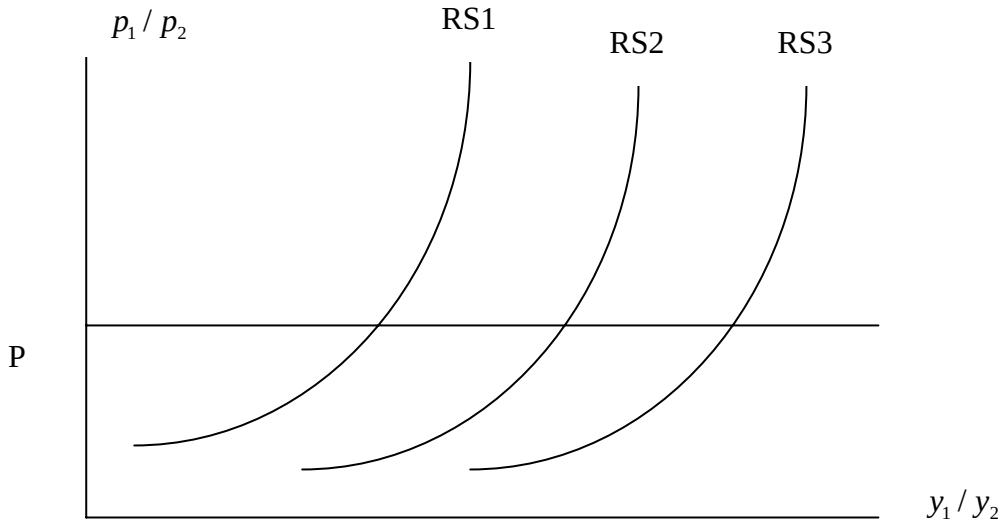
International Trade Theory (1/2008)
Chulalongkorn University
Lecture 5 the Heckscher-Ohlin Model (part II)
Kornkarun Cheewatrakoolpong, Ph.D.

The logic

- Take $\{a_{1L}, a_{1K}, a_{2L}, a_{2K}\}$ as constant and manipulate the full employment conditions to get Rybczinski theorem.
- Use property of identical homothetic tastes plus Rybczinski theorem to get Heckscher-Ohlin theorem.
- Use properties of unit cost function and common world prices to get factor price equalization theorem.
- Use property of unit cost function to show the Stolper-Samuelson theorem.
- Use applications and empirical evidence to show you the model at work.

Rybczinski Theorem (revisited)

We combine the Rybczinski theorem with our assumptions on tastes to generate the Hckscher-Ohlin theorem.



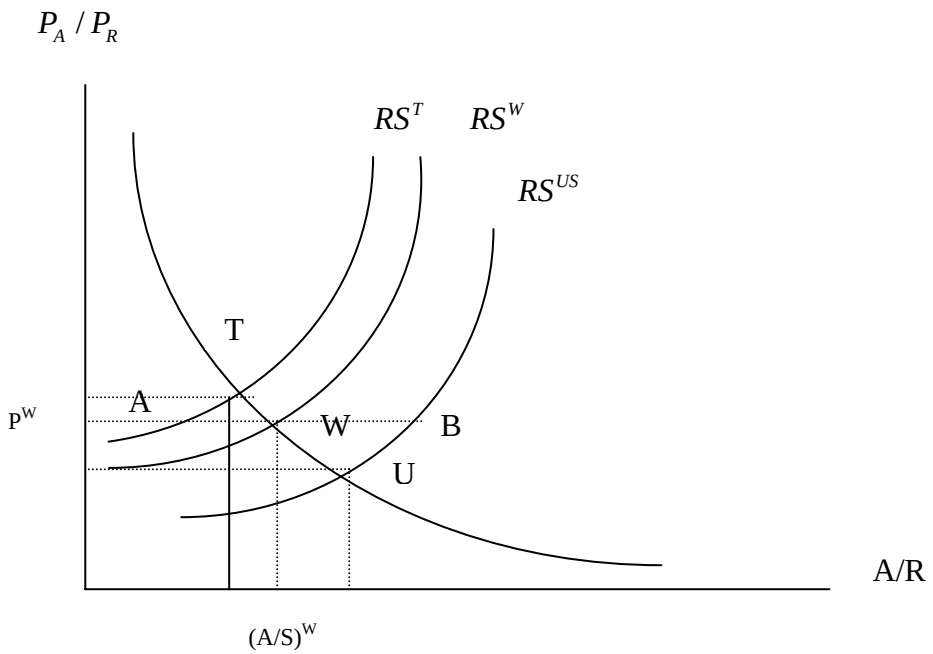
1. We know that since good 1 are labor intensive, we must have :

$$(\frac{K}{L})^3 < (\frac{K}{L})^2 < (\frac{K}{L})^1$$

2. If $K = \lambda K^*$ for $\lambda > 0$

$$L = \lambda L^*$$

Country size has no effect on comparative advantage. Suppose that there are two countries: US and Thailand. The US is capital abundant relative to Thailand. There are two goods: Automobiles and rice. Automobiles are capital intensive and rice is labor-intensive.

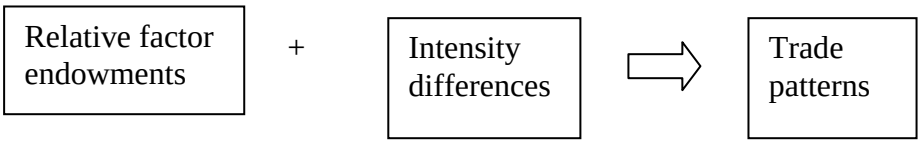


What we can see from graph?

1. US is capital abundant relative to Thailand since RS^{US} is further to the right comparing with RS^T.
2. Autarky relative price in Thailand is higher than in US. Therefore, US has comparative advantage in automobiles while Thailand has comparative advantage in rice. (Note that price is equal to unit cost because of perfect competition assumption).
3. 1) + 2) capital abundant country has comparative advantage in the capital intensive good and labor abundant country has comparative advantage in labor-intensive good.
4. After trade, everyone consumes the ratio $(A/S)^W$ from identical preference and world prices. The world as a whole produces in this ratio. But US produces at point B and Thailand produces at point A. Consumption ratios converge; Production ratios diverge. US exports automobiles while Thailand exports rice.

<u>Heckscher-Ohlin Theorem</u>

Assume countries have identical technologies and tastes; there are no barriers to trade, then the capital abundant country exports the capital intensive goods and the labor abundant country exports the labor intensive good.



In addition to establishing the trade pattern, the HO model has precise implications for who gains and who loses from trade. In summary, the abundant factor in each country gains from trade, and the scarce factor loses. The result follows from

the pattern of price changes and the Stolper-Samuelson theorem. After trade, $P_T^A < P^W < P_{US}^A$.

Using the Stolper-Samuelson, this is similar to, for Thailand, the price of rice increases. As a result, according to the Stolper-Samuelson theorem, the rental price increases and the owners of capital are better off while wage decreases and labors are worse off. For the US, the price of automobiles increases. Therefore, wage increases and rental price decreases. Labors are better off while the capital owners are worse off.

Notice that labor is the abundant factor at Thailand. The fact that $(\frac{L}{K})^T > (\frac{L}{K})^{US}$ means that labor would have been earning less in Thailand autarky than the US autarky .From concavity of the production function, MPL of Thailand < MPL of the US for both goods. However, with free trade, Thailand can shift production toward labor-intensive good and export it; therefore absorbing the abundant factor without lowering its wage. As a result, factor prices are equalized in the two countries after trade which is stated in factor price equalization theorem.

So the abundant factor will gain from trade while the scarce factor loses.

Intuition:

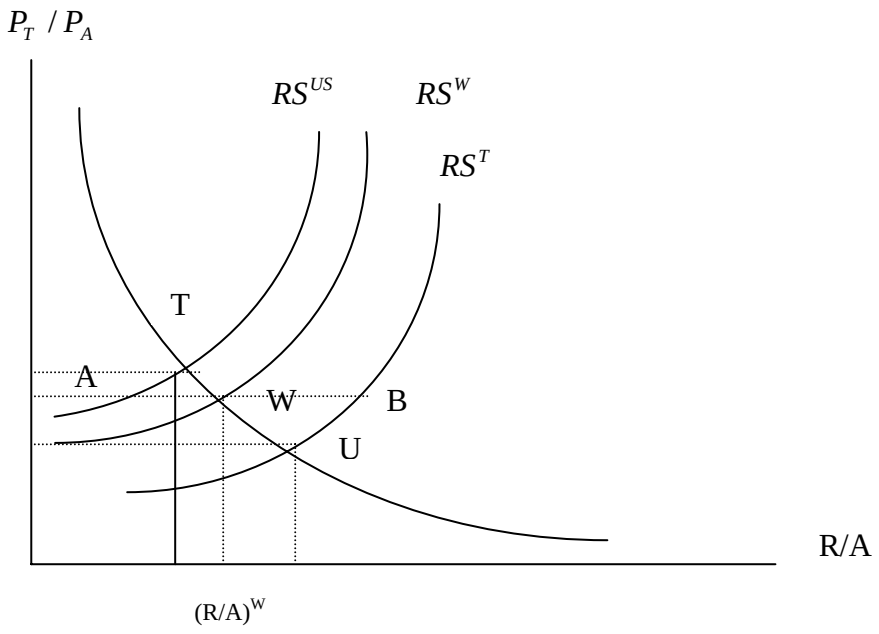
- One country has lot of one factor relative to the other. This tends to make the factor cheap.
- You cannot trade factors directly so you use the relatively cheap factor to make the good using the cheap factor.
- International trade in goods is a roundabout way to trade in service of factors. (Reminder: These countries have the same tastes and technologies).

Notes: In HO theorem, specialization and diversification do not matter for the predictions on trade patterns. Why?

1. In autarky, you have to produce both good s yourself so prices of both goods adjust to ensure that you are diversified. (Of course unless you have nonconvex preferences).
2. In trade, if you do specialize in the production of one good, it is always the good that uses your abundant factor intensively. This implies that you must export it and import the good using your scarce factor intensively which is just what you see in the HO theorem.

Why is 2) true?

Reconsider our US-Thailand example. Focus on Thailand. Japan has comparative advantage in rice because rice is labor intensive and we assume that $(\frac{L}{K})^T > (\frac{L}{K})^{US}$



Moving from autarky to trade , $P^w > P_T^A$ for Japan. This means that if they specialize, it would have been in rice, its comparative advantage good. If they do, you still get the HO theorem.

In summary, if Thailand or/and US specialize, it would not made any difference to trade pattern predictions from the HO theorem.

HO is easily to be empirically tested. For example, Thailand is labor abundant so it should export labor-intensive good and so on. However, it turns out that the HO model is a rather poor predictor of actual trade patterns, indicating that its assumptions are not realistic. However, it has taken many years to understand why this is the case. We begin the exploration by considering the earliest results by Leontif (1953) of what we call Leontief's paradox.

<u>Leontief's Paradox</u>

Leontief (1953) was the first attempt to empirically test the HO model with data. He developed the set of input-output accounts for the US economy to compute the amounts of labor and capital used in each industry for 1947. In addition, he utilized US trade data for the same year to copute the amount of labor and capital used in the production of $1 million of US exports and imports

	Export	Import
Capital ($ millions)	2.5	3.1
Labor (persons)	182	170
Capital/ labor	13,700	18,200

Since there is no knowledge of the foreign technology, Leontief simply used the US technology to calculate the amount of labor and capital used in imports which should be true to validate the test of the HO model since an assumption of the HO model is that technologies are the same across countries.

The result as shown in the table is that the capital-labor ratio in Foreign export is remarkably high comparing with US exports. However, US is capital abundant

country. Therefore, the results contradict the HO theorem which is what we called the "Leontif's paradox". There are wide ranges of the explanations for this paradox:

1. US and Foreign technologies are not the same.
2. Leontief ignored land.
3. Labor should have been disaggregated by skill (since US exports might be concentrated on the skilled labor intensive).
4. Data for 1947 may be unusual (the end of WWII)
5. US was not engaged in free trade.

Couples of years later, many research try to redo the analysis taking into account land, skilled and unskilled labor and so on. The general conclusion is that the paradox continues to occur in some cases until to decades later. Leamer (1980) provided critique of the Leontief's paradox that actually Leontief performed the wrong test! He should not compare capital/labor ratios in export and import but should perform the test relying on the factor content version of the HO model, developed by Vanek (1968), instead.

<u>Heckscher-Ohlin-Vanek (HOV) Model</u>

Consider many countries i=1,…,C, many industries j=1,..,N and many factors k,l = 1,…,M.

<u>Assumptions</u>:

1. Identical technologies
2. Factor price equalization holds
3. tastes are homothetic and identical

Let (MxN) matrix A = $[a_{jk}]'$ denote the amount of factor needed for one unit of production in each industry. Rows measures different factors and columns measure different goods.

$$A = \begin{bmatrix} a_{1L} & a_{2L} \\ a_{1K} & a_{2K} \end{bmatrix}$$

Y^i = (nx1) vector of outputs in each industry for country i

D^i = (nx1) vector of demands in each industry for each good

$T^i = Y^i - D^i$ is the net export for country i

The factor content of trade is then defined as:

$F^i = AT^i$ which is (Mx1) vector with individual components $F_k^i > 0$ if factor is exported and $F_k^i < 0$ if factor is imported. Suppose that there are two factors, labor and capital, then

$$AT^i = \begin{bmatrix} F_l^i \\ F_k^i \end{bmatrix}$$

Now $AT^i = AY^i - AD^i$ with

AY^i is the demand for factors in Country I and from the full employment condition.

$AY^i = V^i$ the endowments of Country i

Next, consider AD^i, from identical and homothetic preferences, the consumption vector must be proportional to each other.

$$D^i = S^i D^W$$

D^W = world consumption

S^i = share of Country i in the world consumption

= share of Country i of the world GDP

$$AD^i = S^i AD^W = S^i AY^W = S^i V^W \qquad (1)$$

(1) is what we call HOV theorem. If country i's endowment of factor k relative to the world endowment exceeds country i's share of world GDP, $\frac{V_k^i}{V_k^w} > S^i$, then country i is abundant in that factor.

Now if we consider the trade balance, each country's expenditure equals its factor income. Then S^i is share of country i's in the world factor endowment. If a country is endowmed with more than its share of a particular factor, then it will be not exporter of the services of that factor. This is what Leontief uses to perform his test and go Leontief's paradox. US is capital abundant and labor scarce relative to the rest of the world so it should embody more capital in its exports than in its import and less labor. However, as we saw last time, the result contradicts this presumption which brings about the famous Leontief's paradox.

An important step toward resolving Leontief's paradox is done by Leamer (1980) who noted that the US has trade surplus in 1947 which contradicts the HOV assumption. Therefore, the US in Leontief's data was actually a net exporter of both capital and labor services. Let us focus on just two elements of the factor content vectors, labor and capital.

$$F_k^i = K^i - S^i K^W \qquad (2)$$

$$F_l^i = L^i - S^i L^W$$

We define capital to be abundant relative to labor in country i if $\frac{K^i}{K^w} > \frac{L^i}{L^w}$

then from (2),

$$K^W = (K^i - F_k^i)/S^i$$

$$L^W = (L^i - F_l^i)/S^i$$

Therefore, $$\frac{K^i}{K^w} = \frac{S^i K^i}{K^i - F_k^i}$$

$$\frac{L^i}{L^w} = \frac{S^i L^i}{L^i - F_l^i}$$

Therefore, $\frac{K^i}{K^w} > \frac{L^i}{L^w}$ implies that $$\frac{K^i}{K^i - F_k^i} > \frac{L^i}{L^i - F_l^i} \qquad (3)$$

Now K^i and L^i are simply the endowments of capital and labor or the capital and labor embodied in production. If we subtract the content of factors embodied in trade, then we end up with the factor content of consumption. Therefore, (3) states that capital abundant should be tested by capital/labor ratio of production exceeding the capital/labor ratio embodied in consumption.

Theorem (Leamer 1980)

HOV theorem (1) implies that capital / labor ratio embodied in production for country i exceeds the ratio embodied in consumption.

Leamer makes this comparison for the US in 1947 and got the following table.

	Production	Consumption
Capital ($ billions)	327	305
Labor (millions person/year)	47	45
Capital/ labor ($/person)	6,949	6,737

Therefore, there is no paradox after all.