Give credit where credit is due: Tracing value added in global production chains

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Presentation outline

• Global value chain: nature and measures
• Conceptual framework and its contribution
  – Three important matrices based on block-matrix formulation
  – Integration of other measures in the literature
  – Complete decomposition of gross exports into value-added components
  – Important distinction in sectoral trade
• Empirical results
  – Differences in regional supply chain participation
  – Effects of multistage production on trade costs
• Database improvements and limitations
  – Covered by Zhi Wang in later panel
Value chain literature, from a product view to a global view

• Single product
  – iPhone: Xing, Yuqing, Detert, 2010

• Single country
  – Vertical specialization: Hummels, Ishii, Yi, 2001
  – Offshoring: Feenstra and Jensen, 2009; Milberg and Winkler, 2010

• Regional focus
  – WTO/IDE-JETRO, 2011; Wang, Powers, and Wei, 2009

• Global analysis
  – GTAP: Daudin et al., 2010; Johnson and Noguera, 2011
  – WIOD: Foster, Stehrer, and de Vries, 2011
  – Other collaborators: OECD (Yamano and Miroudot); WTO; USITC
Global value chains: Multiple measures

• Hummels, Ishii, and Yi (2001) measures of vertical trade
  – VS: share of imported inputs in exports
  – VS1: share of exports sent indirectly through third countries

• Newer measures
  – VAX: domestic value-added in exports (Johnson and Noguera)
  – VS1*: domestic value-added that returns home (Daudin et al.)
    • aka “reflected” exports

• Not previously unified in a fully specified framework – turn to this next
Value-added framework: Gross output in a two-country world

• All output is used as an intermediate or final good at home or abroad

\[ X_r = A_{rr} X_r + A_{rs} X_s + Y_{rr} + Y_{rs} \]

with N goods,

- \( X_r \): (N×1) Gross output of country \( r \)
- \( A_{rs} \): (N×N) IO Coefficient matrix giving use in country \( s \) of intermediates from \( r \)
- \( Y_{rs} \): (N×1) Final demand: Country \( s \)’s use of final goods from country \( r \)

• \( A_{rs} \) requires data in interregional IO model (beyond most IO tables)
Production system in a two-country world

- In block matrix notation

\[
\begin{bmatrix}
X_1 \\
X_2
\end{bmatrix} = \begin{bmatrix}
A_{11} & A_{12} \\
A_{21} & A_{22}
\end{bmatrix} \begin{bmatrix}
X_1 \\
X_2
\end{bmatrix} + \begin{bmatrix}
Y_{11} + Y_{12} \\
Y_{21} + Y_{22}
\end{bmatrix}
\]

- Rearranging,

\[
\begin{bmatrix}
X_1 \\
X_2
\end{bmatrix} = \begin{bmatrix}
I - A_{11} & -A_{12} \\
-A_{21} & I - A_{22}
\end{bmatrix}^{-1} \begin{bmatrix}
Y_{11} + Y_{12} \\
Y_{21} + Y_{22}
\end{bmatrix} = \begin{bmatrix}
B_{11} & B_{12} \\
B_{21} & B_{22}
\end{bmatrix} \begin{bmatrix}
Y_1 \\
Y_2
\end{bmatrix}
\]

where

- \( B_{sr} \): \((N \times N)\) block Leontief inverse matrix, denoting the amount of total output in \( s \) required for a one-unit increase in final demand in country \( r \)
- \( Y_r \): \((N \times 1)\) vector of global use of \( r \)'s final goods
Value added in production

• Direct domestic value added in production:

\[ V_1 = u[I - A_{11} - A_{21}] \quad \text{and} \quad V_2 = u[I - A_{12} - A_{22}] \]

where

\( V_r \): (1×N) domestic value-added coefficient vector;
\( v_{ri} = 1 - \) intermediate input share from all countries

\( u \): (1×N) vector of ones

• Value-added shares matrix (2×2N) decomposes value added in production of each sector in all countries

\[ VAS = VB = \begin{bmatrix} V_1B_{11} & V_1B_{12} \\ V_2B_{21} & V_2B_{22} \end{bmatrix} \]
Value-added exports

- Exports (2N×2) include both intermediate and final goods

\[ E = \begin{bmatrix} E_1 & 0 \\ 0 & E_2 \end{bmatrix} \]  

(See paper for value-added exports at the product level)

- Value-added exports matrix (2×2)

\[ \text{VAS}_E = \text{VBE} = \begin{bmatrix} V_1B_{11}E_1 & V_1B_{12}E_2 \\ V_2B_{21}E_1 & V_2B_{22}E_2 \end{bmatrix} \]

- Fully generalizable to a many-country world

\[ X = (I - A)^{-1}Y = BY \]

\[ \text{VAS} = \text{VB} \]

\[ \text{VAS}_E = \text{VBE} \]
Completely decomposes gross exports and accounts for previous measures in literature

- Gross exports
  - Domestic value in exports consumed by direct importer
  - Domestic value in exports sent on to third countries
  - Domestic value added reflected from abroad (VS1*)
  - Foreign value added in exports (VS)

Domestic value added in exports (VAX)

Indirect value-added exports (VS1)
Important distinction in sectoral exports

- Our framework measures either decomposition.
- Sectoral details in USITC, *Import Restraints*, August 2011
Complete decomposition of gross exports
Supply chain participation: Key differences by region

US uses lots of imported inputs in its exports; considerable imported value originated in US itself

E. Asia has the longest chains—little of its exported value is absorbed by direct importer (see table 3)

East Asia has the most foreign content in its own exports

Integration in NAFTA makes Mexico an outlier among non-Asian economies
Trade costs of multistage production

Trade costs (tariff + transport), as a share of export value

- East Asia pays a price for its long chains and relatively high tariffs
- Advanced economies have low foreign content and, hence, low multistage costs
Database development: Estimating a global Inter-Region IO table

- Start with 2004 GTAP global trade and prod’n database
- Use BEC end-use categories of detailed trade data (HS6) to distinguish intermediate inputs from final goods
- Add processing data for China and Mexico
- Use proportionality assumption to allocate imported intermediate inputs to using sector
Conclusions

• New value-added framework
  – Generalizes all measures in the literature
  – Accounts for the entirety value of gross exports
  – Integrates both measures of sectoral value added
  – Provides new detail on regional differences in supply chain activity and costs

• It is now possible to measure trade in value-added terms consistent with official statistics
  – Ideal database would be consistent with both official trade statistics and national income accounts
Questions/Comments?

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