EC 791 - International Trade
Vertical Specialization

Stefania Garetto
Vertical Specialization

How does a firm procure the intermediate goods necessary for its production process?

Intermediates can be produced within the firm (vertical integration) or acquired from suppliers (outsourcing), in which case the firm is vertically specialized.

Both these organizational choices can be implemented domestically or abroad, giving rise to vertical FDI, when the firm produces intermediate goods in owned plants located abroad, or to foreign outsourcing, when it relies on foreign suppliers.
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Classic examples: the Barbie Doll, Boeing Airplanes, the iPod, Nike shoes.
Hanson, Mataloni and Slaughter (2005): Empirical Evidence

- **Trade in intermediate goods** is about 2/3 of total trade.

- Large role of trade in intermediates in recent growth of trade flows.

- Most trade in intermediates is due to multinational firms locating **input processing** in foreign affiliates and importing intermediates from them.

- Define and describe **vertical production networks**:
  - parent and affiliate(s) perform different activities
  - parent and affiliate(s) trade intermediate goods with each other.

- Large differences in the extent of vertical production networks across industries and countries.
The Data

HMS try to explain the variation in **imported intermediate inputs across foreign affiliates** of U.S.-based multinational firms that are in the **same industry** and share the **same U.S. parent**.
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Data:

- Data on the operations of U.S. Multinational Corporations from the Bureau of Economic Analysis (BEA)
  - 1994 benchmark survey: universe of MOFAs\(^1\) in manufacturing industries (54 industries, 105 host countries).
- Transportation costs and tariffs from Feenstra, TRAINS.

Look at affiliates’ imports from U.S. parents of inputs for further processing: how does this magnitude depends on trade costs, factor prices, taxes, etc.?

\(^1\)Majority-Owned Foreign Affiliates.
The Empirical Framework

\[ s_{aipc}^m = \alpha_{ip} + \gamma_m s \ln(w_s^c) + \gamma_m u \ln(w_u^c) + \gamma_m k \ln(r_{aipc}) + \ldots \]
\[
\ldots \gamma_{mm} \ln(1 + \tau_{ic} + f_{ic}) + \gamma_{mt} \ln(1 - t_c) + \ldots
\]
\[
\ldots \phi_{my} \ln(Y_{aipc}) + \beta X_{ic} + \varepsilon_{aipc}^m
\]

where:

- \( s_{aipc}^m \) = share of imported inputs in total costs for affiliate \( a \) in industry \( i \) belonging to parent \( p \) and located in country \( c \)
- \( \alpha_{ic} \) = parent-industry fixed effect
- \( w_s^c (w_u^c) \) = skilled (unskilled) wage in country \( c \)
- \( r_{aipc} \) = rental price of capital for affiliate \( a \) in industry \( i \) belonging to parent \( p \) and located in country \( c \)
- \( \tau_{ic} (f_{ic}) \) = ad valorem tariff (freight) in industry \( i \) in country \( c \)
- \( t_c \) = corporate tax rate in country \( c \)
- \( Y_{aipc} \) = output of affiliate \( a \) in industry \( i \) belonging to parent \( p \) and located in country \( c \)
- \( X_{ic} \) = other country and industry characteristics.
Results

- Affiliates’ input processing is more important:
  - in countries with **low trade costs** (Canada, Mexico) and **low labor costs** (South-East Asia, Mexico);
  - in industries like machinery, transportation equipment, electronics, where **production is separable in distinct stages** with different factor intensities.

- Document **two-way intrafirm trade**: affiliates import inputs for further processing from the parent, and export processed inputs back to the parent.
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- Document **two-way intrafirm trade**: affiliates import inputs for further processing from the parent, and export processed inputs back to the parent.

- Limitations:
  - take the organizational structure of the firm and the location of the affiliates as given;
  - look only at **intrafirm vertical production networks**, while vertical specialization can also happen across firms’ boundaries.
Hummels, Ishii and Yi (2001) develop a methodology to quantify the extent of vertical specialization.

Definition:
Vertical specialization refers to imported goods that are used as inputs to produce a country's export goods.

Two key elements:

1. The production process must involve at least two countries ("fragmentation" of production).
2. The good-in-process must cross at least two borders.
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Construct a measure of vertical specialization: the **value of imported inputs embodied in goods that are exported**.

To construct this measure, use input-output tables of 14 countries that – at the time of writing – accounted for 3/5 of world trade.
Measurement of Vertical Specialization

Vertical specialization (VS) for country $k$ in sector $i$:

$$VS_{ki} = \left( \frac{\text{imported intermediates}_{ki}}{\text{gross output}_{ki}} \right) \cdot exports_{ki}$$

(Imported input content of export, or foreign value added\(^2\) embodied in exports).

VS share of total exports:

$$\frac{VS_k}{X_k} = \frac{\sum_i VS_{ki}}{\sum_i X_{ki}} = \frac{\sum_i (VS_{ki}/X_{ki}) \cdot X_{ki}}{\sum_i X_{ki}} = \sum_i \left[ \left( \frac{X_{ki}}{X_k} \right) \cdot \left( \frac{VS_{ki}}{X_{ki}} \right) \right]$$

Is an export-weighted average of sector-specific VS shares.

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\(^2\)It is important to make sure that mere border crossings are not included in this calculation (for example, trade “passing by” Hong Kong): value added must be produced in each country.
Measurement of Vertical Specialization (contd.)

Compute VS shares using **input-output tables**, to avoid arbitrary classifications of intermediate goods:

\[
\frac{V S_k}{X_k} = u A^M X / X_k
\]  

where:
- \( u \) is a \((1 \times n)\) vector of ones \((n\) is the number of sectors);  
- \( A^M \) is an \((n \times n)\) matrix of imported coefficients;  
- \( X \) is an \((n \times 1)\) vector of exports by sector;  
- \( X_k \) is the sum of exports by sector (total exports of country \( k \)).
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But this specification ignores the fact that imported intermediates can go through several processing stages in a country before being exported.
Generalize (1) to:

\[
\frac{V S_k}{X_k} = u A_M^M [I - A_D^D]^{-1} X / X_k
\]  

(2)

where:
- \( I \) is an \((n \times n)\) identity matrix;
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Expression (2) allows the good-in-process to go through different stages of production in the domestic country before being exported, but does not allow for exports of intermediates for further processing.
Measurement of Vertical Specialization  (contd.)

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Johnson and Noguera (2012), “Accounting for Intermediates: Production Sharing and Trade in Value Added”, extend the HIY accounting framework to account for multiple stages of production performed in multiple countries (merge I-O tables with bilateral trade data).
Vertical Specialization in the Data

- In 1990, the vertical specialization share of exports was 0.21.
- Vertical specialization growth of 30% from 1970 to 1990.
- Vertical specialization accounts for 30% of total export growth from 1970 to 1990.
- Large variation in levels and growth of vertical specialization across countries.
- Vertical specialization is negatively correlated with GDP: “smaller” countries have higher vertical specialization shares.
Yi (2003): Vertical Specialization and Trade

“Can Vertical Specialization Explain the Growth of World Trade?”
“Can Vertical Specialization Explain the Growth of World Trade?”

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2. Higher responsiveness of trade to falling tariffs since 1908s:
   - prior to 1980, “large” tariff declines and “small” trade growth;
   - after 1980, “small” tariff declines and “large” trade growth.
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   The non-linearity of trade responses is a quantitative puzzle.

Standard trade models (like DFS 1977, or Krugman 1979-1980) can explain the growth in world trade only with elasticities in the range of 15-20, and cannot explain the nonlinearity in the responses.

$\Rightarrow$ Yi (2003) proposes an **explanation based on vertical specialization**.
The Mechanism

1. Due to vertical specialization, a good crosses **multiple borders** during its production process ⇒ a tariff reduction has a **magnified effect** on the cost of producing a good.

   - The more fragmented the production process is (*i.e.*, the larger the number of stages), the larger the impact of tariff reductions.

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   ⇒ Vertical specialization explains the **magnitude of the trade responses** to changes in tariffs.

2. Tariff reductions themselves induce increases in vertical specialization.

   ⇒ Endogenous changes in vertical specialization explain the **nonlinearity of the trade responses**.
The Structure of the Model

- Two-country Ricardian model à la DFS.
- One non-tradeable final good.
- Three-stages production process: stage-1 and stage-2 intermediate goods are tradeable (at a cost) and can be produced in any country.

The model delivers endogenous vertical specialization (i.e., stage 1 and stage 2 goods produced in different countries) and has the following implications:

- The equilibrium with positive tariffs has a smaller (if positive) extent of vertical specialization than the frictionless equilibrium.
- A tariff reduction:
  - generates an increase in the range of goods whose production is vertically specialized, and
  - reduces the costs of those goods whose production is vertically specialized.