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.

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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

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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.

The Data

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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

$$\begin{aligned} s^m_{aipc} &= \alpha_{ip} + \gamma_{ms}\ln(w^s_c) + \gamma_{mu}\ln(w^u_c) + \gamma_{mk}\ln(r_{aipc}) + ... \\ &... \quad \gamma_{mm}\ln(1+\tau_{ic}+f_{ic}) + \gamma_{mt}\ln(1-t_c) + ... \\ &... \quad \phi_{my}\ln(Y_{aipc}) + \beta X_{ic} + \varepsilon^m_{aipc} \end{aligned}$$

where:

- s^m_{aipc} = share of imported inputs in total costs for affiliate a in industry i beloinging to parent p and located in country c

- α_{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.

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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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  - 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.
- 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.

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Hummels, Ishii and Yi (2001): A Methodological Contribution

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:

$$VS_{ki} = \left(\frac{imported\ \ intermediates_{ki}}{gross\ \ output_{ki}} \right) \cdot exports_{ki}$$

(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.

[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:

$$\frac{VS_k}{X_k} = uA^M X / X_k \tag{1}$$

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.

Measurement of Vertical Specialization (contd.)

Generalize (1) to:

$$\frac{VS_k}{X_k} = uA^M[I - A^D]^{-1}X/X_k \qquad (2)$$

where:

- I is an $(n \times n)$ identity matrix;
- A^D is an $(n \times n)$ matrix of domestic coefficients.

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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.

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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).

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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

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"Can Vertical Specialization Explain the Growth of World Trade?"

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1. Trade as a share of GDP increased 3-fold between 1960 and 2000.

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2. Higher responsiveness of trade to falling tariffs since 1908s:

   - prior to 1980, "large" tariff declines and "small" trade growth;
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   The non-linearity of trade responses is a quantitative puzzle.

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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.

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

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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.