Global Innovation Ecosystem 2008

Workshop: Session 5

Measuring Innovation:

"Measurement of TFP by Commodity-Level and the evaluation of Technology Linkages"

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How to measure "outcome of innovation"?

/ Total productivity growth is one of simple measure for the "outcome" of innovation.

/ Aggregate TFP growth .vs. Industry-level and Commodity-level TFP growths

/ How to define inputs and output for measuring TFP growth ?

- · **output measure: service sectors**
- · **input measure: capital service, intangible assets**
- · **measurement of technology linkages**

Decomposition of Sources of Economic Growth：1960−2004
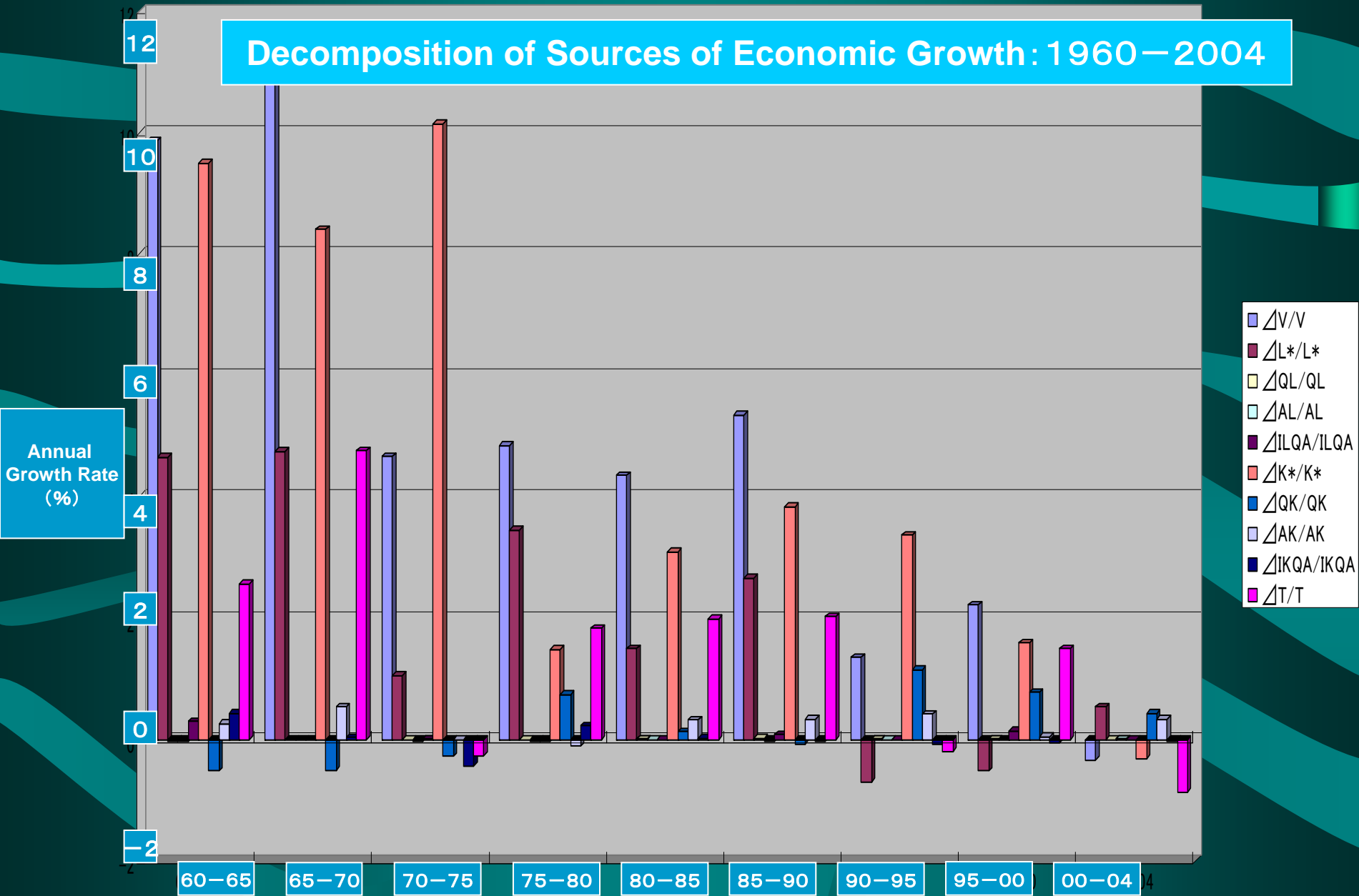
US-Japan Macro Productivity Level Comparison :1960-2000
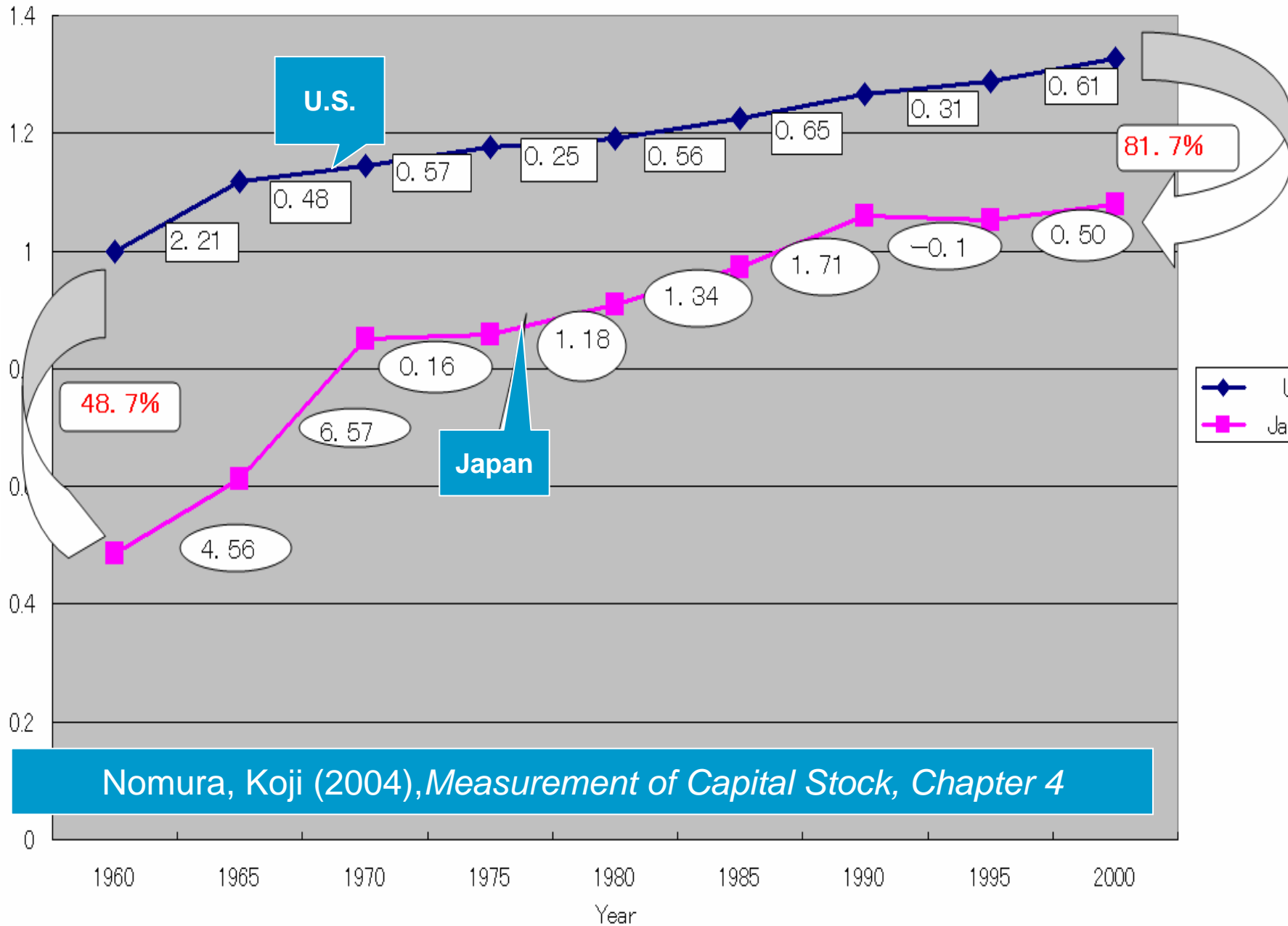
Nomura, Koji (2004),*Measurement of Capital Stock, Chapter 4*

-Abstract-

- One of the important aspects in input-output framework is to provide the analytical tool for describing the structural linkage of the economy based upon technological properties of the society.

- I will focus on 7 Japanese linked Input-Output tables since 1960 and show my observations from the experiments concerning the structural changes of technology linkages from the viewpoints of productivity growth by commodities.

- I would like to focus on the analysis of characters in the deterioration of the economic growth and evaluate the importance of the innovation in economy.

Contents

1. Linked Input-Output Table in Japan
2. Technology Linkage in Triangulated IO
   -Input Coefficients and Unit Structure by Commodity
3. Measurement of Total Factor Productivity
   and Productivity Linkages
   / Own TFP by Commodity
   / Static Unit TFP by Commodity
4. Several Observations in Technology Linkages
5. Unsolved Measurement Problems on the Evaluation
   of Intangible Assets: R&D activity, Soft-ware etc.
6. Conclusions: Proposals for the Challenge on the
   Suggestion for Measurement Issues in Science
   Policy.

Linked IO Tables and Related Data

- **Linked IO Tables**

  /60-65-70 Linked: 339 commodities

  /65-70-75 Linked: 392 commodities

  /70-75-80 Linked: 394 commodities

  /75-80-85 Linked: 349 commodities

  /80-85-90 Linked: 353 commodities

  /85-90-95 Linked: 394 commodities

  /90-95-00 Linked: 394 commodities

  /00-04 Linked: 394 commodities

- **Time-series Labor and Capital Service**

  (Keio Economic Observatory Data)

  Input Quantity and price Index: 43 Industrial sectors : (1960-2004)

Triangulation and Technology Linkage

Construction

Machinery

Electric Products

Metal Products

Food Products
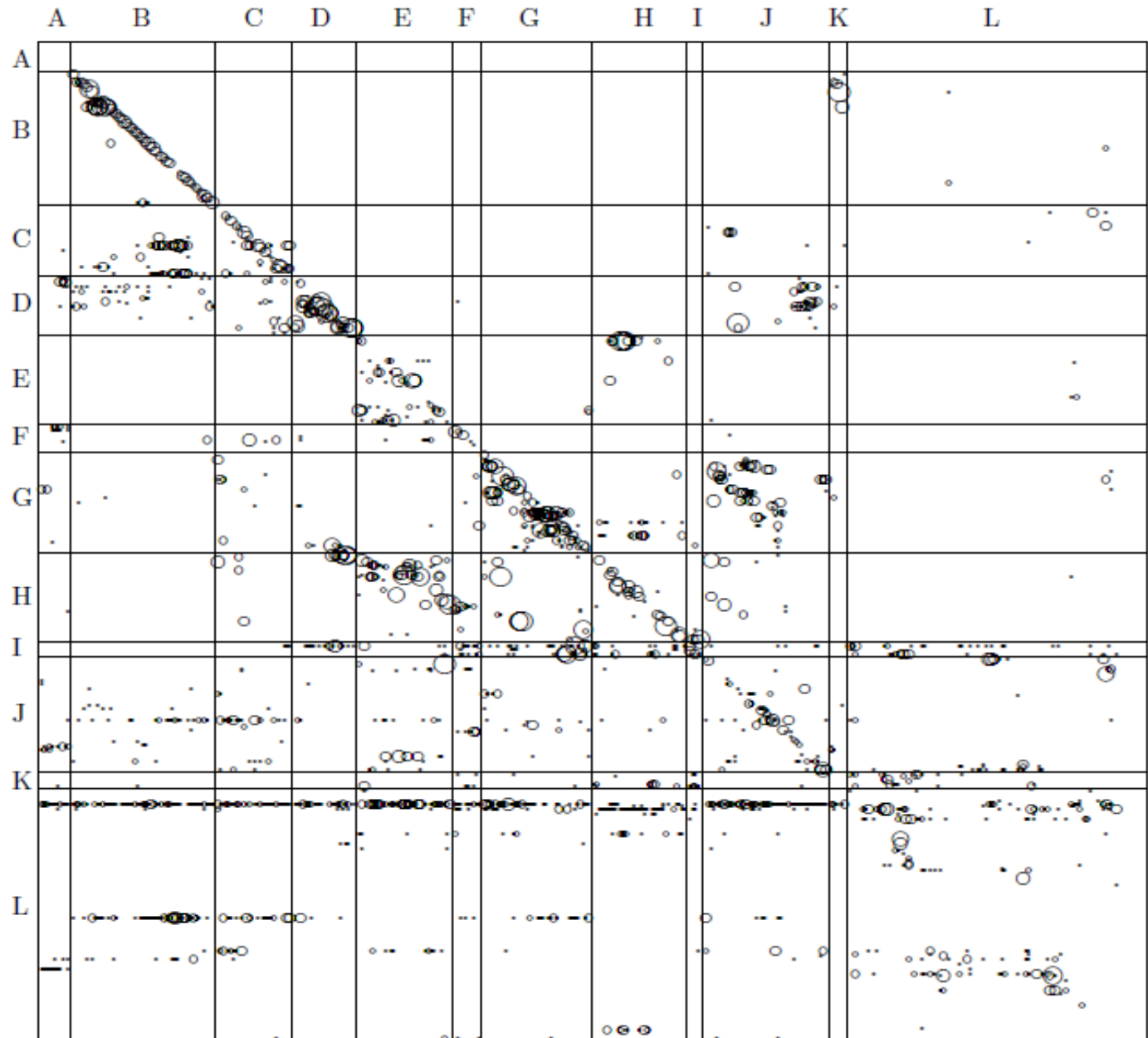
Stone & Clay

Mnf. Final Prod.

Material Prod.

Energy

Auxiliary

Repairs

Service

Block Classification

A	Construction
B	Machinery & Equipment
B1	Construction & Transportation Equipment
B2	General Machinery
B3	Electric Machinery
B4	Precision Instruments
C	Electric & Erectronic Products
C1	Miscellaneous Manufacturing Products
C2	Electronic Equipment & Components
C3	Heavy and Other Electrical Equipment
D	Metal Products
E	Food Products
F	Stone & Clay Products
G	Other Manufacturing Final Products
G1	Textile Products
G2	Paper Products
G3	Chemical Products
H	Material Products
H1	Metal and Non-Metal Material Products
H2	Food and Wood Material Products

I	Secondary Energy Products
J	Auxialry Material
J1	Auxiliary Material: Medical Products
J2	Auxiliary Material:Textile Products
J3	Auxiliary Material: Paper
J4	Auxiliary Material: Metal
J5	Auxiliary Material :Prastic
J6	Auxiliary Material: Chemical
J7	Auxiliary Material: Construction
J8	Auxiliary Material: Others
K	Repairs
L	Service
L1	Water Supply and Waste Management
L2	Transportation & Comminication service
L3	Education & Research
L4	Medical Service
L5	Other service

Technology Linkage: Semiconductor production

Personal Computer etc.

Consump.

Invest.

Other IT installed Machine

Applied Electronics

Semiconductor

Non-ferrous Metal Prod.

Non-ferrous Mine

Productivity Analysis :
Commodity-base Own 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

- Commodity-base
- Structural Change

$$X_j , K_j , L_j$$

- **Production Function**
$$X_j = f(\, K_j,\, L_j,\, X_{ij},\, T_j\,)$$

- **Growth Rate of Own Total Factor Productivity**

$$\frac{\dot{T_j}}{T_j} = \frac{\dot{X_j}}{X_j} - \sum_n s_{x_{ij}} \frac{\dot{X_{ij}}}{X_{ij}} - s_{L_j}\frac{\dot{L_j}}{L_j} - s_{K_j}\frac{\dot{K_j}}{K_j}$$

Unit Structure & Static Unit TFP

Intermediate Input

$$A_{ij}\ X_j$$

Capital Input

$$B_{ij}\ X_j$$

Labor Input

$$L_{kj}\ X_j$$

Output

$$X_j$$

- **Unit Structure**

Taking f*=e(i), where e(i) denotes the i-th unit Vector with a one in position I and all other entities Equal to zero, the matrices of intermediate deliveries, X*, labor L*, and capital K* required for producing A single unit of final demand of commodity are given as follows:

$$\mathbf{U}_{t/f_t^* = e_{(i)}} = \begin{bmatrix} X_t^* \\ L_t^* \\ K_t^* \end{bmatrix} = \begin{bmatrix} A_t \langle (I - A_t)^{-1} f_t^* \rangle \\ B_t^L \langle (I - A_t)^{-1} f_t^* \rangle \\ B_t^K \langle (I - A_t)^{-1} f_t^* \rangle \end{bmatrix}$$

$$\frac{T_i}{T_i} = \Sigma_j \ \frac{P_j X_j}{P_v V} \ \frac{T_j}{T_j}$$
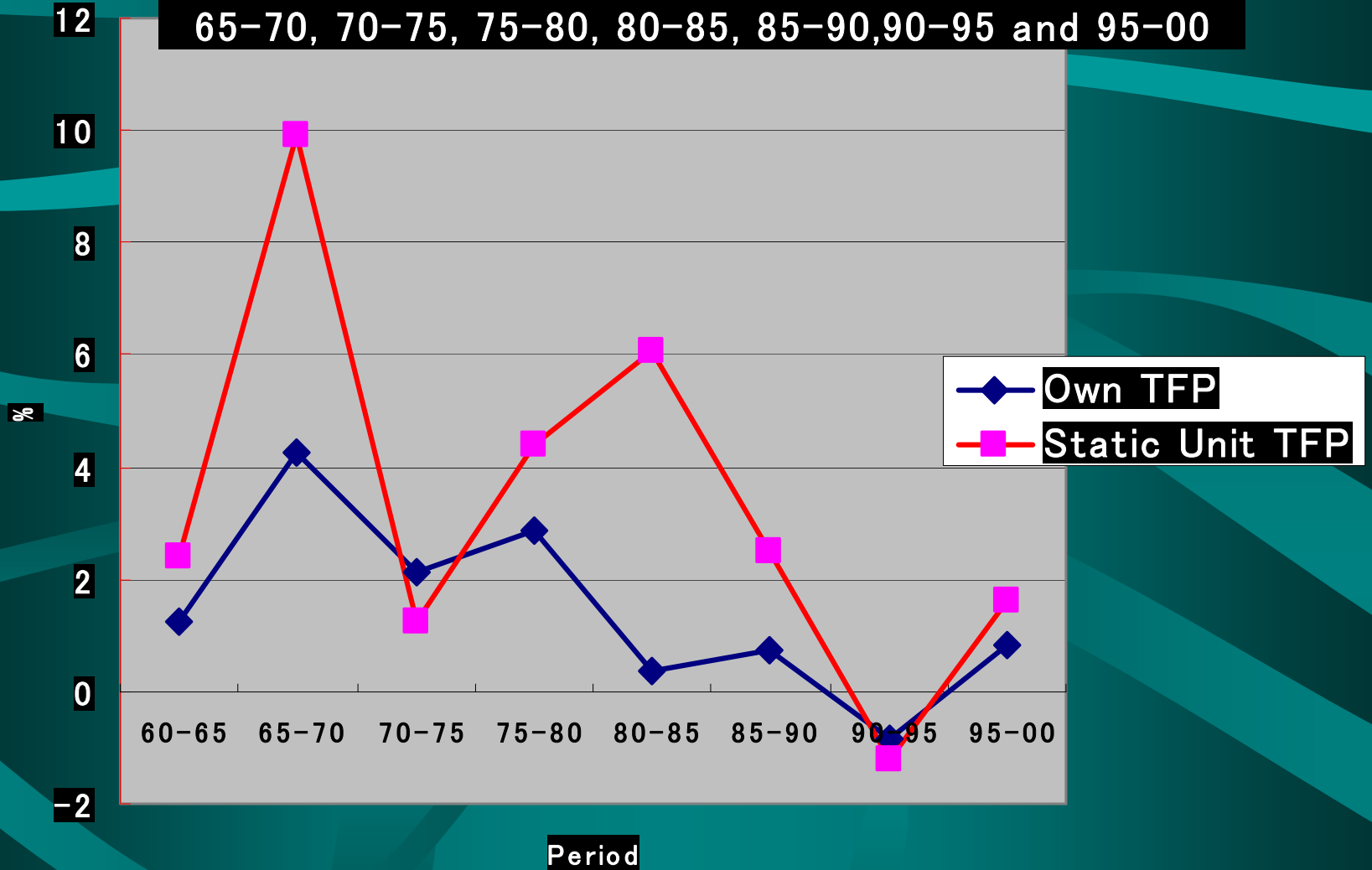
- **Aggregation of commodity-based TFP**
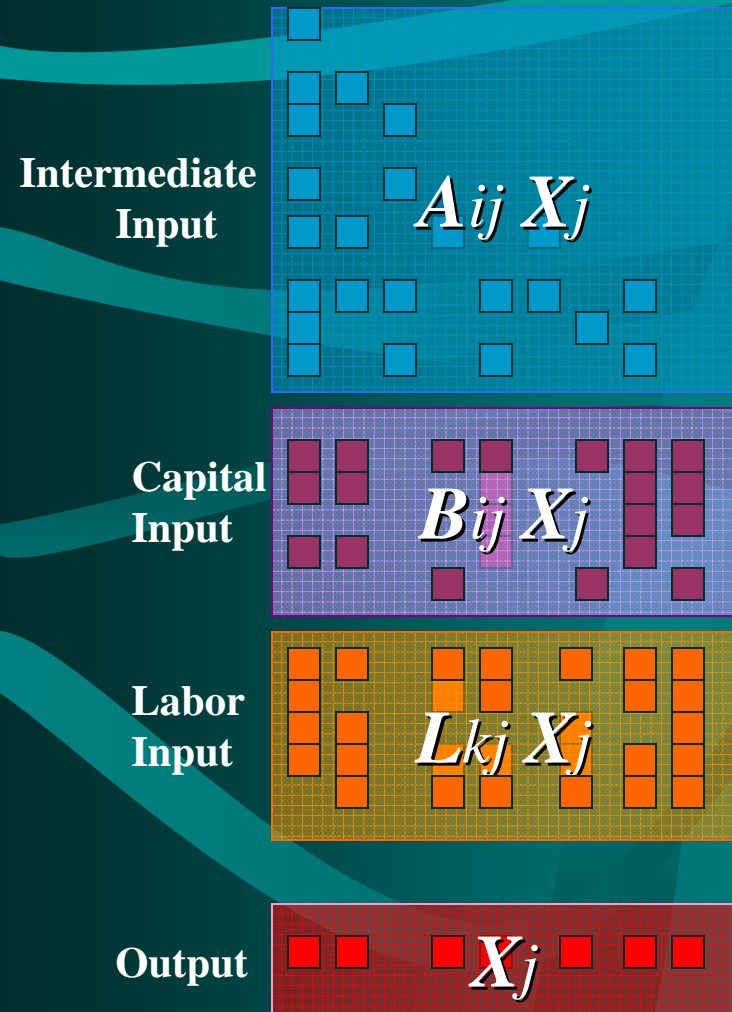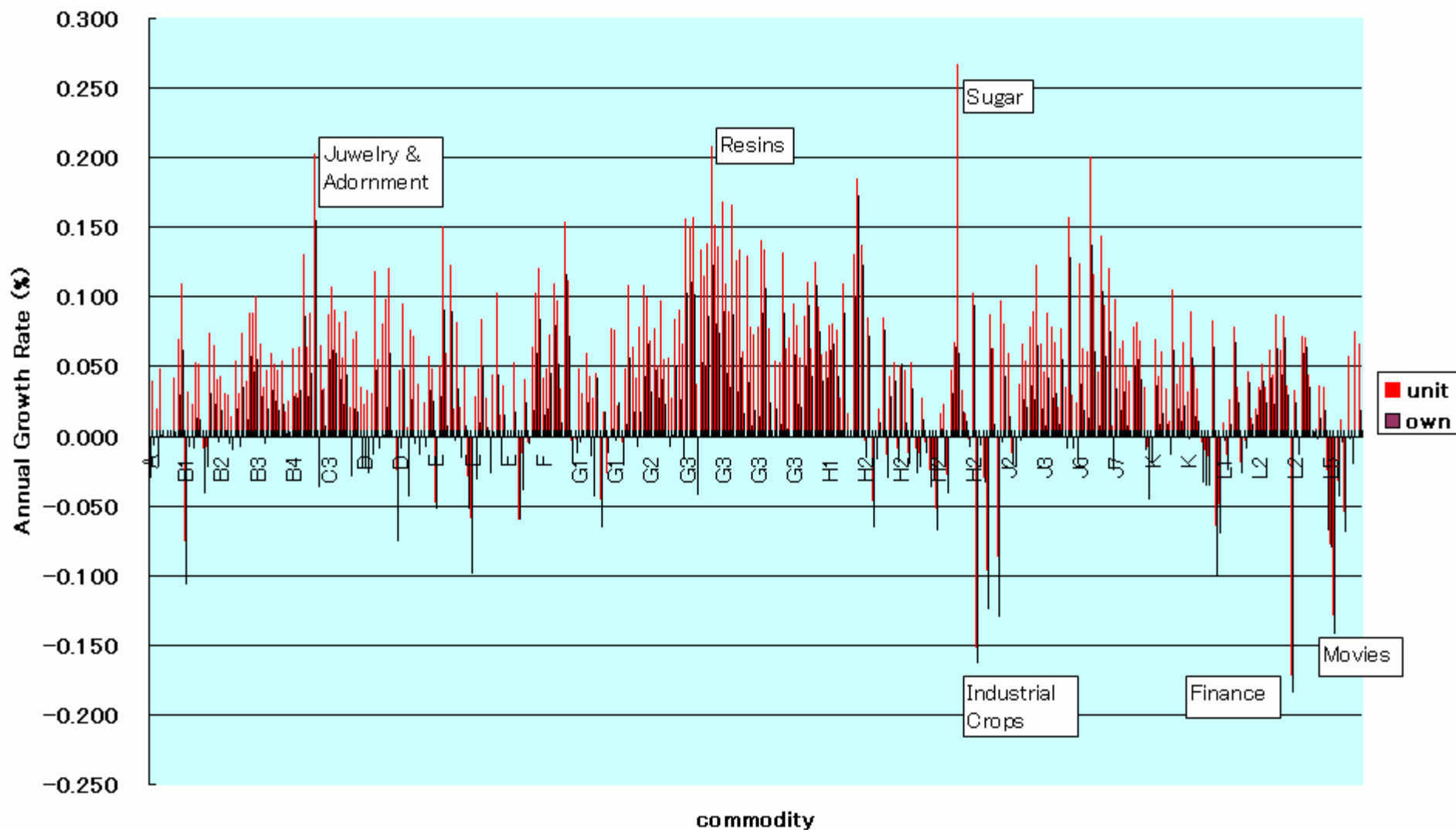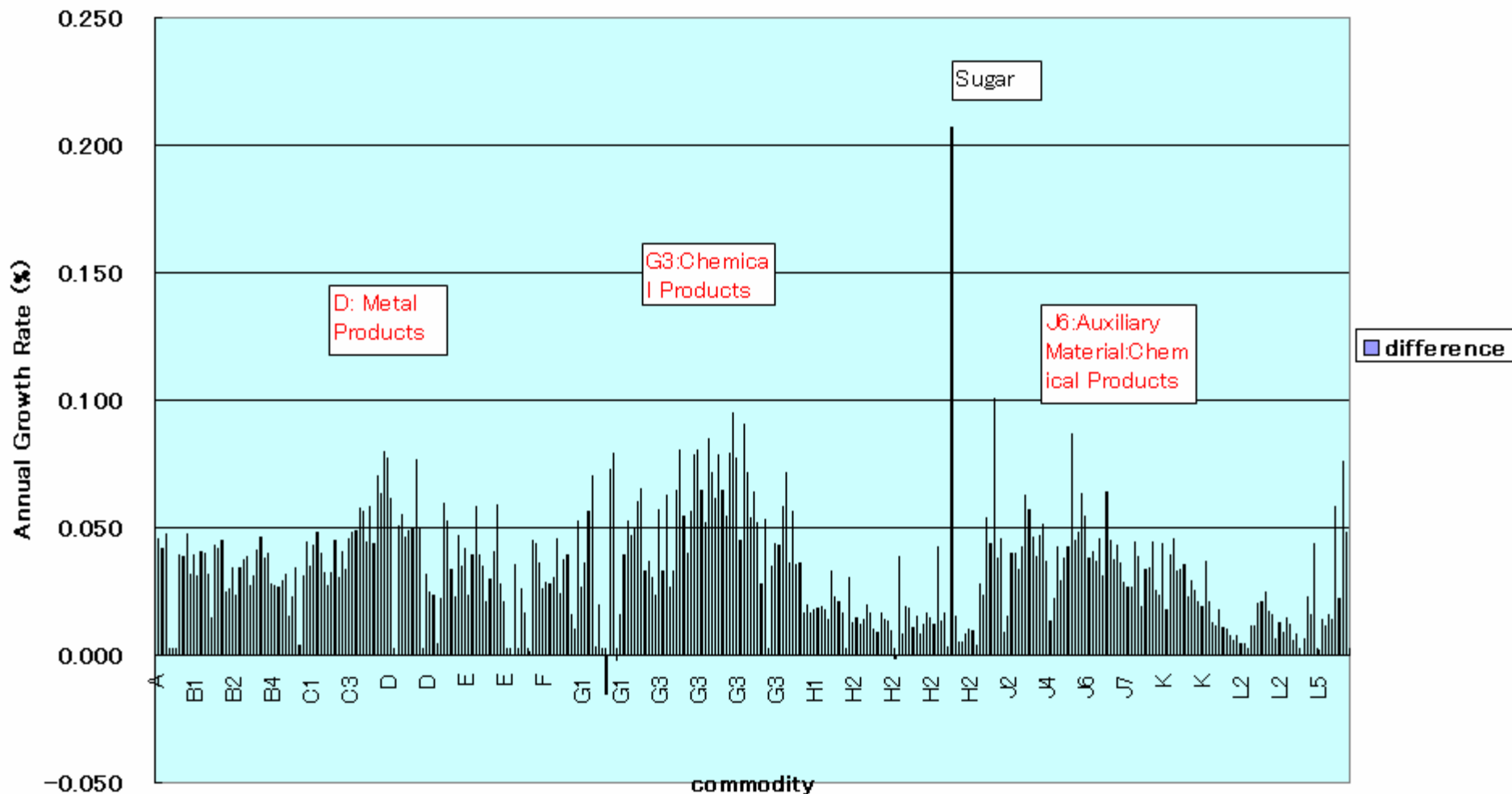
Unit Structure of Motor Vehicle Production
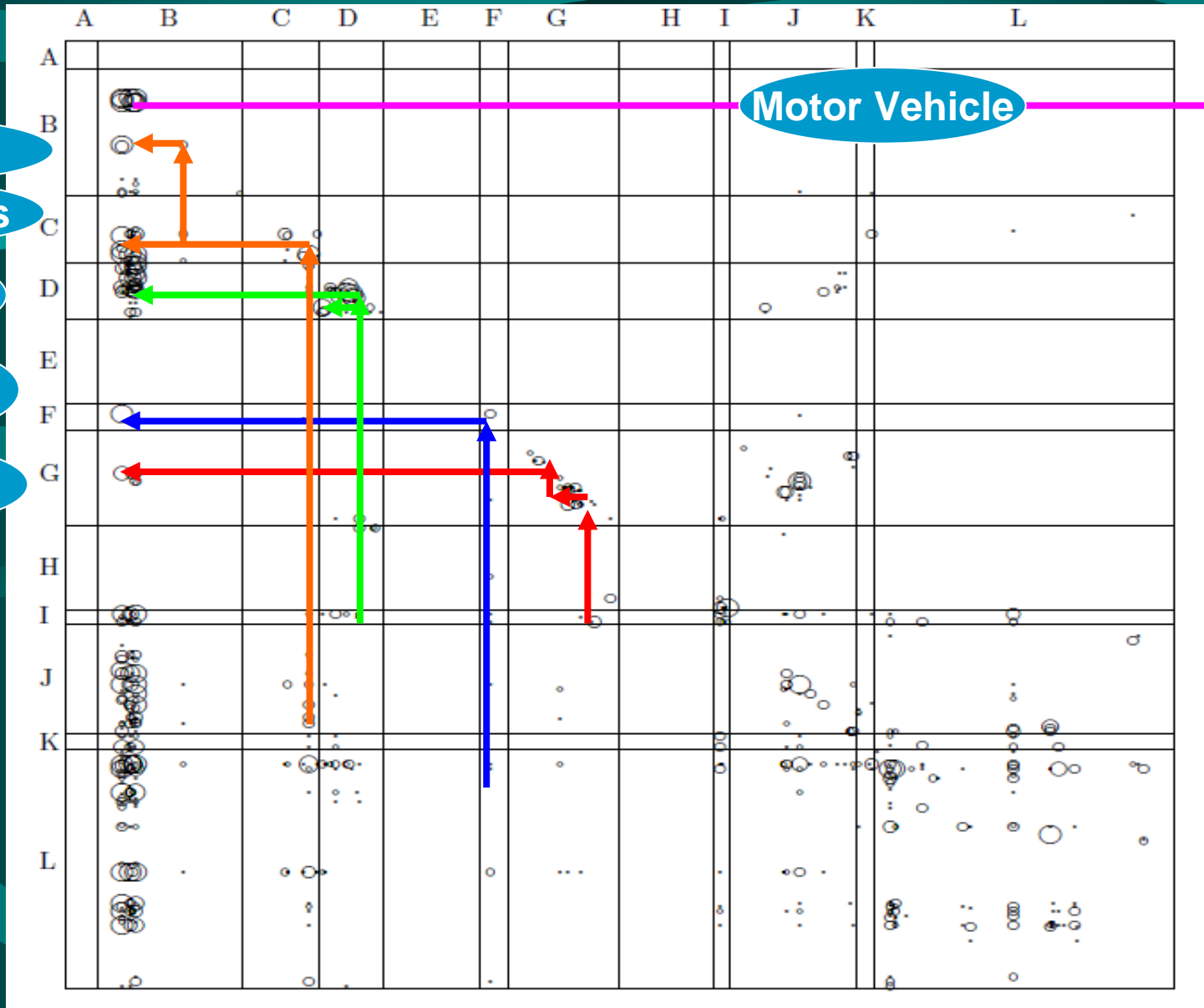
Time-Series Changes of Annual Growth Rate of Own TFP and Unit TFP in Motor Vehicle Producstion: 60-65, 65-70, 70-75, 75-80, 80-85, 85-90,90-95 and 95-00

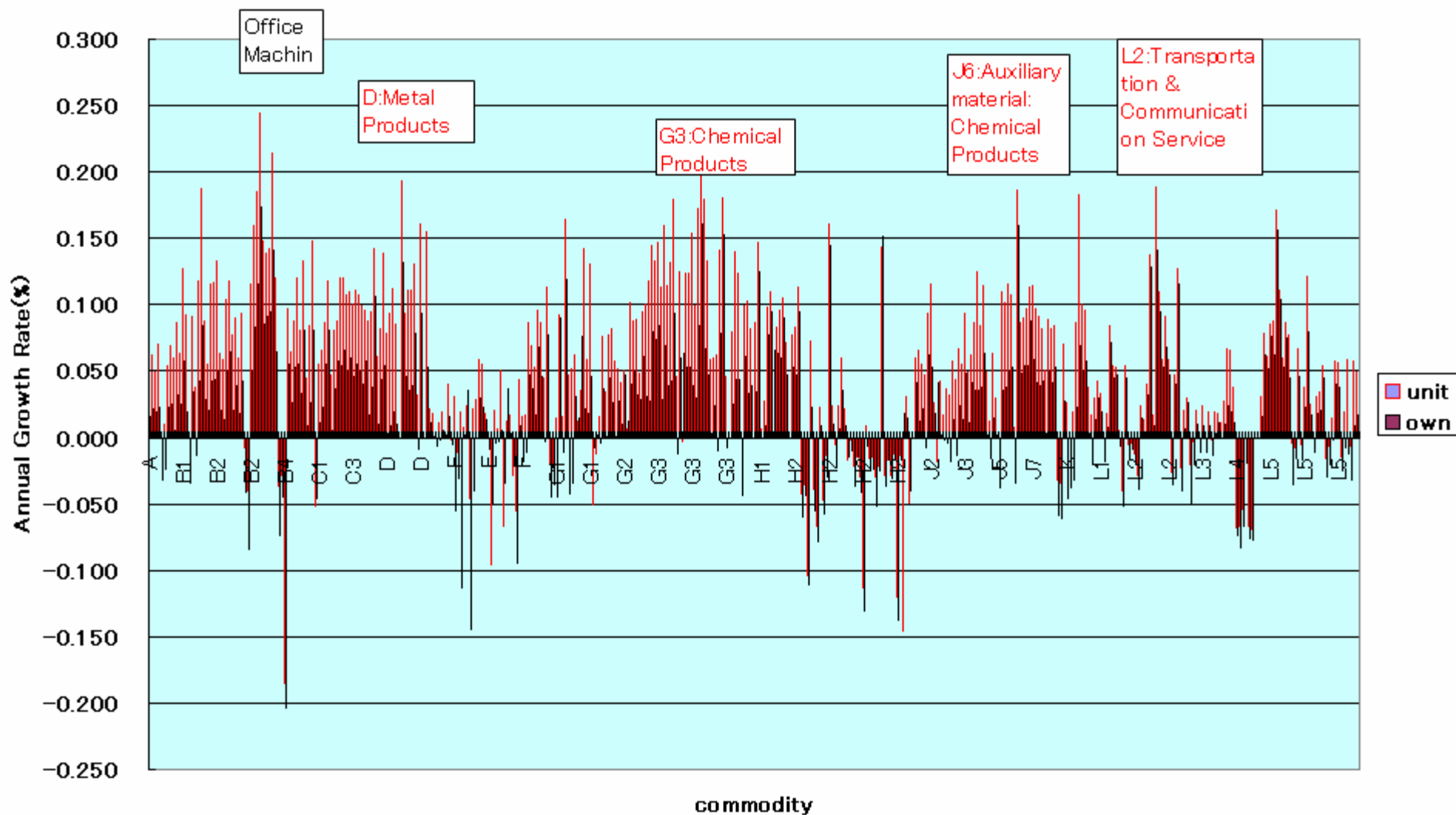Annual Growth Rate of Own and Unit TFP during the period 1960-1965

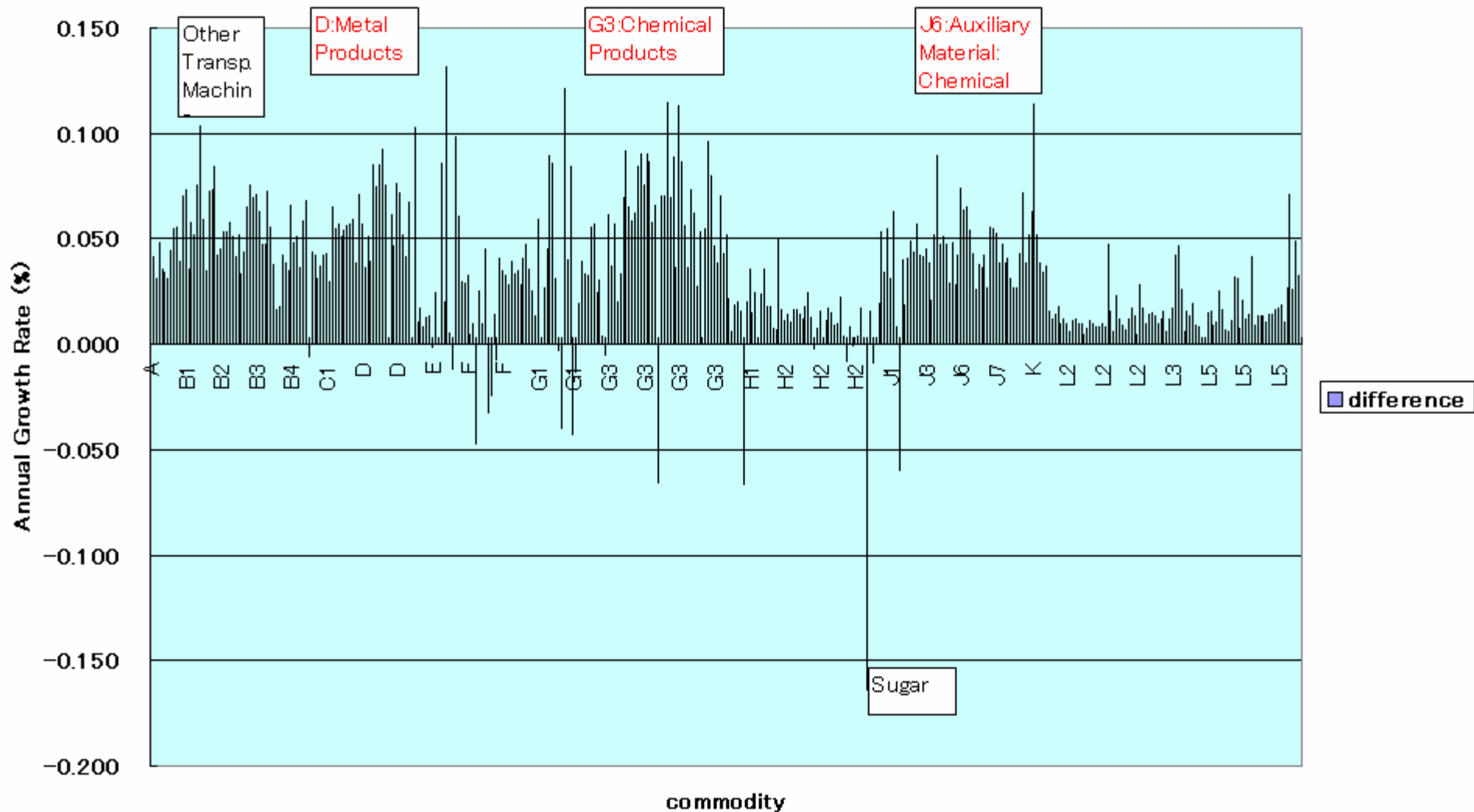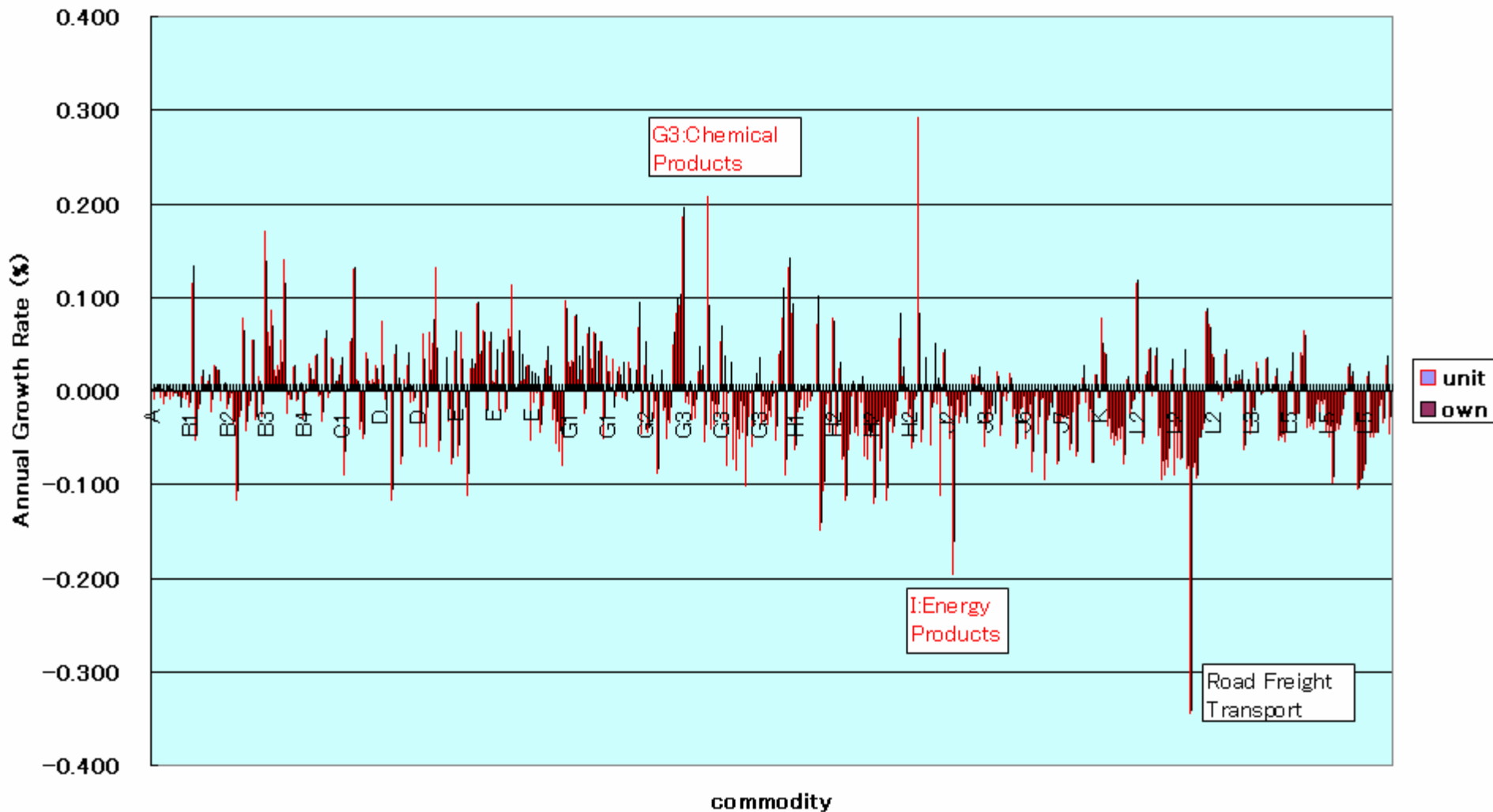Difference between Own and Unit TFP during the period 1960-1965

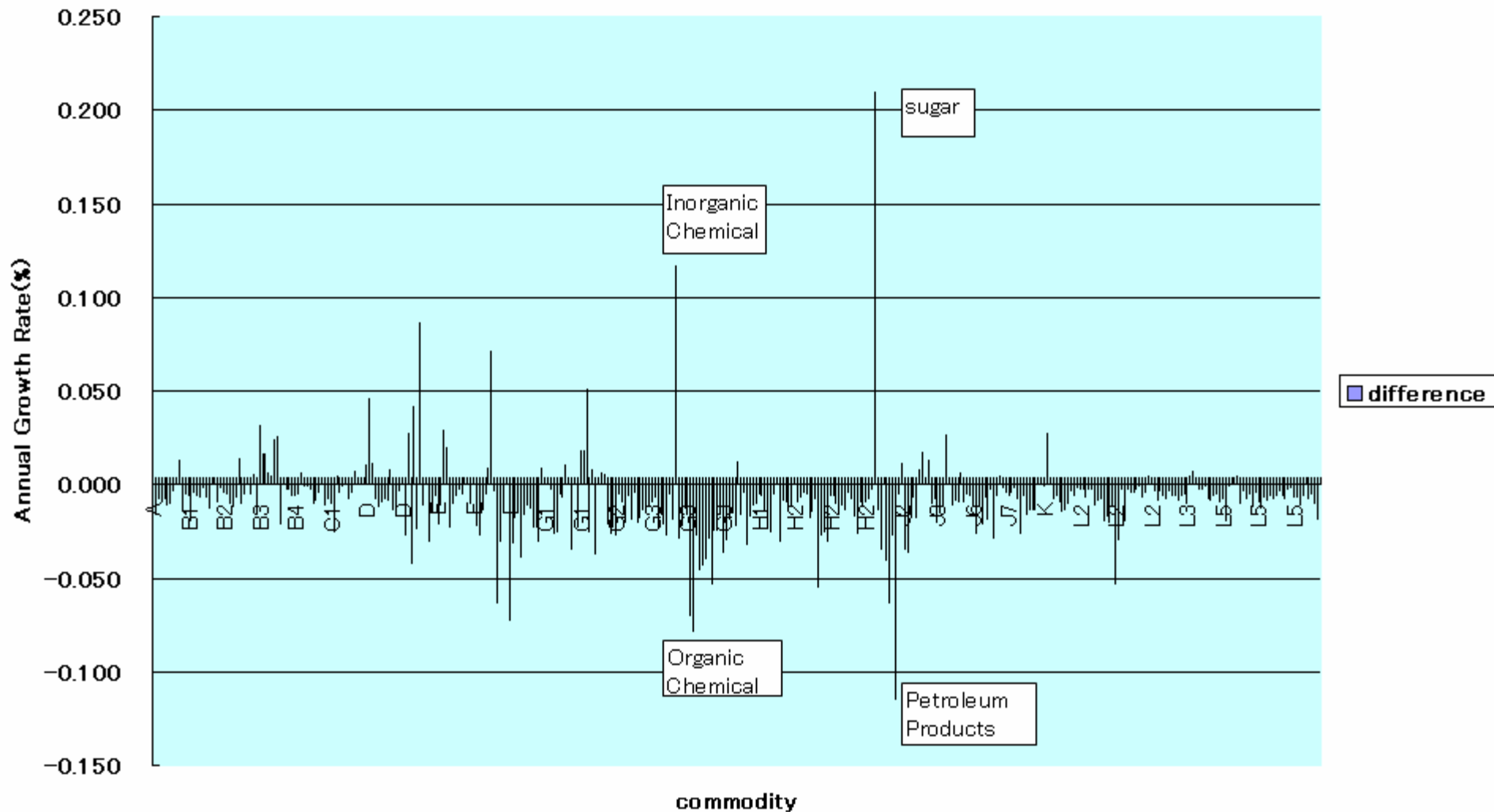Annual Growth Rate of Own and Unit TFP during the period 1965-1970

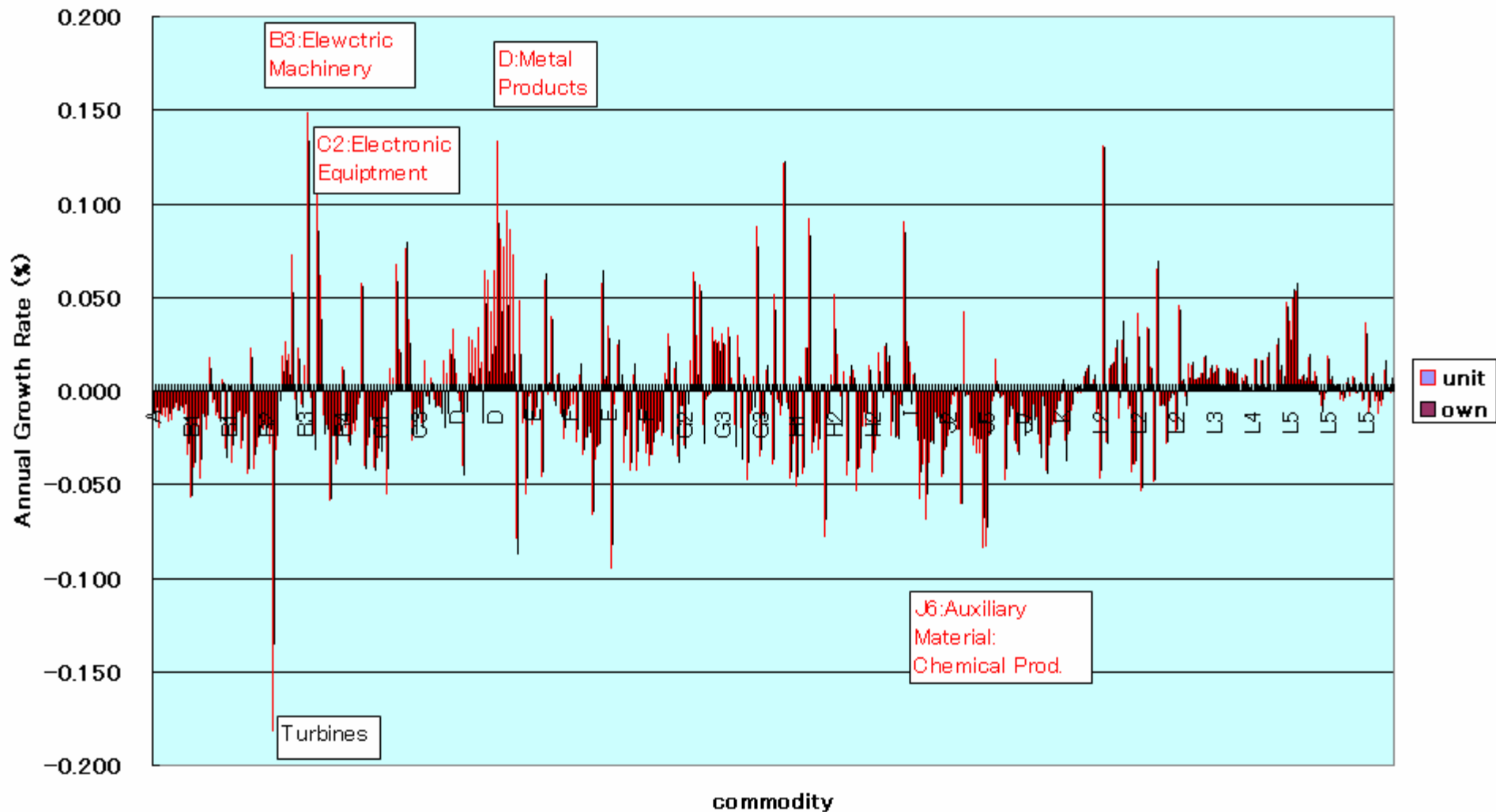Difference of Own and Unit TFP Growth Rate during the period 1965-1970

Annual Growth Rate of Own and Unit TFP during the period 1970–1975

Difference between Own and Unit TFP Growth Rate during the period 1970-1975
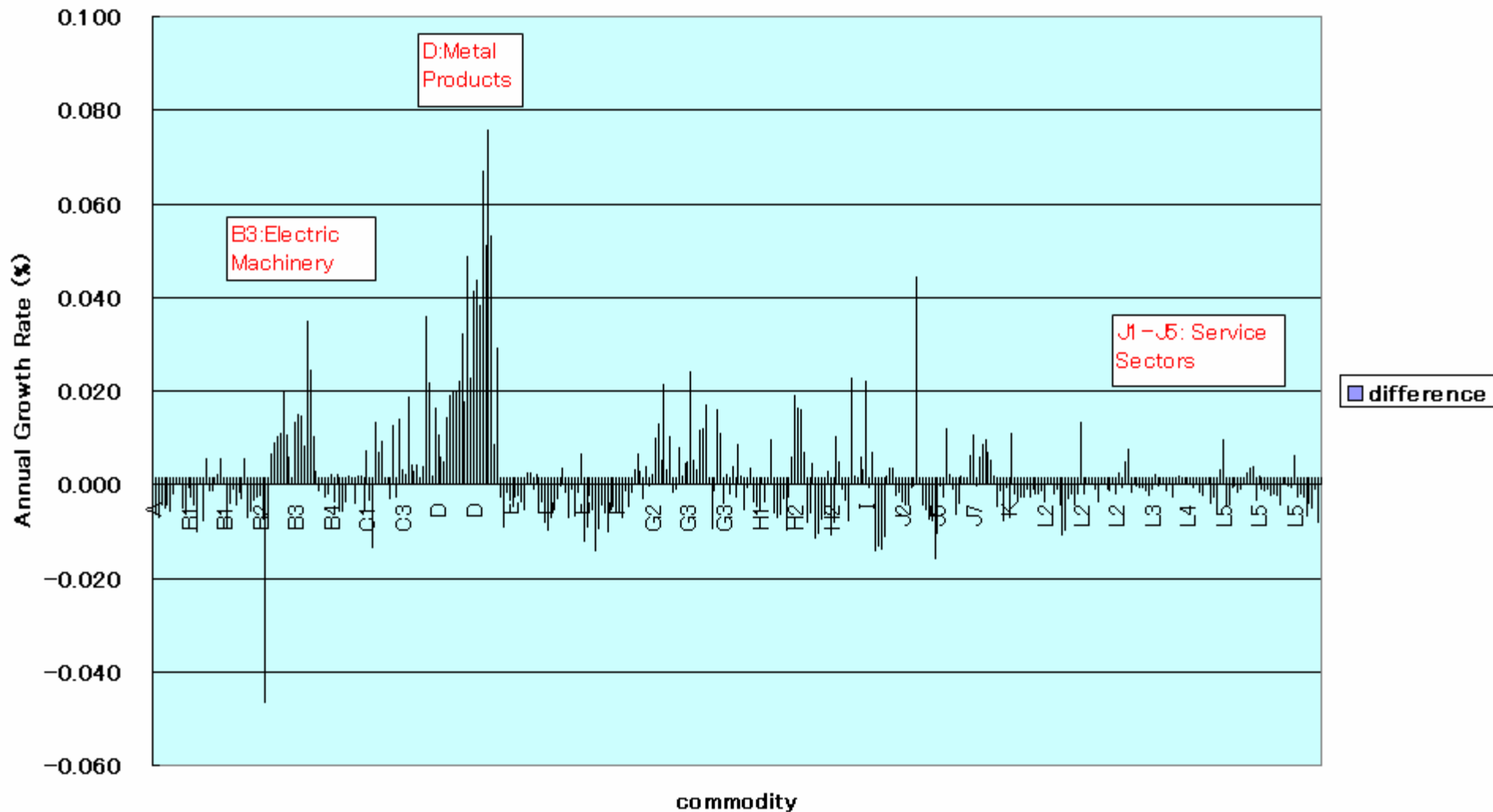
Annual Growth Rate of Own and Unit TFP during the period 1990-1995

Difference between Own and Unit TFP Growth Rate during the period 1990-1995

Annual Growth Rate of Own and Unit TFP during the period 1995-2000

Difference between Own and Unit TFP Growth Rate during the period 1995-2000

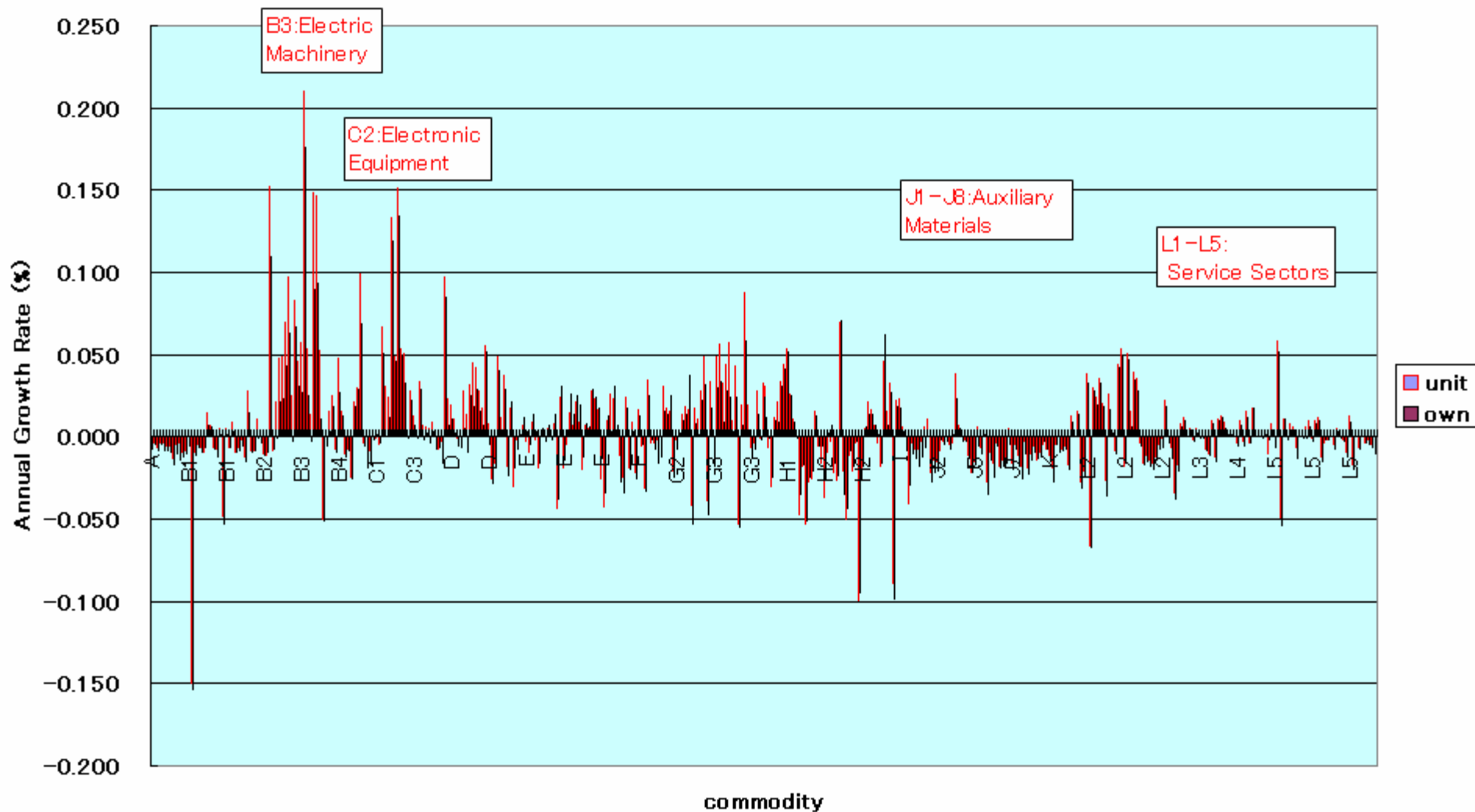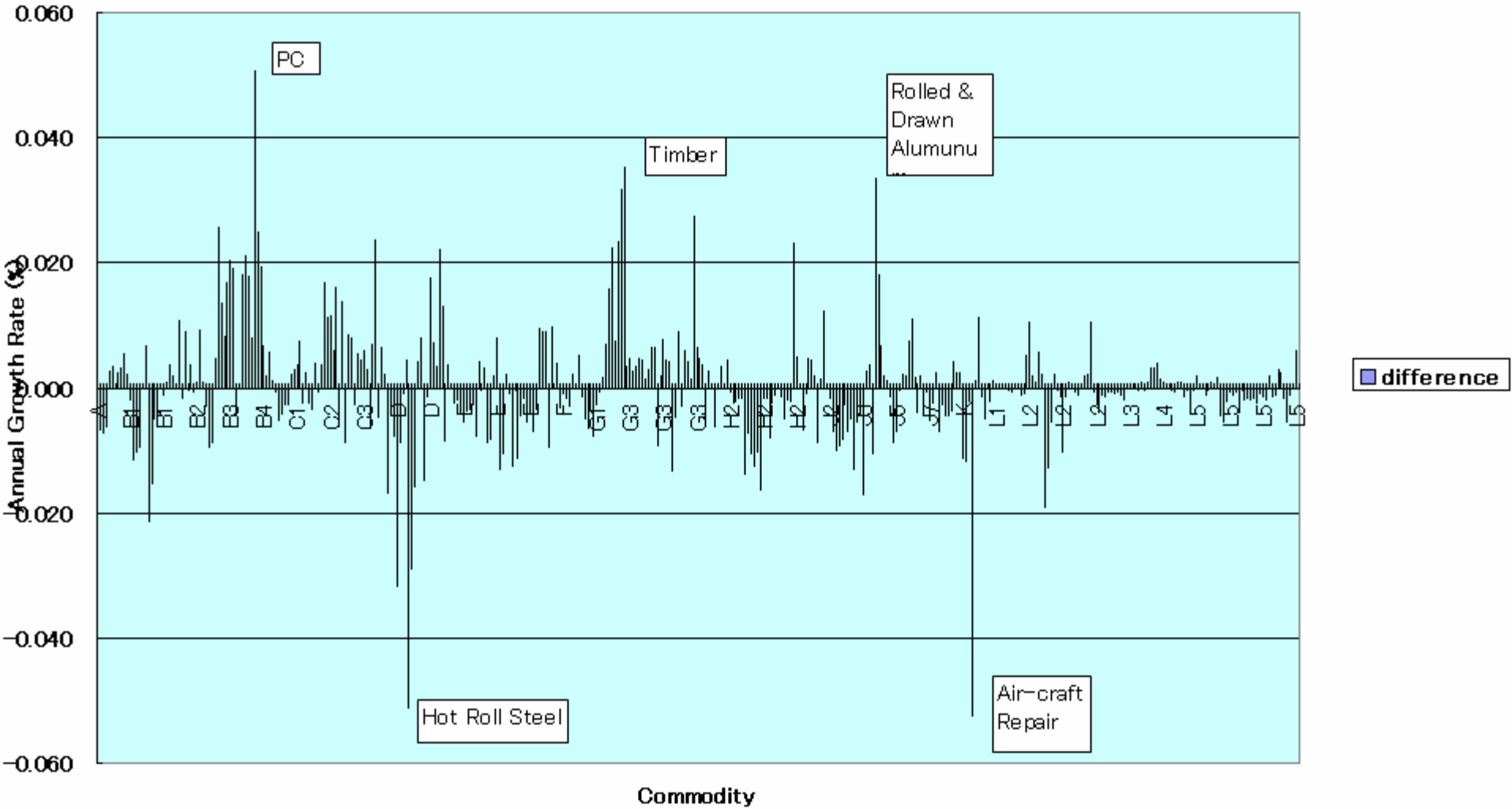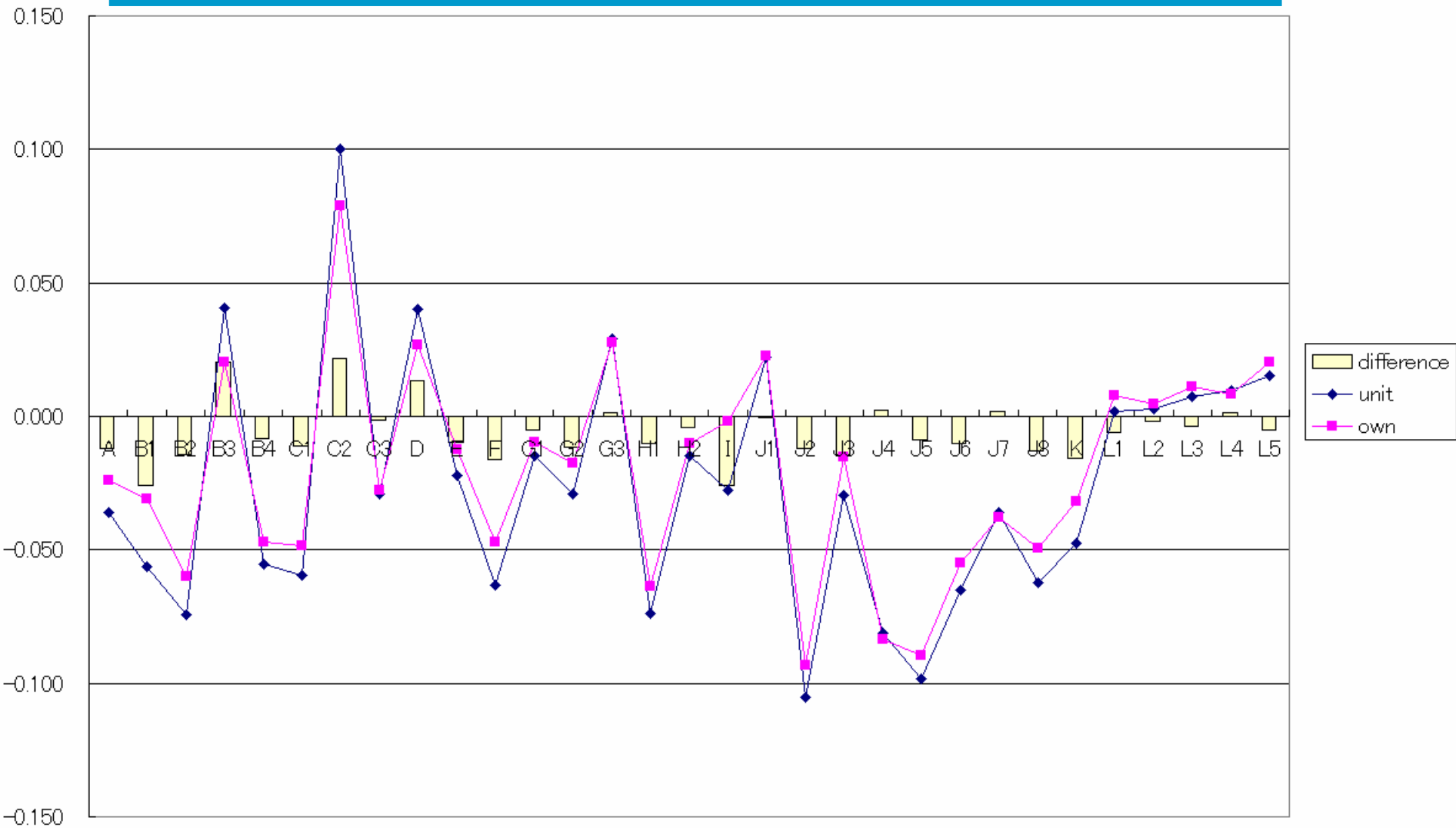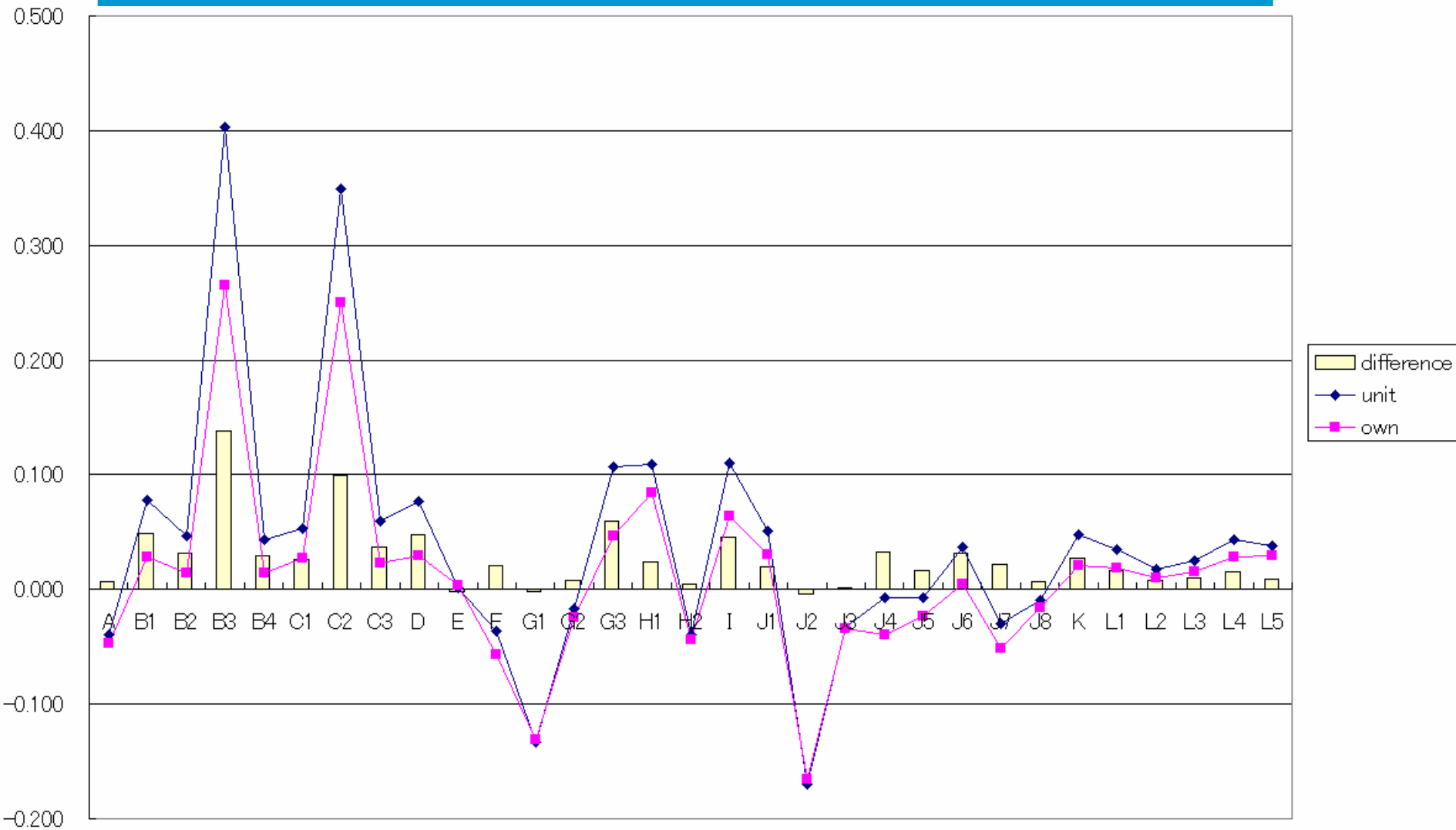Annual Growth Rate of Own and Unit TFP during the period 2000-2004

difference between Own and Unit TFP during the Period 2000-2004

Annual TFP Growth Rate (Own & Unit) by Block 1990-1995

Annual Growth Rate of TFP (Own & Unit) by Block: 1995-2000

Annual Growth Rate of TFP (Own & Unit) by Block: 2000-2004
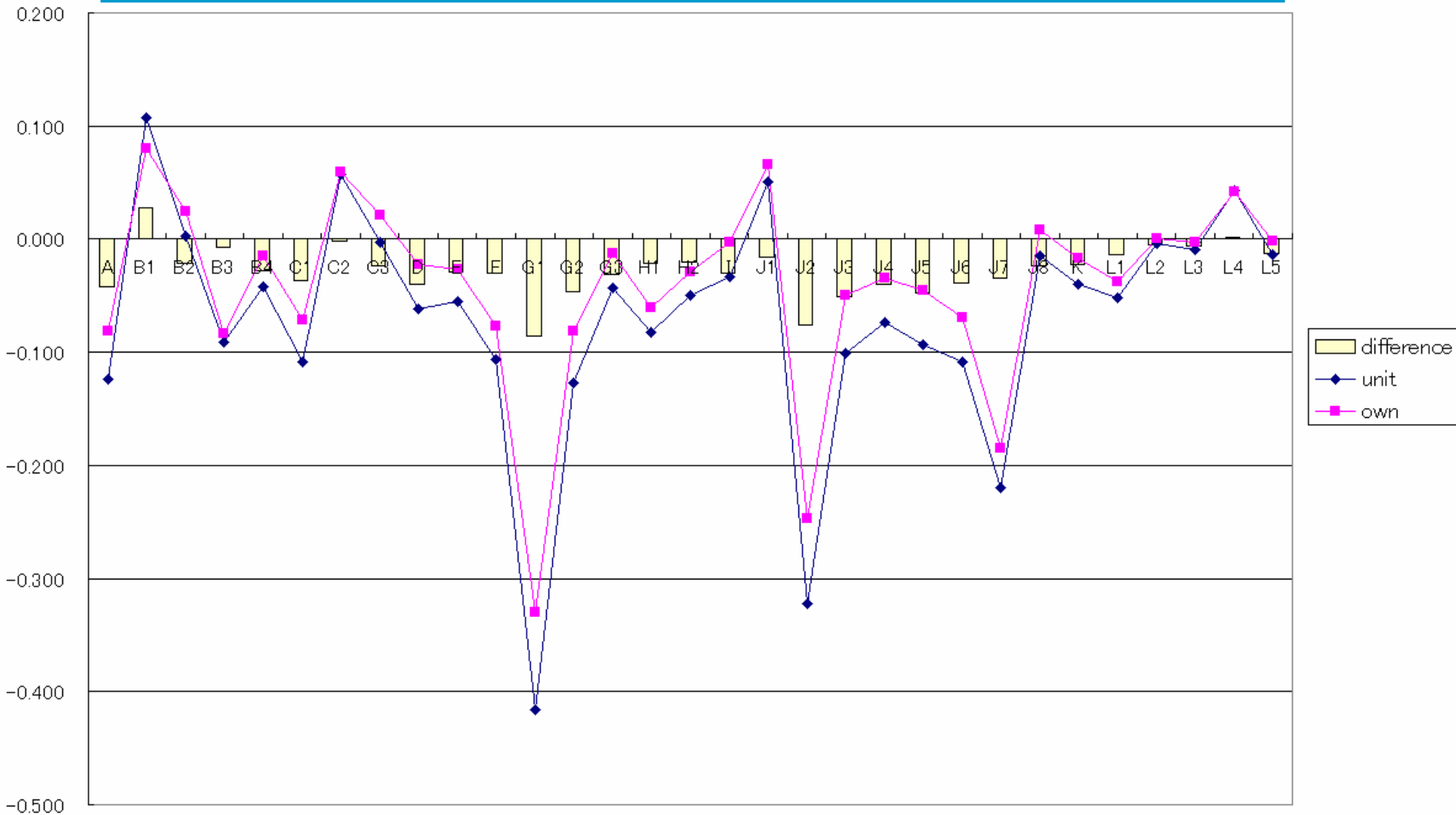
Assessment Map (Block):1995-2004 - Own and Unit Productivity Growth -

quantity			2000-2004					
			1	**2**	**3**	**4**	**5**	**6**
1995-2000	1	unit - own - difference -	G1,J2					
	2	unit + own + difference -	E					
	3	unit - own + difference -						
	4	unit - own - difference +	A,F,G2,H2, J3,J4,J5,J7		J8			
	5	unit + own - difference +						
	6	unit + own + difference +	B3,B4,C1,D ,G3,H1,I,J6, K,L1,L3,L5	B2,C2,J1	C3,I,L2			B1,L4

Assessment Map (Commodity):1995-2004

1:2000-2004

rice	other liquors	household air-conditionar	house rent
potetoes	organic fertilizers	household electric appliance	public administration(local)
vegitables	fiber yarns	magnetic tape & discs	school education(private)
crop for feed	cotton & staple fiber fabrics	electric lights	social education(non-profit)
seeds	bedding	wiring devices	research instituite for natual science(non-profit)
other preserved foodstuffs	other ready-made textile products	electrical equipt.for internal combustion engines	research instituite for social science(non-profit)
dairy cattle farming	petrochemical basic products	passenger motor cars	information service
hogs	petrochemical aromatic products	internal combustion engins	sports facility service
other livestock	leather	repair of ships	theatrical company
agricutural servicer	sheet glass	aircraft	
fish paste	crude steel(converters)	bycycles	
grain milling	crude steel(electric)	camera	
confectionary	steel pipes	other photographic instruments	
beer	other steel products	stationary	
whiskey	turbins	sewage disposal	

6: 1995-2000

Domar Weight

High ⇕ Low

Unit	Own	Difference
1		

Unit	Own	Difference
6		

In order to drive the economy to a state of continuous and sustainable growth by making our country more innovative, we should first focus on putting in place improvement to the measurement of innovation.

1) **Making index for openness and competitiveness in the market：**
   Measure for regulation and deregulation .
   ex/   Construction service: fair competition without collusion.
          Financial service: To open the market internationally and realize the
                benefit of the information and communication technology.

2） **Dissolving the bottleneck in the technology linkage.**
   improving the consistency among data in macro, sector, industry, firm and commodity levels.
   ex/   Small-scale enterprise : To encourage the productivity in small scale   enterprise
          Regional enterprise: To promote regional network of technology linkage

3) **Activating R&D expenditure**

4) **Improving measurement of intangible Asset**
   4－1） Statistics for R&D, software, and property rights
   4－2） Data development with international comparability
   4－3） Collecting qualitative information for organizational and institutional
          structure

5) **Improving measurement of service activities**
   5－1） Quality adjusted output measure of service sectors
   5－2） measuring bland for service