Network use and productivity: a look into the black box


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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

Chart showing the comparison of TFP, Labor, Non-IT, and IT from 1989-2004 for Korea, Japan, and the US.
TFP Decomposition: Japan vs Korea
Kanamori and Motohashi (2006)
IT and productivity at macro level

Productivity at IT supplier

Competition

Productivity at IT supplier

Sharp price
Decline of IT

IT investments
At user sectors

Productivity at
Macro economic level

IT innovation
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

Intra Firm Network

<table>
<thead>
<tr>
<th>Year</th>
<th>Manufacturing</th>
<th>Wholesale/Retail</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991-94</td>
<td>-1%</td>
<td>0%</td>
</tr>
<tr>
<td>1994-97</td>
<td>1%</td>
<td>3%</td>
</tr>
<tr>
<td>1997-2000</td>
<td>2%</td>
<td>4%</td>
</tr>
</tbody>
</table>

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</table>
Comparison with US
(Atrostic, Motohashi and Nguyen 2005)
Needs to look into ‘black box of firm’ but institutional difference across countries?

### Firm level observation

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

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

\[
\ln V_A_{it} = \alpha \ln K_{it} + \beta \ln L_{it} + \gamma \ln IT_{it} + \delta \ln IT_{it} \times DRR_i + \zeta \ln IT_{it} \times DRM_i + \mu DRR_i \times t + \eta DRM_i \times t + \phi \times t + u_{it}
\]  

(1)

<table>
<thead>
<tr>
<th></th>
<th>Centralization</th>
<th></th>
<th>Decentralization</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>coefficient</td>
<td>std.</td>
<td>t</td>
<td>coefficient</td>
</tr>
<tr>
<td>( \alpha ) (Capital Elasticity)</td>
<td>0.064***</td>
<td>0.011</td>
<td>5.66</td>
<td>0.066***</td>
</tr>
<tr>
<td>( \beta ) (Labor Elasticity)</td>
<td>0.445***</td>
<td>0.022</td>
<td>19.85</td>
<td>0.449***</td>
</tr>
<tr>
<td>( \gamma ) (IT Elasticity)</td>
<td>0.071***</td>
<td>0.007</td>
<td>9.81</td>
<td>0.072***</td>
</tr>
<tr>
<td>( \delta ) (Radical Change*ln IT)</td>
<td>0.082***</td>
<td>0.029</td>
<td>2.84</td>
<td>0.136***</td>
</tr>
<tr>
<td>( \zeta ) (Minor Change*ln IT)</td>
<td>0.045**</td>
<td>0.023</td>
<td>1.98</td>
<td>0.024</td>
</tr>
<tr>
<td>( \mu ) (Radical Change*year)</td>
<td>0.018*</td>
<td>0.011</td>
<td>1.65</td>
<td>0.005</td>
</tr>
<tr>
<td>( \nu ) (Minor Change*year)</td>
<td>-0.012</td>
<td>0.008</td>
<td>-1.43</td>
<td>-0.003</td>
</tr>
<tr>
<td>( \phi ) (year)</td>
<td>0.038***</td>
<td>0.002</td>
<td>15.25</td>
<td>0.038***</td>
</tr>
<tr>
<td>Number of Firms</td>
<td>2342</td>
<td></td>
<td></td>
<td>2344</td>
</tr>
<tr>
<td>Number of Observations</td>
<td>9368</td>
<td></td>
<td></td>
<td>9376</td>
</tr>
</tbody>
</table>
METI’s IT Management Index as a broader concept

Model of IT Utilization Development

Stage 1
IT Use but not effective use

Stage 2
Effective use at dept. or function level

Stage 3
Effective use at whole company level

Stage 4
Effective use for a whole supply chain

- 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