Lecture 6 H-O Factor Endowment Theory

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Reference: Feenstra and Taylor, 2017, International Trade, Ch4 Trade and Resources: The H-O Model

Why do the U.S., Western Europe, and Japan export more sophisticated services and manufactured goods? Why do China and other Asian countries export less sophisticated manufactured goods?
https://atlas.media.mit.edu/en/visualize/tree_map/hs92/export/usa/all/show/2017/
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As a significant enrichment to the comparative advantage theory, the Heckscher-Ohlin factor endowment theory explores the source of comparative advantage and further examines the income distribution effects of trade in the long-run when all factors can move across sectors within the country. In this lecture, we will also discuss the empirical evidence and a famous paradox arising from testing the H-O model.

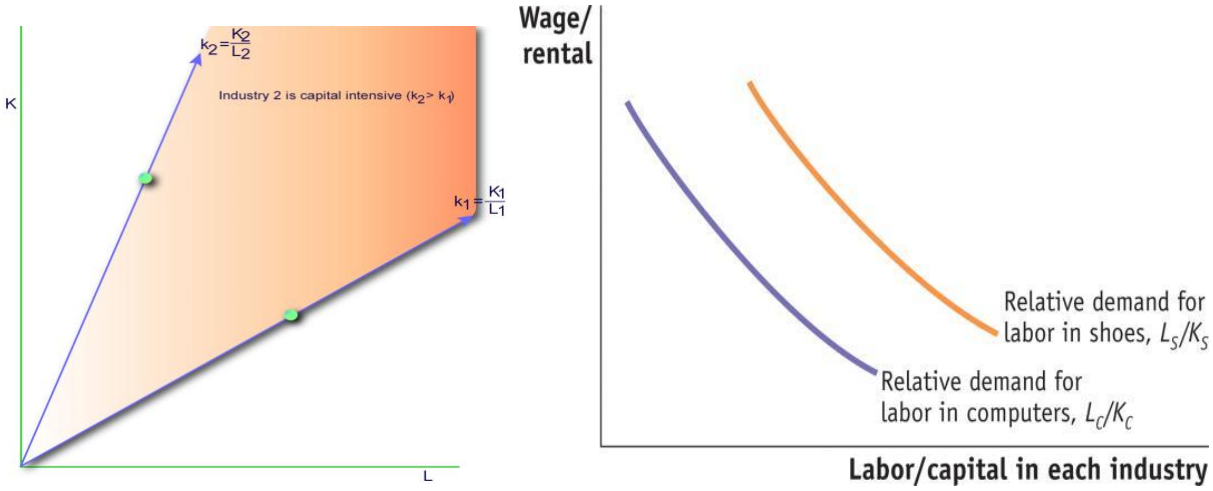
World Price Convergence: $\left(\frac{Pc}{Ps}\right)^H \uparrow \rightarrow \left(\frac{Pc}{Ps}\right)^* \leftarrow \downarrow \left(\frac{Pc}{Ps}\right)^F$ & $\left(\frac{R}{W}\right)^H \uparrow \rightarrow \left(\frac{R}{W}\right)^* \leftarrow \downarrow \left(\frac{R}{W}\right)^F$

Trade Effects in Home (capital abundant): $\left(\frac{Pc}{Ps}\right) \uparrow \Rightarrow \left(\frac{R}{W}\right) \uparrow \Rightarrow \left(\frac{K}{L}\right) \downarrow \Rightarrow MPK \uparrow \& MPL \downarrow$

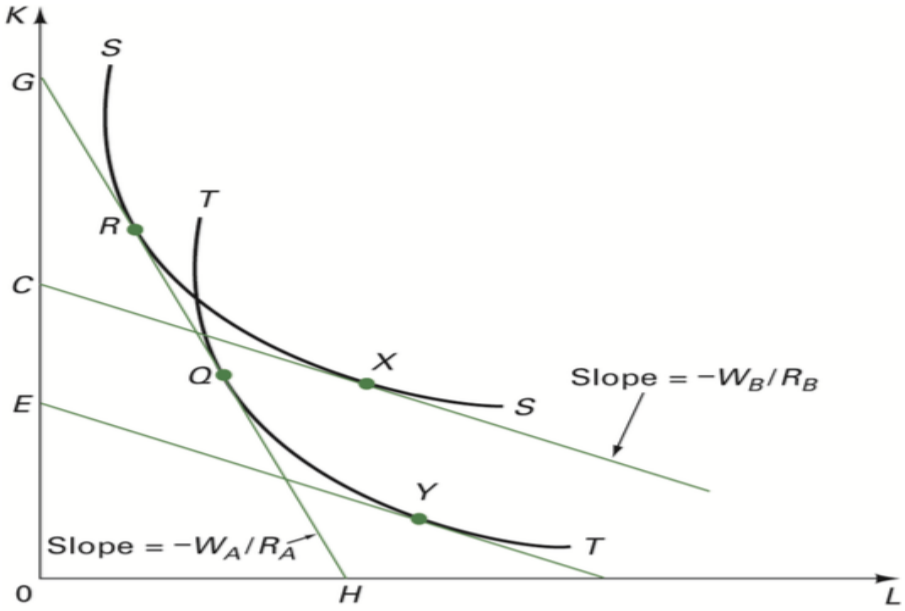
Trade Effects in Foreign (labor abundant): $\left(\frac{Pc}{Ps}\right) \downarrow \Rightarrow \left(\frac{R}{W}\right) \downarrow \Rightarrow \left(\frac{K}{L}\right) \uparrow \Rightarrow MPK \downarrow \& MPL \uparrow$

I. Model Assumptions
1. Two countries, two industries, and two factors
2. Home country is capital-abundant and Foreign country is labor-abundant
3. Two sectors: capital-intensive sector (computer) & labor-intensive sector (shoe)
4. Both countries have access to the same production technology (*!!*)
5. Production factors, labor and capital, are mobile across different sectors (*!*)
6. Products are tradable between countries whereas factors are not tradable
7. Consumers have the same tastes across countries and they do not vary with income.
8. No transportation and transaction costs considered

II. Two pivotal concepts
1. Factor endowment: a country's resources available in production
   1) Home country is a capital abundant country: Home(K/L)>Foreign(K/L)
   2) Foreign country is a labor abundant country: Foreign(L/K)>Home(L/K)
2. Factor intensity: the ratio of production inputs applied in the production
   1) Computer is a capital-intensive product with input requirement (K/L)c>(K/L)s
   2) Shoe is a labor-intensive product with input requirement (L/K)s>(L/K)c
   3) Given the relative price of wage to rent, the relative demand for labor is greater in shoe production than in computer production. Why?



3. Factor endowment, factor prices, factor intensity, and marginal rate of technological substitution
   1) In capital abundant country, the price of capital is relatively cheap; in labor abundant country, the price of labor is relatively cheap. Thus, Home(W/R)>Foreign(W/R)
   2) Recall the concepts of iso-quanit and MRTS. SS curve represents capital-intensive production (iso-quantity curve) and TT curve represents labor-intensive production (iso-quantity curve).
   3) At a factor price ratio WA/RA (capital is relatively cheap), the capital abundant country will adopt capital-intensive method to produce both goods (point R and Q)
   4) At a factor price ratio WB/RB (labor is relatively cheap), the labor abundant country will adopt labor-intensive method to produce both goods (point X and Y), implied by cost minimization.
   5) When factor price changes, a country can choose among different factor intensity production methods subject to the cost minimization constraint.

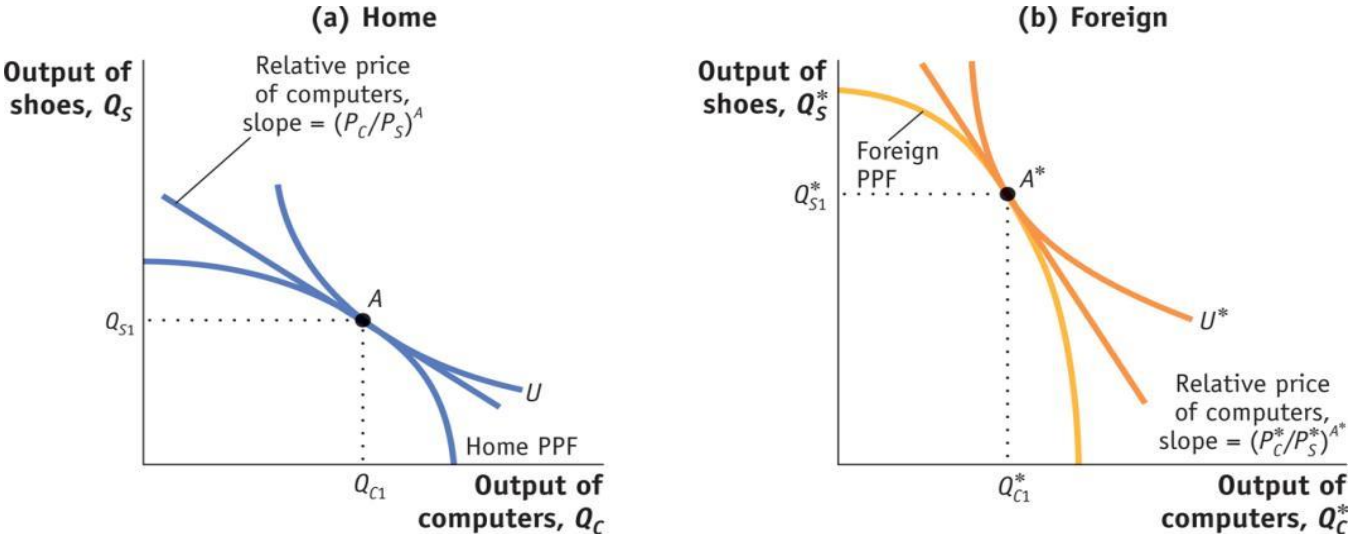


III. Autarky equilibrium

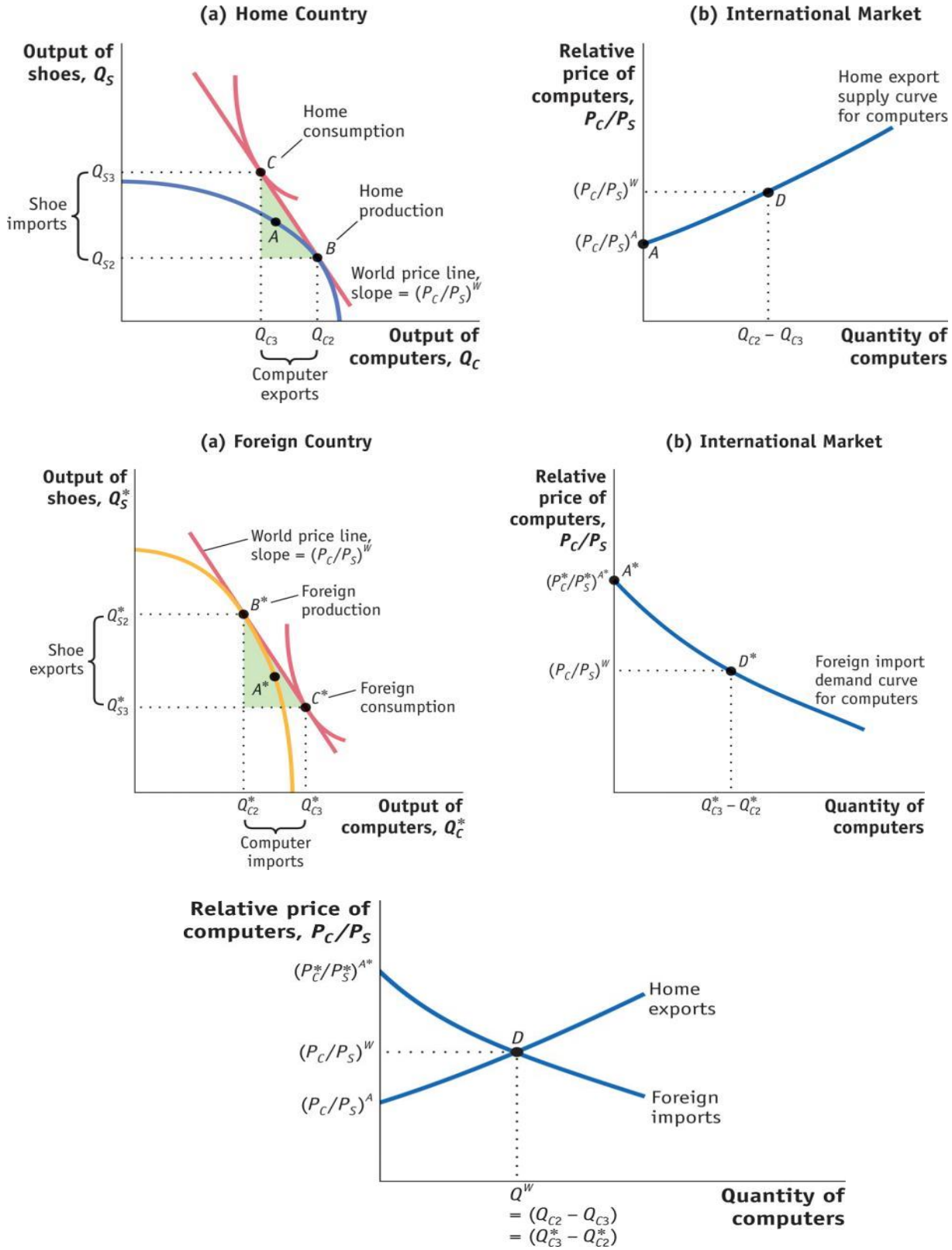
1. In autarky, home country produces more of computers and less of shoes because it is a capital abundant country and capital is **relatively** cheap so that its production is capital-intensive and pro-computers.
2. In autarky, foreign country produces more of shoes and less of computers because it is a labor abundant country and labor is relatively cheap so that production is labor intensive and pro-shoes.
3. Since total cost of producing computer is lower in capital abundant country (Why? Can you prove?), the price of computer is cheaper, home country consumers are willing and able to consume more computers than foreign consumers.
4. Since total cost of producing shoes is lower in labor abundant country, the price of shoe is cheaper, foreign consumers are willing and able to consume more shoes than home country consumers.
5. Example: home country w=3, r=1; foreign country w=1, r=3; unit computer production Kc=20, Lc=1; unit shoe production Ks=1, Ls=2; what would be the costs for H and F?

		Home	Foreign
Wage		$3	$1
Rent		$1	$3
Factor Input	Comp	K= 20 & L=1	K= 20 & L=1
	Shoe	K=1 & L=2	K= 1 & L=2
Total Cost	Comp		
	Shoe		

6. Since computers are cheaper in the home country and shoes are cheaper in foreign country, it offers opportunities to trade, specialization, and more trade.



IV. Trade equilibrium: Home(Pc/Ps) < (Pc/Ps)* <Foreign(Pc/Ps) & Export=Import



V. Empirical evidence on H-O model and Leontief Paradox

H-O model predicts that the U.S. would have exported more of capital-intensive products and imported more of labor-intensive products, since it is one of the richest country in the world with abundant capital resources. The first serious attempt to test the theory was made by Professor Wassily W. Leontief in 1953. Leontief reached a paradoxical conclusion that the US—the most capital abundant country in the world by any criterion—exported labor-intensive commodities and imported capital- intensive commodities. This result has come to be known as the Leontief Paradox.

1. Leontief's test (1947): To perform the test, Leontief used the 1947 input-output table of the US economy (He received his Nobel prize for his contribution to input-output analysis later). He aggregated industries into 50 sectors, but only 38 industries produced commodities that enter the international markets, and the remaining 12 sectors were created for accounting identities and nontraded goods. He also aggregated factors into two categories, labor and capital. He then estimated the capital and labor requirements to produce:

	Exports	**Imports**
Capital ($ millions)	2.55	3.1
Labor (person-years)	182	170
Capital/Labor ($/person)	14,000	18,200

Table: Leonief's test on H-O model with 1947 U.S. data.

2. Some other relevant findings: Boris Swerling (1953) complained that 1947 was not a typical year: the postwar disorganization of production overseas was not corrected by that time. Leontief (1956) repeated the test for 1951 U.S. data by aggregating industries into 192 sectors. He found that US imports were still more capital-intensive than US exports. US imports were 6% more capital-intensive. Robert Baldwin (1971) used the 1962 US trade data and found that US imports were 27% more capital-intensive than US exports. The paradox continued.
3. What went wrong? The theory or the test? Several possible explanations.
    1) U.S. and foreign technologies are not the same, in contrast to what the model assumed.
    2) By focusing only on labor and capital, Leontief ignored land abundance.
    3) Factor heterogeneity: we should have distinguished between skilled and unskilled labor (because it would not be surprising to find that U.S. exports are intensive in skilled labor).
    4) The data for 1947 may be unusual because World War II had ended just two years earlier.
    5) The United States was not engaged in completely free trade, as the model assumes.
    6) Factor intensity reversal: capital-rich country adopts capital-intensive technology in producing the products to which labor-rich country applies labor-intensive technology.
    7) Differences in consumption preference. More specifically, capital-rich country extremely prefers consumption on the capital-intensive products.

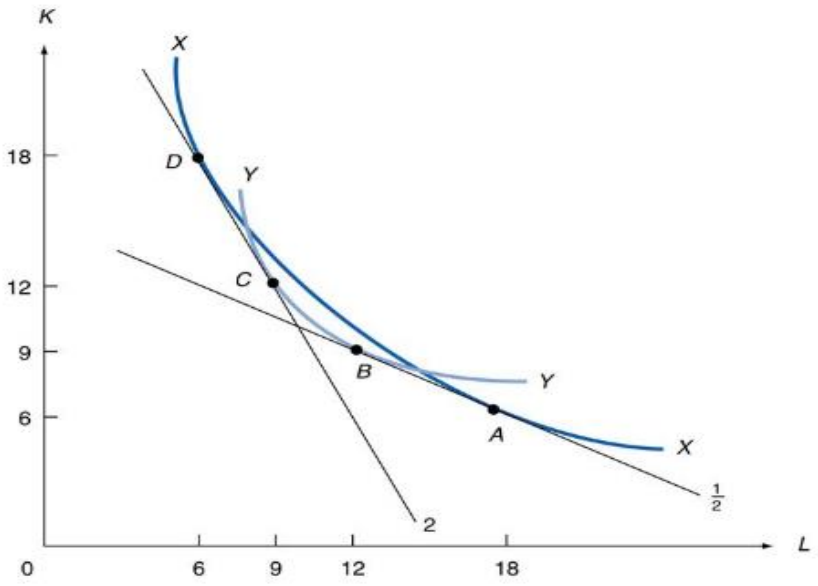


Figure: Factor intensity reversal in production

VI. Cross-country factor endowment comparison

1. Measurement: the ratio of a country's share of a factor to its share of world GDP. If its share of a factor exceeds (is less than) its share of world GDP, then the country is abundant (scarce) in that factor.

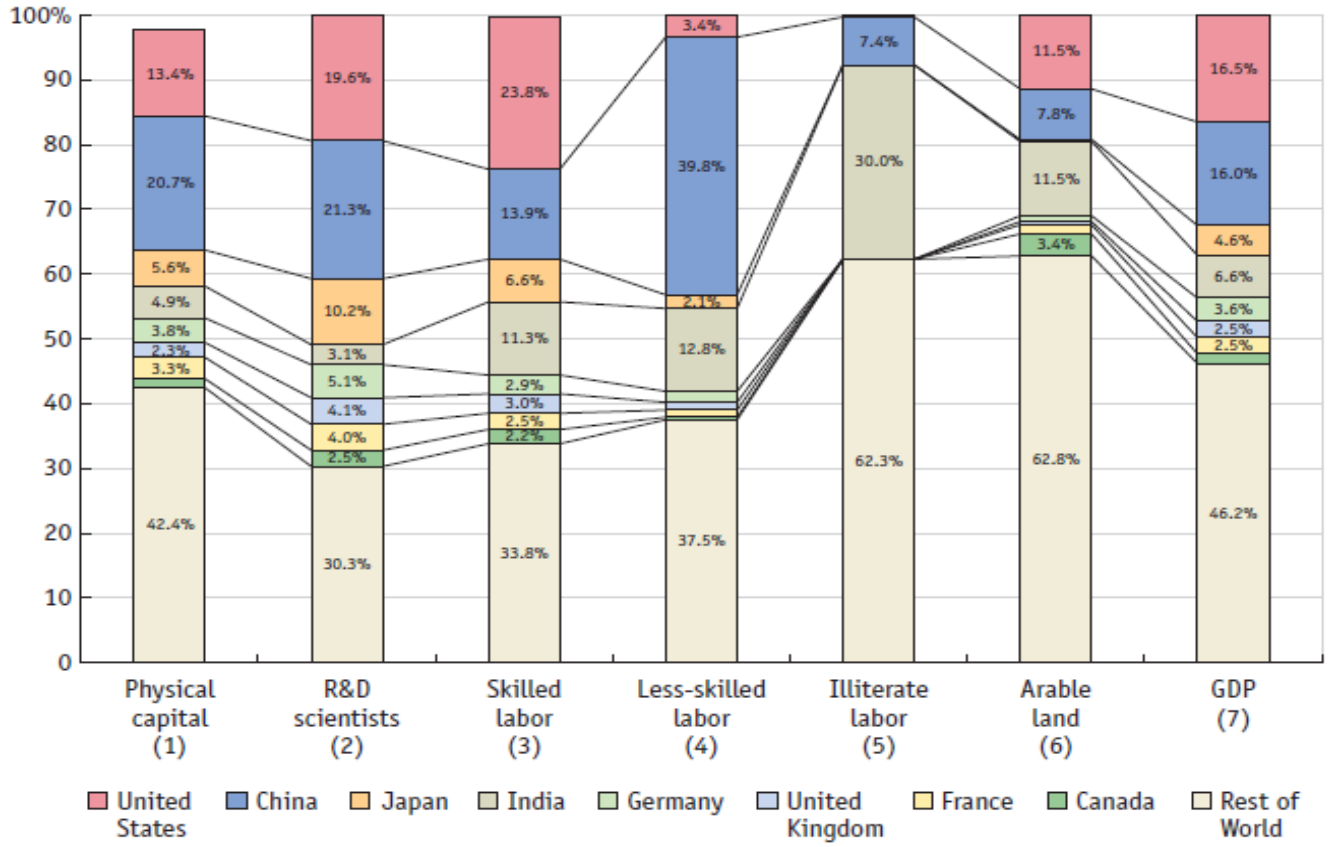


Figure: 2013 country factor endowment comparison

2. Findings from the Figure:
   1) Because the U.S. had 13.4% of the world's capital and 16.5% of world GDP, we can conclude that the U.S. was scarce in physical capital in 2013.
   2) China is abundant in in physical capital: it had 20.7% of the world's capital and produces 16% of the world's GDP. However, China exports greater quantities of basic manufactured goods.
   3) Capital abundant countries: China, Japan, Germany, France.
   4) Capital scarce countries: U.S., India, U.K., and others.
   5) R&D abundant countries: U.S., China (? did not match its export structure)
   6) Skill-labor abundant countries: U.S.
   7) Arable land scarce countries: U.S. (? major exporter of agricultural commodities)
   8) Arable land abundant countries: Canada
   9) Some findings do not quite fit H-O model predictions—factor abundant country exports factor intensive products.

3. Adjustment for quality of the factor endowment
   1) The findings above regrading R&D scientists and land can cause us to question whether an R&D scientist or an acre of arable land has the same productivity in all countries. The assumption behind the H-O model—identical technology across countries—can be misleading in empirical testing.
   2) Effective factor endowment: actual factor endowment*factor productivity. For instance, effective R&D scientists=*Actual R&D scientists • R&D spending per scientist.*
   3) Revised findings: the U.S. was not an arable land scarce country and China was not an R&D abundant country; more importantly, the U.S. is very R&D abundant!

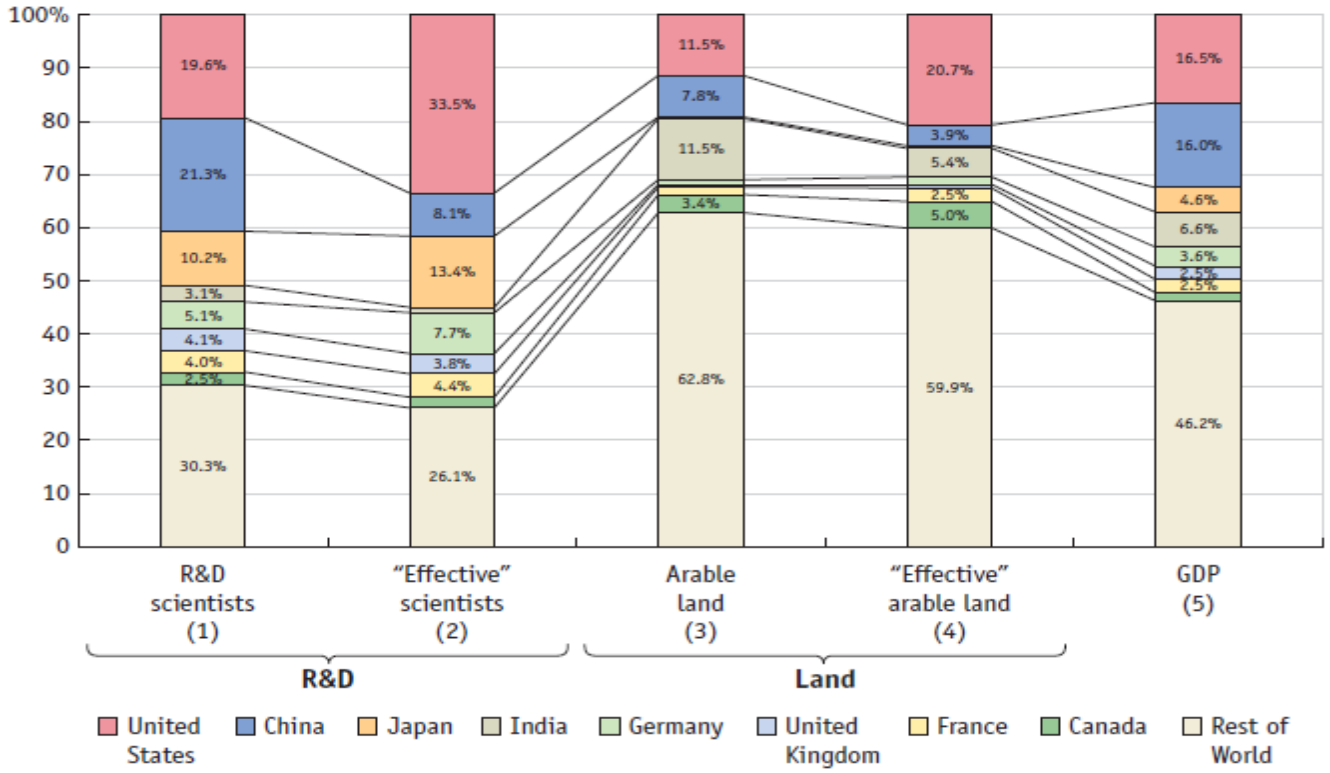


Figure: 2013 country "effective" factor endowment comparison

4) The table below shows that U.S. food trade has fluctuated between positive and negative net exports since 2000, while total agricultural trade (including nonfood items like cotton) shows positive net exports. This is consistent with our finding that the United States is abundant in land.

	2000	2002	2004	2006	2008	2010	2012	2014
U.S. food trade (billions of U.S. dollars)								
Exports	41.4	43.2	50.0	57.8	97.4	92.3	132.9	138.5
Imports	41.4	44.7	55.7	68.9	81.3	86.6	101.2	119.7
Net exports	0.0	−1.5	−5.7	−11.1	16.1	5.7	31.7	18.8
U.S. agricultural trade (billions of U.S. dollars)								
Exports	51.3	53.1	61.4	70.9	115.3	115.8	141.3	150.0
Imports	39.2	42.0	54.2	65.5	80.7	81.9	102.9	111.9
Net exports	12.1	11.1	7.2	5.5	34.6	33.9	38.4	38.1

Table: U.S. Food Trade and Total Agricultural Trade, 2000–2014

5) Shown below are the share of labor, "effective" labor, and GDP of the U.S. and the rest of the world in 1947. The U.S. had only 8% of the world's population, as compared to 37% of the world's GDP, so it was very scarce in labor. But when we measure effective labor by the total wages paid in each country, then the U.S. had 43% of the world's effective labor as compared to 37% of GDP, so it was abundant in effective labor.

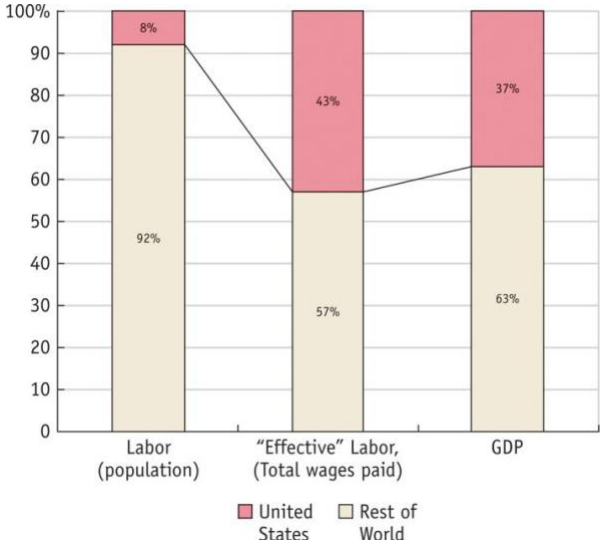


Figure: Labor Endowment and GDP, 1947

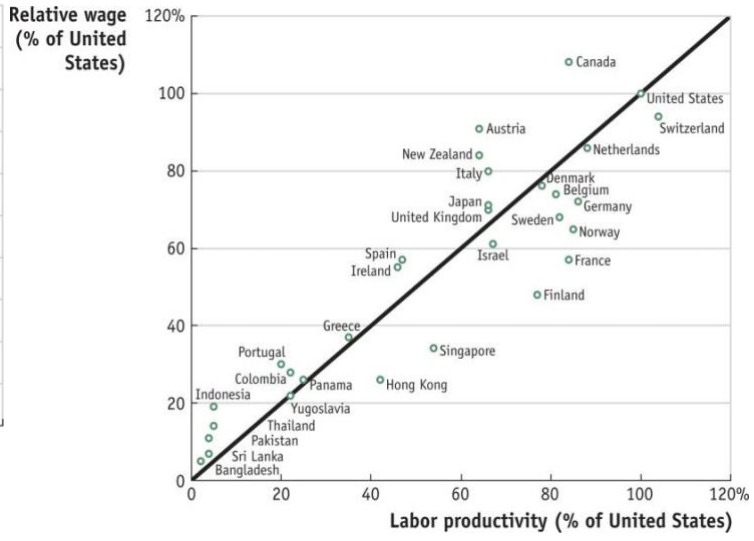
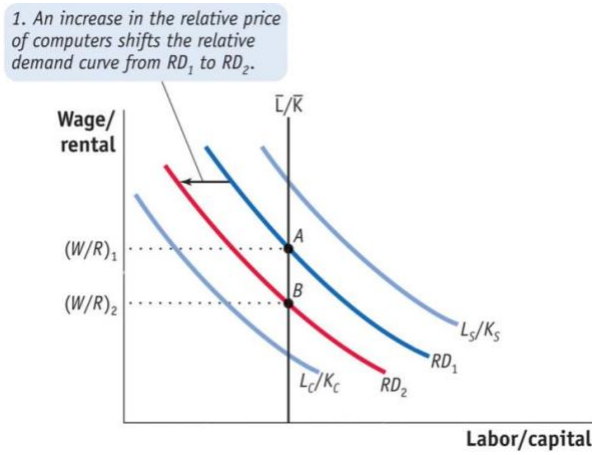


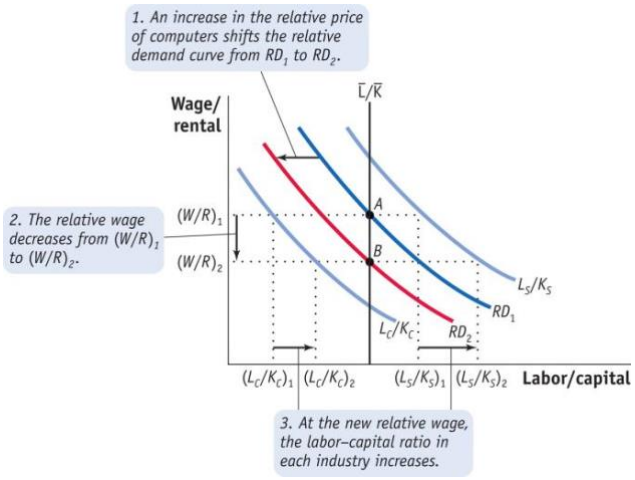
Figure: Labor Productivity and Wages, 1990

6) Shown above are estimated labor productivities across countries, and their wages, relative to the United States in 1990.

VI. Home country income distribution after trade: long-run analysis

1. In the long run, all factors can move between sectors and producers can adjust input ratios (K/L) in response to changes in the relative price of the production factors.
2. When opening up to trade, since home country is capital abundant, it will export capital-intensive products and import labor-intensive products, computer price will rise and shoe price will fall (Pc/Ps)'>(Pc/Ps). Computer industry expands and shoe industry contracts.
3. In expansion, the computer industry must pay higher factor prices to attract labor and capital from the shoe industry. Both nominal wage and rent shall rise in the country.
4. In the factor markets, since computer production relies more heavily on capital than on labor, the relative demand for labor vs capital will fall. Given the factor endowment, the decline in relative demand of labor to capital will lead to lower wage to rent ratio (W/R)'<(W/R), which further implies the rise in wage is smaller than the rise in rent (W'-W) < (R'-R).





5. As labor becomes relatively cheaper than before, producers will substitute capital with labor across industries, though labor moves out of the shoe industry. ***As the L/K ratio increases, the marginal product of capital will rise in both industries whereas marginal product of labor will fall.***
6. In computer industry, MPKc'=(R/Pc)'>(R/Pc)=MPKc, since Pc'>Pc, therefore R'>>R; in shoe industry, MPKs'=(R/Ps)'>>(R/Ps)=MPKs, since R'>>R and Ps'<Ps.
7. In computer industry, MPLc'=(W/Pc)'<<(W/Pc)=MPLc, since W'<W and Pc'>Pc; in shoe industry, MPLs'=(W/Ps)'<(W/Ps)=MPLs, since W'<W and Ps'<Ps, therefore |W'-W|>|Ps'-Ps|.
8. Conclusion: in the long run when all factors are mobile, international trade will benefit the abundant factor but harm the scarce factor. This effect is different from the specific factor model in which real gains to mobile factor (labor) depend on the consumption weight on the goods.
9. **Stolper-Samuelson Theorem:** a country's abundant factor gains and scarce factor loses from the opening of trade. **Factor price equalization**: by forcing product prices into equality, international trade also tends to force factor prices into equality across countries.

Readings

Economists explain the link between inequality and globalization
https://www.weforum.org/agenda/2019/05/the-new-globalisation-and-income-inequality/

Leontief Paradox
http://www2.econ.iastate.edu/classes/econ355/choi/leo.htm