Accounting for Intermediates: Production Sharing and Trade in Value Added

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June 9, 2011
World Bank Workshop on Value Added Trade
Value Added to Export (VAX) Ratio

1. What is it?
   
   Value added exports track value added from source country/sector to destination country where it is absorbed in final demand.
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   Value added exports track value added from source country/sector to destination country where it is absorbed in final demand.

2. How to calculate it?

3. How to interpret it?

4. What do the data say?

5. What for?

6. What next?
How to calculate it?

**Step 1:** Assemble global IO matrix ($A$) and final demand vectors ($c_j$).

Use GTAP and proportionality assumptions here.
How to calculate it?

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**Step 2:** Compute output used to produce final goods absorbed in dest.

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\begin{pmatrix}
y_{1j} \\
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\end{pmatrix} = (I - A)^{-1} c_j
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**Step 3**: Use source country VA-to-output ratios to compute value added.

\[
va_{ij}(s) = \left(\frac{va_i(s)}{y_i(s)}\right) y_{ij}(s)
\]
How to interpret it?

In the aggregate: ‘domestic content’ of exports.

For sectors: direct vs. indirect participation in trade.

- Three influences: (1) VA-to-output ratio; (2) participation in cross-border production chains; (3) within-country linkages.
- Within-country linkages dominate:
  e.g., services are exported embodied in manufactures.

For bilateral partners: bilateral vs. multilateral production chains.

- Bilateral “back-and-forth” trade dominates.
- Triangular linkages (e.g., Australia to US through China).
Aggregate and Sector-Level VAX Ratios

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<th>Ag. &amp; Nat.R.</th>
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Gross vs. Value Added Trade Shares

Manufactures

Services

Export Share  Value Added Export Share
Decomposing the Aggregate VAX Ratio

**Between Sectors:** changing composition of exports.

**Within Sectors:** differences in VAX ratios.

Between Term drives variation in Agg. VAX ratio.
### Panel A: Aggregate VAX vs. Income

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<th>Between Term</th>
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<td>Log Income Per Capita</td>
<td>-0.008</td>
<td>0.028**</td>
<td>-0.036***</td>
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<td></td>
<td>(0.005)</td>
<td>(0.011)</td>
<td>(0.013)</td>
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<tr>
<td>$R^2$</td>
<td>0.02</td>
<td>0.07</td>
<td>0.08</td>
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<tr>
<td>N</td>
<td>90</td>
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### Panel B: Manufacturing VAX vs. Income

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<td>-0.007</td>
<td>0.025***</td>
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Robust s.e.; * $p < .1$, ** $p < .05$, *** $p < .01$; Outliers excluded.
U.S. Bilateral VAX Ratios
Three Observations

1. Production sharing drives bilateral VAX ratios, not trade composition. “It’s not what you export, it’s how it’s used abroad.”

2. VAX ratios shaped by triangular production chains.
   - VAX ratios $> 1$, or $VAX_{ij} \neq VAX_{ji}$
   - Decomposing trade: absorption, reflection, and redirection.
     - Japan exports to U.S. $\approx 93\%$ absorbed.
     - Japan exports to China $\approx 65\%$ absorbed, 11% redirected to U.S.

3. Bilateral balances are distorted: focus on U.S. balances with Asia.
U.S. Bilateral Balances
What for?

Macroeconomics: measuring openness and bilateral linkages.

▶ Supply shocks and comovement: Johnson (2011).
What for?

**Macroeconomics:** measuring openness and bilateral linkages.
- Supply shocks and comovement: Johnson (2011).

**Trade:** quantitative theory of input trade.
What’s next?

Investing in data to relax ‘proportionality’:

- Splitting inputs and final goods in trade is the ‘easy’ problem.
- Need better information on use behind border.
- Processing trade (writ large).
  - Better data for countries with explicit regimes (e.g., China, Mexico).
  - Data says imports are concentrated among large, exporting firms.
    ⇒ exports are import intensive in all countries.

Our priorities:

2. More theory: looking at VA flows through lens of theory.
GBIO Framework I

$S$ sectors and $N$ countries.

Output used as both intermediate and final good.

Markets clear in quantities. Evaluate at common prices.

Output: $y_i(s) = c_{ii}(s) + \sum_t m_{ii}(s, t) + \sum_{j \neq i} x_{ij}(s)$.

Exports: $x_{ij}(s) = c_{ij}(s) + \sum_t m_{ij}(s, t)$.

Output (again): $y_i(s) = \sum_j c_{ij}(s) + \sum_j \sum_t m_{ij}(s, t)$. 
Define: \( A_{ij}(s, t) = m_{ij}(s, t)/y_j(t) \) and collect objects:

\[
A = \begin{pmatrix}
A_{11} & \cdots & A_{1N} \\
\vdots & \ddots & \vdots \\
A_{N1} & \cdots & A_{NN}
\end{pmatrix}, \quad y = \begin{pmatrix} y_1 \\ \vdots \\ y_N \end{pmatrix}, \quad c_j = \begin{pmatrix} c_{1j} \\ \vdots \\ c_{Nj} \end{pmatrix}.
\]

Re-write \( S \times N \) goods market clearing conditions:

\[
y = Ay + \sum_j c_j
\]

\[
\Rightarrow y = \sum_j (I - A)^{-1} c_j
\]
Output decomposition:  \( y = \sum_j (I - A)^{-1} c_j \)

Output used directly or indirectly to produce \( c_j \):

\[
\begin{pmatrix}
  y_{1j} \\
  \vdots \\
  y_{Nj}
\end{pmatrix} \equiv (I - A)^{-1} c_j
\]

“Leontief inverse” \( \rightarrow (I - A)^{-1} = I + A + A^2 + \ldots \)

Value Added Exports:  \( va_{ij} = \sum_s \left( \frac{va_i(s)}{y_i(s)} \right) y_{ij}(s) \)
Data

GTAP 7.1 Data Base

- WDI/IMF BOP + Comtrade + national IO tables.
- 57 sectors, 94 countries (+19 comp. regions) for 2004.
- 18 ag. & nat. resources, 24 manufacturing, 15 service sectors.

Data contains: \{y_i, c_{Di}, c_{li}, A_{ii}, A_{li}, \{x_{ij}\} \forall j \neq i\}

Proportionality assumptions to split \{A_{li}, c_{li}\}:

\[ A_{ji}(s, t) = A_{li}(s, t) \left( \frac{x_{ji}(s)}{\sum_{j} x_{ji}(s)} \right) \quad \text{and} \quad c_{ji}(s) = c_{li}(s) \left( \frac{x_{ji}(s)}{\sum_{j} x_{ji}(s)} \right) \]

Extension: adjust for processing trade in China and Mexico.