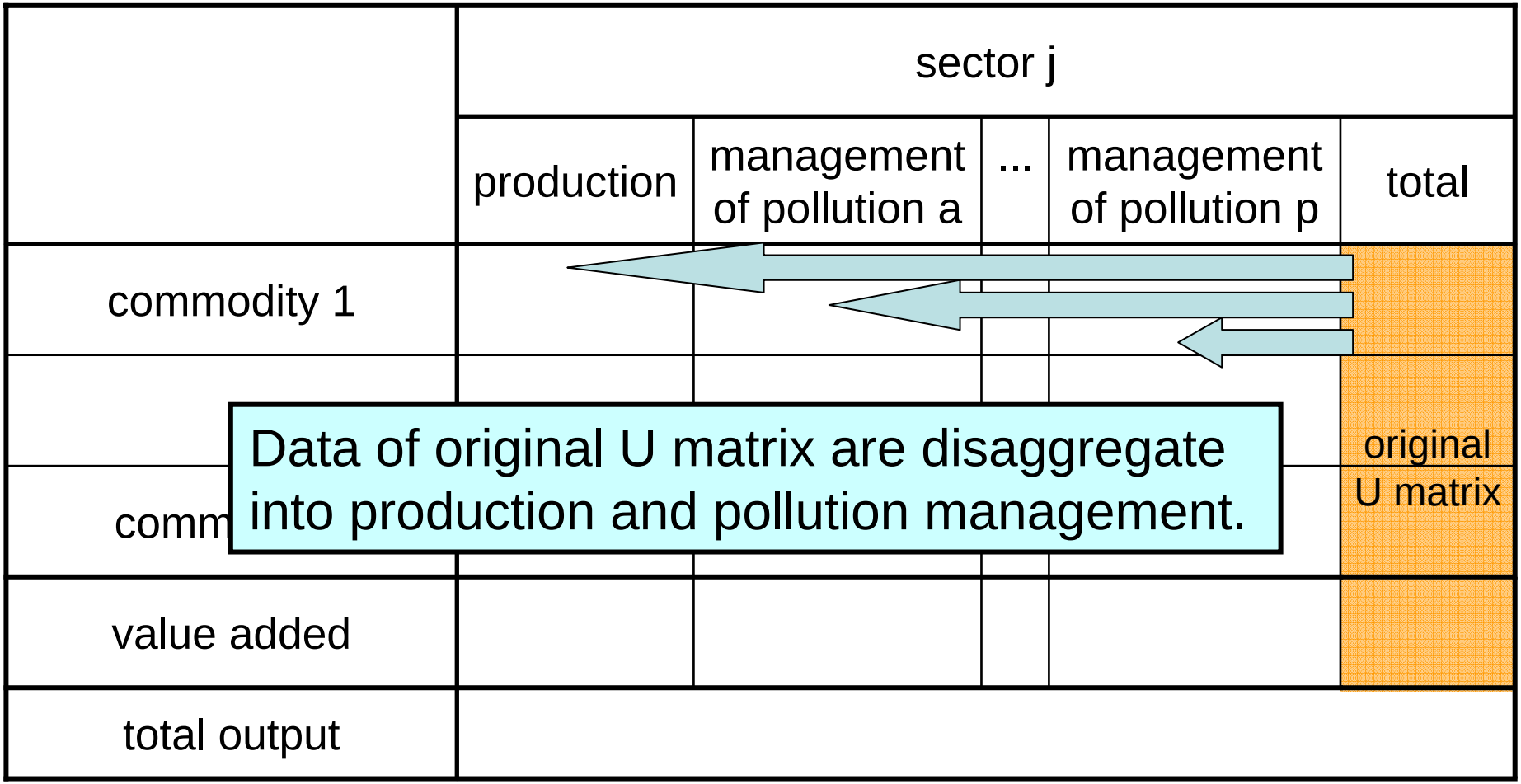
	sector 1	...	sector j	final demand	total output
commodity 1					
:					
commodity i					
value added					
total output					

Distribution of produced commodity to sectors and final demand is presented.

What kind and how much of input for production activity are necessary in sector.

Revised U matrix

(disaggregate production and pollution management)



IO/U/V/investment/
pollution/reuse

V matrix (Make matrix)

	commodity 1	...	commodity i	total output
sector 1				
:				
sector j				
total output				

How much of commodity i
produced by sector j
is represented.

- Necessary data for simulation-

Investment by sector

	commodity 1	...	commodity i	total investment
sector 1				
:				
sector j				
total output				

How much of commodity invested to sector j is represented.

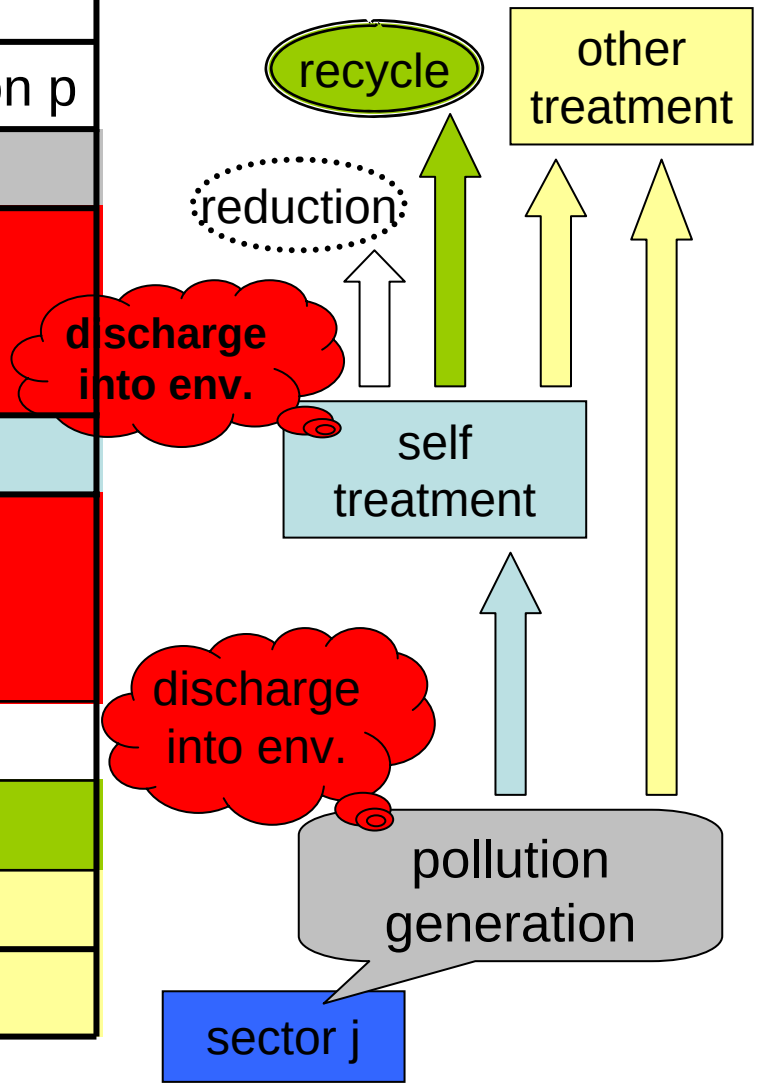
Pollution flow by sector

Pollution type

- **Air pollution: SOx, NOx, CO2, ...**
- **Water pollution: BOD load, COD load, ...**
- **Solid waste: sludge, scrap metal, slag, ...**
  - **In the case of Japan, the number of the most detailed classification is almost 70.**
- **Other:**
  - **Toxic waste: Pb, dioxin, ...**

Pollution flow by sector

	sector j		
	pollution a	...	pollution p
generation			
discharge into environment without treatment			
self treatment			
discharge into environment after treatment			
reduction			
recycle			
other treatment			
direct other treatment			



- Necessary data for simulation-

Supply and demand of reused material

	commodity 1	...	commodity i	total generation of reused pollution
pollution a				
:				
pollution p				
total supply of reused commodity				

How much of pollution p
can be supplied as commodity i.

- Necessary data for simulation-

Supply and demand of reused material

	sector 1	...	sector j	total supply of reused pollution
commodity 1				
:				
commodity i				
total demand of reused commodity				

How much of recycled commodity i can be demanded in sector j.

Optional Data for AIM/Material Model

- **Energy balance table**
  - **Link physical data from energy balance table and monetary data from U matrix**
- **Other physical material data**
  - **Raw materials such as wood, paper, steel, ...**
  - **Link these physical data and monetary data**

Not yet completed

Scenarios for AIM/Material Model

- **Technology change**
  - **Energy efficiency, pollution generation, pollution management, recycled material input, and so on for new equipment (investment)**
- **Labor force**
- **Export and import**
- **Preference change**
  - **Final consumption, investment, ...**

Application of AIM/Material Model

- **Economic impacts due to environmental preservation**
  - **CO2 reduction (Kyoto target), waste reduction, waste water treatment, ...**
- **Mitigation by countermeasures**
  - **Environmental investment, preference change, new technology, tax reform, CDM, ...**
- **Link with bottom up model such as AIM/Emission**

➔Detailed results will be represented in session 7.