International Trade: Lecture 2

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The Heckscher-Ohlin Model: the Leontief's Paradox (1953)

The Heckscher-Ohlin Theorem:

Each country will export the good that uses the abundant factor intensively. That is: the home country will export good 1, while the foreign country will export good 2.

The United States in 1947 were a capital abundant country. Therefore, according to the H-O theory, the U.S. will export capital intensive goods and import labor intensive. Leontief was the first to confront the model with the data. He had developed the set of input-output accounts (the analogue of a_{iL} and a_{iK}), which allowed him to compute the amounts of labor and capital used in each industry. Then, using the trade data, he computed the amounts of labor and capital used in the US exports and imports.

The Heckscher-Ohlin Model: the Leontief's Paradox (1953)

	Exports	Imports
Capital ($ million)	2.5	3.1
Labor (person-years)	182	170
Capital/Labor ratio ($ per person)	13.700	18.200

The capital/labor ratio is greater in imports. Paradox!

The Heckscher-Ohlin Model: Possible Explanations

- U.S. and foreign technologies are not the same
- land is ignored (another factor of production)
- labor should be divided into skilled and unskilled
- The US was not engaged in free trade
- bad data set (WW2)

In general, the reasons are quite valid. A number of papers took into account those reasons. However, in some cases, the paradox continued to occur. **Until Leamer (1980) showed that Leontief performed a wrong test: the capital/labor ratios in exports and imports should not be compared (necessary reading!)**

The Heckscher-Ohlin-Vanek Model (the "factor content" version of the H-O model)

Assumptions:

- many countries indexed by i
- many industries indexed by j
- many factors indexed by k, l
- identical technologies
- FPE under free trade
- identical homothetic preferences

The Heckscher-Ohlin-Vanek Model

- Let us denote $A = [a_{jk}]'$ as the input-output matrix. That is, these are amounts of capital, labor, and other factors need for one unit of product in each industry (industry j, factor k). No differences across the countries.
- Let us also denote a *vector* Y^i as output in each industry in country i
- In the same way, D^i is demand for each good in country i.

The Factor Content of Trade:

$$\begin{aligned} T^i &= Y^i - D^i \\ F^i &\equiv AT^i \end{aligned}$$

Let F_k^i be an individual component of the vector F^i. If $F_k^i > 0$ (< 0), then country i exports (imports) factor k. The goal of the model is to relate F^i to factor endowments.

The Heckscher-Ohlin-Vanek Model

- V^i is the vector of endowments in country i:

$$AY^i = V^i$$

- Identical, homothetic preferences:

$$\begin{aligned} D^i &= s^i D^W \Longrightarrow \\ AD^i &= s^i AD^W = s^i AY^W = s^i V^W \end{aligned}$$

  where s^i is the share of country i in the world consumption.

- To summarize,

$$F^i \equiv AT^i = V^i - s^i V^W.$$

- Note: if trade is balanced (exports=imports), then s^i is the share of country i in the world GDP: $\frac{p'Y^i}{p'Y^W}$.

Testing the Heckscher-Ohlin-Vanek Model

A number of studies (Trefler (1995) and Davis and Weinstein (2001) (see the reading list)) tried to test the model. The key relationship in the model:

$$AT^i = V^i - s^i V^W.$$

So if the data are available, one can run a regression or perform a sign test to test the model (see the mentioned papers and the textbook).

Testing the Heckscher-Ohlin-Vanek Model

- The sign test (1966-1967 data):

$$sign(F_k^i) = sign\left(V_k^i - s^i V_k^W\right).$$

  - $M * C$ observations (C countries, M factors)
  - flipping a coin: 50%; the data: 61% (27 countries and 12 factors)

- The rank test:

$$F_k^i > F_l^i \iff V_k^i - s^i V_k^W > V_l^i - s^i V_l^W$$

  - for each country: $M(M-1)/2$ observations
  - a random assignment: 50 %; the data: 49%.

Testing the Heckscher-Ohlin-Vanek Model

The main conclusion: Tests of the HOV model **fail** under the assumption about identical homothetic preferences and **identical** technologies. Trade patterns cannot be explained only by differences in factor endowments! It is not the whole story.

We need differences in technologies across countries!! $\Longrightarrow$ *The Ricardian model of trade!!*

The Ricardian Model: Continuum of Goods (Dornbusch, Fischer and Samuelson (1977))

Assumptions:

- two countries
- continuum of goods $z \in [0, 1]$
- one factor (labor) $\Longrightarrow$ no FPE across the countries
- identical homothetic preferences
- different technologies and factor endowments:
  - $a(z)$ and $a^*(z)$ are labor requirements in industry z at home and abroad, respectively
  - L and L^* are labor endowments: labor is perfectly mobile between sectors, but immobile across countries

The Ricardian Model: Continuum of Goods

Let us arrange industries such that the relative unit labor requirement function

$$A(z) = \frac{a^*(z)}{a(z)}$$

is decreasing: $A'(z) < 0$. That is, the foreign country is relatively more productive in industries that are "closer" to 1.

Let us define w and w^* as nominal wages at home and abroad, respectively. The home country will produce all those commodities for which domestic unit labor costs are less than or equal to foreign unit labor costs. In other words, good z is produced at home if

$$a(z)w \leq a^*(z)w^*.$$

The Ricardian Model: Continuum of Goods

Hence, if we denote $\omega = \frac{w}{w^*}$, then there exists a cutoff $\tilde{z}$ such that goods with index $z \leq \tilde{z}$ are produced at home, while goods with $z > \tilde{z}$ are produced abroad. The cutoff $\tilde{z}$ solves

$$A(\tilde{z}) = \omega.$$

In other words, given wages, the home country has comparative advantage in goods with $z \in [0, \tilde{z}]$, while the foreign country has comparative advantage in goods with $z \in (\tilde{z}, 1]$.

The Ricardian Model: Continuum of Goods

Finally, the prices are given by

$$P(z) = \min(wa(z), w^*a^*(z)).$$

Thus, the relative price of good z with respect to good z' is as follows:

$$\frac{P(z)}{P(z')} = \begin{cases} a(z)/a(z') & \text{if} \quad z, z' \leq \tilde{z} \\ \omega a(z)/a^*(z') & \text{if} \quad z < \tilde{z} < z' \\ a^*(z)/a^*(z') & \text{if} \quad \tilde{z} < z, z' \end{cases}$$

The Ricardian Model: Continuum of Goods

Demand side:

Identical and homothetic preferences:

$$P(z)C(z) = b(z)Y > 0,$$

where $C(z)$ is demand for good z, Y is total income, and $b(z)$ is the fraction of income spent on good z. This fraction is exogenous. Moreover,

$$\int_0^1 b(z)dz = 1.$$

Therefore, the fraction of total income spent on the goods in which the home country has a comparative advantage:

$$\theta(\tilde{z}) = \int_0^{\tilde{z}} b(z)dz > 0$$

with $\theta'(\tilde{z}) = b(\tilde{z}) > 0$.

The Ricardian Model: Continuum of Goods

Factor market clearing condition:

The labor supply at home is given by L. Recall that the demand for good z is given by

$$\frac{b(z)Y^w}{P(z)}.$$

Therefore, if the good is produced at home, then labor, which is necessary to produce that good, is

$$a(z)\frac{b(z)Y^w}{P(z)} = \frac{b(z)Y^w}{w} \ \text{(as } P(z) = wa(z)\text{)}.$$

As a result, total labor demand is given by

$$\int_0^{\tilde{z}} \frac{b(z)Y^w}{w}dz = \theta(\tilde{z})\frac{Y^w}{w}.$$

The Ricardian Model: Continuum of Goods

Equilibrium:

- Labor supply is equal to labor demand:

$$\begin{aligned} L &= \theta(\tilde{z})\frac{Y^w}{w} \iff \\ \omega &= \frac{\theta(\tilde{z})}{1-\theta(\tilde{z})}\frac{L^*}{L}, \end{aligned}$$

  as $Y^w = wL + w^*L^*$.

- Finally,

$$\omega = A(\tilde{z})$$

So we have two equations and two unknowns (ω and $\tilde{z}$). This closes the model (see the picture in the class).

The Ricardian Model: Continuum of Goods

Gains from trade:

To analyze the gains from trade, we look at the changes in real return to labor (real income). Specifically, we look at $\frac{w}{P(z)}$ for all $z \in [0, 1]$.

In autarky: $P(z) = wa(z) \implies \frac{w}{P(z)} = \frac{1}{a(z)}$ for all z.

The Ricardian Model: Continuum of Goods

In the trade equilibrium,

- for $z \in [0, \tilde{z}]$, $P(z) = wa(z) \implies$

$$\frac{w}{P(z)} = \frac{1}{a(z)}.$$

  No gains and losses!

- for $z \in [\tilde{z}, 1]$, $P(z) = w^* a^*(z) \implies$

$$\frac{w}{P(z)} = \frac{w}{w^* a^*(z)} = \frac{wa(z)}{w^* a^*(z)} \frac{1}{a(z)} > \frac{1}{a(z)},$$

  as $wa(z) > w^* a^*(z)$. Consumers can buy greater amounts of goods with $z \in [\tilde{z}, 1]$.

The Ricardian Model with Transport Costs (Tariffs)

Consider the same model with continuum of goods, but also with non-zero transport costs. In particular, we consider the "iceberg" transport costs. That is, to deliver one unit of a good, τ units have to be sent, where $\tau > 1$. In other words, a fraction $\frac{1}{\tau}$ of a shipped good actually arrives. This modifies the equilibrium equations in the following way. If good z is such that

$$wa(z)\tau < w^* a^*(z),$$

then good z is produced at home and exported to the foreign country. This gives the cutoff $\tilde{z}$:

$$\omega\tau = A(\tilde{z}).$$

The Ricardian Model with Transport Costs (Tariffs)

If good z is such that

$$w^* a^*(z)\tau < wa(z),$$

then this good is produced abroad and imported by the home country. We have one more cutoff $\tilde{z}^*$:

$$\frac{\omega}{\tau} = A(\tilde{z}^*).$$

Lemma

$\tilde{z}^* > \tilde{z}$ if and only if $\tau > 1$.

Hence, we can see that if good z is such that $z \in (\tilde{z}, \tilde{z}^*)$, then this good is produced in both countries and not traded. In other words, we have a set of not traded goods (see the picture in the class). This is due to the presence of transport costs.

The Ricardian Model with Transport Costs (Tariffs)

Equilibrium:

In the same manner as before, we compute labor demand in the home country. In particular, if $z \in [0, \tilde{z}]$, then it is exported abroad and, thereby, the demand is given by $\frac{b(z)Y^w}{P(z)}$. However, if $z \in (\tilde{z}, \tilde{z}^*)$, then this good is not traded and, in this case, the demand is given by $\frac{b(z)Y}{P(z)}$, where Y is the total income in the home country.

The Ricardian Model with Transport Costs (Tariffs)

Hence, the total labor demand is given by

$$\int_0^{\tilde{z}} a(z)\frac{b(z)Y^w}{P(z)}dz + \int_{\tilde{z}}^{\tilde{z}^*} a(z)\frac{b(z)Y}{P(z)} = \frac{(wL + w^*L^*)}{w}\int_0^{\tilde{z}} b(z)dz + \frac{wL}{w}\int_{\tilde{z}}^{\tilde{z}^*} b(z)dz$$

Labor marker clearing condition:

$$\begin{aligned} L &= \frac{(wL + w^*L^*)}{w}\int_0^{\tilde{z}} b(z)dz + \frac{wL}{w}\int_{\tilde{z}}^{\tilde{z}^*} b(z)dz \iff \\ \omega &= \frac{L^*}{L}\frac{\int_0^{\tilde{z}} b(z)dz}{1 - \int_0^{\tilde{z}^*} b(z)dz}. \end{aligned}$$

The Ricardian Model with Transport Costs (Tariffs)

Equilibrium conditions:

$$
\begin{aligned}
\omega &= \frac{L^*}{L}\frac{\int_0^{\tilde{z}} b(z)dz}{1-\int_0^{\tilde{z}^*} b(z)dz} \\
\omega\tau &= A(\tilde{z}) \\
\frac{\omega}{\tau} &= A(\tilde{z}^*).
\end{aligned}
$$

Three equations, three unknowns $\Longrightarrow$ we can find ω, $\tilde{z}$, and $\tilde{z}^*$.

Bringing Model to the Data

- The model above is very simple and stylized $\Longrightarrow$ what is the right test of the model?
- We consider some simple regressions that take the intuition of a 2-country Ricardian model.
- Not a true test of the model! **JUST SOME SUPPORTIVE EVIDENCE!**

The MacDougall Test

- MacDougall (Economic Journal, 1951):
    - used comparative productivity measures (for the UK and the USA in 1937) to 'test' the intuitive prediction of Ricardian theory
    - recall that Home exports good z if
      $wa(z) < a^*(z)w^* \implies a^*(z)/a(z) > w/w^*$
    - $a(z)$ is inverted productivity or inverted output per worker
    - thus, if there are 2 countries in the world (UK an USA), then each country will export those goods for which the ratio of its output per worker to that of the other country exceeds the ratio of its money wage rate to that of the other country
    - in the model with more two countries, this is statement is not necessarily true!

The MacDougall Test: The Correlation

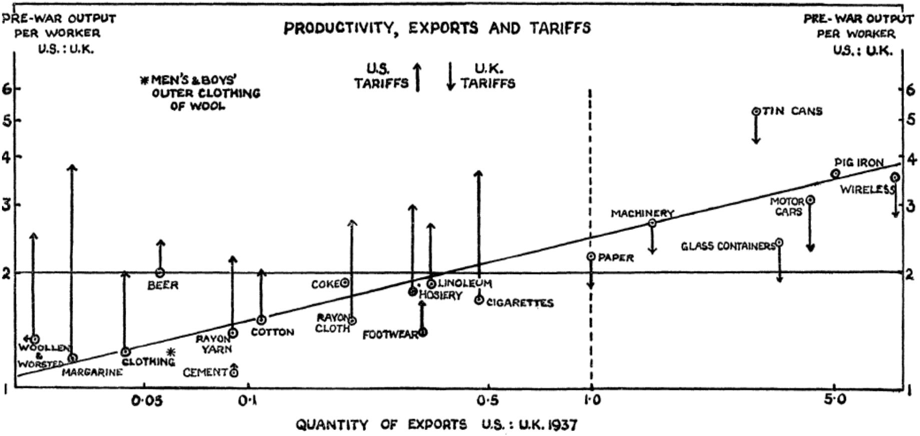

Fig. 1.

The MacDougall Test: Another Replication by Stern (1962)

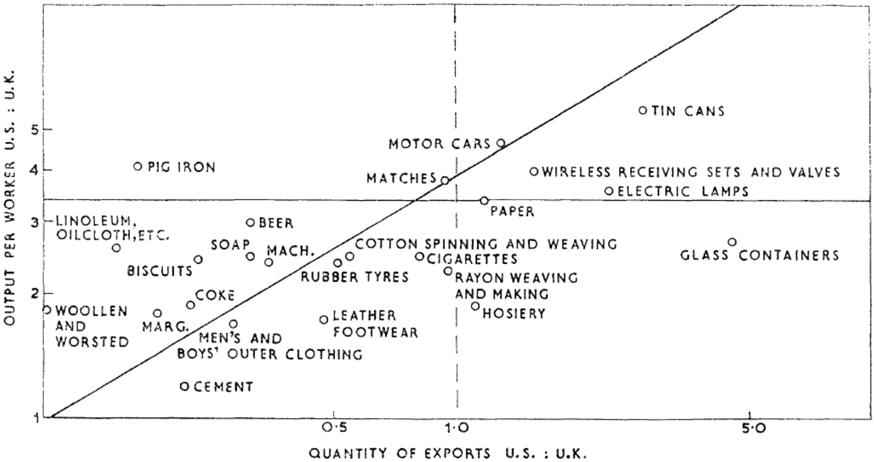

Fig. 1. Scatter diagram of American and British ratios of output per worker and quantity of exports, 1950.