ECO 445/545: International Trade

Jack Rossbach

Spring 2016

Previous Lectures: Ricardian Framework

- Countries have single factor of production (labor)
- Countries differ in their labor productivities for producing different goods, only source of comparative advantage

Common uses:

- Understanding effects of trade barriers
- Thinking about transfers (e.g. war reparations, trade imbalances)
- Understanding the effects of technological progress

Heckscher-Ohlin Framework

- Multiple factors of production
- Same production technology across countries, goods differ in their factor intensities
- Countries differ in their factor endowments, only source of comparative advantage

Common uses:

- Understanding the effect of trade on wages and capital prices
- Effect of trade on capital accumulation and investment
- Thinking about factor mobility: migration and foreign investment

Standard H-O Framework (2x2x2)

- Two countries: $i, j = 1,2$ (naming countries 1 and 2 instead of H and F)
- Two goods: $z = 1,2$ (using z instead of m to represent good)
- Two factors of production: K and L
- Same technology function for good z in each country (homogeneous of degree 1):

$$y_{i,z} = A_z\left(k_{i,z}\right)^{\alpha_z}\left(l_{i,z}\right)^{1-\alpha_z}$$

- Goods differ in their factor intensity: $1 > \alpha_1 > \alpha_2 > 0$ (no factor intensity reversals)
- Countries differ in their relative factor endowments:

$$\frac{K_1}{L_1} > \frac{K_2}{L_2}$$

Equilibrium Definition

Equilibrium Elements

- Factor prices: $\{\hat{r}_i, \widehat{w}_i\}_{i=1,2}$
- Good prices:$\{\hat{p}_1, \hat{p}_2\}$
- Consumption, output, factor alloctions: $\left\{\hat{c}_{i,z}, \hat{y}_{i,z}, \hat{k}_{i,z}, \hat{l}_{i,z}\right\}_{i=1,2;z=1,2}$

Such that

1. Consumers maximize utility
2. Firms maximize profits
3. Markets clear

Consumer Problem

Consumers in country i maximize utility (identical across countries and homothetic):

$$\max \theta_1 \log c_{i,1} + \theta_2 \log c_{i,2}$$

Subject to their budget constraint

$$p_1 c_{i,1} + p_2 c_{i,2} = w_i L_i + r_i K_i$$

Firm Problem

Firms in country i producing good z maximize profits

$$\max p_z y_{i,z} - w_i l_{i,z} - r_i k_{i,z}$$

Subject to their production function

$$y_{i,z} = A_z \left(k_{i,z}\right)^{\alpha_z} \left(l_{i,z}\right)^{1-\alpha_z}$$

Market Clearing

Goods market clearing:

$$c_{1,z} + c_{2,z} = y_{1,z} + y_{2,z}, \qquad z = 1,2$$

Factor market clearing

$$l_{i,1} + l_{i,2} = L_i, \qquad i = 1,2$$

$$k_{i,1} + k_{i,2} = K_i, \qquad i = 1,2$$

Patterns of Production and Trade

Four big theorems:

- Heckscher-Ohlin theorem
- Rybczynski theorem
- Stolper-Samuelson theorem
- Factor-price equalization theorem

Heckscher-Ohlin Theorem

Countries export the good that is more intensive in the factor that the country is abundant in

- Country 1 is capital abundant $\left(\frac{K_1}{L_1} > \frac{K_2}{L_2}\right)$ and therefore will export good 1 $(\alpha_1 > \alpha_2)$
- Country 2 is labor abundant $\left(\frac{L_2}{K_2} > \frac{L_1}{K_1}\right)$ and therefore will export good 2 $(1 - \alpha_1 > 1 - \alpha_2)$

Rybcznski Theorem

If the amount of factor increases, the production of the good that makes more intensive use of that factor will increase and the production of the other good will decrease

- Suppose K_1 increases to K_1'. Then $y_{1,1}' > y_{1,1}$, while $y_{1,2}' < y_{1,2}'$ (since $\alpha_1 > \alpha_2$)
- Captital stock of Country 1 Increases ⇒ Produces more good 1, less good 2.

Stolper-Samuelson Theorem

When the relative price of a good increases, the relative price of the factor that is used more intensively in the production of that good will increase, and the relative price of the other factor will decrease.

- Normalize $p_2 = 1$. Suppose p_1 increases to p_1'. Then $r_i' > r_i$ and $w_i' < w_i$ (since $\alpha_1 > \alpha_2$)

- Price of capital-intensive good increases ⇒ Price of capital increases, wages decrease

Factor Price Equalization Theorem

If both countries produce both goods, then factor prices will be equal across countries

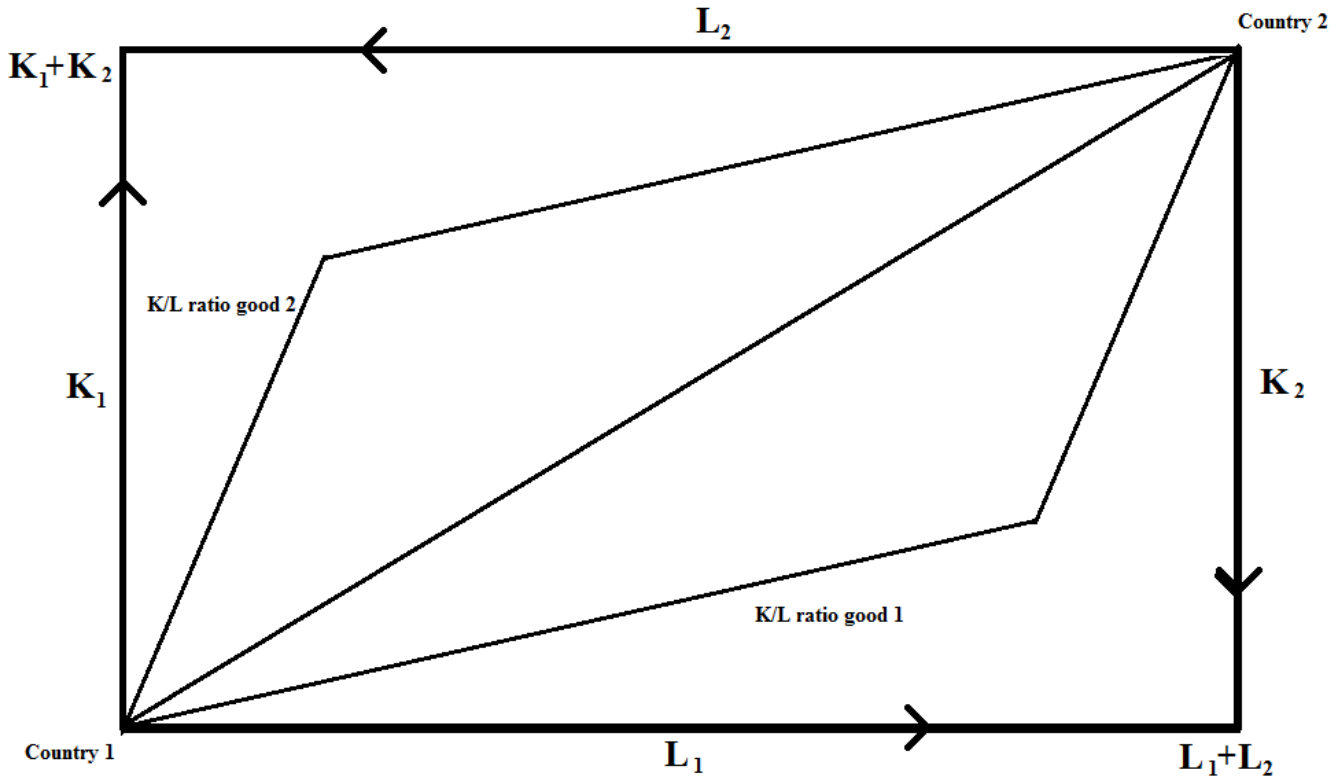
- If $y_{i,z} > 0 \; \forall i, z = 1,2$, then $w_1 = w_2 = w$ and $r_1 = r_2 = r$
- Wages and Capital Rental Rates equal across countries if both countries make both goods

Integrated Economies

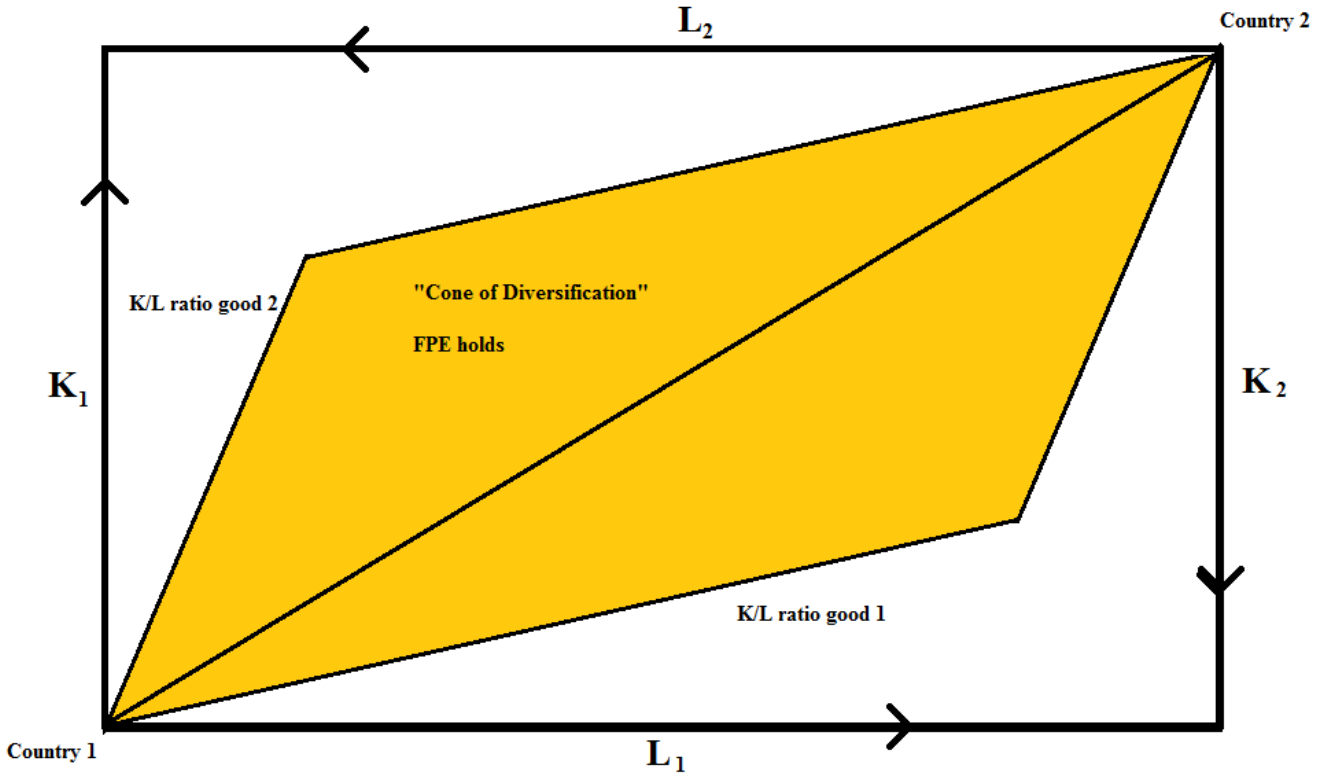
Suppose that factors are mobile across countries in addition to free trade

- Is the resulting equilibrium (consumption/prices) the same as when factors are immobile?
- If in “cone of diversification”: Yes
    - Factor price equalization theorem will hold
    - If factor prices and good prices are already equalized across countries from free trade, no additional gains from allowing mobile factors

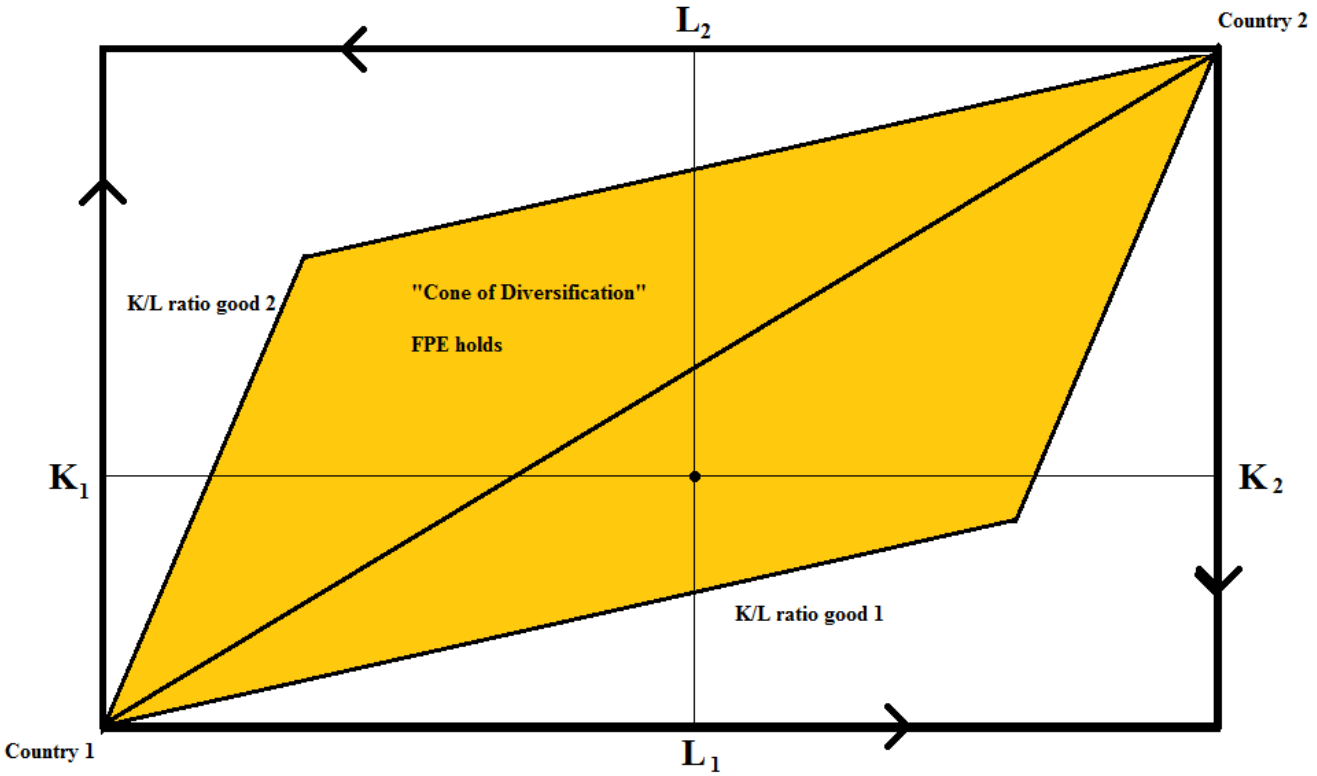
Graphical Analysis: Edgeworth Diagram



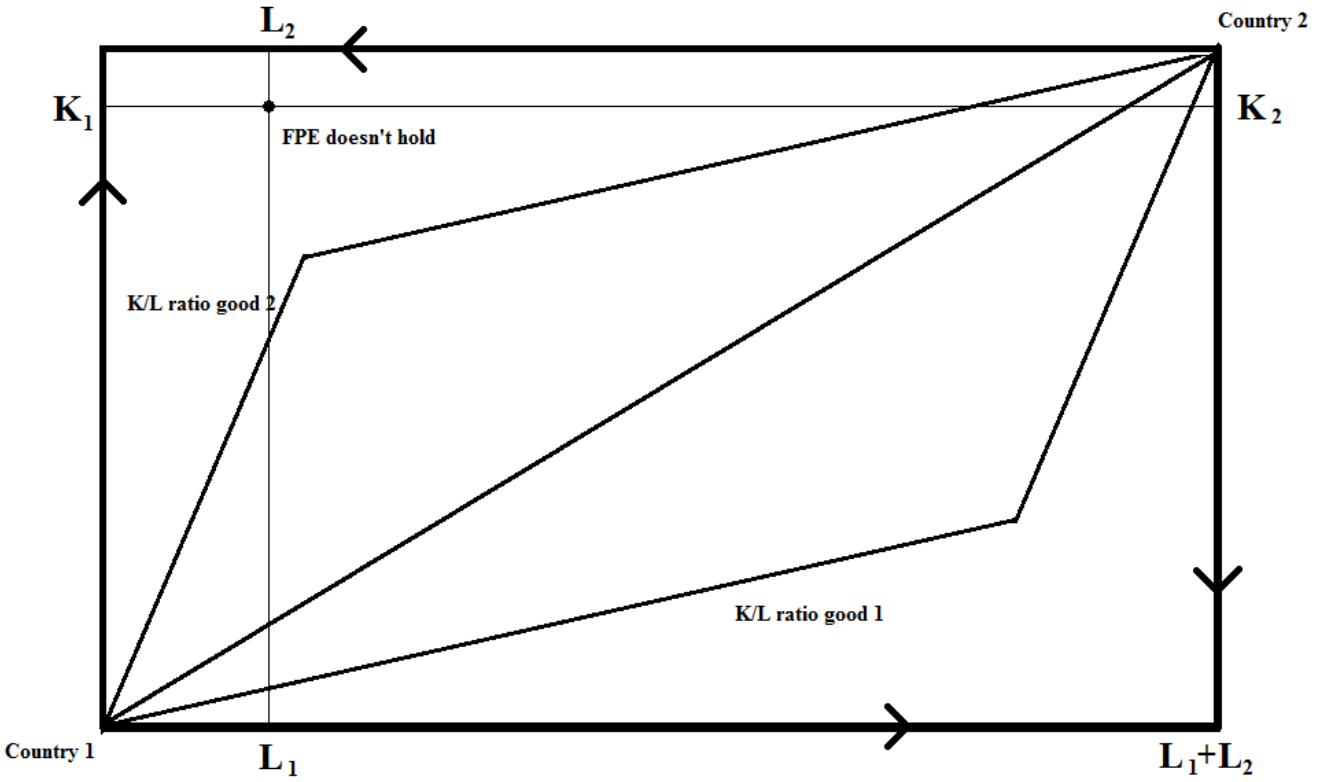
Graphical Analysis: Edgeworth Diagram



Graphical Analysis: Edgeworth Diagram



Graphical Analysis: Edgeworth Diagram



Winners and Losers from Trade

Suppose within each country there are workers and capital owners

- Workers gain income only from wages
- Capital owners gain income only from capital rents

What happens to the welfare of each group when moving from autarky to free trade?

- Stolper-Samuelson theorem: owners of the scarce factor will see their real returns go down
- Opens avenue for some groups to lose from trade

Giant Sucking Sound

Famous quote about NAFTA from Ross Perot in 1992 Presidential Debate

“It's pretty simple: If you're paying $12, $13, $14 an hour for factory workers and you can move your factory South of the border, pay a dollar an hour for labor,...have no health care—that's the most expensive single element in making a car— have no environmental controls, no pollution controls and no retirement, and you don't care about anything but making money, there will be a giant sucking sound going south.

...when [Mexico's] jobs come up from a dollar an hour to six dollars an hour, and ours go down to six dollars an hour, and then it's leveled again. But in the meantime, you've wrecked the country with these kinds of deals.”

Effects of Free Trade

Suppose country moves from autarky to free trade

- From profit maximization we have $GDP_i^{trade} \geq GDP_i^{autarky}$
- Household types can be worse off if cost of utility equivalent autarky consumption bundle increases relative to the revenue earned from household factor endowments
- Can domestic transfers between household types make it so there are no losers from trade? Answer is Yes.

(Note: Second Welfare Theorem holds, so can certainly make everybody better off with cross-country transfers)

Pareto Optimality of Free Trade

- No need for cross-country transfers to make everybody better off under free trade
- Within-country transfers sufficient

Caveat: Flat transfers difficult in practice

- Marginal taxes/subsidies can offset gains from trade
- Still no households worse off if only marginal taxes/subsidies available

Extension: Sector Specific Factors (Ricardo-Viner Model)

Suppose there are two types of capital, each specific to a certain good.

Production technology for good 1 (homogeneous of degree one):

$$y_{i,1} = f_1(l_{i,1}, k_{i,1})$$

$$y_{i,2} = f_2(l_{i,2}, k_{i,2})$$

And market clearing is

$$l_{i,1} + l_{i,2} = L_i$$

$$k_{i,1} = K_i^1$$

$$k_{i,2} = K_i^2$$

Application of Extension: Lobbying for Protection

Grossman and Helpman (1994):

- $z = 1, .., M$ goods and sector specific capital for each good
- Multiple households in country, households of type z own one unit of capital of type K_z
    - Some households own no capital
- Each household owns one unit of labor
- Small open economy, so world prices given.
- Government can levy import tariffs and export subsidies on goods.

Application: Lobbying for Protection

- Set of households types that contain organized lobbies Z_L
- Lobbying: Households of type $z \in Z_L$ can contribute to Government campaign revenues: R_z
  - Will depend on the tariffs/export subsidies, or equivalently effective prices: p
- Government maximizes a weighted combination of campaign revenues and welfare

$$\max_p \sum_{z \in Z_L} R_z(p) + \alpha \sum_{z \in Z} W(p)$$

- Can derive equilibrium set of campaign revenue functions $R_z(p)$ and resulting equilibrium tariffs
  - Equilibrium tariffs will depend on fraction of population owning a specific factor

Higher Dimensional H-O Models

Suppose we have two countries, but F factors of production and M goods. Three cases:

Case 1: More factors than goods ($F > M$)

- Goods can't be intensive in a single factor, no FPE (cone of diversification has measure zero).

Case 2: Equal number of factors and goods ($F = M$)

- Everything goes through similar to 2x2x2 framework

Case 3: More goods than factors ($M > F$)

- FPE can hold, but pattern of production/trade indeterminate.

Higher Dimensional H-O Models

FPE may not hold with general number of factors/goods, what about other theorems?

- Stolper-Samuelson results hold generally: Every good still has some factors that, if the factor price increases ⇒ good production increases (or, conversely, good production decreases)

- Rybczynski results only hold if $\mathrm{F} = M$. If $F > M$ could have all goods increase output when a factor endowment increases. If $M > F$ pattern of production/trade still indeterminate.

- H-O results only hold if $F = M$. If $F > M$, goods aren‘t necessarily abundant in a factor; if $M > F$ pattern of production/trade indeterminate

- Alternative to H-O Theorem: Heckscher-Ohlin-Vanek Theorem

Heckscher-Ohlin-Vanek Theorem

Countries will export the factors they are relatively abundant in (share of factor in total exports higher than world's share of factor)

- Similar to H-O theorem, but doesn't make predictions about what specific commodities are traded, instead about the factor content of trade flows

- Doesn't require $F = M$ (does require $F \leq M$)

Testing the H-O Framework Empirically

H-O framework makes predictions regarding patterns of trade and changes in factor prices

- Some of the main predictions depend on number of goods and number of factors
- Not clear whether more goods or factors, but probably don‘t have equal number of each
- If more factors than goods, pattern of trade in goods is determinate, but no factor price equalization. Can test if predicted goods are exported.
- If more goods than factors, then pattern of trade in goods is indeterminate, but can use Heckscher-Ohlin-Vanek Theorem for predictions regarding factor content of trade

Leontief (1953) Paradox

Leontief used the 1947 U.S. input-output table to examine the capital and labor shares for different industries in the U.S.

- In 1947 the U.S. economy was the most capital abundant country in the world
- Look at capital (USD) per worker in both exports and imports and found:

$$(K/L)_{Imports} = \$18{,}200, \qquad (K/L)_{Exports} = \$13{,}700;$$

- Contrary to H-O theory, imports were more capital intensive than exports
- Similar results for other years

Leontief (1953) Paradox: Possible Explanations

Many proposed explanations for the Leontief paradox

- Technologies different across countries
- The U.S. in abundant in skilled labor
- Missing factors
- Unsuitable test of H-O theory

Leontief (1953) Paradox: Possible Explanations

	Imports	Exports
Capital per million dollars	$2,132,000	$1,876,000
Labor (person-years) per million dollars	119	131
Capital-labor ratio (dollars per worker)	$17,916	$14,321
Average years of education per worker	9.9	10.1
Proportion of engineers and scientists in work force	0.0189	0.0255

Source: Robert Baldwin, "Determinants of the Commodity Structure of U.S. Trade," *American Economic Review* 61 (March 1971), pp. 126–145.

Leontief (1953) Paradox: Leamer's (1980) Response

- Leamer argued that comparing the capital and labor ratios in trade not proper test of H-O theory
- Instead, should look at capital and labor ratios of production and consumption.
- Therefore, if U.S. is capital intensive, test should be:

$$\frac{K_{US}}{L_{US}} > \frac{K_{US} - K_{US}^{net\ trade}}{L_{US} - L_{US}^{net\ trade}}$$

Not, as Leontief tested,

$$\frac{K_{US}^{exports}}{L_{US}^{exports}} > \frac{K_{US}^{imports}}{L_{US}^{imports}}$$

- Leamer found that the U.S. satisfied the first test, consistent with H-O theory

Leamer's (1980) Response: Reasoning

Why don't exports have to be more capital intensive than imports if US is capital abundant?

- Trade can be unbalanced
- If trade balanced then Leontief's test is correct, however, U.S. ran large trade surplus in 1947.
- Example: $K^{exports} = .4K; K^{imports} = .1K; L^{exports} = .3L; L^{imports} = .05L$. Then, both:

$$\frac{K_{US}^{imports}}{L_{US}^{imports}} = 2\frac{K}{L} > \left(\frac{4}{3}\right)\frac{K}{L} = \frac{K_{US}^{exports}}{L_{US}^{exports}}$$

$$\frac{K}{L} > \frac{K - K^{exports} + K^{imports}}{L - L^{exports} + L^{imports}} = \frac{K - .4K + .1K}{L - .3L + .05L} = \left(\frac{.7}{.75}\right)\frac{K}{L}$$

Followup to Leamer

Bowen, Leamer, and Sveikaukas (1987):

- H-O theory still has predictions for factor content of trade even if trade unbalanced
    - Factor Ratios misleading, but Net Factor Exports don’t have same problem
- Two tests: Sign test and Rank test
    - Are countries net exporters of factors they are most abundant in?
    - Compare two factors: are net exports higher in factor the country is more abundant in?

Followup to Leamer

Bowen, Leamer, and Sveikaukas (1987):

- H-O theory still has predictions for factor content of trade even if trade unbalanced
    - Factor Ratios misleading, but Net Factor Exports don't have same problem
- Two tests: Sign test and Rank test
    - Are countries net exporters of factors they are most abundant in?
    - Compare two factors: are net exports higher in factor the country is more abundant in?
    - **Results**: Sign test correct 61% of the time, rank test correct 49% of the time.

Testing H-O Theory: Technological Differences

Trefler (1993): Allows for technological differences across countries for each factor

- Effective endowment of factor f is scaled by factor productivity: $v_{i,f}^{effective} = A_{i,f} v_{i,f}$
- Test whether factor returns are proportional to factor productivity (should have slope of 1 if FPE)

Labor Productivity vs Wage Rate: Slope Close to 1

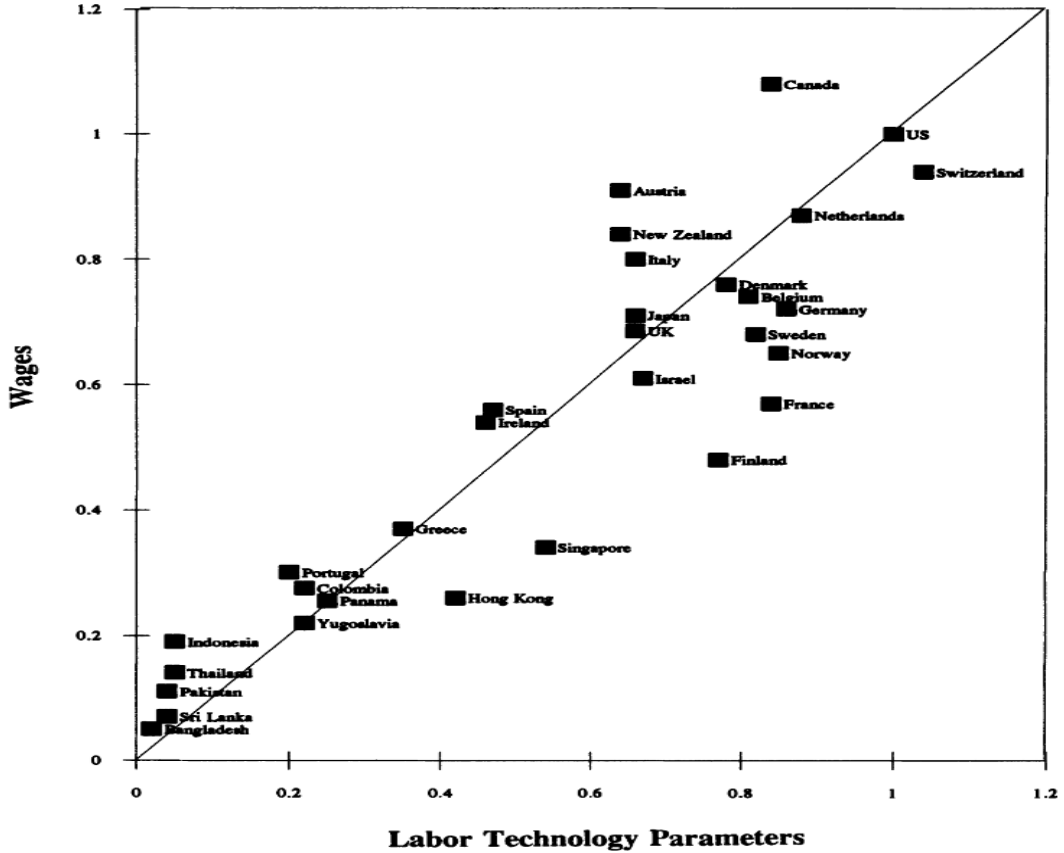


FIG. 1.—Wages and labor technology parameters

Graph from Trefler (1993)

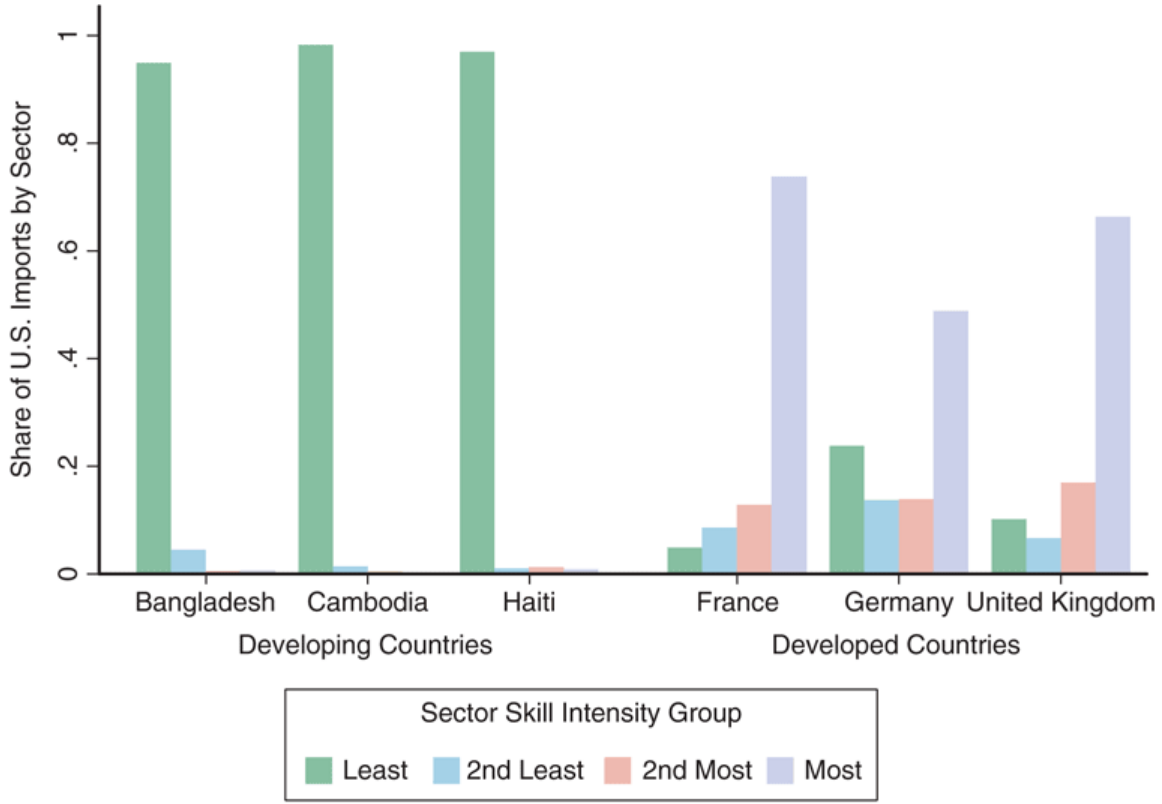
Labor Productivity For Selected Countries

Country	
Bangladesh	0.03
Thailand	0.17
Hong Kong	0.40
Japan	0.70
West Germany	0.78

Source: Daniel Trefler, "The Case of the Missing Trade and Other Mysteries," *American Economic Review* 85 (December 1995), pp. 1029–1046.

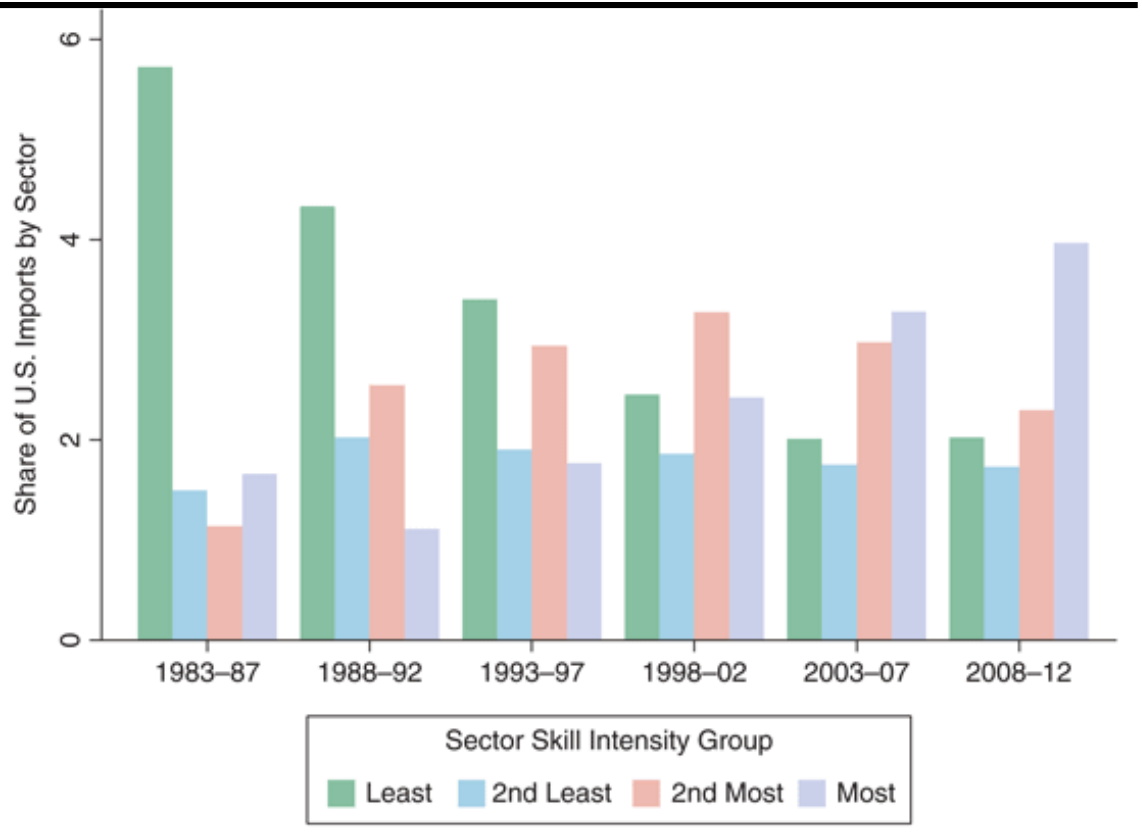
Graph from Trefler (1993)

Developing Countries Export Primarily Low-Skilled Manufactures



Source: NBER-CES U.S. Manufacturing Productivity Database, U.S. Census Bureau, and Peter K. Schott, "The Relative Sophistication of Chinese Exports," *Economic Policy* (2008), pp. 5–49.

Pattern of Chinese Exports over Time



Source: NBER-CES U.S. Manufacturing Productivity Database, U.S. Census Bureau, and Peter K. Schott, "The Relative Sophistication of Chinese Exports," *Economic Policy* (2008), pp. 5–49.

Testing H-O Theory: Technological Differences

Trefler (1993): Allows for technological differences across countries for each factor

- Effective endowment of factor f is scaled by factor productivity: $v_{i,f}^{effective} = A_{i,f} v_{i,f}$
- Test whether factor returns are proportional to factor productivity (should have slope of 1 if FPE)

Caveats

- Caveat 1: Trade flows much smaller in data than predicted by base H-O model.
- Caveat 2: Way factor productivity parameters are computed can make results mechanical. Can be approximately equal to GDP per factor for small economies. Therefore results just reflecting that that wages are correlated with GDP per capita.

Failure of H-O Theory Due to Assumptions That Don't Hold

	Assumptions Dropped*			
	None	**Drop (1)**	**Drop (1)–(2)**	**Drop (1)–(3)**
Predictive Success (sign test)	0.32	0.50	0.86	0.91
Missing Trade (observed/ predicted)	0.0005	0.008	0.19	0.69

*Assumptions: (1) common technologies across countries; (2) countries produce the same set of goods; and (3) costless trade equalizes goods prices.

Source: Don R. Davis and David Weinstein, "An Account of Global Factor Trade," *American Economic Review* (2001), pp. 1423–1453.

Wrap Up of Heckscher-Ohlin Trade Theory

Provides an alternative to comparative advantage based on technological differences

- Intuitively, makes a lot of sense. Fits view lots of people have of the world
- Gives us a way to think about Winners and Losers from trade

Why we won't be focusing on it more

- Difficulty generalizing model and taking it to data
- Only works well if you drop almost all the assumptions that make the model nice to work with
- Not much recent research makes use of it anymore. Other models seem to work better.