

Technological Change and Accumulated Capital :A Dynamic Decomposition of Japan's Growth

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*Keio Data Base :Keio Economic Observatory
Japan , May 30, 2003*

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- Structural Change vs New Technology
 - A_{ij} (Input Coefficient), B_{ij} (Capital Coefficient)
- TFP and Structural Change
 - Total Factor Productivity:TFP
 - TFP under Static Structure
 - : Static Unit TFP through Static Interdependency
 - TFP under the Dynamic Structural Change
 - : Dynamic Unit TFP through Capital Accumulation

Official Statistics

- **Input-Output Table**

- **Basic Table** : every five years from 1955
 - activity base - 519×403 (1995)
 - **Extended Table** : every year from 1973

- **Capital Measurement**

- **Capital Formation Matrix** : every five years from 1970
 - **Capital Stock Matrix** : National Wealth Survey in 1955,70

KEO Data Base (KDB)

Demography

Environment

Economy

Technology

KDB

- Input-Output Table
 - every year during 1960-95
- Measurement of Capital
 - every year during 1955-92
 - Capital Formation Matrix : I_{ij}
 - Capital Stock Matrix : S_{ij}
- Measurement of Labor
 - every years during 1960-92
 - **Man, Hour and Wage**
industry × age × sex × education × employment status

Input-Output Table

	commodity	industry	Final Demand domestic	E	M	Output
com.	X	U	fd			
scrap input						
ind.	V					
non-competitive import						
scrap output						
value added		va				
Output						

I-O Table: X Table

Time-Series X-table

[Intermediate Inputs]

43 commodities

8 scraps

[Non-competitive Imports]

raw oil, natural gas,
iron ore, others

[Year]

1960-95

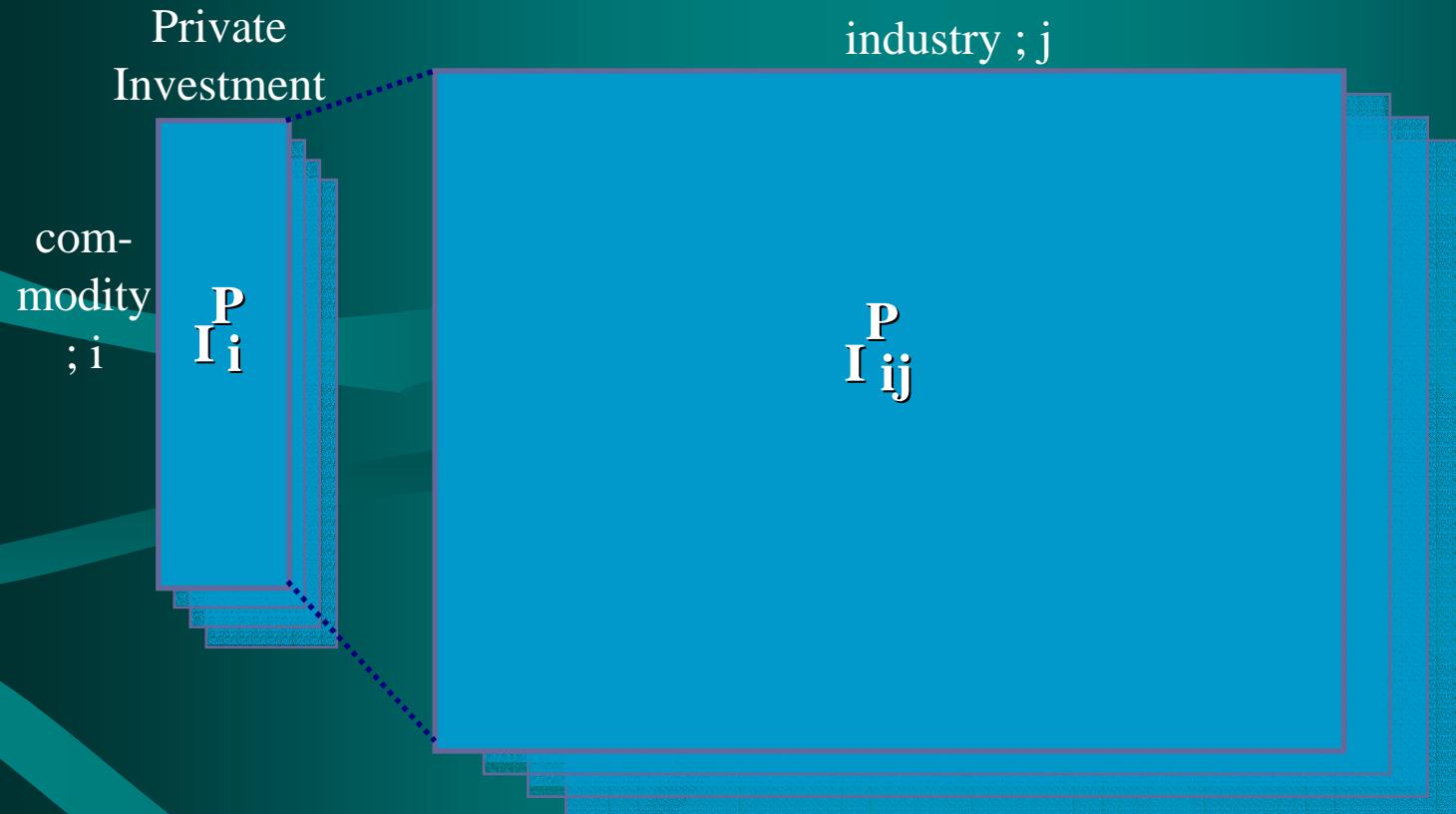
	commodity	industry	Final Demand domestic E	M	Output
com.	X				
scrap input					
ind.					
non-competitive import					
scrap output					
value added Output					



「Input-Output Table」
Management and Coordination Agency
in 1960,65,70,75,80,85,90

Private Investment

Private Fixed Capital Formation Matrix

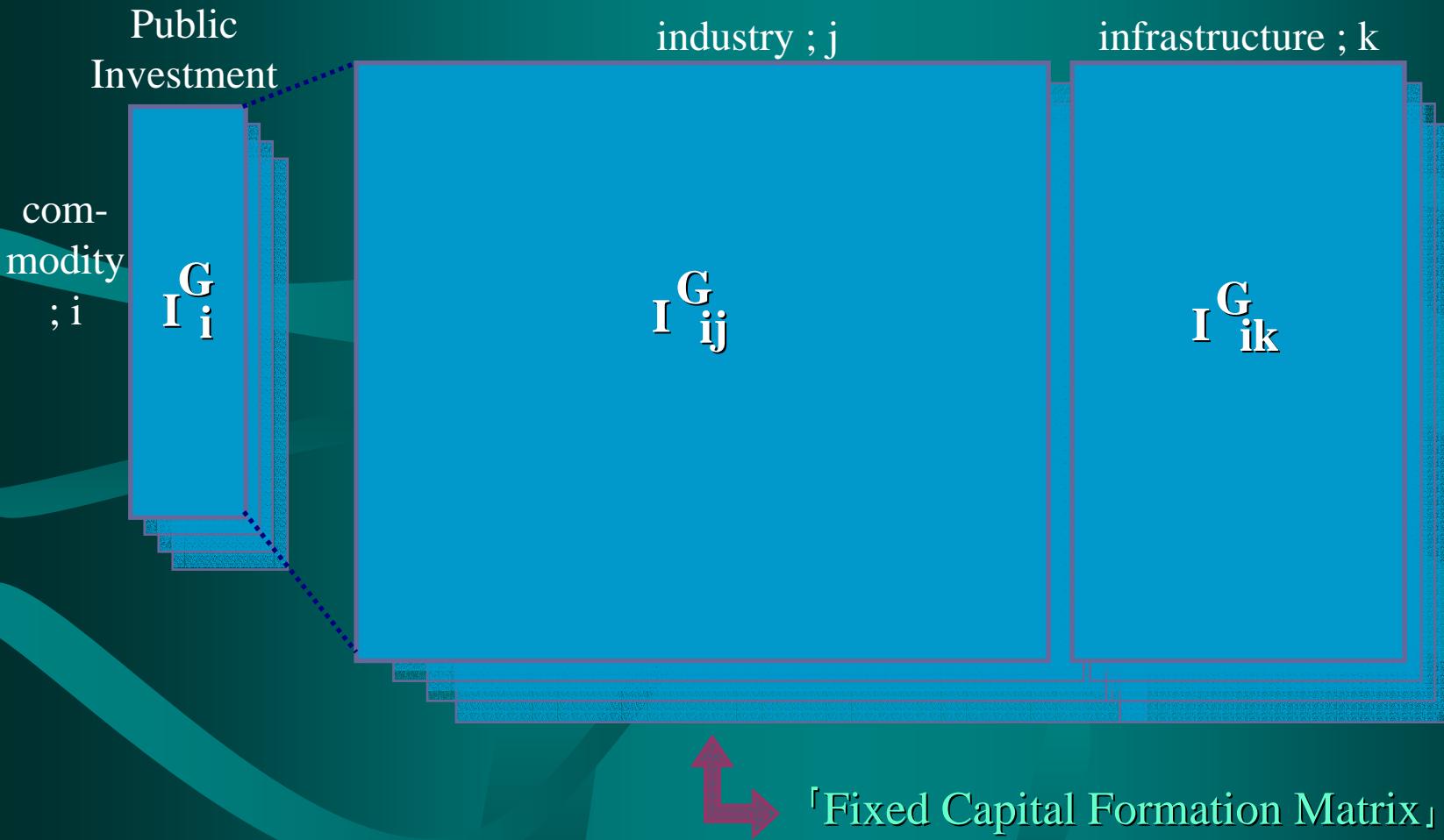


「Fixed Capital Formation Matrix」

Management and Coordination Agency
in 1970,75,80,85,90

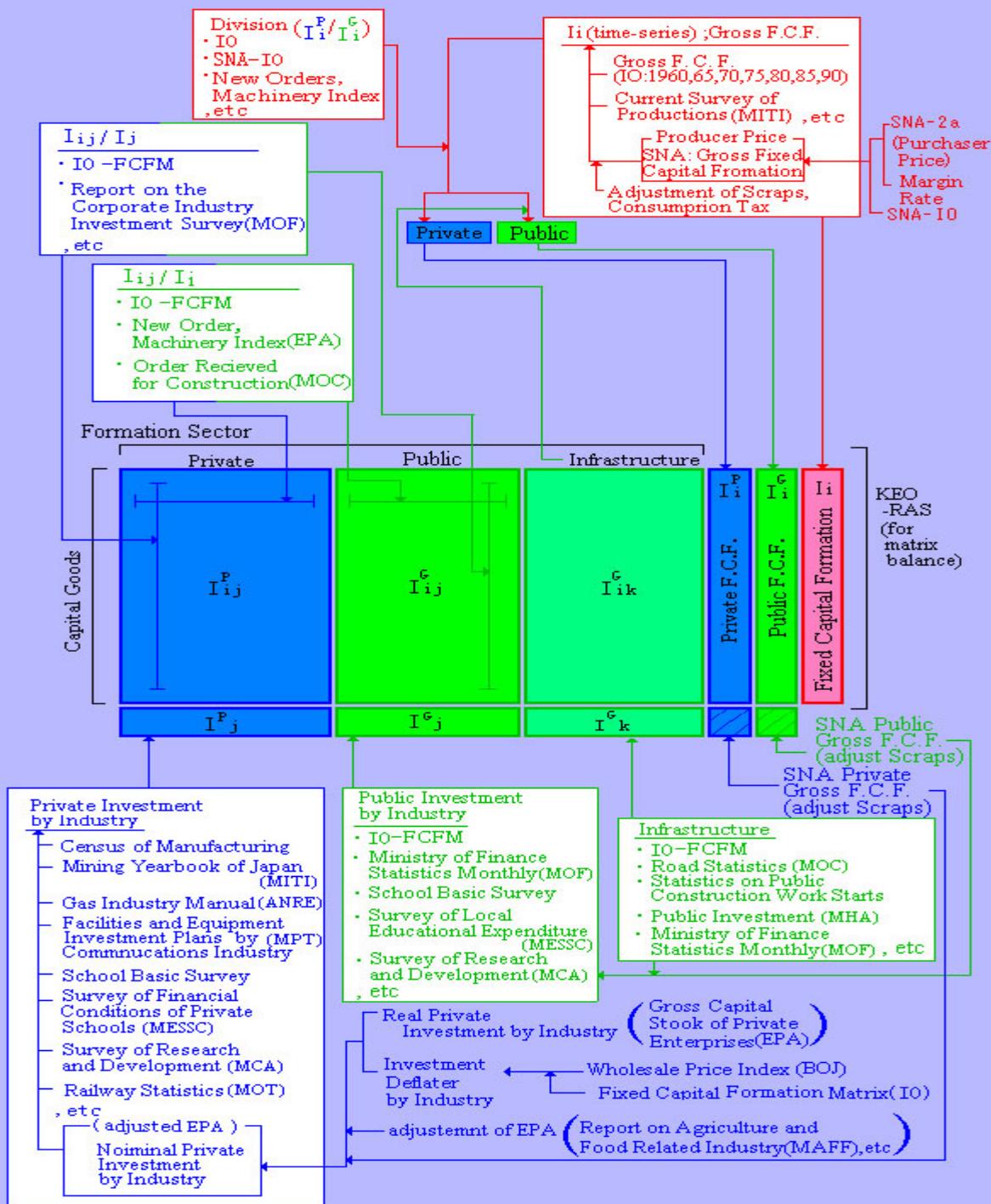
Public Investment

Public Fixed Capital Formation Matrix

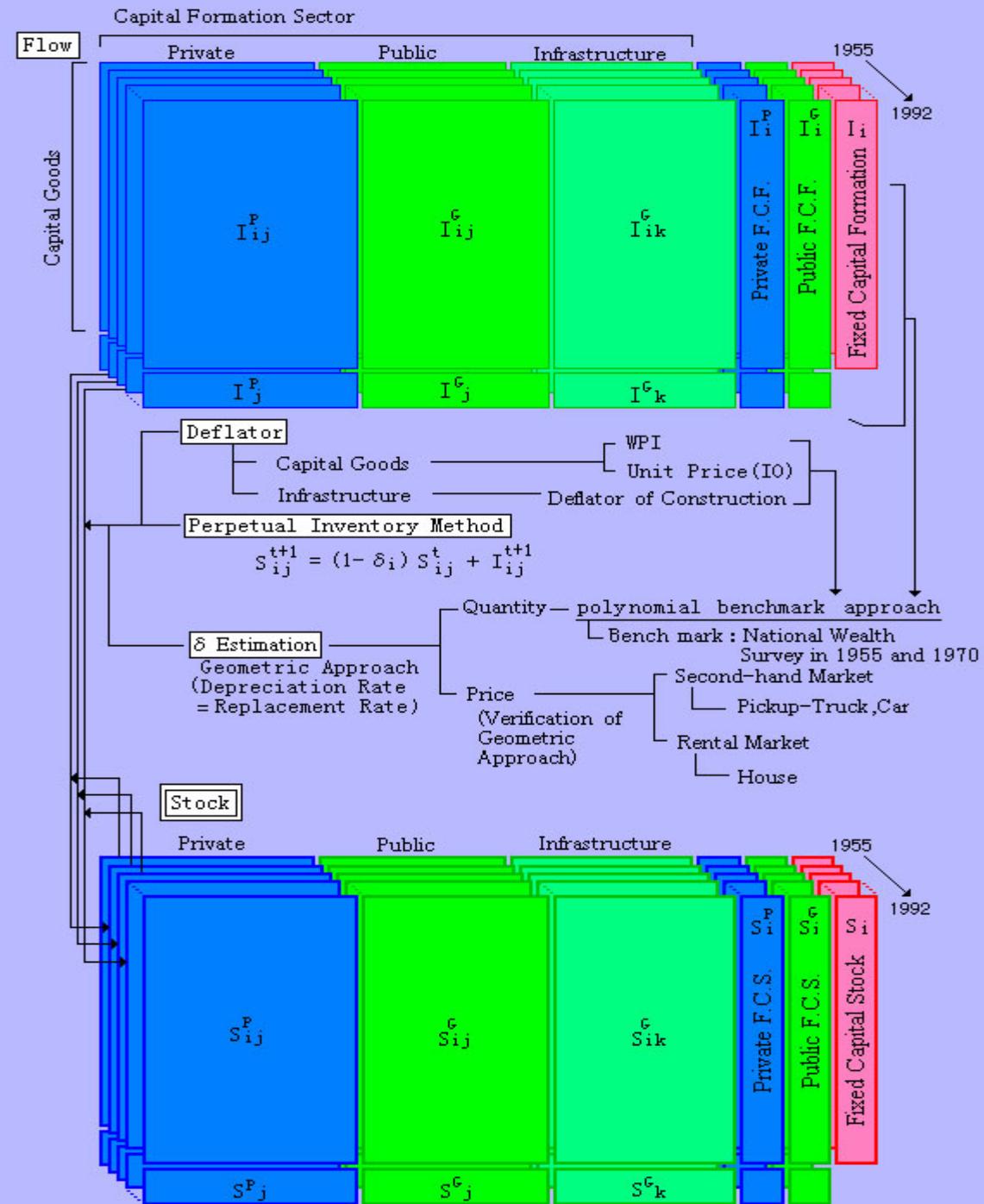


Fixed Capital Formation Matrix
Management and Coordination Agency

Estimation of Capital Formation Matrix

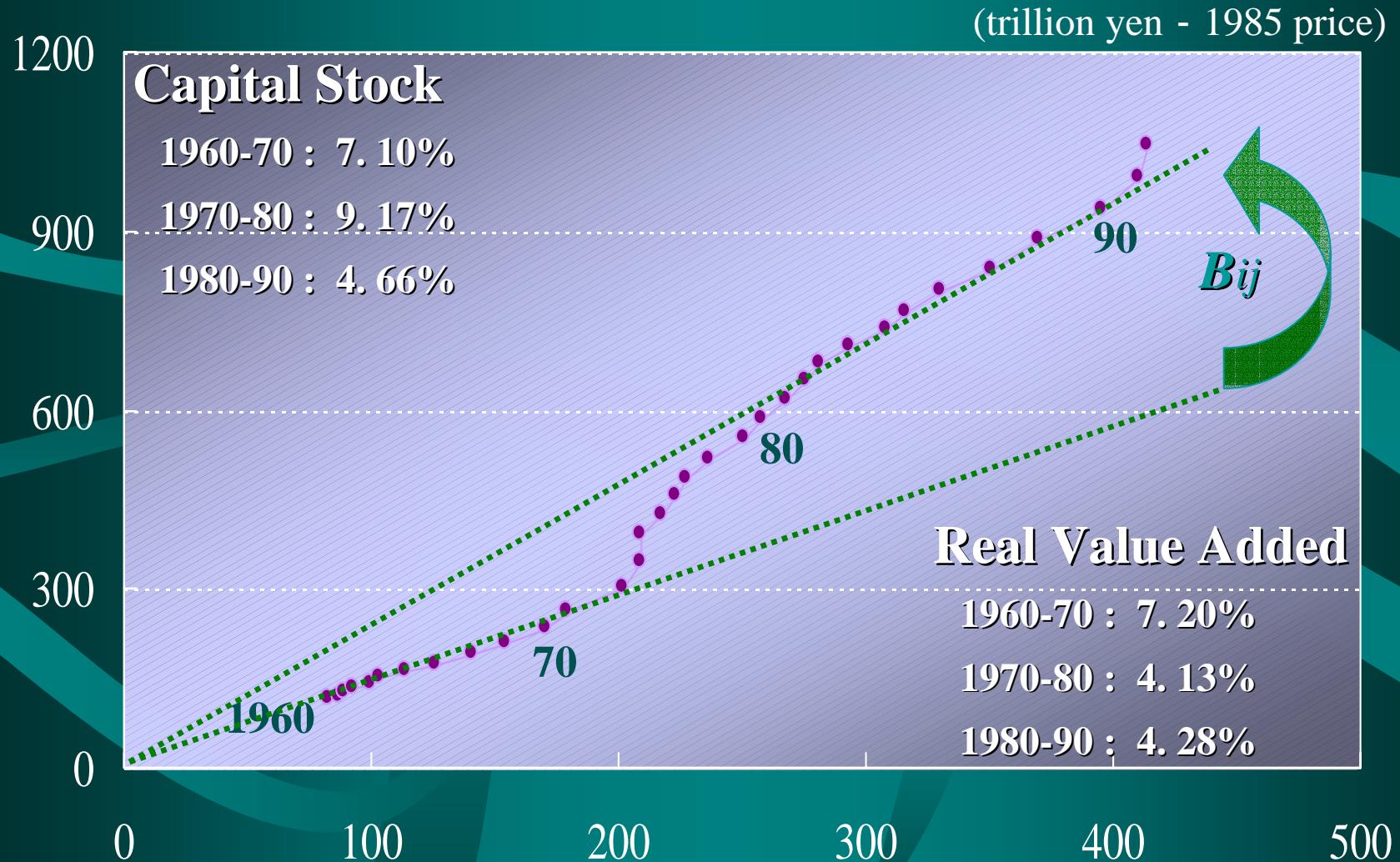


Estimation of Capital Stock Matrix



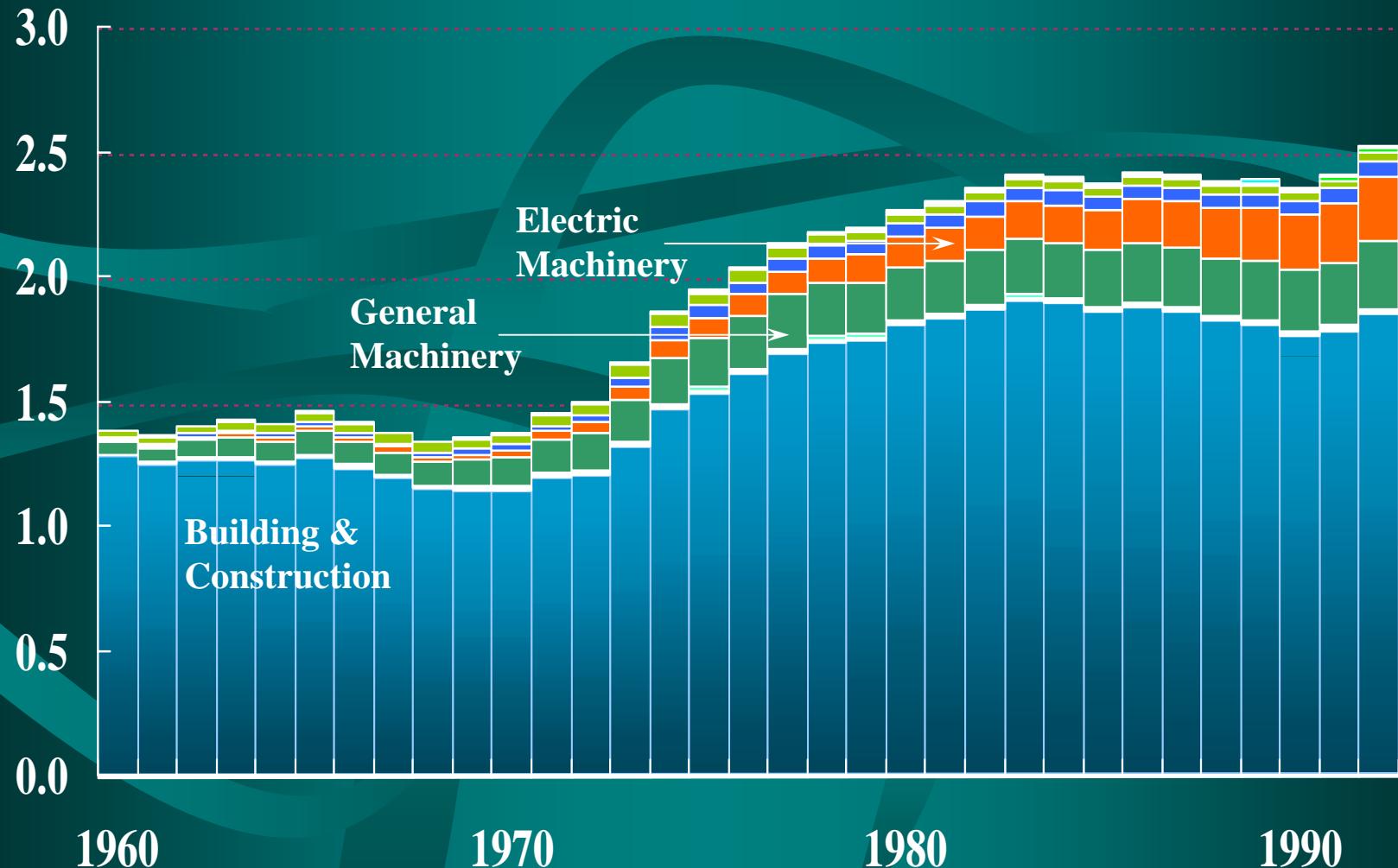
Capital Stock and Value Added

: Aggregated Level



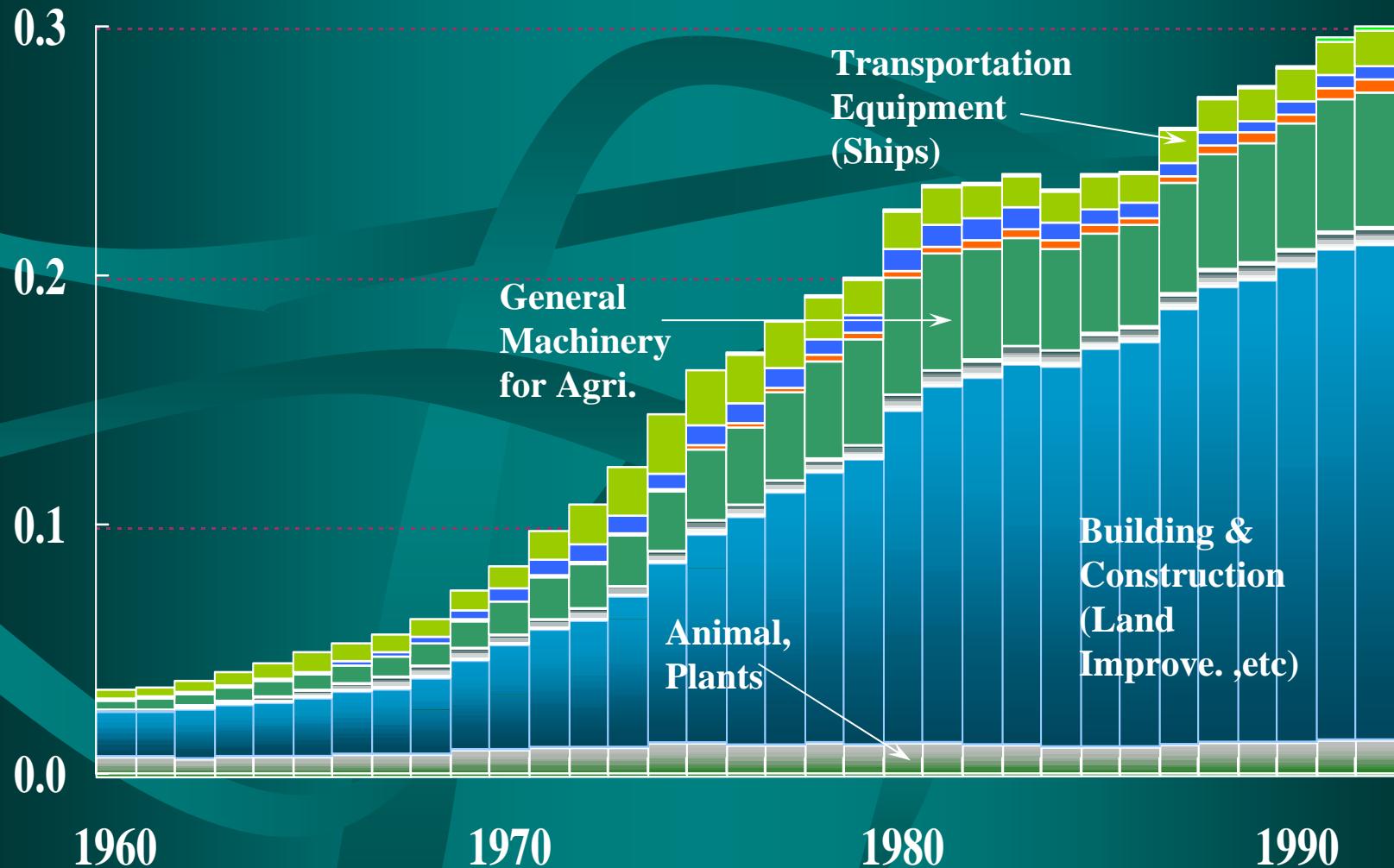
Capital Coefficient -*Bij*

: Aggregated Level



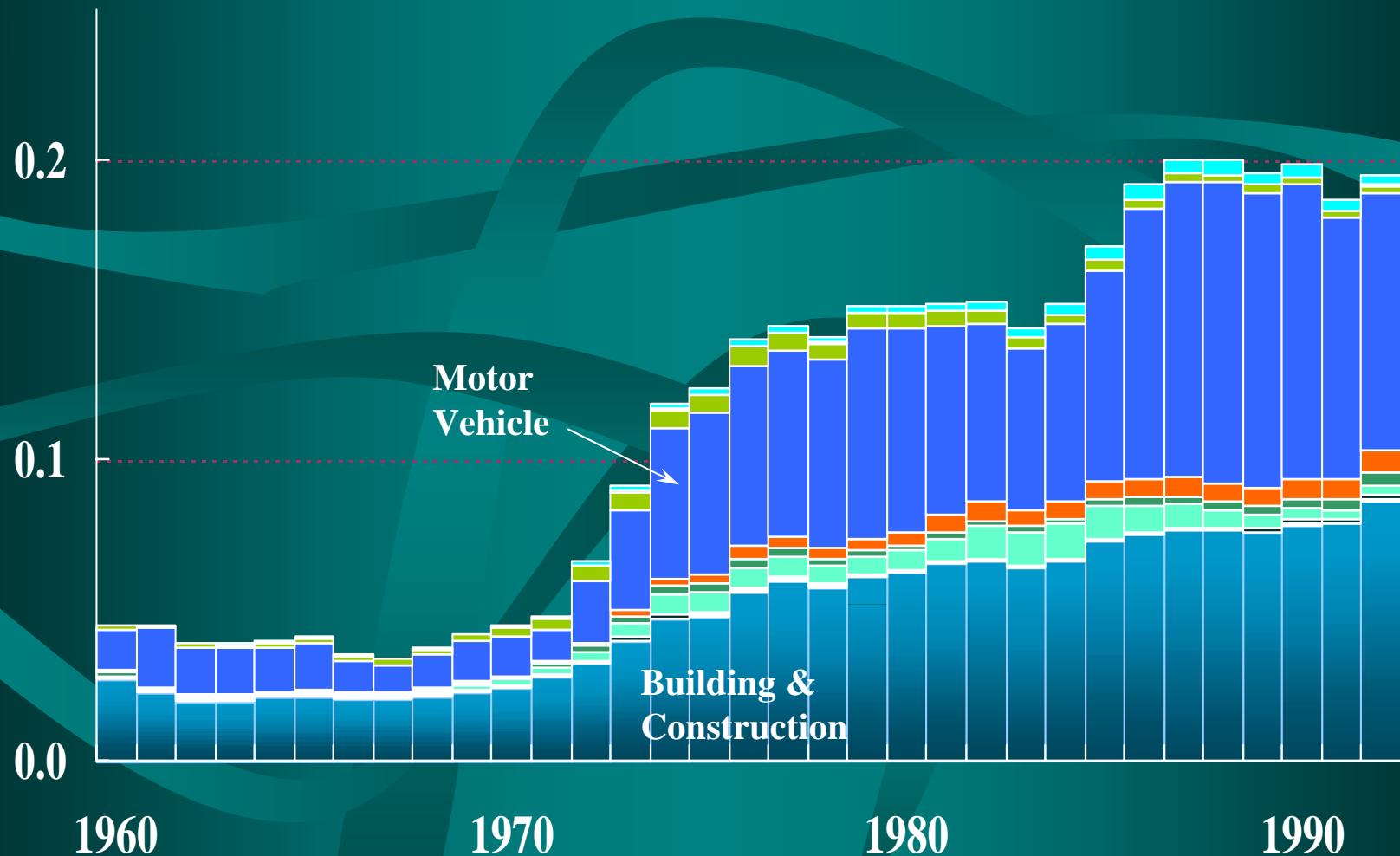
Capital Coefficient -*Bij*

: Agriculture, Forestry and Fishery Industry



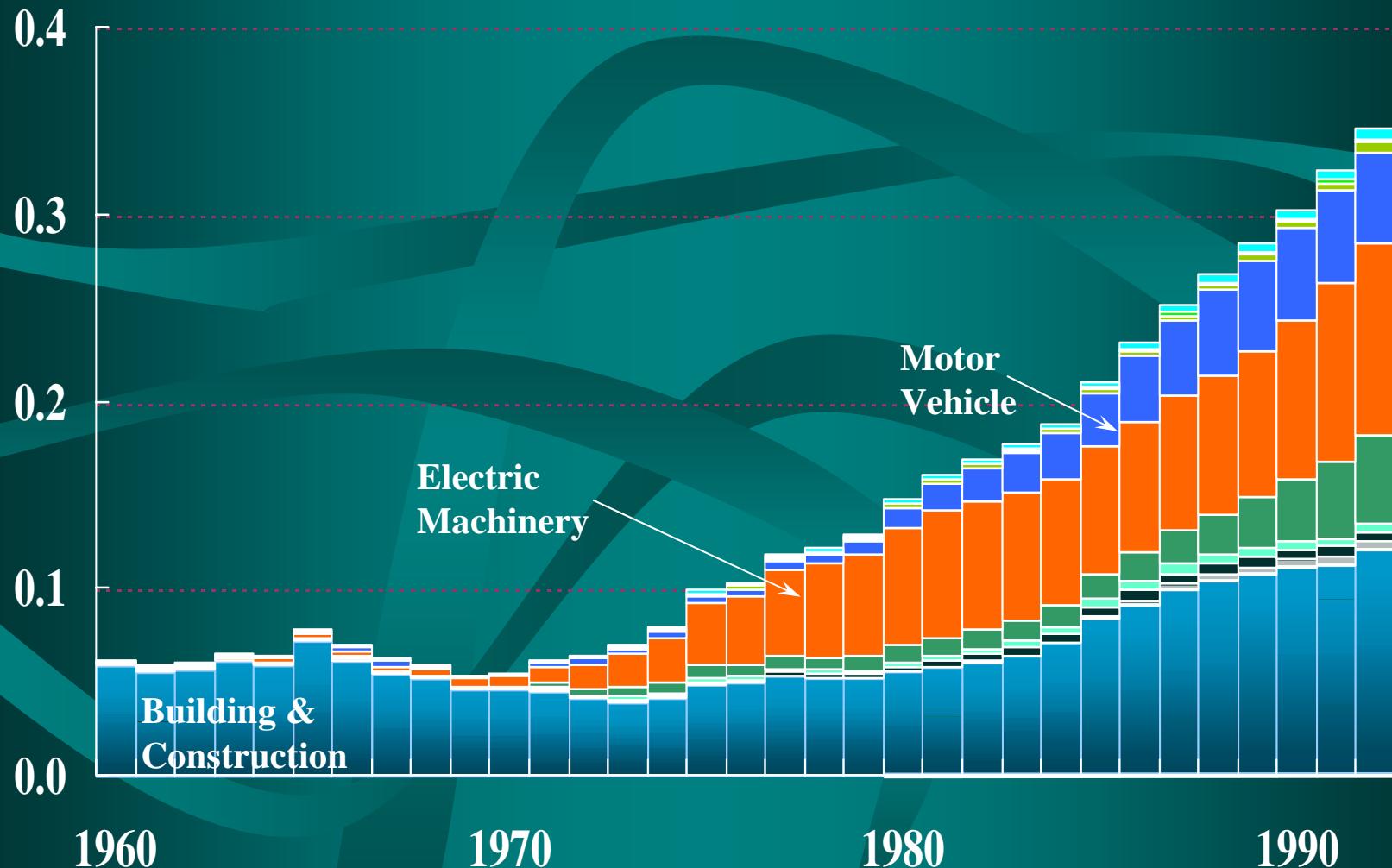
Capital Coefficient -*Bij*

: Road Transportation



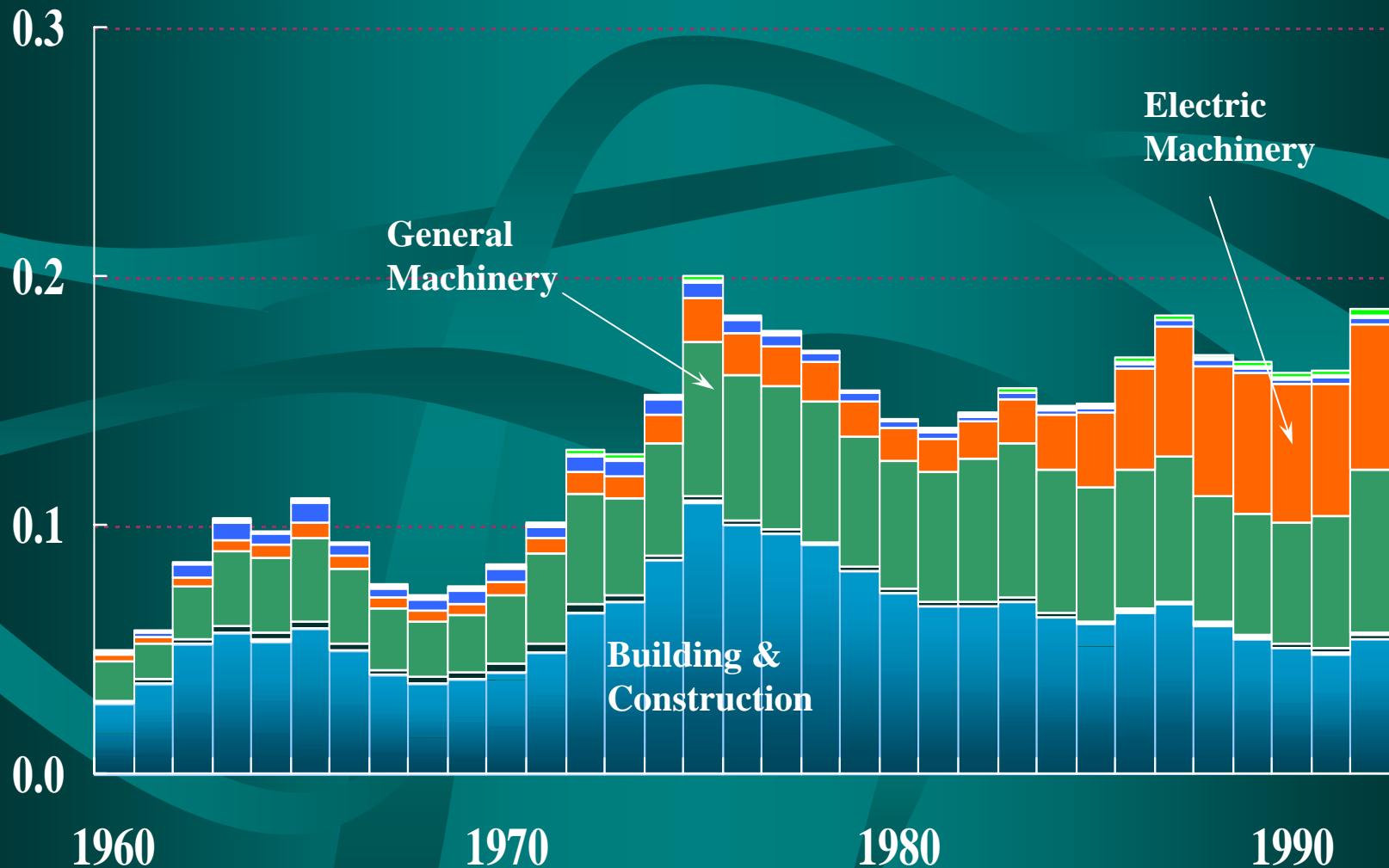
Capital Coefficient - B_{ij}

: Service except Commerce, Trans., Medical, etc



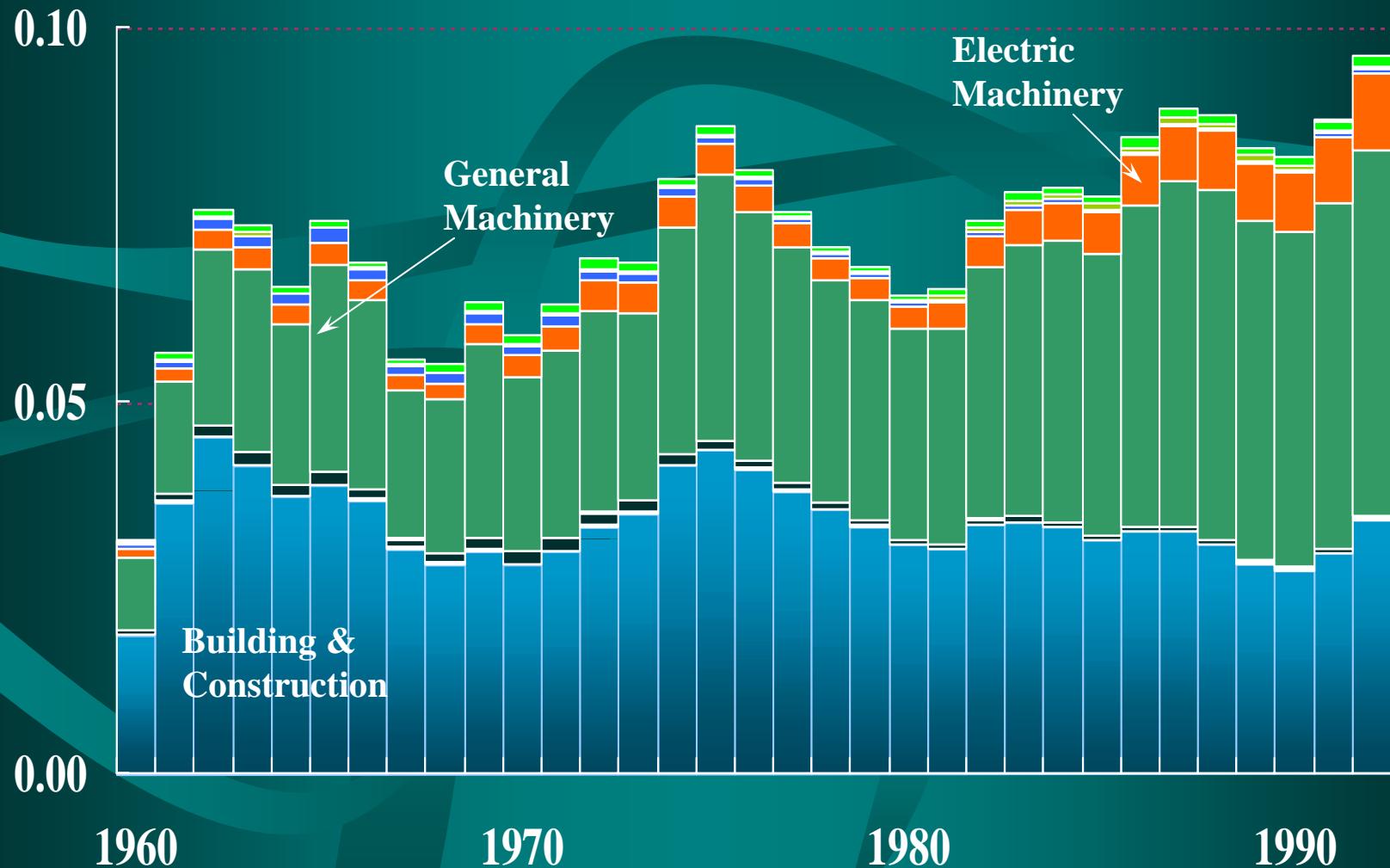
Capital Coefficient - B_{ij}

: General Machinery Manufacturing



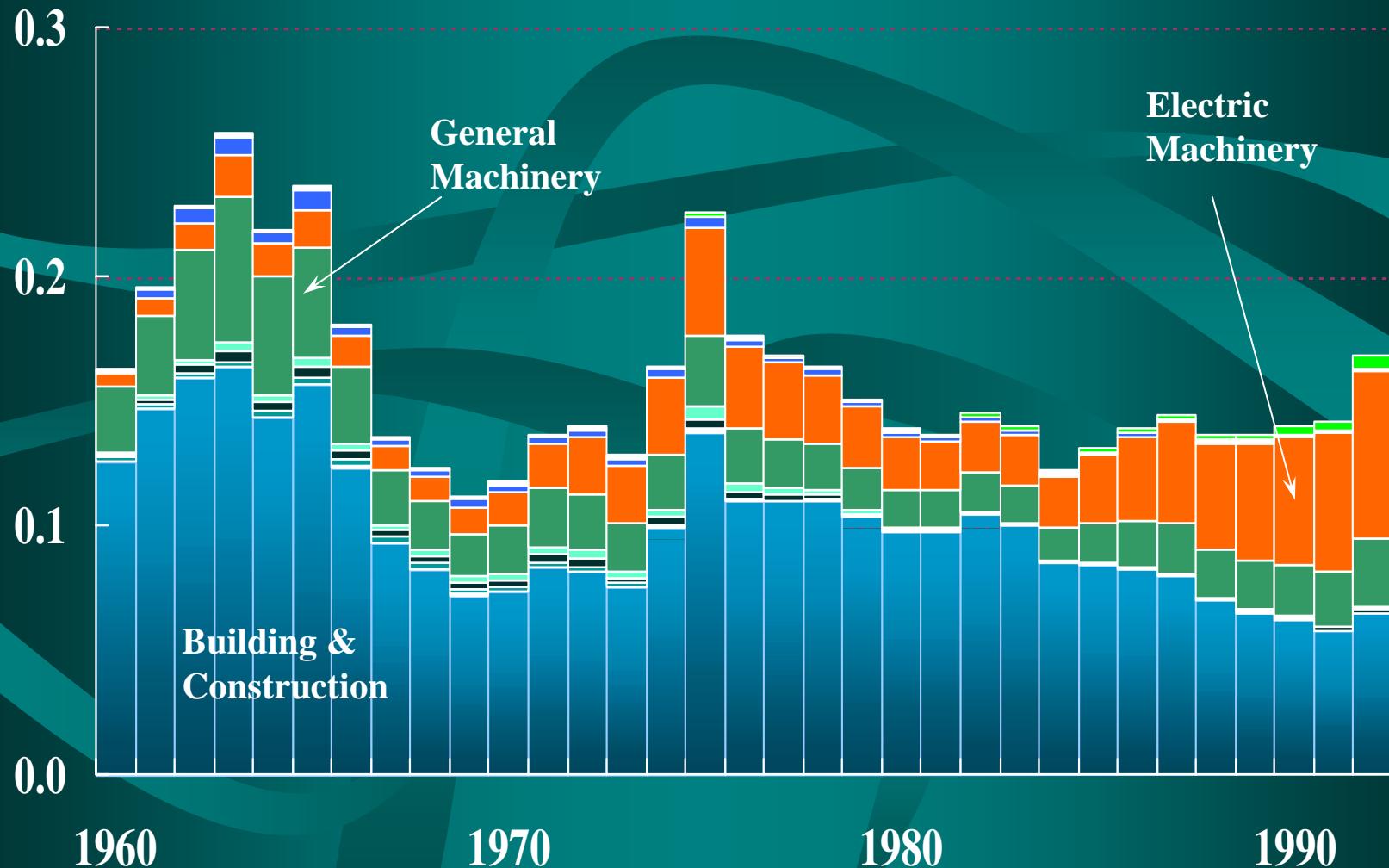
Capital Coefficient -*Bij*

: Motor Vehicle Manufacturing



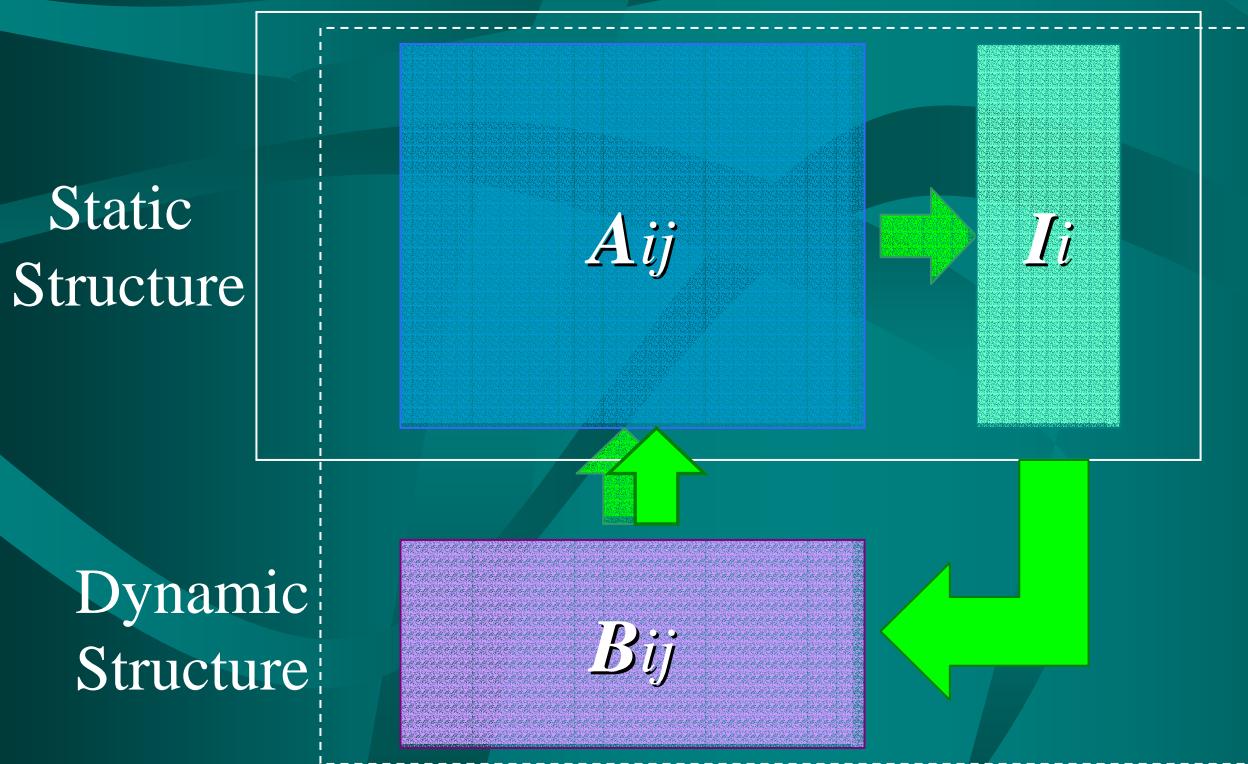
Capital Coefficient - B_{ij}

: Electric Machinery Manufacturing



Structural Change

- Definition of Economic “Structure”
 - $A_{ij} = X_{ij} / X_j$: Input Coefficient
 - $B_{ij} = S_{ij} / X_j$: Capital Coefficient



Industry-base TFP

I-O Table

	j -Industry
Intermediate Input	$A_{ij} X_j$
Capital Input	$B_{ij} X_j$
Labor Input	$L_{kj} X_j$
Output	X_j

TFP ; T_j

- Industry-base
- Structural Change

A_j, B_j, L_j

- Production Function

$$X_j = f(K_j, L_j, X_{ij}, T_j)$$

The Rate of Traditional TFP Growth in sector j

X_j :real gross output

X_{ij} : intermediate input I

L_{lj} : labor input of type l

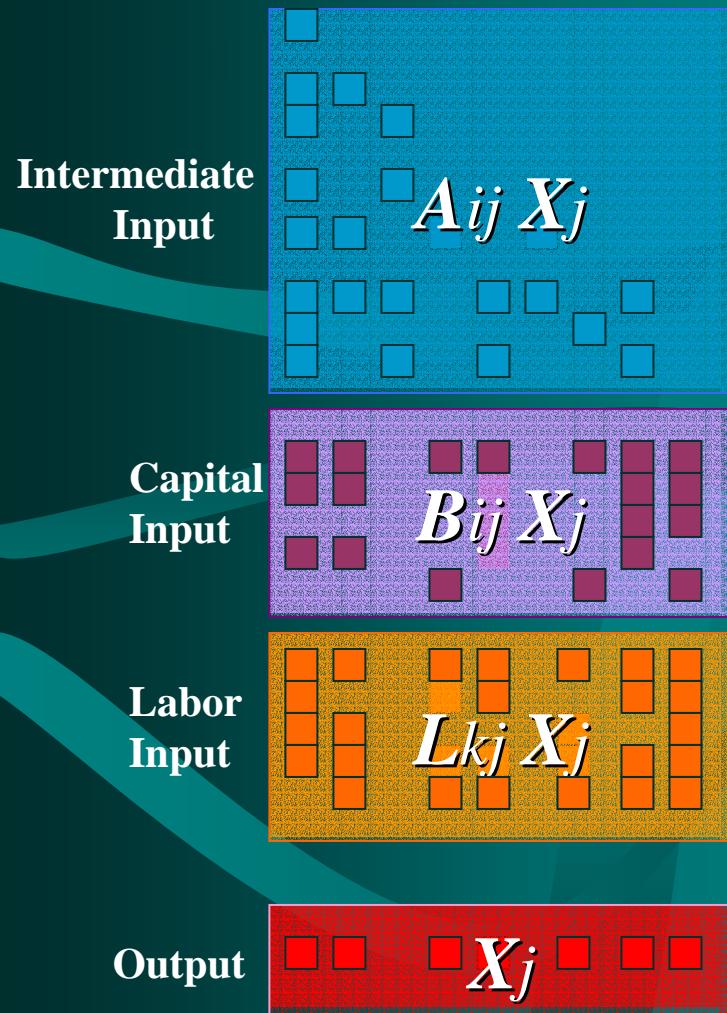
K_{kj} :capital input of type k

p_{jt}, p_{lj}, p_{kj} :prices of output, labor and capital inputs

$$\left(\frac{\dot{T}_j}{T_j} \right)_t = \left(\frac{\dot{X}_j}{X_j} \right)_t - \sum_i \frac{p_{i,t} X_{ij,t}}{p_{j,t} X_{j,t}} \left(\frac{\dot{X}_{ij}}{X_{ij}} \right)_t - \sum_l \frac{p_{lj,t} L_{lj,t}}{p_{j,t} X_{j,t}} \left(\frac{\dot{L}_{lj}}{L_{lj}} \right)_t - \sum_k \frac{p_{kj,t} K_{kj,t}}{p_{j,t} X_{j,t}} \left(\frac{\dot{K}_{kj}}{K_{kj}} \right)_t$$

Static Unit TFP

Unit Structure of i - commodity



Static Unit TFP ; T_i

- Unit Structure
- Structural Change

$$A_{ij}, B_{ij}, L_{kj}$$

- Aggregation of Industry-base TFP

$$\frac{\dot{T}_i}{T_i} = \sum_j \frac{P_j X_j}{P_v V} \frac{\dot{T}_j}{T_j}$$

- Pecuniary Spillover Effects through Static Technological Relationship

Static Unit TFP of Commodity i

$$\mathbf{L}_t^* = \mathbf{B}_t^L \left\langle (\mathbf{I} - \mathbf{A}_t)^{-1} \mathbf{e}_{(i)} \right\rangle$$

$$\mathbf{K}_t^* = \mathbf{B}_t^K \left\langle (\mathbf{I} - \mathbf{A}_t)^{-1} \mathbf{e}_{(i)} \right\rangle$$

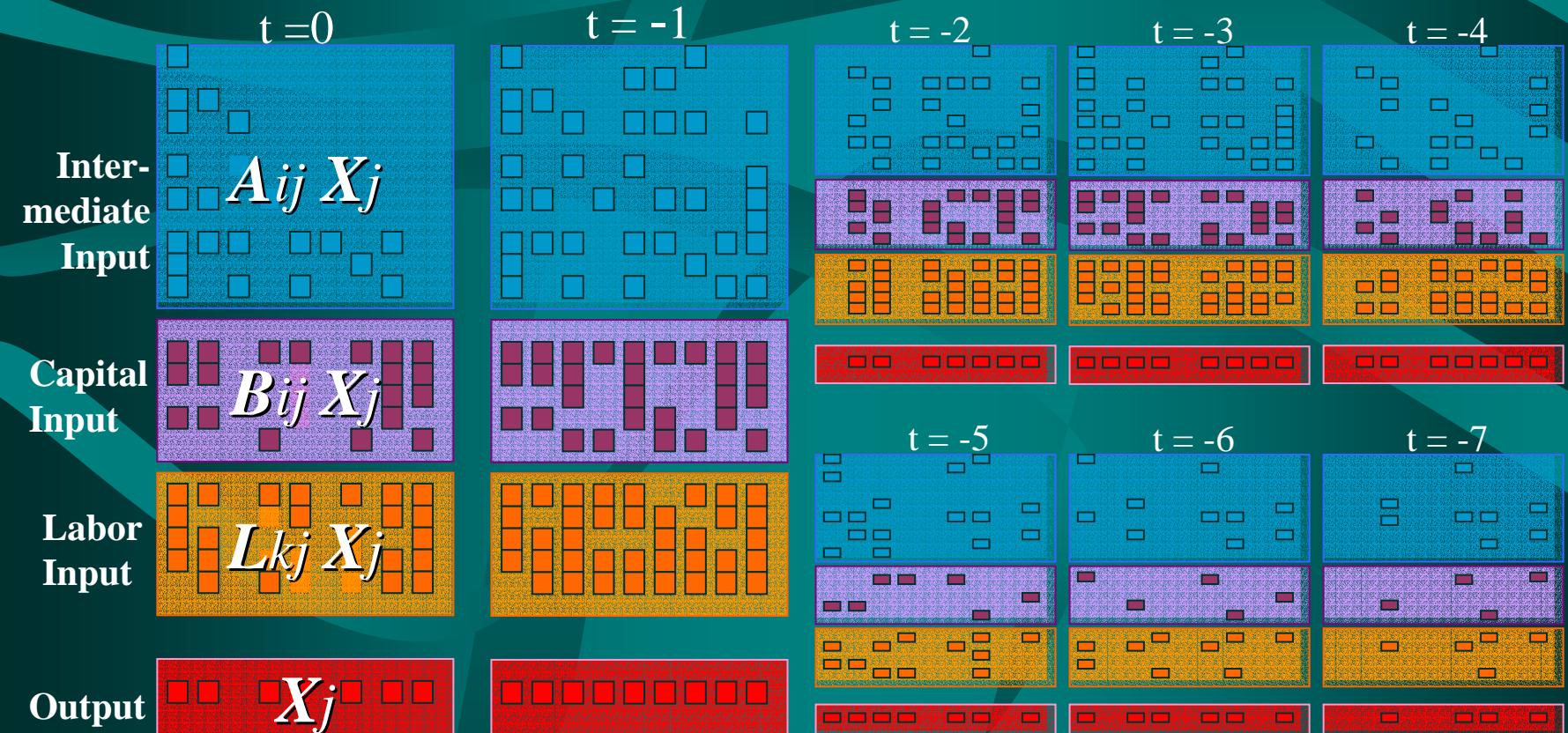
$$\left(\frac{\dot{T}_i}{T_i} \right)_t^U = - \sum_j \sum_l \frac{p_{lj,t}^L L_{lj,t}^* \left(\frac{\dot{L}_{lj}^*}{L_{lj}^*} \right)_t}{p_{i,t}} - \sum_j \sum_k \frac{p_{kj,t}^K K_{kj,t}^* \left(\frac{\dot{K}_{kj}^*}{K_{kj}^*} \right)_t}{p_{i,t}}$$

Dynamic Inverse

Static IO Balance ; $A_{ij} X_j + I_{ij} + C_i = X_i$

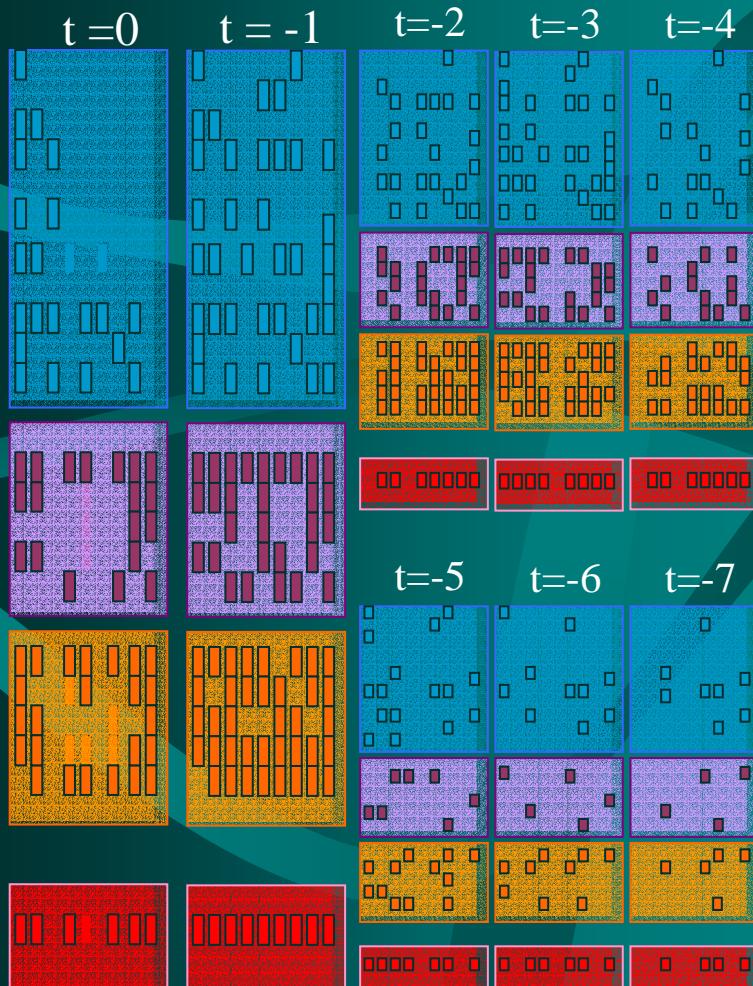
Capital Accumulation ; $K_{ij}^{t+1} = (1 - \delta) K_{ij}^t + I_{ij}^t$

Dynamic IO Balance ; $A_{ij}^t X_j^t + B_{ij}^{t+1} X_j^{t+1} + C_i^t = X_i^t$



Dynamic Unit TFP

Dynamic Unit Structure of i - commodity



Dynamic Unit $\overset{*}{\text{TFP}} ; T_i$

- Decomposition by Dynamic Inverse
- Structural Change

$$A_{ij}^t, B_{ij}^t, L_{kj}^t, t=0, \dots, -$$

- Aggregation of Time-series Static Unit TFP

$$\frac{\dot{T}_i^*}{T_i^*} = \frac{\dot{T}_i^0}{T_i^0} + \frac{\dot{K}^{00}}{P^0 V^0} - \sum_{t=1}^T \frac{\dot{T}_i^t}{T_i^t}$$

- Pecuniary Spillover Effects through Capital Accumulation and Structural Change

Dynamic Unit TFP

$$\left(\frac{\dot{T}}{T} \right)_t^{D(\mathbf{f}_t^*)} = \left(\frac{\dot{T}}{T} \right)_t^{U(\mathbf{f}_t^*)} + \sigma_{K,t}^* \sum_{\tau=1}^{\infty} \Phi_{t-\tau}^* \left(\frac{\dot{T}}{T} \right)_{t-\tau}^{U(\mathbf{f}_{t-\tau}^*)}$$

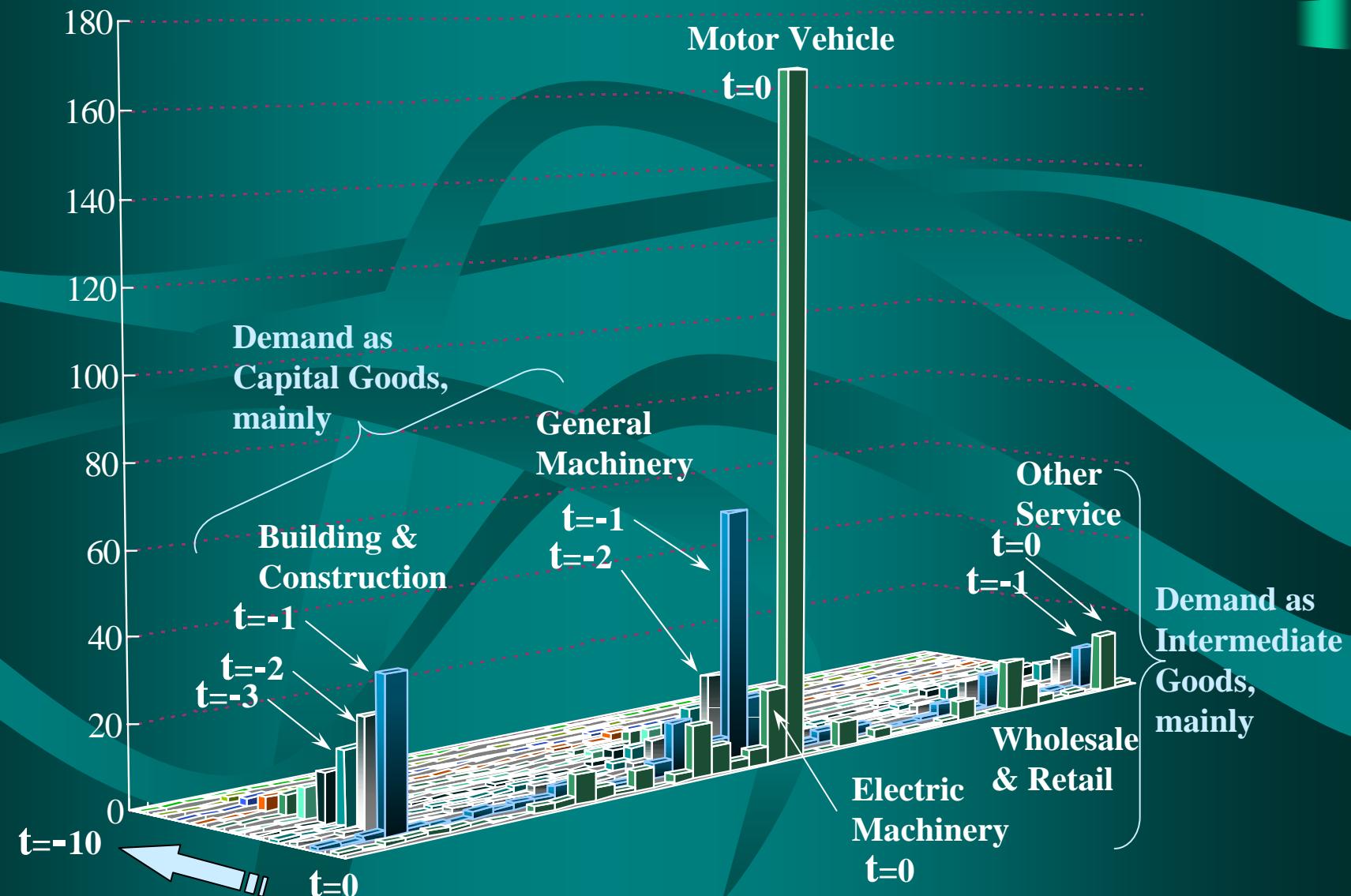
and

$$\left(\frac{\dot{T}}{T} \right)_t^{D(\mathbf{f}_t^*)} = \left(\frac{\dot{f}^*}{f^*} \right)_t - \sigma_{L,t}^* \left(\frac{\dot{L}^*}{L^*} \right)_t - \sigma_{K,t}^* \sum_{\tau=1}^{\infty} \Phi_{t-\tau}^* \sigma_{L,t-\tau}^* \left(\frac{\dot{L}^*}{L^*} \right)_{t-\tau}$$

$$\Phi_{t-\tau}^* = s_{t-\tau}^* s_{t-\tau+1}^* \left(\frac{(1-\delta)S_{t-\tau+1}^*}{I_{t-\tau+1}^*} + \sigma_{K,t-\tau+1}^* \right)$$

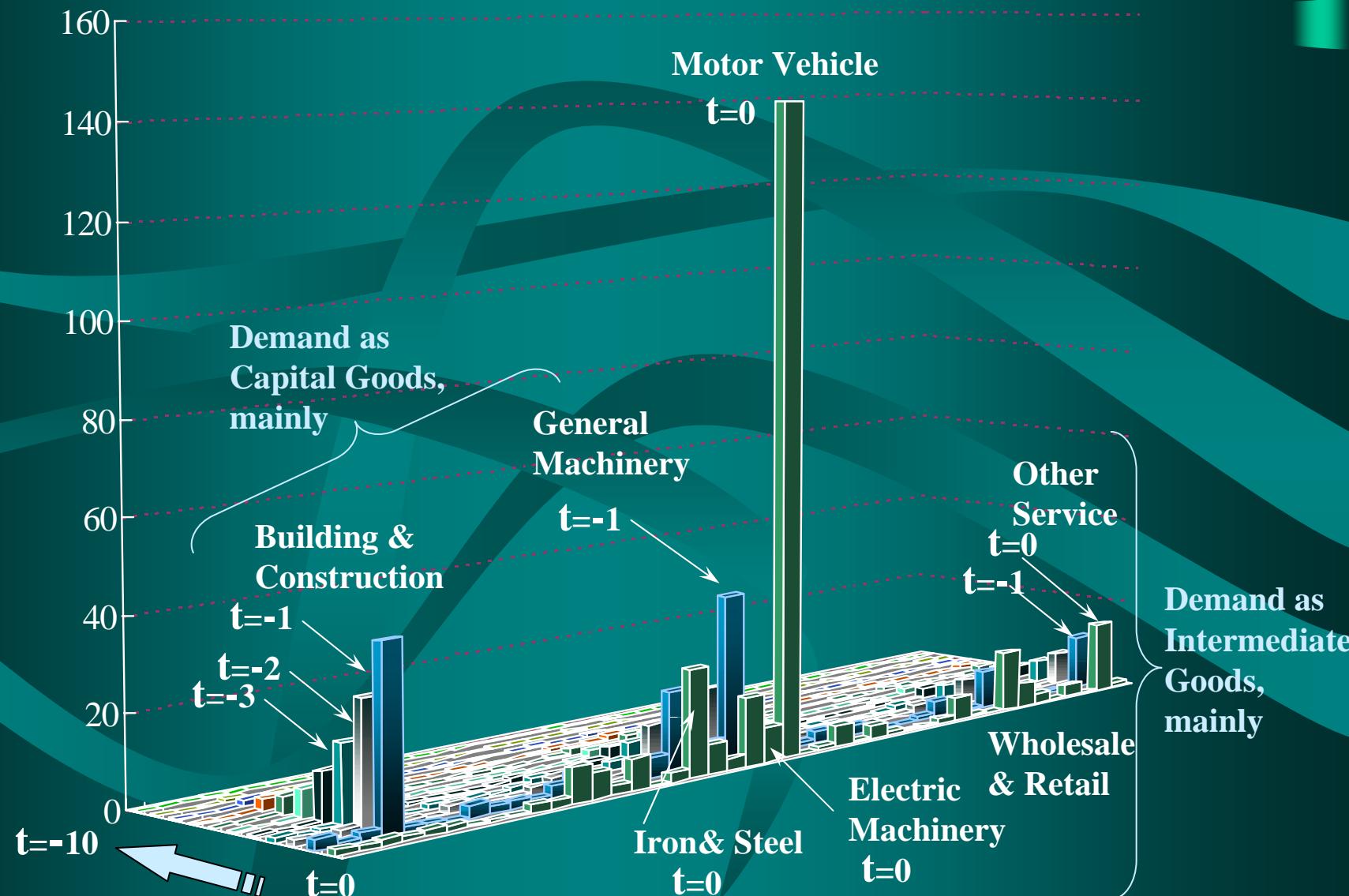
Dynamic Inverse

: Required Output Induced by Motor Vehicle Demand in 1992



Dynamic Inverse

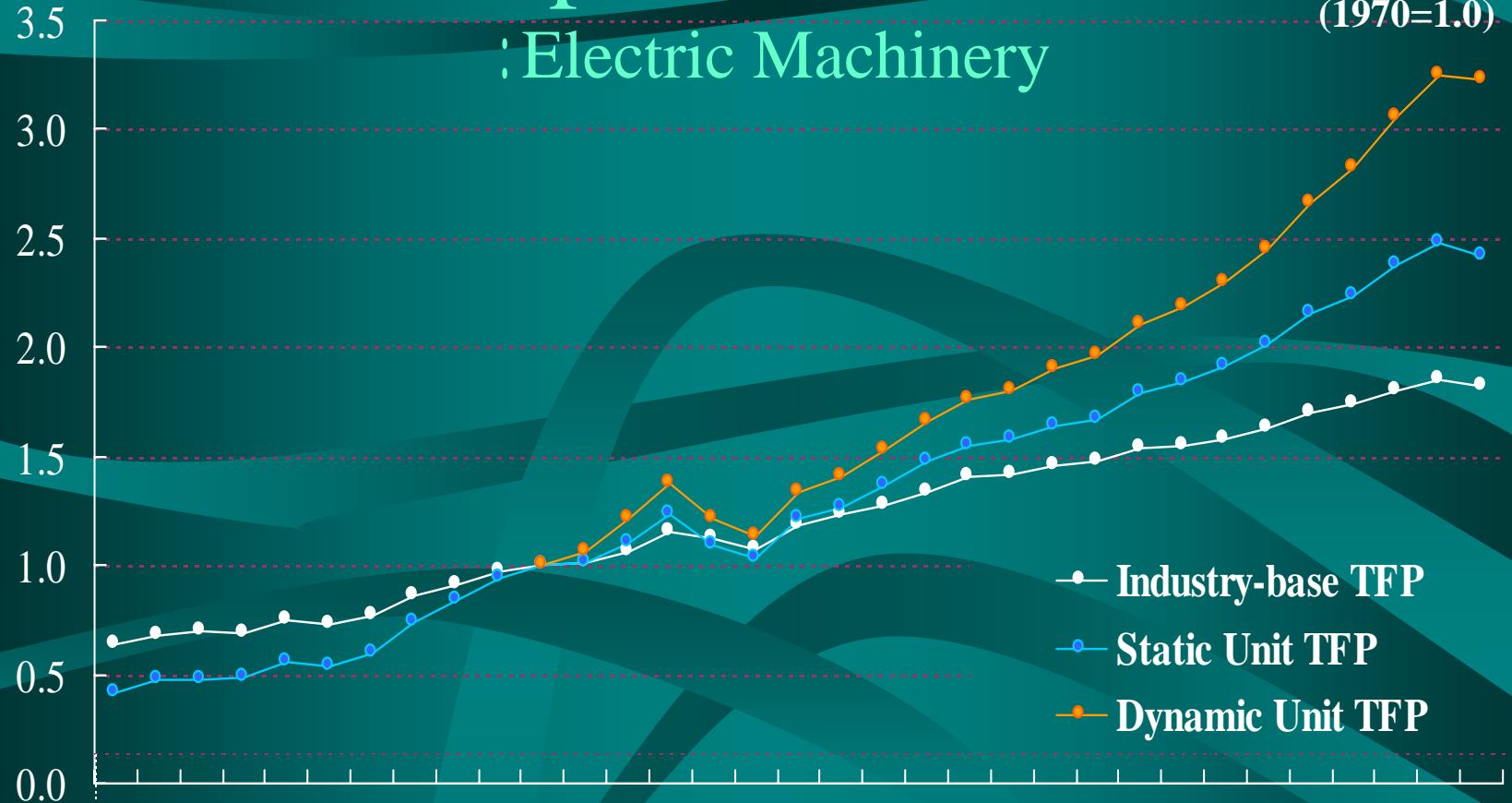
: Required Output Induced by Motor Vehicle Demand in 1980



Comparison of TFP

: Electric Machinery

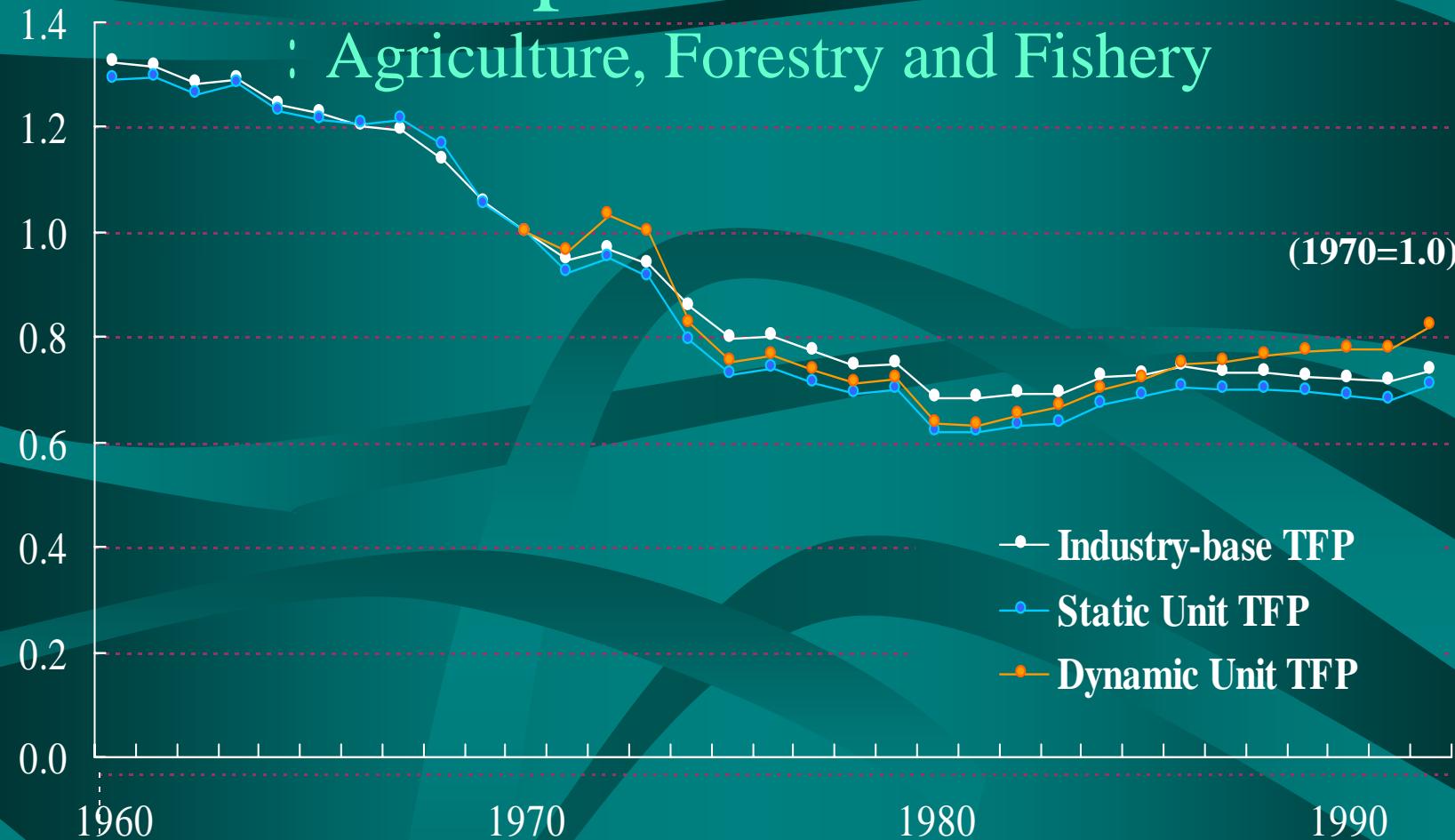
(1970=1.0)



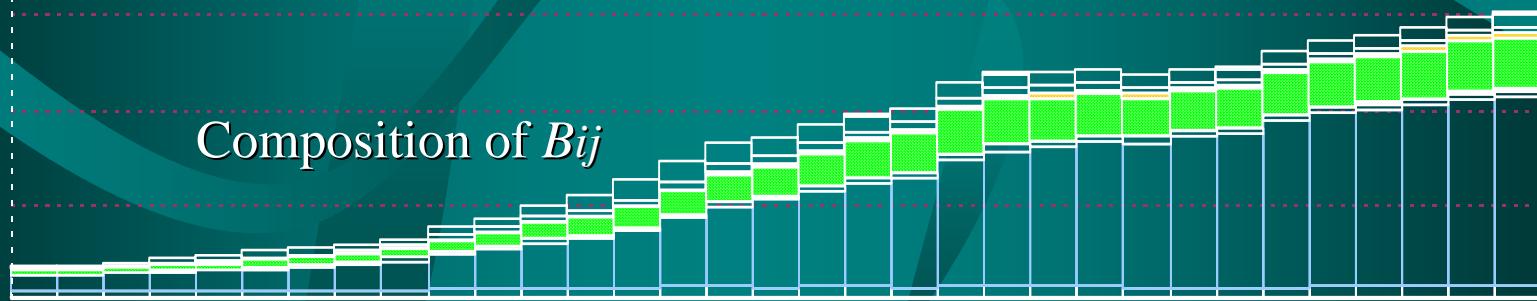
Comparison of TFP

: Agriculture, Forestry and Fishery

(1970=1.0)

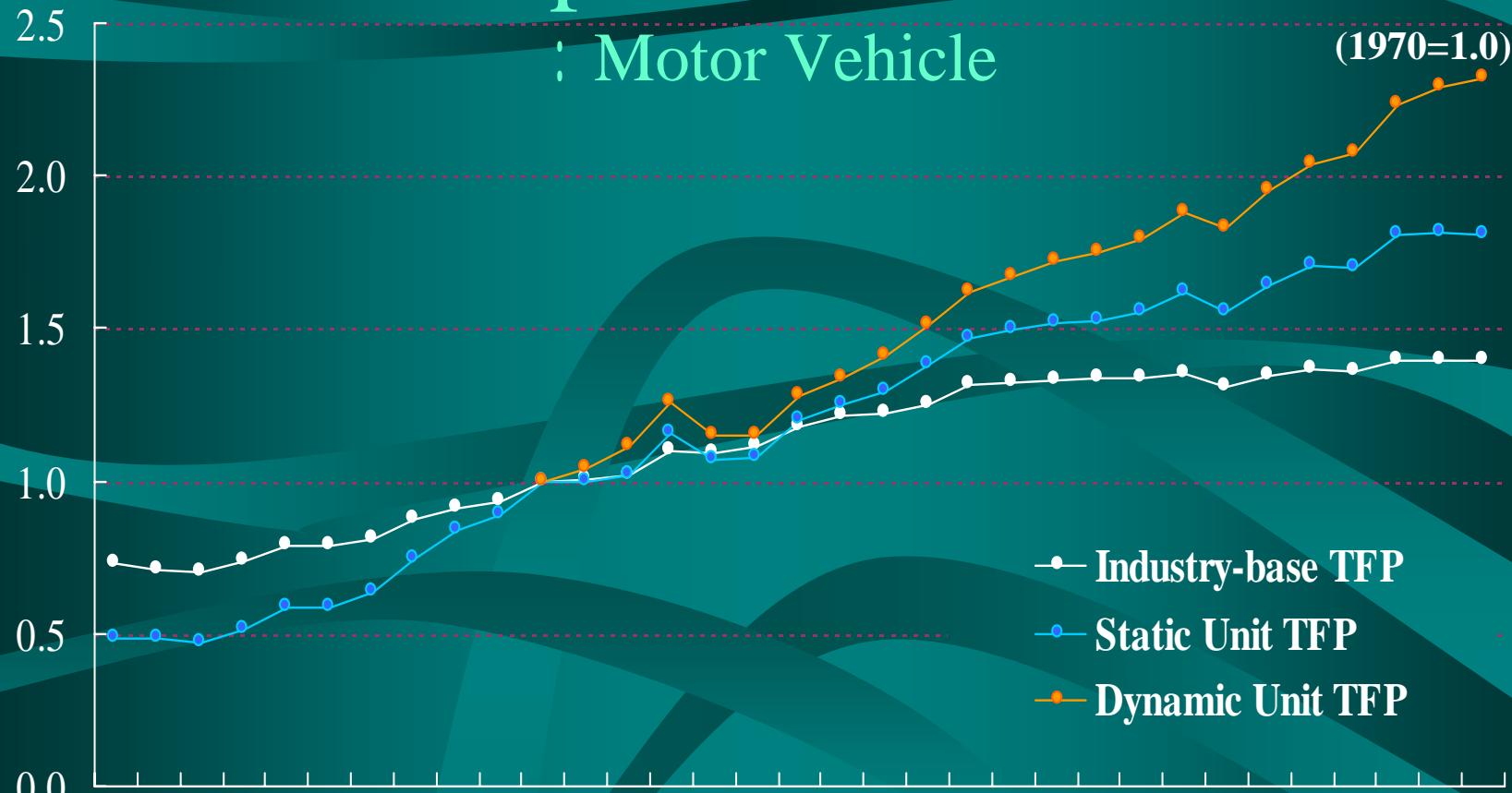


Composition of B_{ij}



Comparison of TFP

: Motor Vehicle



- Industry-base TFP
- Static Unit TFP
- Dynamic Unit TFP

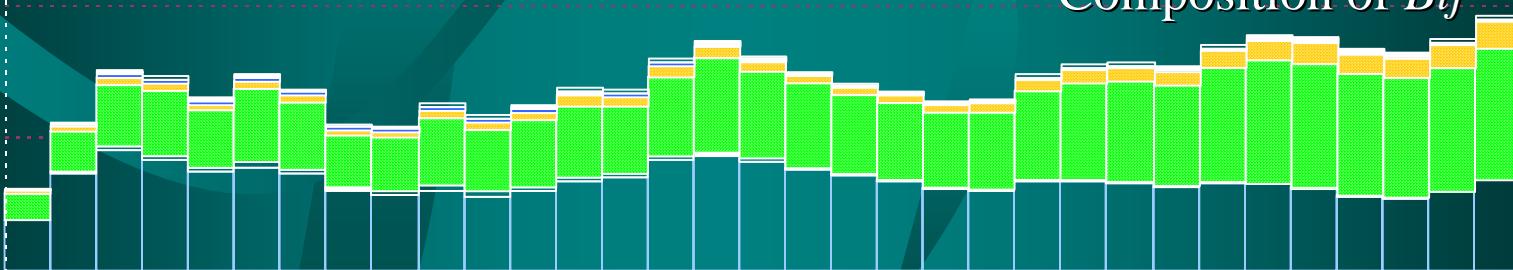
1960

1970

1980

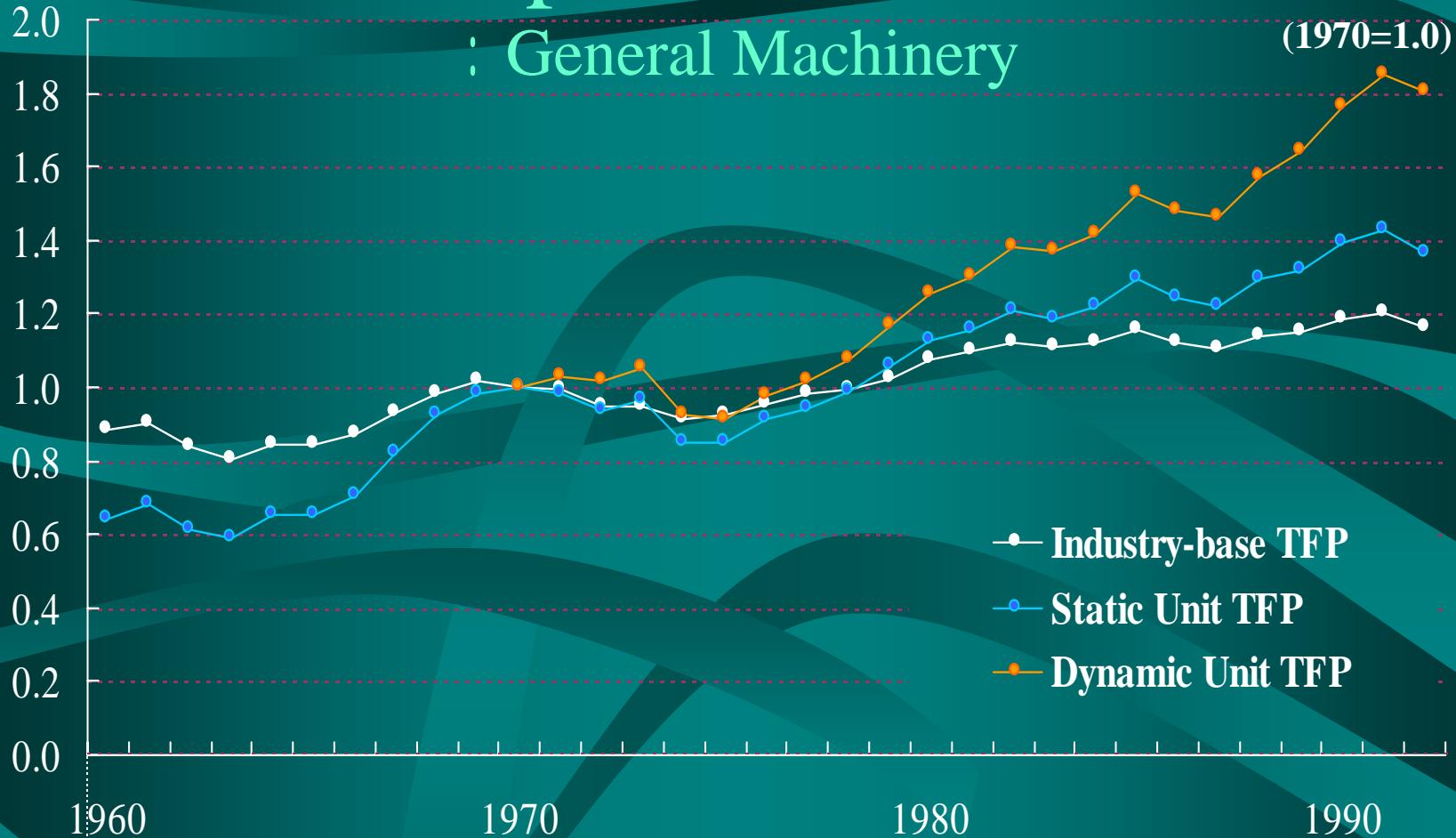
1990

Composition of B_{ij}

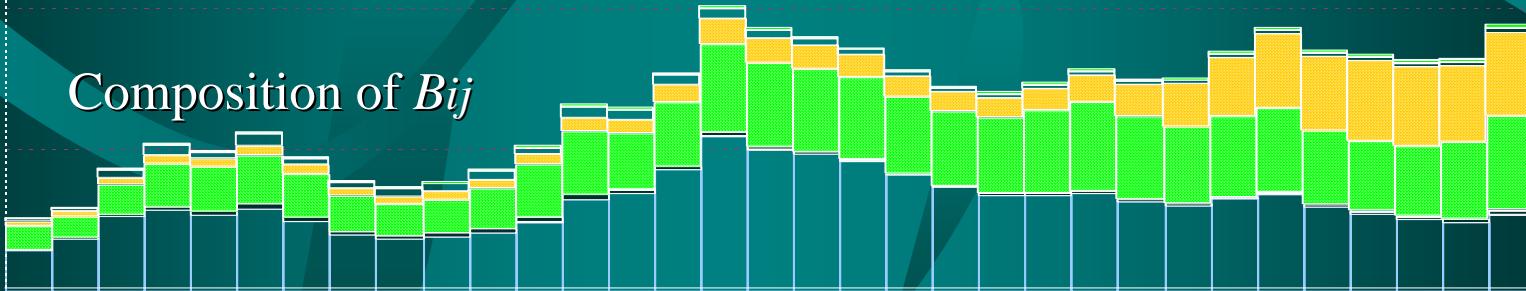


Comparison of TFP

: General Machinery

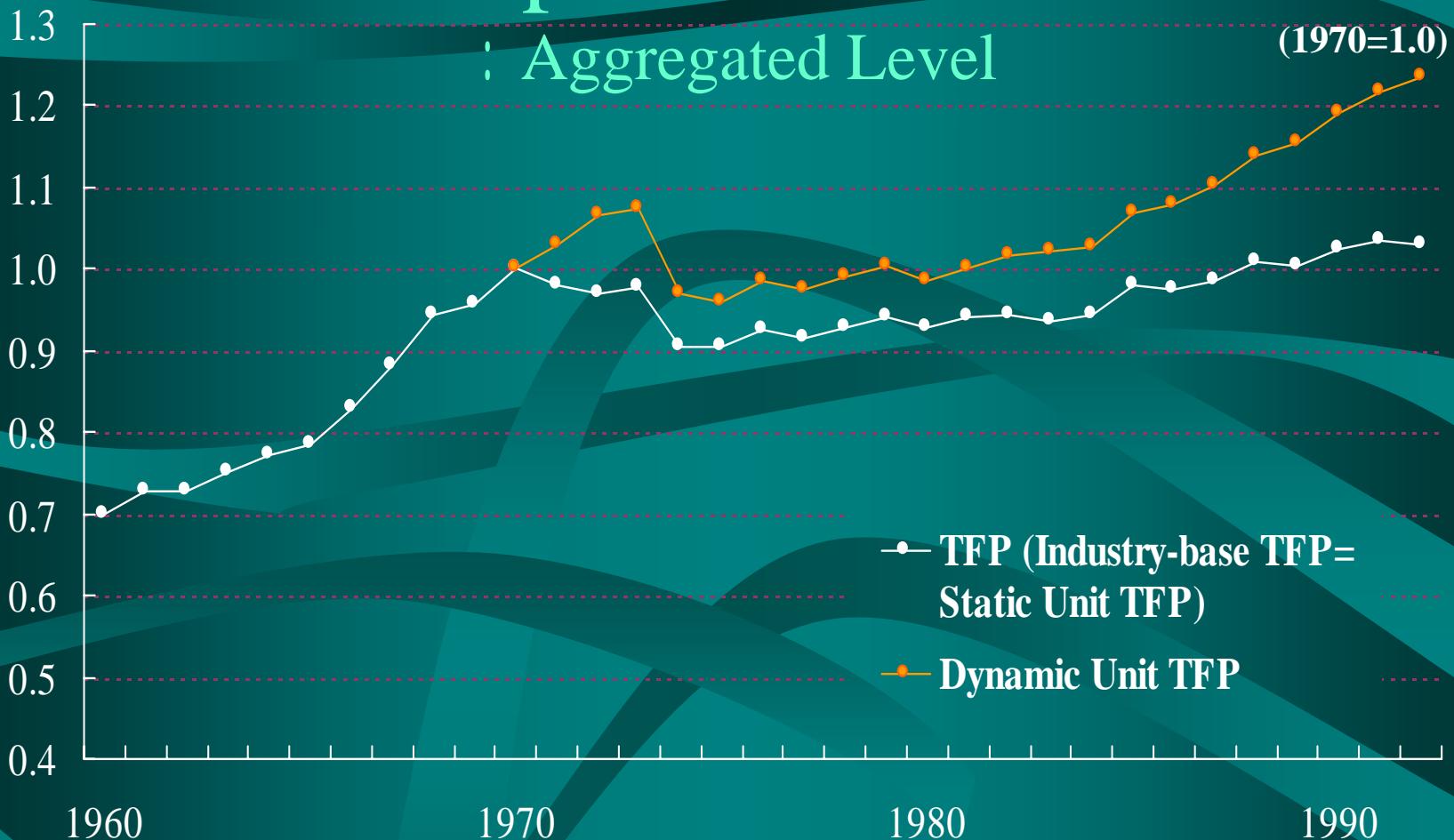


Composition of B_{ij}



Comparison of TFP

: Aggregated Level

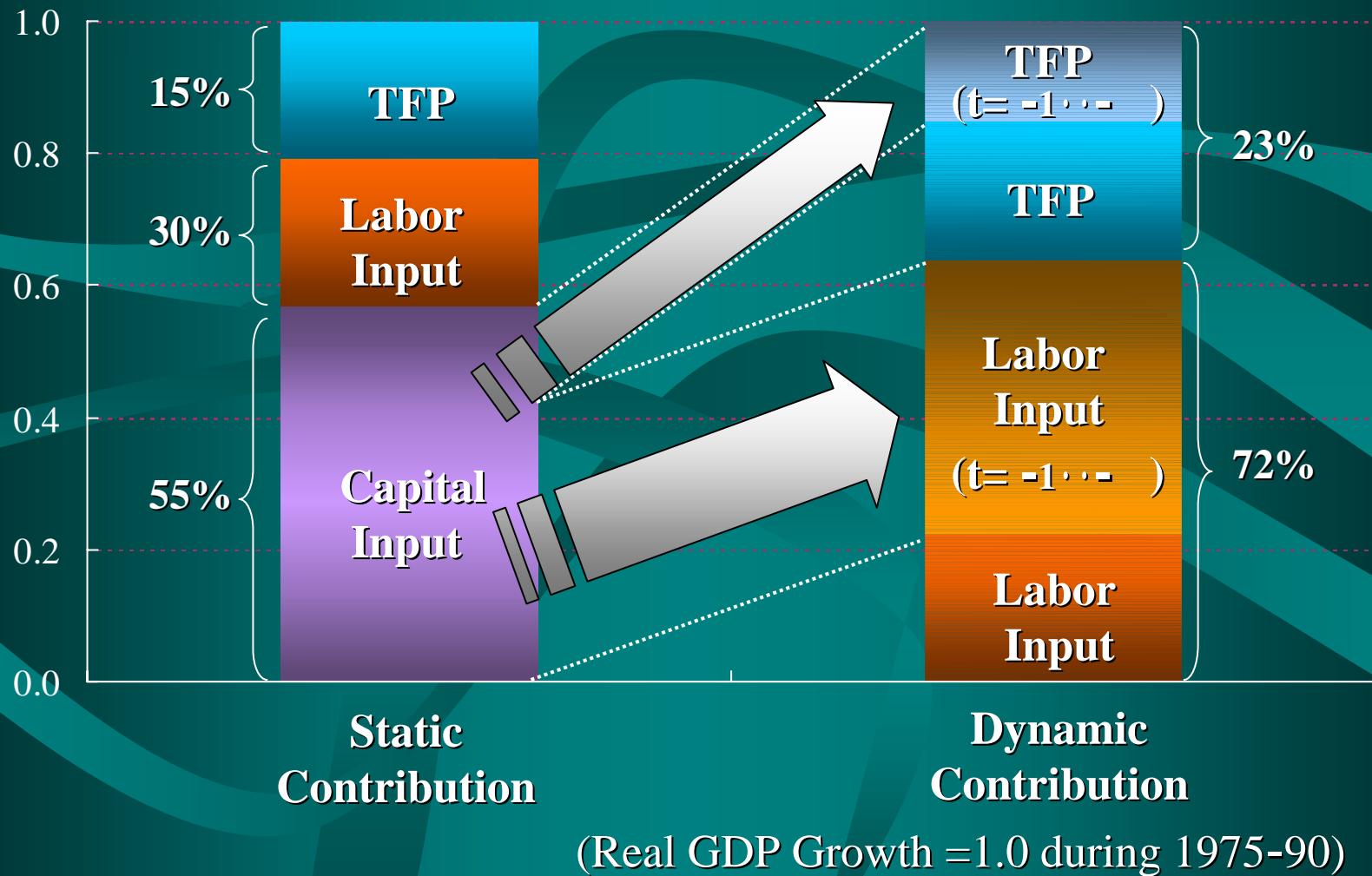


Composition of B_{ij}

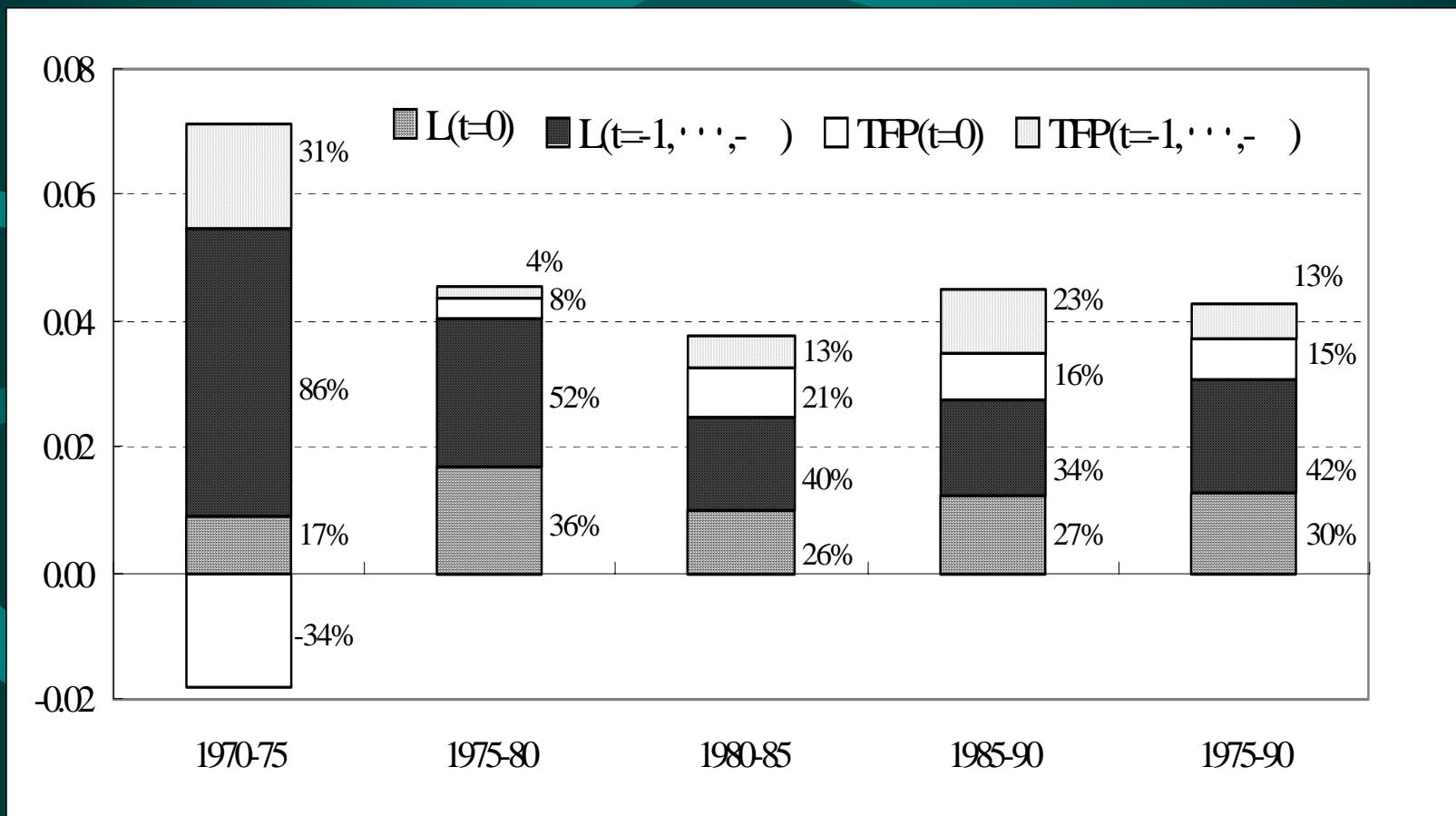


Contribution to Growth

: Aggregated Level



Contribution to Growth :Aggregated Level



Thank you for your attention.
If you need more information,
please take a contact to the
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nomura@sanken.keio.ac.jp