Data Structure and Productivity Estimates of Korea Productivity Database

Workshop on Productivity Database in China, Japan, and Korea
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I. Introduction

• Data structure for
  – Capital
  – Labor
  – Output & intermediate input (E,M,S)

• Changes in the pattern of sectoral growth after the 1997 crisis

• Growth Accounting
II. Labor Input

Source data

• Persons engaged
  - Economically Active Population Survey (NSO): 1970(6 sectors), 2004(20 sectors)
• Working hours
  - Survey Report on Wage Structure (MOL)
  - Report on Monthly Labor Survey (MOL)
    : 1970(17 sectors), 2004(57 sectors)

• Wage
  - Survey Report on Wage Structure (MOL)

• Labor Compensation
  - National Accounts (B.O.K)
Classification of Labor (18 types)

- Gender: (1) male, (2) Female
- Age: (1) below 30, (2) 30-49, (3) above 50
- Skill (Education):
  - (1) Low-skilled (middle school under)
  - (2) Middle-skilled (high school)
  - (3) High-skilled (above college)
III. Gross Output, Value Added, and Intermediate Inputs (E,M,S)

• Compare old vs. EUKLEMS method
• Reaming issues: E,M,S
• Real value added
Previous Approach

• Using U & V tables to get GO, VA, II, and II (E,M,S)

Sources

• National Accounts
  – Nominal GO, VA, II (1970-2005, 21 industries)

• Use table

• Make table
Following EUKLEMS Method

Two Step Method

• First step: Use detailed BOK (internal) NA data to get GO, VA, II for 72 industries

• Second step: Use U & V tables to divide II into E,M,S
Two Step Method

• First step: Use detailed BOK NA data to get GO, VA, II for 72 industries
  – Use BOK internal data: Nominal and real GO (1970-2005, 397 industries)

• Second step: Use U & V tables to divide II into E, M, S
Other Issues: E, M, S

• Inconsistency between (GO, VA, II) and (E, M, S)
Other Issues: Real Value-Added

• Double deflation (DD) method
  – Real value added using Laspeyres DD
  – DD for most industries except finance, insurance, real estate, and public administration (53-57, 63)

• Tornqvist vs. Laspeyres index
IV. Changes in the Sectoral Contribution to Output Growth: Focusing on the Service Sector

- Before and After the 1997 financial crisis
- After the crisis, resurgence in the manufacturing sector’s output growth, but no resurgence in service sector’s output
- Overall output growth rate declined.
Changes in Sectoral Contribution to Output Growth (Gross Output)

Growth Rate of Gross Output

- 1971-1990
- 1991-1996
- 2000-2005

Domar Weight

- 1971-1990
- 1991-1996
- 2000-2005

Sectoral Contribution to Aggregate Gross Output Growth (Domar weighted)

- All Sectors
- Manufacturing
- Services

1971-1990
1991-1996
2000-2005
Changes in Sectoral Contribution to Output Growth (Value-Added)

Growth Rate of Value Added

Share of Value Added

Sectoral Contribution to Aggregate Value Added Growth (Value-added share weighted)

- All Sectors
- Manufacturing
- Services

• Changes in the pattern of value-added growth rates

• Changes in the contribution to value added growth (including within sector share effects)
  – Resurgence across most MFG industries?
  – Decline across most Non-MFG industries?

- Other electrical machinery and apparatus nec
- Rubber and plastics products
- Tobacco products
- Radio and television receivers
- Other electrical machinery and apparatus nec
- Scientific instruments
- Fabricated metal products
- Electronic valves and tubes
- Textiles
- Wood and products of wood and cork
- Other non-metallic mineral products
- Food products and beverages
- Publishing
- Leather, leather products and footwear
- Machinery, nec
- Chemicals excluding pharmaceuticals
- Basic metals
- Building and repairing of ships and boats
- Motor vehicles, trailers and semi-trailers
- Coke, refined petroleum products and nuclear fuel
- Printing and reproduction
- Pulp, paper and paper products
- Insulated wire
- Manufacturing nec
- Railroad equipment and transport equipment nec
- Office, accounting and computing machinery

(B) - (A)
- 2000–2005 (B)
- 1991–1996 (A)

- Electronic valves and tubes
- Wearing Apparel
- Radio and television receivers
- Aircraft and spacecraft
- Pharmaceuticals
- Textiles
- Rubber and plastics products
- Leather, leather products and footwear
- Other electrical machinery and apparatus nec
- Tobacco products
- Scientific instruments
- Building and repairing of ships and boats
- Fabricated metal products
- Wood and products of wood and cork
- Manufacturing nec
- Railroad equipment and transport equipment nec
- Publishing
- Printing and reproduction
- Insulated wire
- Office, accounting and computing machinery
- Other non-metallic mineral products
- Food products and beverages
- Pulp, paper and paper products
- Machinery, nec
- Coke, refined petroleum products and nuclear
- Chemicals excluding pharmaceuticals
- Motor vehicles, trailers and semi-trailers
- Basic metals
- (B) - (A)
- 2000–2005 (B)
- 1991–1996 (A)
Changes in Value Added Growth Rate in the Service Sector:

- Supporting and auxiliary transport activities
- Wholesale trade and commission trade
- Inland transport
- Health and social work
- Water supply
- Activities of membership organizations nec
- Activities related to financial intermediation
- Public admin and defense; compulsory social security
- Electricity supply
- Air transport
- Research and development
- Legal, technical and advertising
- Education
- Other business activities, nec
- Imputation of owner occupied rents
- Hotels and restaurants
- Other real estate activities
- Post and telecommunications
- Sewage and refuse disposal, sanitation and similar activities
- Other recreational activities
- Construction
- Media activities
- Other service activities
- Financial intermediation, except insurance and pension funding
- Sale, maintenance and repair of motor vehicles and motorcycles
- Private households with employed persons
- Computer and related activities
- Gas supply
- Renting of machinery and equipment
- Retail trade
- Insurance and pension funding, except compulsory social security
- Water transport

- Wholesale trade and commission trade
- Supporting and auxiliary transport activities
- Post and telecommunications
- Health and social work
- Gas supply
- Inland transport
- Other business activities, nec
- Water supply
- Activities of membership organizations nec
- Computer and related activities
- Activities related to financial intermediation
- Media activities
- Sewage and refuse disposal, sanitation and similar activities
- Private households with employed persons
- Air transport
- Research and development
- Electricity supply
- Sale, maintenance and repair of motor vehicles and motorcycles
- Other recreational activities
- Other real estate activities
- Legal, technical and advertising
- Other service activities
- Education
- Public admin and defense; compulsory social security
- Imputation of owner occupied rents
- Hotels and restaurants
- Water transport
- Renting of machinery and equipment
- Financial intermediation, except insurance and pension funding
- Insurance and pension funding, except compulsory social security
- Construction
- Retail trade
- Transportation and storage
- Other service activities

(Δ) - (A)

2000–2005 (B)

1991–1996 (A)
Searching for Underlying Causes of Lower Growth in the Service Sector through Growth Accounting

<table>
<thead>
<tr>
<th></th>
<th>Output</th>
<th>Capital</th>
<th>Labor</th>
<th>Energy</th>
<th>Materials</th>
<th>Service</th>
<th>MFP</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) 1991-1996</td>
<td>0.084</td>
<td>0.034</td>
<td>0.019</td>
<td>0.004</td>
<td>0.014</td>
<td>0.025</td>
<td>-0.013</td>
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<tr>
<td>(B) 2000-2004*</td>
<td>0.052</td>
<td>0.018</td>
<td>0.013</td>
<td>0.003</td>
<td>0.009</td>
<td>0.017</td>
<td>-0.009</td>
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<tr>
<td>(B)-(A)</td>
<td>-0.032</td>
<td>-0.016</td>
<td>-0.006</td>
<td>-0.001</td>
<td>-0.006</td>
<td>-0.008</td>
<td>0.004</td>
</tr>
</tbody>
</table>

Contribution to (B-A) (%)

- 100.0%        48.7%   18.5%   2.0%   18.3%   25.1%   -12.6%
Input vs. Productivity Growth

Growth Accounting results suggest that decline in output growth in the service sector is

- Mainly because of declines in input growth
- Not because of changes in productivity growth
Preliminary Answers for Decline in Input Growth

- Lower demand for services by firms and/or households (Demand)
- Regulation → Lower entry

To answer the above, need to look at more detailed industries

The following two factors related to both input and TFP growth
- Low investment in IT
- Mismatched skills
V. Growth Accounting

• Gross output accounting and TFP growth: Manufacturing versus. Services
• Cumulative contribution of sectors to TFP growth
• Relations labor productivity, gross output and TFP growth
# 1. Gross Output Growth Accounting and TFP Growth

## Table 1. Gross Output Growth Accounting and TFP Growth in Manufacturing

<table>
<thead>
<tr>
<th>Period</th>
<th>Gross Output</th>
<th>Capital input</th>
<th>Total input</th>
<th>Quantity input</th>
<th>Quality input</th>
<th>Energy Input</th>
<th>Material Input</th>
<th>Service Input</th>
<th>TFP</th>
</tr>
</thead>
<tbody>
<tr>
<td>71-'79</td>
<td>15.14</td>
<td>1.42</td>
<td>1.11</td>
<td>0.94</td>
<td>0.16</td>
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<td>80-'89</td>
<td>10.27</td>
<td>1.29</td>
<td>0.54</td>
<td>0.39</td>
<td>0.14</td>
<td>1.03</td>
<td>6.44</td>
<td>0.64</td>
<td>0.34</td>
</tr>
<tr>
<td>90-'99</td>
<td>7.02</td>
<td>1.00</td>
<td>-0.12</td>
<td>-0.37</td>
<td>0.25</td>
<td>0.76</td>
<td>3.35</td>
<td>1.07</td>
<td>0.97</td>
</tr>
<tr>
<td>00-'04</td>
<td>8.16</td>
<td>0.53</td>
<td>0.32</td>
<td>0.21</td>
<td>0.11</td>
<td>0.40</td>
<td>4.66</td>
<td>1.12</td>
<td>1.15</td>
</tr>
<tr>
<td>90-'98</td>
<td>5.65</td>
<td>1.08</td>
<td>-0.18</td>
<td>-0.46</td>
<td>0.28</td>
<td>0.70</td>
<td>2.49</td>
<td>0.93</td>
<td>0.64</td>
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<tr>
<td>99-'04</td>
<td>10.03</td>
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<td>0.33</td>
<td>0.24</td>
<td>0.09</td>
<td>0.54</td>
<td>5.73</td>
<td>1.32</td>
<td>1.62</td>
</tr>
<tr>
<td>71-'04</td>
<td>10.29</td>
<td>1.13</td>
<td>0.46</td>
<td>0.29</td>
<td>0.18</td>
<td>1.11</td>
<td>5.89</td>
<td>0.92</td>
<td>0.79</td>
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</tbody>
</table>

**Contribution to output growth**

<table>
<thead>
<tr>
<th>Period</th>
<th>Contribution</th>
<th>Capital</th>
<th>Total</th>
<th>Material</th>
<th>Service</th>
<th>TFP</th>
</tr>
</thead>
<tbody>
<tr>
<td>71-'79</td>
<td>100.0</td>
<td>9.4</td>
<td>7.3</td>
<td>13.2</td>
<td>6.2</td>
<td>5.9</td>
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<tr>
<td>80-'89</td>
<td>100.0</td>
<td>12.5</td>
<td>5.2</td>
<td>10.1</td>
<td>6.2</td>
<td>3.3</td>
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<td>90-'99</td>
<td>100.0</td>
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<td>-1.7</td>
<td>10.8</td>
<td>15.2</td>
<td>13.8</td>
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<tr>
<td>00-'04</td>
<td>100.0</td>
<td>6.5</td>
<td>3.9</td>
<td>4.8</td>
<td>13.7</td>
<td>14.0</td>
</tr>
<tr>
<td>90-'98</td>
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<td>19.1</td>
<td>-3.1</td>
<td>12.3</td>
<td>16.4</td>
<td>11.3</td>
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<tr>
<td>99-'04</td>
<td>100.0</td>
<td>4.8</td>
<td>3.3</td>
<td>5.4</td>
<td>13.2</td>
<td>16.2</td>
</tr>
<tr>
<td>71-'04</td>
<td>100.0</td>
<td>10.9</td>
<td>4.5</td>
<td>10.8</td>
<td>8.9</td>
<td>7.7</td>
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</table>
Table 2. Gross Output Growth Accounting and TFP growth in Service

<table>
<thead>
<tr>
<th>Period</th>
<th>Gross Output</th>
<th>Capital input</th>
<th>Labor input</th>
<th>Energy Input</th>
<th>Material input</th>
<th>Service Input</th>
<th>TFP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Total labor</td>
<td>Quantity labor</td>
<td>Quality labor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>71-'79</td>
<td>7.98</td>
<td>2.39</td>
<td>1.89</td>
<td>1.48</td>
<td>0.41</td>
<td>0.73</td>
<td>2.65</td>
</tr>
<tr>
<td>80-'89</td>
<td>7.92</td>
<td>3.38</td>
<td>1.20</td>
<td>1.10</td>
<td>0.09</td>
<td>0.44</td>
<td>2.31</td>
</tr>
<tr>
<td>90-'99</td>
<td>6.66</td>
<td>3.18</td>
<td>1.46</td>
<td>1.17</td>
<td>0.29</td>
<td>0.17</td>
<td>0.84</td>
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<tr>
<td>00-'04</td>
<td>5.17</td>
<td>1.85</td>
<td>1.35</td>
<td>1.00</td>
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<td>0.29</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>90-'98</td>
<td>6.74</td>
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<td>0.82</td>
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<td>0.28</td>
<td>0.31</td>
<td>0.88</td>
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<tr>
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<td>7.16</td>
<td>2.83</td>
<td>1.48</td>
<td>1.21</td>
<td>0.27</td>
<td>0.42</td>
<td>1.75</td>
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</table>

Contribution to output growth

<table>
<thead>
<tr>
<th>Period</th>
<th>Gross Output</th>
<th>Capital input</th>
<th>Labor input</th>
<th>Energy Input</th>
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<th>Service Input</th>
<th>TFP</th>
</tr>
</thead>
<tbody>
<tr>
<td>71-'79</td>
<td>100.0</td>
<td>29.9</td>
<td>23.7</td>
<td>18.5</td>
<td>5.1</td>
<td>9.1</td>
<td>33.2</td>
</tr>
<tr>
<td>80-'89</td>
<td>100.0</td>
<td>42.7</td>
<td>15.1</td>
<td>13.9</td>
<td>1.2</td>
<td>5.5</td>
<td>29.2</td>
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<tr>
<td>90-'99</td>
<td>100.0</td>
<td>47.7</td>
<td>22.0</td>
<td>17.6</td>
<td>4.3</td>
<td>2.6</td>
<td>12.6</td>
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<tr>
<td>00-'04</td>
<td>100.0</td>
<td>35.8</td>
<td>26.0</td>
<td>19.2</td>
<td>6.8</td>
<td>5.5</td>
<td>16.6</td>
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<tr>
<td>90-'98</td>
<td>100.0</td>
<td>48.8</td>
<td>23.8</td>
<td>18.9</td>
<td>4.9</td>
<td>2.1</td>
<td>12.2</td>
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<tr>
<td>99-'04</td>
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<td>21.8</td>
<td>16.6</td>
<td>5.2</td>
<td>5.9</td>
<td>16.6</td>
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<tr>
<td>71-'04</td>
<td>100.0</td>
<td>39.5</td>
<td>20.7</td>
<td>16.9</td>
<td>3.8</td>
<td>5.8</td>
<td>24.5</td>
</tr>
</tbody>
</table>
2. Cumulative Contribution of Sectors to TFP growth

- The weight of gross output of the sectors with positive economy-wide TFP growth is about 57%.
- The weight with negative TFP growth is about 43% during the entire period of 1971-2004.
Figure 1. Cumulative contribution of sectors to TFP growth in economy-wide (1971-2004)
3. Relations between Labor Productivity, Gross output and TFP Growth

Figure 2. Plotting between Sectoral Labor Productivity Growth and TFP Growth (1971-2004, %)
Figure 3 Plotting between Sectoral Gross output Growth and TFP Growth (1971-2004, %)
• A visual inspection
  - TFP growth is positively correlated with both labor productivity growth and output growth and TFP-LP relation is stronger than TFP–Output relation.
• Following by two simple regression results, we are adopting implicit hypotheses that higher LP and output growth induces TFP growth through enhanced human capital and economies of scale.

\[
\log \left( \frac{\text{TFP}_t}{\text{TFP}_{t-1}} \right) = \alpha + \beta \log \left( \frac{\text{LP}_t}{\text{LP}_{t-1}} \right) + \gamma
\]

<table>
<thead>
<tr>
<th>Dependent var.</th>
<th>( \beta )</th>
<th>S.E</th>
<th>DW</th>
<th>adjR(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TFP Growth rate</td>
<td>0.345***</td>
<td>0.034</td>
<td>1.711</td>
<td>0.677</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dependent var.</th>
<th>( \beta )</th>
<th>S.E</th>
<th>DW</th>
<th>adjR(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TFP Growth rate</td>
<td>0.326***</td>
<td>0.060</td>
<td>1.473</td>
<td>0.301</td>
</tr>
</tbody>
</table>

***: Pr\(>t\) is 1%, **:Pr\(>t\) is 5%, *:Pr\(>t\) is 10%
• The linear rank statistics reject the null hypotheses that TFP growth is stochastically independent of LP growth and that TFP growth is stochastically independent of output growth at the 1 % significance level.

• Table 3 Test Statistics for Testing the Stochastic Independence

\[ r_s(TFP - LP) = 0.8864 \]
\[ r_s(TFP - GO) = 0.6150 \]

\[ H_0 : \rho = 0 \quad \quad H_1 : \rho \neq 0 \]

\[ Pr_{H_0}(r_s) \geq r_s(n; \alpha) = \alpha \]

\[ \frac{r - E_{H_0}(r_s)}{\sqrt{Var_{H_0}(r_s)}} = r_s \sqrt{n - 1} \rightarrow N(0,1) \]

\[ Z(TFP - LP) = 0.8864 \times \sqrt{(49 - 1)} = 6.141 \]
\[ Z(TFP - GO) = 0.6150 \times \sqrt{(49 - 1)} = 4.261 \]
4. Results

• TFP growth (1971-2004)
  – Economy-wide : -0.52 %,
  – Manufacturing: 0.79%
  – Service: -1.07 %

• Leading sectors
  – Manufacturing: Chemical and Basic Metals
  – Service: Financial Intermediation, Post and Telecommunications
• TFP growth is positively correlated with both LP and Output

  – TFP-LP relation is stronger than TFP-Output relation
  – An implicit hypotheses: Higher LP and output growth induces TFP growth through enhanced human capital and economies of scale.