Offshoring, Terms of Trade and the Measurement of U.S. Productivity Growth

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Based on: “Offshoring Bias in U.S. Manufacturing: Implications for Productivity and Value Added” (w/ Susan Houseman, Christopher J. Kurz, and Paul Lengermann).

“Effects of Terms of Trade Gains and Tariff Changes on the Measurement of U.S. Productivity Growth” (w/ Robert C. Feenstra, Marshall B. Reinsdorf and Matthew J. Slaughter), and

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The Role of Economic Research at the Federal Reserve

1. Policy relevance

2. Expertise in a part of the U.S. or global economy

3. Credibility of monetary policy
I. Motivation:

1. Acceleration in U.S. productivity growth after 1995, simultaneous with a major improvement in the U.S. terms of trade
2. This productivity acceleration was particularly pronounced in the manufacturing sector.
These contrasting trends are reconciled through the lens of productivity. Labor productivity for manufacturing rose avg. annual rate 4.1 % compared to 2.7% all nonfarm business, 1997-2007.
3. But in suggesting a link between the terms of trade and productivity, we need to recognize that in theory, improvement the terms of trade do not have a first-order impact on value added or productivity when tariffs are small (e.g., Kehoe and Ruhl, 2007)

- Intuition: terms of trade affect both real output and real inputs in an offsetting manner, thus terms of trade effects do not have a large impact on real value added.

4. We illustrate the terms of trade – productivity link in two ways:

- In theory, real value added measures are affected by trade prices in the presence of ad valorem tariffs. We will extend Kehoe-Ruhl to a multi-sector setting and show this result.

- What about if the terms of trade are mismeasured due to index number issues?
5. In that case, we will argue that the mismeasurement in the terms of trade spills over into productivity growth. If the improvement in the terms of trade is *understated*, then productivity is *overstated*. 

![Diagram of economic relations]
That is suggested by e.g. Michael Mandel, “The Real Cost of Offshoring.” *Business Week*, June 18, 2007.
6. Indeed, part of the reason that manufacturing employment is declining is the substitution of foreign-made inputs for those previously produced domestically.
7. One might expect that these large increases in foreign input shares corresponded to decreases in the relative price of imported intermediates, but official statistics actually indicate the opposite.
8. We address this issue by:

- Identifying a bias to measured input price indexes from offshoring analogous to outlet substitution bias in CPI literature. Price indexes generally fail to capture price drops associated w/entry & market share expansion of low-cost supplier.

- Correcting for the bias using in input prices using a formula-based adjustment due to Diewert & Nakamura (2010) and estimating its quantitative importance in a growth accounting decomposition of manufacturing MFP.
Conclusions:

- The growth rates of our alternative materials input price indexes are as much as 1 ppt. per year lower than the growth rate of official statistics.
- This mismeasurement can account for about 0.3 ppt. per year, or about 15% of the annual value added growth for the U.S. manufacturing sector over the past decade.

Broader Implications

  - “Lean and productive” vs. “hollowed out”
- International trade is more important in driving the U.S. economy than official statistics suggest.
- Measurement errors in import prices are themselves a byproduct of globalization.
• Illustration of ‘offshoring bias’: The matched model index computes price changes for the same item in two adjacent periods. Since t-1 is unobserved from the perspective of IPP, the entering item is not included in (‘linked out of’) the index in its initial period.

• The level difference between exiting items in the PPI and entering items in the IPP is not observed.
Example of ‘offshoring bias’:

<table>
<thead>
<tr>
<th>Hypothetical Offshoring of Obtanium</th>
<th>t</th>
<th>t+1</th>
<th>t+2</th>
<th>t+3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic supplier price</td>
<td>$10.00</td>
<td>$10.00</td>
<td>$10.00</td>
<td>$10.00</td>
</tr>
<tr>
<td>Domestic quantity sold</td>
<td>100</td>
<td>90</td>
<td>80</td>
<td>70</td>
</tr>
<tr>
<td>Chinese supplier price</td>
<td>$6.00</td>
<td>$6.00</td>
<td>$6.00</td>
<td>$6.00</td>
</tr>
<tr>
<td>Chinese quantity sold</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>Average price paid for obtanium</td>
<td>$10.00</td>
<td>$9.60</td>
<td>$9.20</td>
<td>$8.80</td>
</tr>
<tr>
<td>Domestic input price index</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Import input price index</td>
<td>—</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Input index, as computed</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>True input price index</td>
<td>100</td>
<td>96</td>
<td>92</td>
<td>88</td>
</tr>
</tbody>
</table>
• Bias to input price index at elemental level from shifts in sourcing (Diewert and Nakamura, 2009):

\[ Bias \approx (1 + i) \times s \times d \]

Where \( i \) is the rate of price increase, \( s \) is share captured by new, low-cost supplier, and \( d \) is percent discount of the low-cost supplier (foreign) relative to the high-cost (domestic) supplier.

• Characterization of bias to input price from offshoring identical to that of bias to CPI from outlet substitution (Diewert 1998)
• Evidence of shifting shares (s):
• Evidence of the offshoring discount (d):
  o **Method 1 - Full Sample IPP Microdata:**
    ▪ The import price discount for an individual item in the developing set is defined as:
      \[
      \ln(1 + d(1)_{ituj}^{CED}) = \ln p_{ituj}^{CED} - \sum_{i} \sum_{u} \sum_{i} w_{ijt} \cdot \ln p_{ituj}^{CEA}
      \]
    ▪ Discount aggregated further using IPP item- and establishment-level weights.
Evidence of the offshoring discount (d), cont’d:

- **Method 2 - Switching Sample:**
  - A closer empirical counterpart to the decision of U.S. producers to offshore is the decision of U.S. importing firms to switch among foreign source countries
  - Controls for cross-firm variation in import composition

<table>
<thead>
<tr>
<th>1993-2007</th>
<th>INCUMBENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Developing</td>
</tr>
<tr>
<td>Developing</td>
<td>3%</td>
</tr>
<tr>
<td>N</td>
<td>391</td>
</tr>
<tr>
<td>Intermediate</td>
<td>18%</td>
</tr>
<tr>
<td>N</td>
<td>192</td>
</tr>
<tr>
<td>Advanced</td>
<td>43%</td>
</tr>
<tr>
<td>N</td>
<td>163</td>
</tr>
</tbody>
</table>
Evidence of the offshoring discount ($d$), cont’d:

- **Method 3 - Full Sample: Adjusted Estimates**
  - Estimate degree of unobserved compositional differences driving relative prices
  - Products with a high correlation of price skewness and firm size skewness are classified as high quality scope industries (Mandel, 2010)
  - Intuition:
    \[
    \text{var}_j(\ln q_i) \approx \text{var}_j(\ln p_i) - \text{var}_j(\ln z_i)
    \]
  - Implementation:
    \[
    |d(1)_{kjt}| = \alpha_0 + \alpha_1 \times \text{var}_j(\ln z_i) + \alpha_2 \times \text{var}_j(\ln z_i)^2 + \varepsilon_{kjt}
    \]
Evidence of the offshoring discount (d), cont’d:

- **Unadjusted Full Sample**
  - 63% for developing
  - 58% for intermediate

- **Switching Estimates**
  - 44% for developing
  - 28% for intermediate

- **Adjusted Full Sample**
  - 25% for developing
  - 14% for intermediate

Industry case studies:

<table>
<thead>
<tr>
<th>Country</th>
<th>Industry/product</th>
<th>Discount off U.S.</th>
<th>Source</th>
<th>NAICS</th>
<th>Unadjusted</th>
<th>Firm-Level</th>
<th>Quality-Adjusted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Semiconductors</td>
<td>40</td>
<td>Byrne, Kovak, and Michaels (2009)</td>
<td>3344: Semiconductor and Other Electronic Components</td>
<td>82</td>
<td>54</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>General Manufactured Products</td>
<td>30-50, sometimes higher</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mexico</td>
<td>Aluminum Wheels</td>
<td>19 (36% on processing costs)</td>
<td>Klier and Rubenstein (2009)</td>
<td>3361: Motor Vehicle Manufacturing</td>
<td>34</td>
<td>26</td>
<td>-60</td>
</tr>
<tr>
<td>Singapore</td>
<td>Semiconductors</td>
<td>24</td>
<td>Byrne, Kovak, and Michaels (2009)</td>
<td>334: Semiconductor and Other Electronic Components</td>
<td>72</td>
<td>40</td>
<td>34</td>
</tr>
</tbody>
</table>