Framework on Estimating Expected Benefits through Facilitating the Nagoya Protocol on Access and Benefit-Sharing:

Interim Report – An Attempt of Estimation of Non-Monetary Benefits

CEPA

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3 **Method of Simulating Ripple Effects by Input-Output Analysis**

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Method of Simulating Ripple Effects by Input-Output Analysis

Simulating ripple effect

- Conditions for simulation have been set in the previous presentation.
- Benefits are simulated and are expressed as ripple effects.
- The ripple effects can be calculated by input-output analysis.

What is input-output analysis anyway?

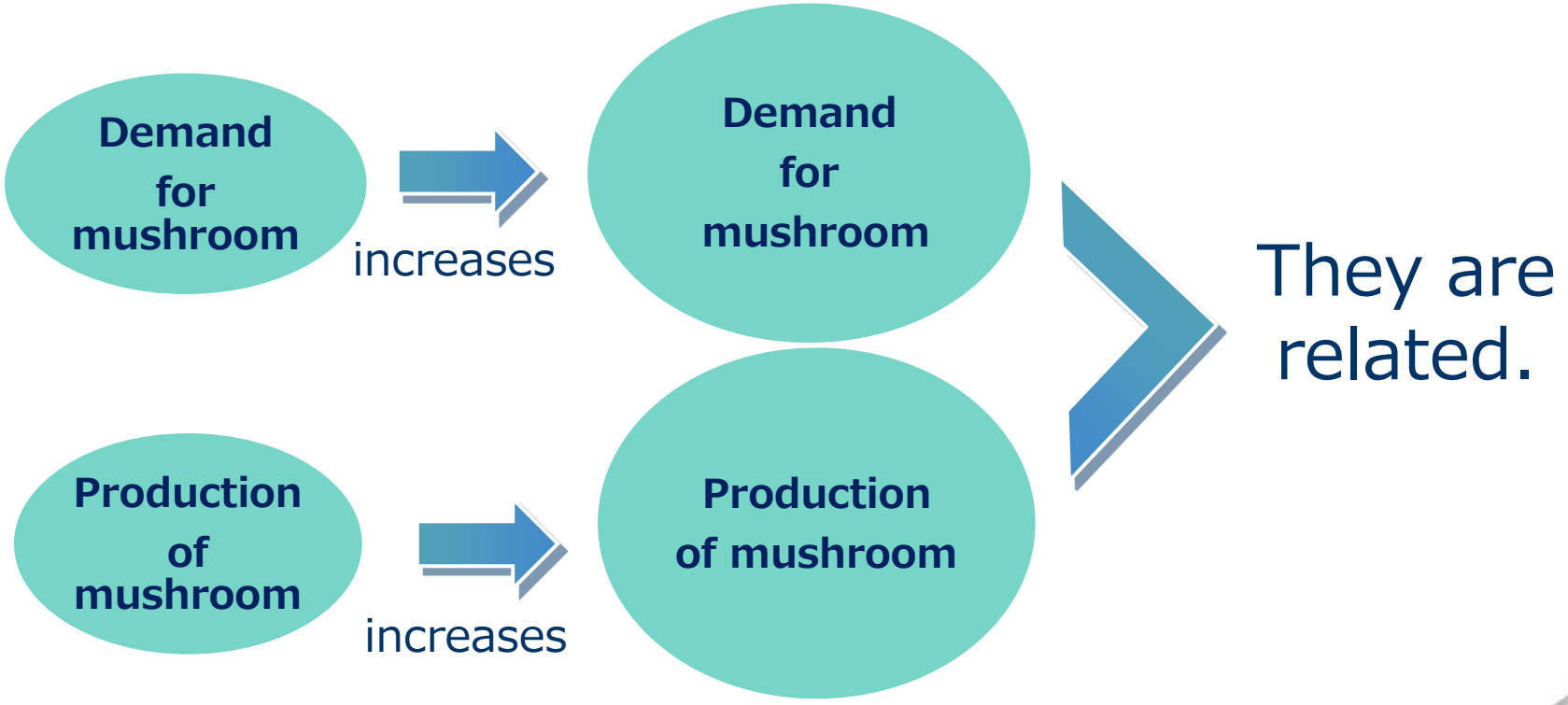
- Input-output analysis is one of the standard analytical models to analyse all the relationships among all the inputs and outputs in production systems in one economy of one country.
- The analysis was explored by Leontief who won a Nobel Prize in Economics.
- During analysis, an input output table (see the next slide) is used and is applied to a general equilibrium model.
- Nowadays, many tables of many countries are available.

Proto-type of Non-competitive import I-O table

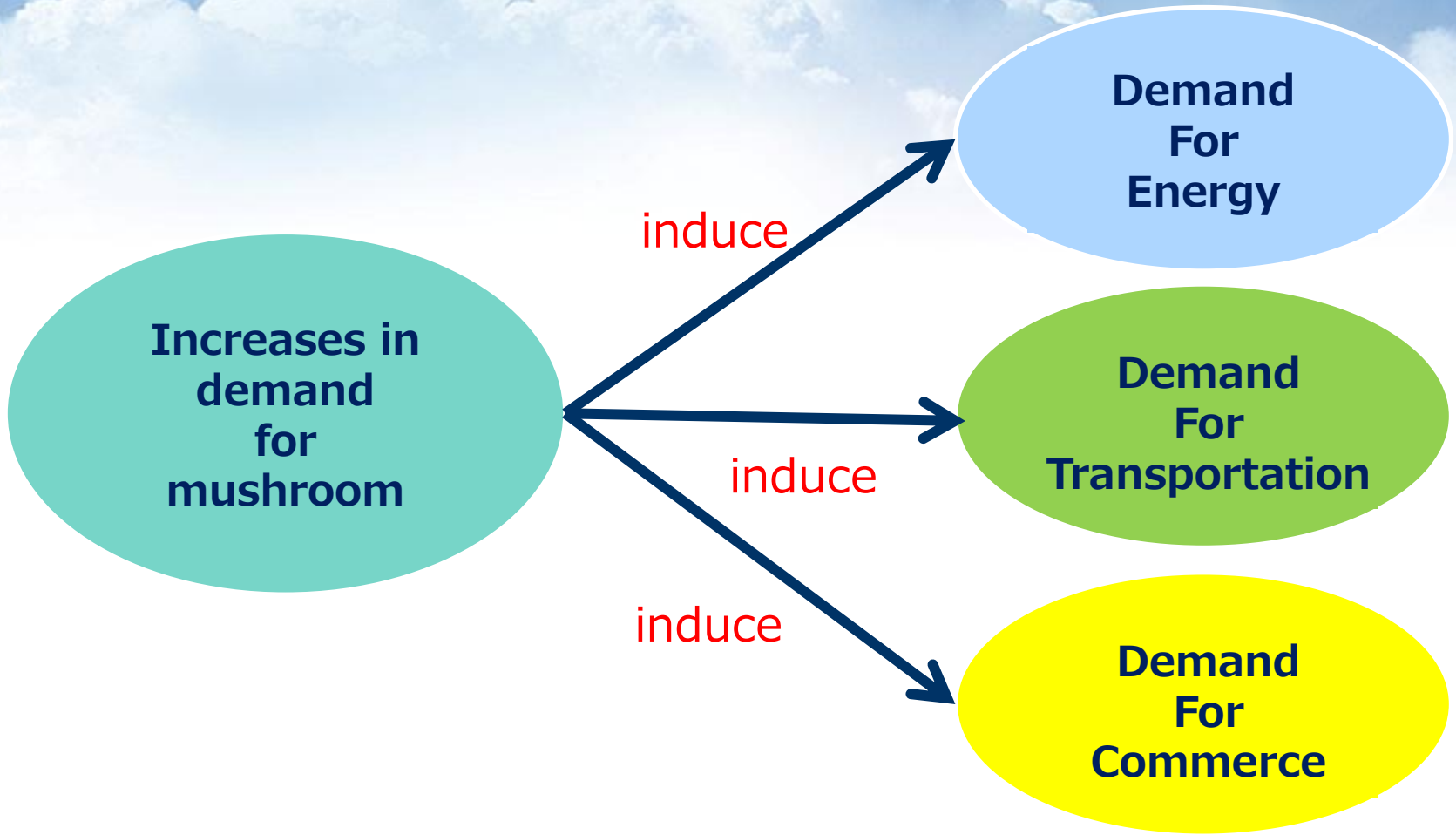
		Intermediate Demand				Final Demand	Dom Prod & Import
		Ind 1	Ind 2	⋯	Ind *n*		
Domestic Production	Industry 1	$p^d_1X^d_{11}$	$p^d_1X^d_{12}$	⋯	$p^d_1X^d_{1n}$	$p^d_1F^d_1$	$p^d_1X^d_1$
	Industry 2	$p^d_2X^d_{21}$	$p^d_2X^d_{22}$	⋯	$p^d_2X^d_{2n}$	$p^d_2F^d_2$	$p^d_2X^d_2$
	⋮	⋮	⋮		⋮	⋮	⋮
	Industry *n*	$p^d_nX^d_{n1}$	$p^d_nX^d_{n2}$	⋯	$p^d_nX^d_{nn}$	$p^d_nF^d_n$	$p^d_nX^d_n$
Import	Industry 1	$p^m_1X^m_{11}$	$p^m_1X^m_{12}$	⋯	$p^m_1X^m_{1n}$	$p^m_1F^m_1$	$p^m_1M_1$
	Industry 2	$p^m_2X^m_{21}$	$p^m_2X^m_{22}$	⋯	$p^m_2X^m_{2n}$	$p^m_2F^m_2$	$p^m_2M_2$
	⋮	⋮	⋮		⋮	⋮	⋮
	Industry *n*	$p^m_nX^m_{n1}$	$p^m_nX^m_{n2}$	⋯	$p^m_nX^m_{nn}$	$p^m_nF^m_n$	$p^m_nM_n$
	Value added	V_1	V_2	⋯	V_n		
	Domestic Production	$p^d_1X_1$	$p^d_2X_2$	⋯	$p^d_nX_n$		

What is an advantage of input-output analysis?

- It can highlight the relationships among inputs and outputs.
- For instance



Induction of inputs



These relationships are strictly expressed by equations
in the next slide.

Demand-supply equilibrium

- Nominal base equilibrium (for any *j* industry)

$$\underbrace{p_j X_{j1} + p_j X_{j2} + \cdots + p_j X_{jn}}_{\text{Intermediate demands for other industries}} + \underbrace{p_j f_j}_{\text{Final demands}} = \underbrace{p_j X_j}_{\text{Domestic output}}$$

- Quantity base equilibrium (for any *j* industry)

$$X_{j1} + X_{j2} + \cdots + X_{jn} + f_j = X_j$$

- Input coefficient (fixed in the short period)

$$a_{ij} = \frac{X_{ij}}{X_j}$$

What can input-output analysis do in this session's context?

- It can calculate increases in intermediate demands AND value added (incomes)
- if you put the figures of increases in final demands.
- This calculation can be done, using Leontief inverse matrix on the next slide.

Leontief Inverse Matrix

- Quantity base equilibrium (for any *j* industry)

$$a_{j1}X_1 + a_{j2}X_2 + \cdots + a_{jn}X_n + f_j = X_j \qquad a_{ij} = \frac{X_{ij}}{X_j}$$

- Demand-supply equilibrium in matrix form

$$\mathbf{Ax} + \mathbf{f} = \mathbf{x} \quad \Rightarrow \quad [\mathbf{I} - \mathbf{A}]\mathbf{x} = \mathbf{f}$$

- Equilibrium output model of I-O Analysis

$$\mathbf{x} = [\mathbf{I} - \mathbf{A}]^{-1}\mathbf{f}$$

Domestic output

Leontief inverse matrix

Final demands

How can be ripple effects calculated?

- **First round ripple effects.**

1. **If final demands increase, intermediate demands will increase.**
2. **For instance, increases in mushrooms induces increases in energy, those of transportation, and those of commerce.**

How can be ripple effects calculated?

- **Second round ripple effects.**

1. **The first ripple effects result in increases in incomes in the mushroom sector, the energy sector, the transportation sector, and the commerce sector.**
2. **Now they have increased "money". Hence, they consume more.**
3. **This consumption results in increases in demands.**

- **The round continues to the third, the fourth, and eternally. It is sensible to stop at the second round.**

For strict formulas, see the next slide.

Equilibrium Output Model

- Basic equation

$$\mathbf{x} = \left[\mathbf{I} - \mathbf{A}\right]^{-1}\mathbf{f}$$

- If we know the final demand, we can obtain equilibrium output to provide this final demand. (first round ripple effect)

$$\mathbf{x}_1 = \left[\mathbf{I} - \mathbf{A}\right]^{-1}\mathbf{f}_1$$

Initial increase in final demands

- Output increase creates additional value-added (income)
- Income increase creates additional consumption demands
- we can obtain equilibrium output to provide these consumption demands. (second round ripple effect)

$$\mathbf{x}_2 = \left[\mathbf{I} - \mathbf{A}\right]^{-1}\mathbf{f}_2$$

increase in consumption through the first round ripple effect

- *Shall we move to the next presentation….*

4 **Clarifying Benefits**