

# Network use and productivity: a look into the black box

OECD ICCP WPIIS-WPIE Workshop, London, May 22, 2007

**Kazuyuki Motohashi**

Department of Technology Management for  
Innovation (TMI) University of Tokyo & RIETI

<http://mo.rcast.u-tokyo.ac.jp/>

# Outline of presentation

1. Macro level comparison: Japan, Korea and United States
2. Stylized facts: IT network use and productivity at firm level (in Japan)
3. How to quantify IT use at firm?
4. METI's IT management index

# Comparative Analysis of Japan and US

## Jorgenson and Motohashi (2005)

$$\bar{w}_{I,n} \Delta \ln I_n + \bar{w}_{I,c} \Delta \ln I_c + \bar{w}_{I,s} \Delta \ln I_s + \bar{w}_{I,t} \Delta \ln I_t + \bar{w}_{c,n} \Delta \ln C_n + \bar{w}_{c,c} \Delta \ln C_c =$$
$$\bar{v}_{K,n} \Delta \ln K_n + \bar{v}_{K,c} \Delta \ln K_c + \bar{v}_{K,s} \Delta \ln K_s + \bar{v}_{K,t} \Delta \ln K_t + \bar{v}_L \Delta \ln L + \Delta \ln A$$

Output: Ic: Investment in computers

Is: Investment in software

It: Investment in communications equipment

Cc: Consumption of IT products

In, Cn: investment and consumption of non-IT

Input: Kc: Capital service flow from computers

Ks: Capital service flow from software

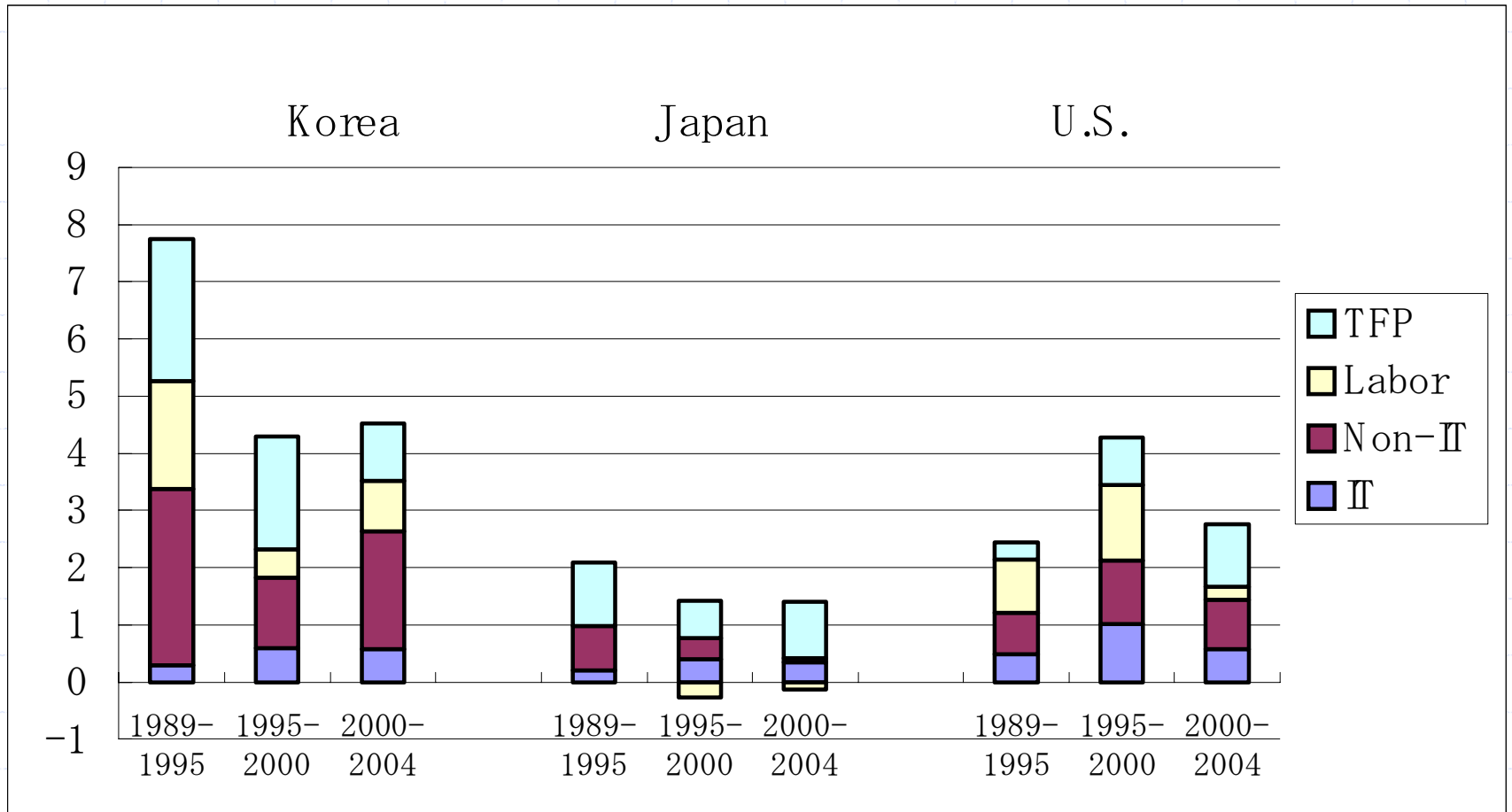
Kt: Capital service flow from communications equipment

Kn: Capital service from non-IT

L: Labor service

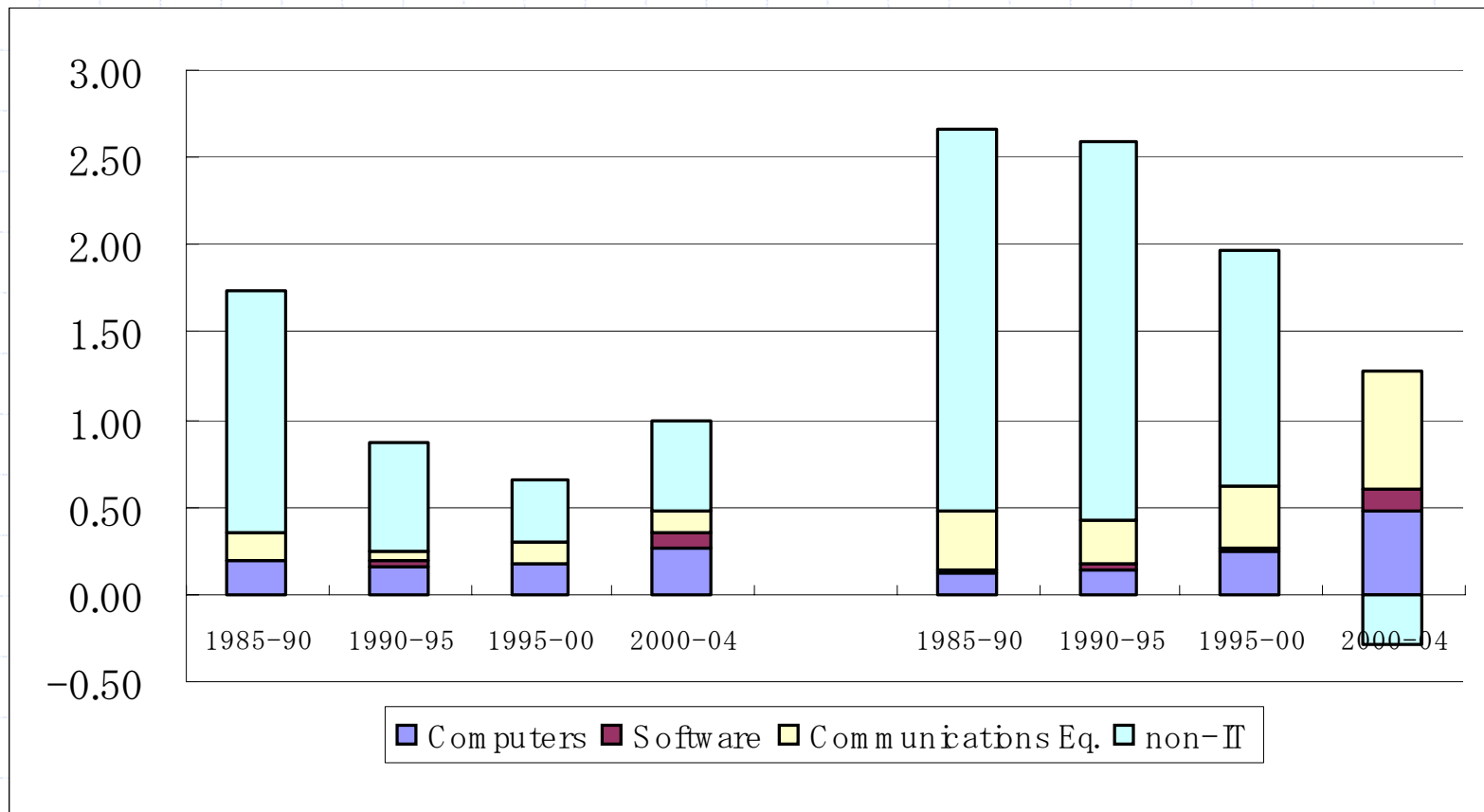
Total Factor Productivity: A

# Comparison: Japan, Korea and US

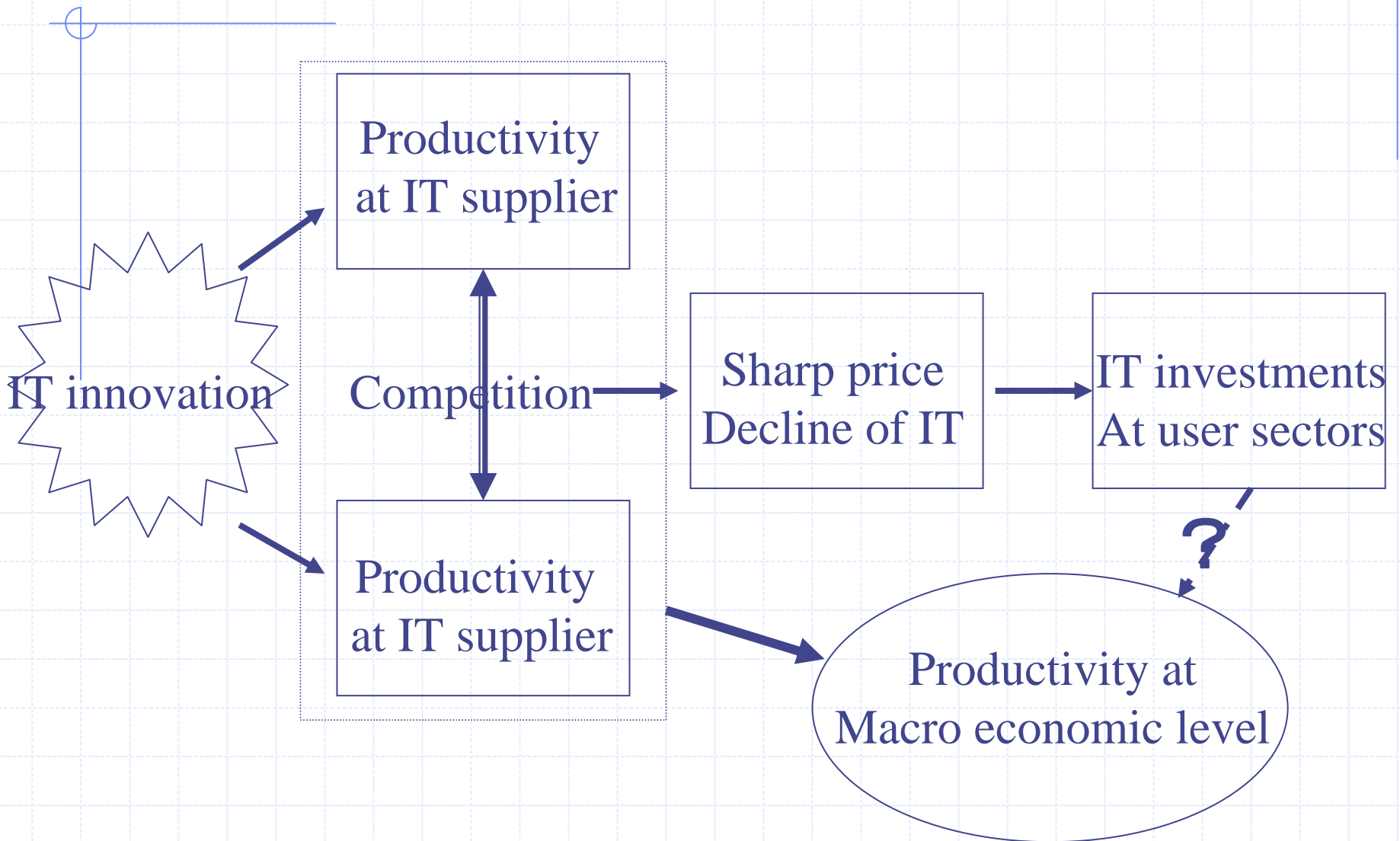


# TFP Decomposition: Japan vs Korea

Kanamori and Motohashi (2006)



# IT and productivity at macro level

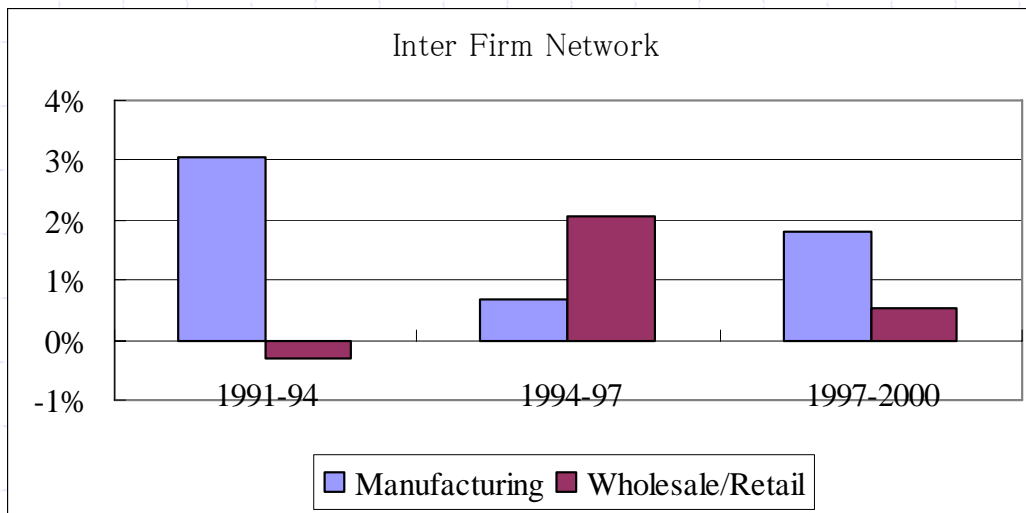
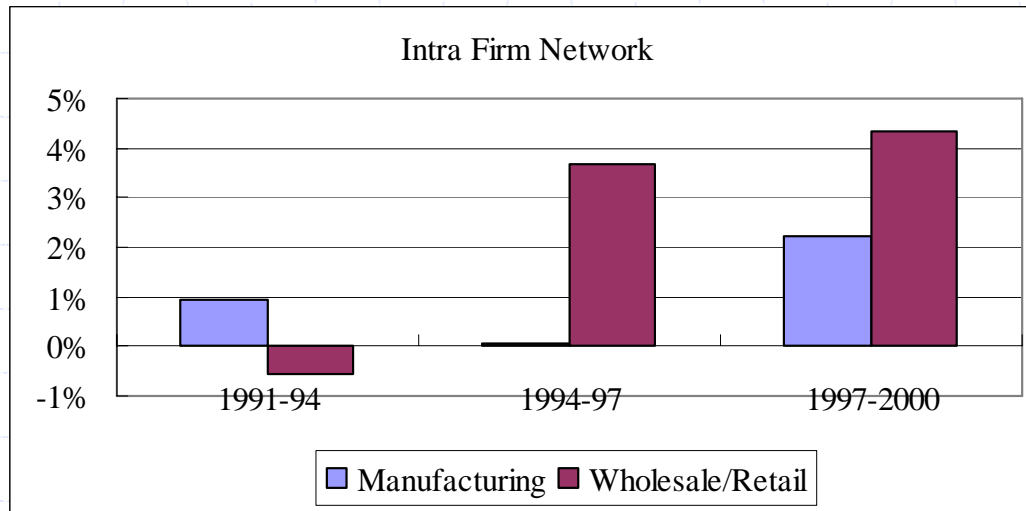


# IT and productivity at firm level

## Motohashi (2007)

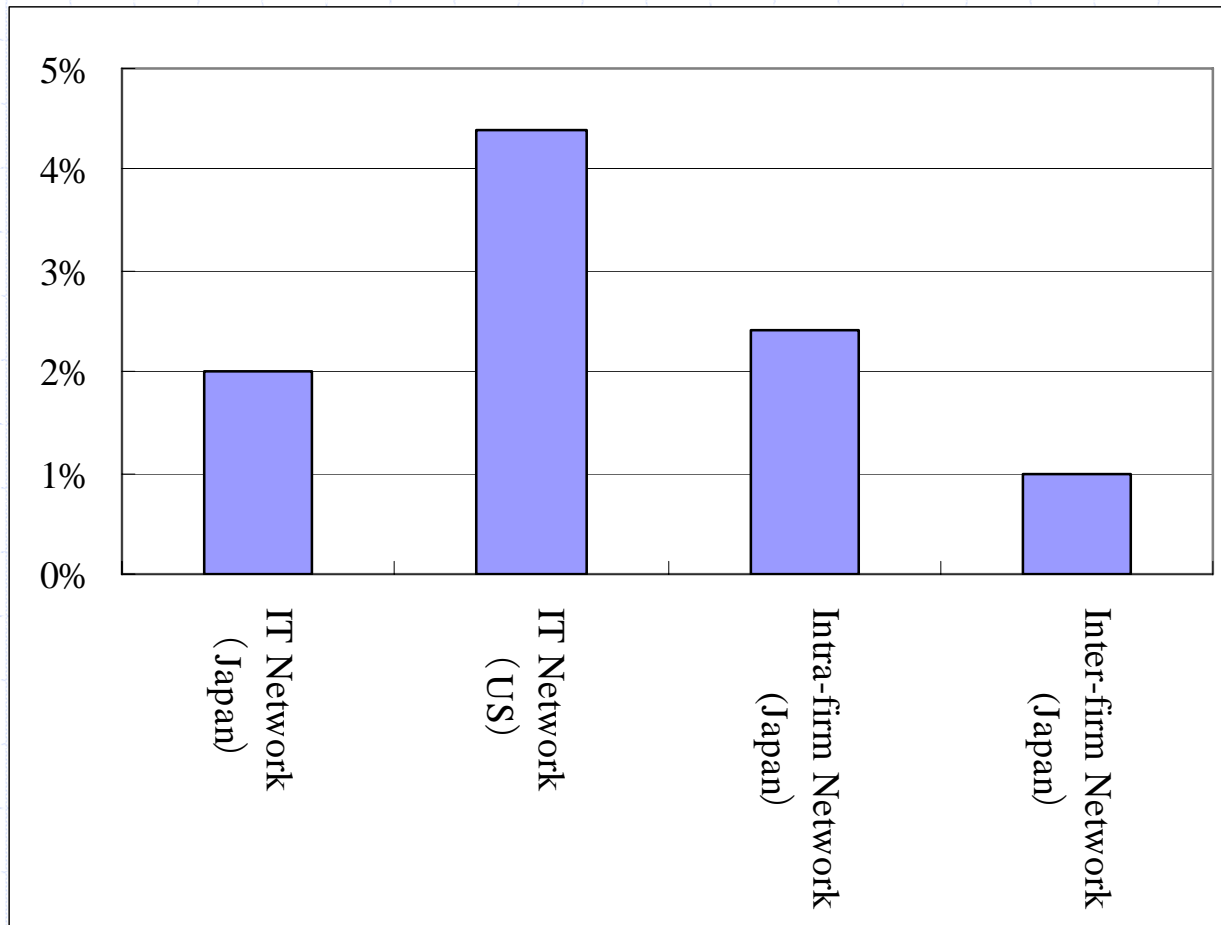
- ◆ Data: BSBSA (all firms with 50 employees and 30 mil yen capital, for manufacturing and wholesale/retail, about 15,000 samples from 91-2000)
- ◆ IT network use (only in 91, 94 and 97, (2000))
  - Intranet, CAD/CAM, CALS, EDI, EC
  - Type of business process
- ◆ Occupation mix: information processing workers
- ◆ Information related expenses (incl. Computer rental fees, but not investment)

# IT network and productivity



# Comparison with US

(Atrostic, Motohashi and Nguyen 2005)



# Needs to look into 'black box of firm' but institutional difference across countries?

## Firm level observation

	A-type	J-Type		Implications for IT use
Cross functional coordination	Inactive	Active	→	Comparative disadvantage in using IT tools
Job description and responsibility	Clear	Unclear	→	Difficulty in business process reengineering
Decision making process	Top-down	Bottom-up	→	Fragmentation of IT system
Knowledge Creation Process	Explicit knowledge	Tacit knowledge	→	Ineffective use of digitalized information

Aoki, Nonaka-Takeuchi, Kagono et. al

## Economic system level observation

- Effective information sharing within firm and bottom-up decision making system for J-firms
- Used to be working in pre-IT revolution era, but what about in IT revolution era? (global competition, innovation speed, increasing business complexity -> needs IT based effective corporate decision making system)

# Examples of statistical analysis

## 1. US Studies

- Bresnahan, Brynjolfsson and Hitt, QJE2001
- IT+HR/Org strategy (flat organization, performance based payment, bottom up business practices such as QC circles)  
→productivity

## 2. Japanese Studies

- Same kind of approach: FRI(1996)、EPA(2001)
- Not only decentralization but also centralization may work: Kanamori and Motohashi (2006)
- Taking into account different business practice and “model of firm” across countries

# Centralization or Decentralization?

(Gurbaxani and Whang, 1991)

## ◆ IT reduces

- Agency cost (monitoring cost) :  
Decentralization

- Decision information cost: Centralization

## ◆ Which factor is relevant?: depending on the type of IT application

# New Dataset: ICTWP Survey

- ◆ Annual Survey by METI from 1960's
- ◆ Detail information on ICT Use by enterprises
  - ICT expenditure by detail category
  - IT human resources
  - Use of network (e-business)
  - Organizational questionnaire in 2000
- ◆ Linked with BSBSA for productivity analysis (about 3,000 samples annually)

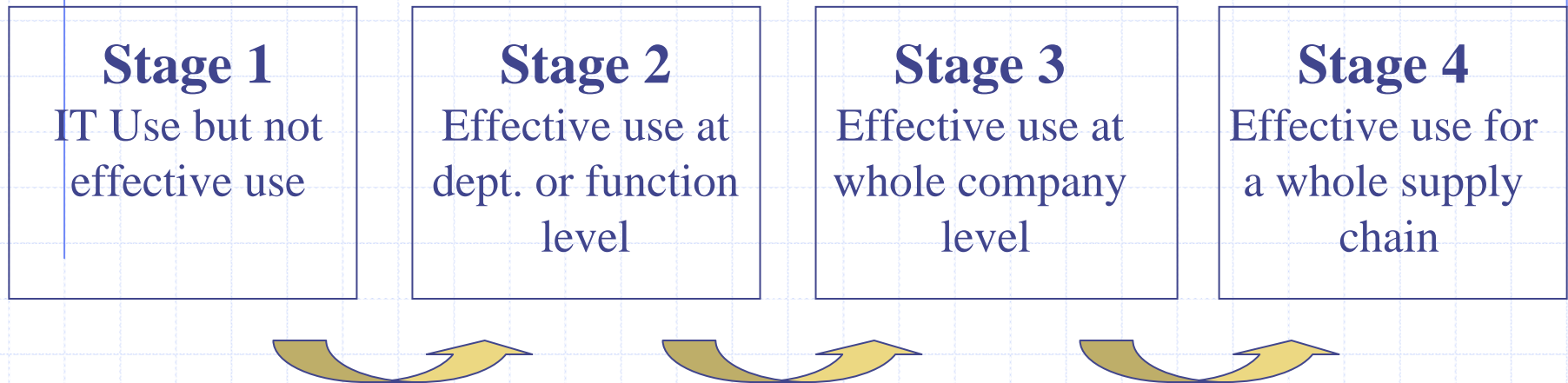
# Results

$$\ln VA_{it} = \alpha \ln K_{it} + \beta \ln L_{it} + \gamma \ln IT_{it} + \delta \ln IT_{it} * DRR_i + \zeta \ln IT_{it} * DRM_i + \mu DRR_i * t + \eta DRM_i * t + \phi * t + u_{it} \quad (1)$$

	Centralization			Decentralization		
	coefficient	std.	t	coefficient	std.	t
$\alpha$ (Capital Elasticity)	0.064***	0.011	5.66	0.066***	0.011	5.78
$\beta$ (Labor Elasticity)	0.445***	0.022	19.85	0.449***	0.022	20.06
$\gamma$ (IT Elasticity)	0.071***	0.007	9.81	0.072***	0.007	9.86
$\delta$ (Radical Change*ln IT)	0.082***	0.029	2.84	0.136***	0.030	4.51
$\zeta$ (Minor Change*ln IT)	0.045**	0.023	1.98	0.024	0.020	1.18
$\mu$ (Radical Change*year)	0.018*	0.011	1.65	0.005	0.011	0.46
$\nu$ (Minor Change*year)	-0.012	0.008	-1.43	-0.003	0.007	-0.45
$\phi$ (year)	0.038***	0.002	15.25	0.038***	0.003	15.15
Number of Firms	2342			2344		
Number of Observations	9368			9376		

# METI's IT Management Index as a broader concept

## Model of IT Utilization Development



- In Japan, most firms are still in Stage 2 (60%-70% by METI Survey)
- TFP Growth rate is higher for higher stage of firms (research project with METI, undergoing)

# How to define the stage?

- ◆ Data are collected through firm level questionnaire
- ◆ Composite indicator using the following items
  - Consistency of IT strategy with an overall corporate strategy
  - Visualization of business processes
  - Type of IT infrastructure
  - IT management system and organization
  - Evaluation of IT investment projects
  - IT skills at employees
  - Investment in security system
- ◆ Self evaluation tool provided at “IT Management Portal” at METI web-site

# Summary and policy implications

- ◆ Some evidence of under-utilization of IT system in Japanese firms
- ◆ Possible factors hampers effective use of IT
  - Organizational inertia for J-type firms
  - Lower IT Utilization development stage (does not support company-wide decision making effectively)
- ◆ Substantial potentiality of productivity growth by effective use of IT: leading to growth potential in graying society and decreasing labor force
- ◆ Support for IT investments to facilitate business practice transformations
- ◆ Important to conduct international comparative studies to extract cross country implications in an era of globalization