International Economics: Lecture 9
Testing Trade Theories & HOV Model

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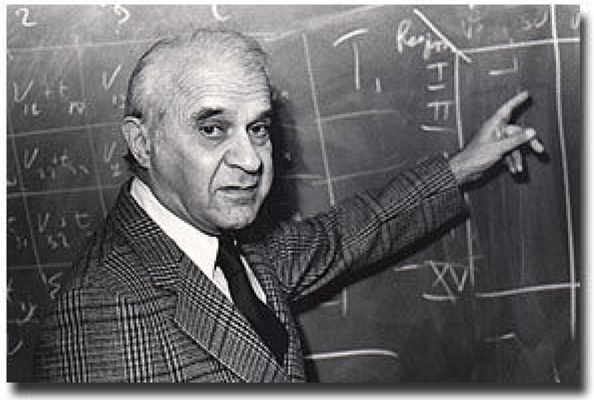
ATC, February 27, 2017

Leontief Paradox

- In 1953 Leontief published the results of HO theorem test.
- These results became so famous, that were dubbed as “Leontief Paradox”.

- Leontief test was based on Input-Output Tables, which was pioneered by him.



Wassily Leontief (1906-1999)

Leontief Paradox

- *Data*: U.S. Input-Output tables data for 1947.
- *Hypothesis*: The U.S. was assumed to be the most K-abundant country in the world. So based on HO theorem it was expected that the U.S. exported K-intensive goods and imported L-intensive goods.
- *Test method*: Leontief calculated the U.S. capital and labor requirements per $1 million of U.S. exports and of import substitutes for 1947.
- *Result*: U.S. exports were more L-intensive than U.S. import substitutes.

	Exports	Imports Substitutes
Capital (mln. dollars in 1947 prices)	2.6	3.1
Labor (man-years)	182	170
K/L ($1000 / man-year)	14.0	18.2

Leontief Paradox

	Exports	Imports Substitutes	Imports/ Exports
Leontief *(1947 input req. 1947 trade, 50 sectors)*			
Capital (dollars in 1947 prices)	2,550,780	3,091,339	
Labor (man-years)	182	170	
K/L ($1000 / man-year)	14	18.2	1.3
Leontief *(1947 input req. 1951 trade, 192 sectors)*			
K/L ($1000 / man-year)	13	13.7	1.06
K/L , excluding natural resources			0.88
Baldwin *(1958 input req. 1962 trade)*			
K/L			1.27
K/L, excluding natural resources			1.04
K/L, excluding natural resources & human capital			0.92

Input – Output tables

show intersectoral flows

into *from*	Agriculture	Manufacture	Households	Total Output
Agriculture	25	20	55	100 bushels of wheat
Manufacture	14	6	30	50 yards of cloth
Households	80	180	40	300 man-years of labor

Rows show output distribution:
e.g. of 100 units of Agri. output 25 are used by Agri. itself, 20 by Manu., 55 by Households.

Columns show input structure:
To produce 100 units of wheat 25 wheat, 14 cloth, 80 labor are used.

Source: Input-Output analysis, Leontief, 1985.

Input – Output tables

show intersectoral flows

IO table in value terms, when
P(wheat)=$2, P(cloth)=$5, P(labor)=$1

into / *from*	Agriculture ($)	Manufacture ($)	Households ($)	Total Output ($)
Agriculture	50	40	110	200
Manufacture	70	30	150	250
Households	80	180	40	300
Total Input ($)	220	250	300	

Total value of output

Total value of inputs used by each sector

$300 is value of services supplied by households. It is national income, which equals to sum of payments made by each sector to households (3rd row).

Input – Output tables

input coefficients

into *from*	Agriculture	Manufacture	Households
Agriculture	0.25=25/100	0.40	0.133
Manufacture	0.14	0.12	0.10=30/300
Households	0.80	3.6=180/50	0.133

Input coefficients of one sector product into another sector.

e.g. to produce 1 unit of manufacturing output

0.4 units of agricultural output

0.12 units of manufacturing output, and

3.6 units of household services are needed.

Input – Output tables

Capital and labor requirements for $1mln worth of cars

Industry	Output require-ments ($1000)	Requirements per $1mln of output of industry listed on left		Requirements per $1mln of final output of cars	
		Capital ($1000)	Labor (man-years)	Capital ($1000)	Labor (man-years)
Cars	1,457	566	60	825	88
Iron & steel	235	1,026	78	241	18
Nonferrous metals	79	1,002	56	79	4
Chemicals	58	593	50	34	3
Textile	39	494	111	19	4
…	…	…	…	…	…
TOTAL				2,105	201

Input – Output tables

Capital and labor requirements per $1mln worth of U.S. exports & import substitutes

	Exports	Imports Substitutes
Capital (mln. dollars in 1947 prices)	2.6	3.1
Labor (man-years)	182	170
K/L ($1000 / man-year)	14.0	18.2

U.S. imports were about 30% more K-intensive than U.S. exports.

Possible Explanation #1

Data validity

- Boris Swerling (1953) criticized that 1947 was not a typical year: the postwar recovery was not yet finished.
- That is why in 1956 Leontief repeated the test for U.S. 1951 trade data. This time imports were just 6% more K-intensive than exports (K/L_M=1.06 K/L_X). But the Paradox still existed.

'… exports from Europe was still 1/3 below, that from North America … more than 1oo% above, the prewar level. … close to half of [U.S. exports] were financed by grants and credits under various foreign aid programs. Surely any conclusions about the structure of [U.S. trade] based on I947 trade data can be accepted only with reservations'. *B. Swerling (1954)*

Possible Explanation #2

U.S. Labor's higher efficiency

- Leontief himself explained the Paradox by claiming that U.S. labor is 3 times more efficient.
- In that case U.S. is labor (not capital) abundant and Leontief findings are consistent with HO predictions.
- Note: This higher efficiency should be due not to higher K/L ratio, because, as per HO assumptions, countries share the same technologies.

… one man-year of American labor is equivalent to, say, three man-years of foreign labor. *Leontief (1953)*

Possible Explanation #2

U.S. Labor's higher efficiency

- According to Leontief, higher efficiency was due to '*entrepreneurship, superior organization, and favorable environment*', i.e. economic incentives available in the U.S.
- But, if economic incentives increased the productivity of U.S. labor, they should had increased also the productivity of U.S. capital.

- It is reasonable to argue, that U.S. labor efficiency is higher, but data is not supporting so much difference.
- Reasonable difference is estimated to be between 20% to 25%, not 3 times (Kreinin, 1965).

"Leontief paradox" cannot be explained by reference to the relative superiority of U.S. labor. *Kreinin (1965)*

Possible Explanation #3

Demand reversal

- When the K-abundant country strongly prefers K-intensive good, then the K-abundant country will export the L-intensive good because it has relative cost advantage in it.
- But studies suggest that international consumption patterns are similar (at least in developed world).
- Besides, when income increases, demand rises more for L-intensive (e.g. services), than for K-intensive goods.

Data do seem to indicate that there are more similarities than differences in tastes across countries. *Selvanathan (2012)*

Possible Explanation #4

Factor intensity reversal

- FIR occurs when a good is K-intensive in one country, but L-intensive in another.
- When relative factor prices are drastically different, then a good my be produced by a L-intensive process in the L-rich country and by a K-intensive process in the K-rich country.
- E.g. cotton production is L-intensive in Uzbekistan, but K-intensive in the U.S.

Possible Explanation #4

Factor intensity reversal

- So, when U.S. imports cotton, as per Leontief's test method, it seems the import is K-intensive, though actually it is L-intensive.
- If FIR is commonplace, then the Paradox always occurs in at least one of two trading countries.
- But empirical studies don't show strong evidence for FIR (Kurokawa, 2011).

[FIR is] much less important empirically than it is interesting theoretically. *Samuelson (1951)*

Definite critique of the Paradox

Leontief's test was wrong!!!

- In 1980 Edward Leamer showed that
  K/L ratios
  not in exports & imports
  but in production and consumption should be compared.

- Leamer's critique was based on Heckscher-Ohlin-Vanek model.

Heckscher-Ohlin-Vanek Model

The central point: Not trade in goods, but trade in factor services.

- Many countries (i=1,…,C), goods (j=1,…,G), factors (k=1,…F).
- Technologies are identical, CRS.
- Factor prices are equalized under free trade.
- Tastes are identical and homothetic.

- Matrix $A=[a_{jk}]'$ (F×G) denotes unit input requirements:

$$A = \begin{bmatrix} a_{L1} & a_{L2} & a_{L3} \\ a_{K1} & a_{K2} & a_{K3} \\ a_{T1} & a_{T2} & a_{T3} \end{bmatrix} \qquad A = \begin{bmatrix} 1.5 & 2 & 0.5 \\ 3 & 1.3 & 8 \\ 6 & 4.3 & 0.2 \end{bmatrix}$$

rows: factors
columns: goods

Homothetic preferences – when relative prices are constant, the consumption of each good changes by the same rate as income, i.e. consumption shares do not change.

Heckscher-Ohlin-Vanek Model

The central point: Not trade in goods, but trade in factor services.

- Output vector: Y^i $(G\times1)$.
- Demand vector: D^i $(G\times1)$.
- Net exports vector: $T^i = Y^i - D^i$

$$Y^i = \begin{bmatrix}100\\50\\80\end{bmatrix}, \quad D^i = \begin{bmatrix}70\\110\\70\end{bmatrix} \quad \Rightarrow T^i = \begin{bmatrix}30\\-60\\10\end{bmatrix}$$

- *Factor content of trade*: $F^i = AT^i$ (F×1 vector)

$$F^i \equiv AT^i = \begin{bmatrix}1.5 & 2 & 0.5\\3 & 1.3 & 8\\6 & 4.3 & 0.2\end{bmatrix} \times \begin{bmatrix}30\\-60\\10\end{bmatrix} = \begin{bmatrix}-70\\92\\-76\end{bmatrix}$$

Country i imports labor and land services, exports capital services.

$$AT^i \equiv \begin{bmatrix}F_L^i\\F_K^i\\F_T^i\end{bmatrix}$$

if $F_K^i > 0$, then country i exports resource K.

Heckscher-Ohlin-Vanek Model

The central point: Not trade in goods, but trade in factor services.

- Our goal is to explain

how the factor content of trade relates to factor endowment.

Heckscher-Ohlin-Vanek Model

The central point: Not trade in goods, but trade in factor services.

$$T^i = Y^i - D^i \qquad AT^i = AY^i - AD^i$$

- AY^i - Demand for factors

as Full Employment, then AY^i = Endowment: V^i

$$AY^i = V^i$$

$$AY^i = \begin{bmatrix} 1.5 & 2 & 0.5 \\ 3 & 1.3 & 8 \\ 6 & 4.3 & 0.2 \end{bmatrix} \times \begin{bmatrix} 100 \\ 50 \\ 80 \end{bmatrix} = \begin{bmatrix} 290 \\ 1005 \\ 831 \end{bmatrix} = V^i$$

The country is endowed with 290 units of labor, and that much labor is needed to produce 100, 50, 80 units of goods 1, 2, 3.

Heckscher-Ohlin-Vanek Model

The central point: Not trade in goods, but trade in factor services.

$T^i = Y^i - D^i$ $AT^i = AY^i - AD^i$ $AY^i = V^i$

AD^i

- As tastes are identical and homothetic, and
- Factor prices are equalized,

consumption vectors of all countries *are proportional*.

$D^i = s^i D^W$ s^i – share of country i in world consumption.
D^W – world consumption vector.

$AD^i = s^i AD^W$ $D^W = Y^W$ world consumption is necessarily equal to world production.

$s^i AD^W = s^i AY^W$ $AY^W = V^W$ V^W world endowment.

as Full Employment

$AD^i = s^i V^W$

$$F^i = V^i - s^i V^W$$

Heckscher-Ohlin-Vanek Model

The central point: Not trade in goods, but trade in factor services.

$$F^i = V^i - s^i V^W$$

- for individual factors $F_k^i = V_k^i - s^i V_k^W$
- **country is k-abundant** if $F_k^i > 0$ that is $V_k^i / V_k^W > s^i$
- country is k-abundant if country i's endowment with factor k relative to the world endowment is higher than country i's share in world consumption.
- if country is k-abundant, then **factor content of trade is positive** ($F_k^i > 0$).

Heckscher-Ohlin-Vanek Model

The central point: Not trade in goods, but trade in factor services.

$$F_K^i = K^i - s^i K^W$$

$$F_L^i = L^i - s^i L^W$$

$$\frac{K^i}{K^W} > \frac{L^i}{L^W}$$

China population: 1.357 billion
World population: 7.137 billion
China's share: 19%

China GNI: 10.8 T
World GNI: 73.4 T
China's share: 14.7%

Leamer's theorem

$$\frac{K^i}{L^i} > \frac{(K^i - F_K^i)}{(L^i - F_L^i)}$$

$K^W = (K^i - F_K^i)/s^i$ $\quad K^i/K^W = s^i K^i/(K^i - F_K^i)$

$L^W = (L^i - F_L^i)/s^i$ $\quad L^i/L^W = s^i L^i/(L^i - F_L^i)$:

$K^i/K^W > L^i/L^W$ $\quad s^i K^i/(K^i - F_K^i) > s^i L^i/(L^i - F_L^i)$:

Heckscher-Ohlin-Vanek Model

The central point: Not trade in goods, but trade in factor services.

	Exports	Imports Substitutes
Capital ($ mln.)	2.6	3.1
Labor (man-years)	182	170
K/L ($1000 / man-year)	14.0	18.2

Leamer's theorem $\frac{K^i}{L^i} > \frac{(K^i - F_K^i)}{(L^i - F_L^i)}$

	Production	Consumption
Capital ($ bln.)	327	305
Labor (mln. man-years)	47	45
K/L ($1000 / man-year)	6.946	6.737

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Thank you and take care,

but remember

The roots of education are bitter, but the fruit is sweet.

Aristotle