1.10 — Testing the Heckscher-Ohlin Model

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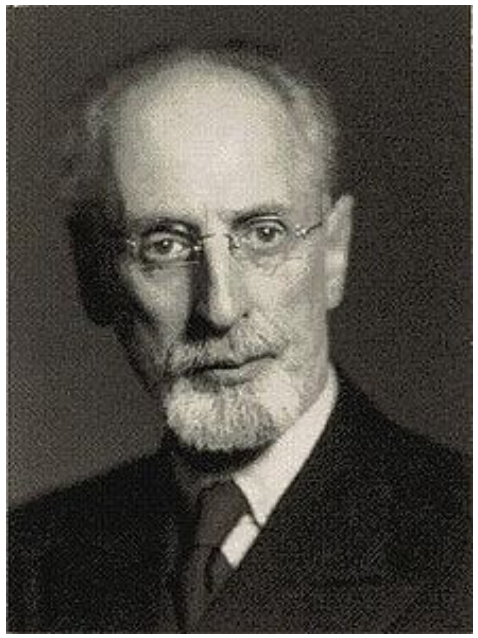
Outline

Predictions of the Hecksher-Ohlin Model

Hecksher-Ohlin Theorem

1) **Hecksher-Ohlin (H-O) Theorem**: a nation will export the good whose production requires the intensive use of the nation's relatively abundant factor, and import the good whose production requires the intensive use of the nation's relatively scarce factor



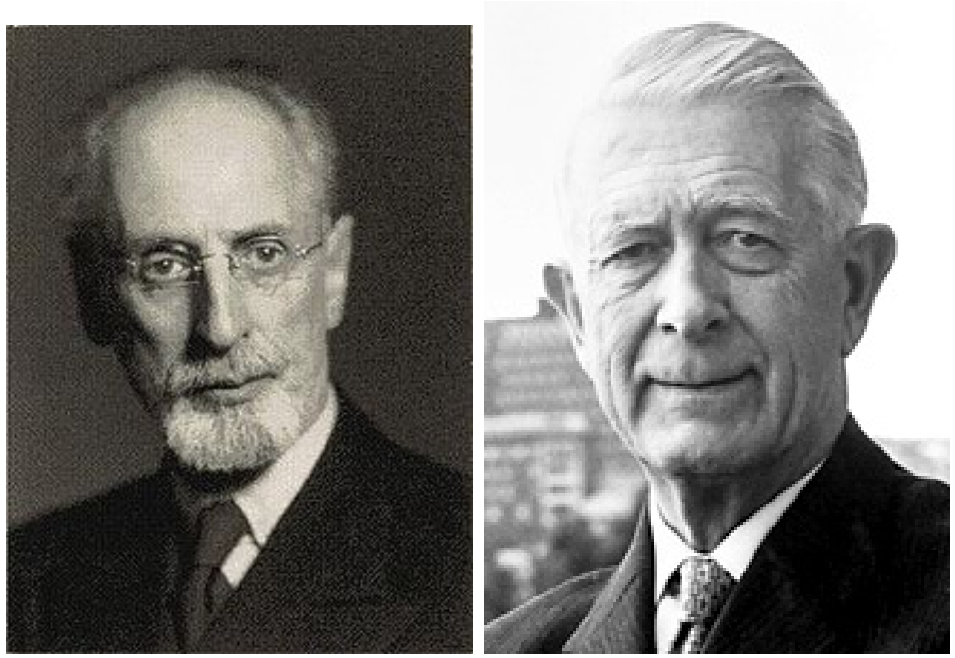
L: Eli Hecksher (1879-1952)

R: Bertil Ohlin (1899-1979)

Factor-Price Equalization Theorem

2) **Factor Price Equalization (FPE) Theorem**: under certain conditions, international trade tends to bring about equalization in relative and absolute returns to homogeneous factors across nations

3) **Stolper-Samuelson Theorem**: in the long run, an increase in the relative price of a good will increase the real earnings of the factor used intensively in that good's production and decrease the earnings of the other factor



L: Eli Hecksher (1879-1952)

R: Bertil Ohlin (1899-1979)

Trade and Factor Prices

- Assume:
  - U.S. is relatively capital abundant $\longrightarrow$ produces & exports capital-intensive goods
  - China is relatively labor abundant $\longrightarrow$ produces & exports labor-intensive goods

Trade and Factor Prices

- U.S. opens up trade with China
- U.S. is a relatively high-wage country, China is a relatively low-wage country
- What would we expect to happen to wages in both countries? capital returns?

Trade and Factor Prices

- **Factor price equalization theorem**:
- U.S.: ↓ wages; ↑ capital returns
- China: ↑ wages; ↓ capital returns

Trade and Factor Prices

- **Stolper-Samuelson Theorem**:
- U.S.: ↓ real income to labor; ↑ real income to capital
- China: ↑ real income to labor; ↓ real income to capital

Trade and Factor Prices

- Essentially an **arbitrage** story
  - why hire expensive labor in U.S.? Outsource to China!
  - why invest capital in China? Earn higher returns in the U.S.!
  - process continues until **long run equilibrium**: no more gain in shifting resources across countries

Limits to Factor Price Equalization

- But clearly, wages in reality remain higher in U.S. than China!
- FPE theorem has restrictive assumptions:
  - identical technology (and institutions) across countries
  - perfect competition
  - free trade
  - no transaction costs

Limits to Factor Price Equalization

- FPE theorem applies only to **identical** or **homogenous** factors of production
  - e.g. not “Labor” or “Capital”, but python programmers, or football players, or beer barrels, or blast furnaces, etc.

Limits to Stolper-Samuelson Theorem

- What about the Stolper-Samuelson Theorem?
- In most cases, it seems (final goods) prices have converged globally more than wages!
- Considered an interesting analytical result, but doesn't really hold in practice

Limits to FPE and SS Theorems

TABLE 5-1 **Comparative International Wage Rates (United States = 100)**

Country	Hourly Compensation of Production Workers, 2005
United States	100
Germany	140
Japan	92
Spain	75
South Korea	57
Portugal	31
Mexico	11
China*	3

*2004

Source: Bureau of Labor Statistics, *Foreign Labor Statistics Home Page.*

Krugman, Paul, Maurice Obstfeld, and Mark Melitz, 2011, *International Economics: Theory & Policy*, 9th ed., p.97

Limits to FPE and SS Theorems

- Both FPE and SS theorems apply only when factors are **mobile** within each nation
- In short run, factors (especially capital) are **fixed** or **specific**
- Specific factors will not flow out of its specific sector, keeping returns unequal

The Leontief Paradox

H-O Theory's Prediction

- **Main prediction**: countries should export the goods that require a relatively intensive use of the country's relatively abundant factor (and import goods that require a relatively intensive use of the country's scarce factor)

- e.g. relatively capital-abundant U.S. should export capital-intensive goods and import relatively labor-intensive goods

Leontief Paradox

Wassily Leontief

1905-1999

DOMESTIC CAPITAL AND LABOR REQUIREMENTS PER MILLION DOLLARS OF U. S. EXPORTS AND OF COMPETITIVE IMPORT REPLACEMENTS (OF AVERAGE 1947 COMPOSITION)

	Exports	Import Replacements
Capital (dollars, in 1947 prices)	2,550,780	3,091,339
Labor (man years)	182.313	170.004

Leontief (1953, p.343)

Leontief, Wassily (1953). "Domestic Production and Foreign Trade; The American Capital Position Re-Examined," *Proceedings of the American Philosophical Society* 97(4): 332-349

Leontief Paradox

Wassily Leontief

1905-1999

"These figures show that an average million dollars' worth of **our exports embodies considerably less capital and somewhat more labor** than would be required to replace from domestic production an equivalent amount of our competitive imports. **America's participation in the international division of labor is based on its specialization on labor intensive, rather than capital intensive, lines of production**. In other words, this country resorts to foreign trade in order to economize its capital and dispose of its surplus labor, rather than vice versa. **The widely held opinion that as compared with the rest of the world- the United States' economy is characterized by a relative surplus of capital and a relative shortage of labor proves to be wrong. As a matter of fact, the opposite is true**" (p.343)

Leontief, Wassily (1953). "Domestic Production and Foreign Trade; The American Capital Position Re-Examined," *Proceedings of the*

Leontief Paradox

Wassily Leontief

1905-1999

- Leontief (1953) found in 1947, U.S. (then clearly a capital-abundant nation) exported more labor-intensive goods and imported capital-intensive goods
- Calculated L-output and K-output ratios for U.S. sectors to find how much K & L were 'embodied' in exports
- **A direct contradiction of H-O theory**! In fact, the exact opposite!

Leontief, Wassily (1953). "Domestic Production and Foreign Trade; The American Capital Position Re-Examined," *Proceedings of the American Philosophical Society* 97(4): 332-349

Leontief Paradox

Wassily Leontief

1905-1999

TABLE 5-2 Factor Content of U.S. Exports and Imports for 1962

	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.

Krugman, Paul, Maurice Obstfeld, and Mark Melitz, 2011, *International Economics: Theory & Policy*, 9th ed., p.99

Responses to the Leontief Paradox

Responses to the Leontief Paradox

- 70 years of responses to Leontief (1953):

1) H-O Theorem is overly simple, restrictive assumptions

- 2-factor, 2-good, 2-country world
- identical technologies
- perfect mobility of factors

Responses to the Leontief Paradox

- 70 years of responses to Leontief (1953):

2) Other minor quibbles:

- Leontief only measures land and labor, what about land? U.S. is also relatively land abundant
- Leontief looked right after WWII (returning from major disruption)
- U.S. was not engaged in full free trade at the time

Responses to the Leontief Paradox

- 70 years of responses to Leontief (1953):

3) What counts as “L” vs “K”?

- High-skilled vs. low-skilled labor?
- U.S. Labor highly-skilled from human-capital embodied in “L”, not “K”
- This could make U.S. a labor-abundant country (H-O predicts we export labor-intensive goods)!

Leontief's Suggested Explanation

Wassily Leontief

1905-1999

"What is the explanation of this somewhat unexpected result? The conventional view of the position which the United States occupies today in the world economy is...that the United States possesses more productive capital per worker than any other country. It can hardly be disputed.' (p.343)

"**Let us, however, reject the simple but tenuous postulate of comparative technological parity** and make the plausible alternative assumption that in any combination with a given quantity of capital, **one man year of American labor is equivalent to, say, three man years of foreign labor**...Spread trice as thinly as the unadjusted figures suggest the **American capital supply per [foreign] 'equivalent worker' turns out to be comparatively smaller, rather than larger, than that of many other countries.**" (p.344)

Responses to the Leontief Paradox

Wassily Leontief

1905-1999

- 70 years of responses to Leontief (1953):

4) Revisions, extensions, replacements to H-O theory:

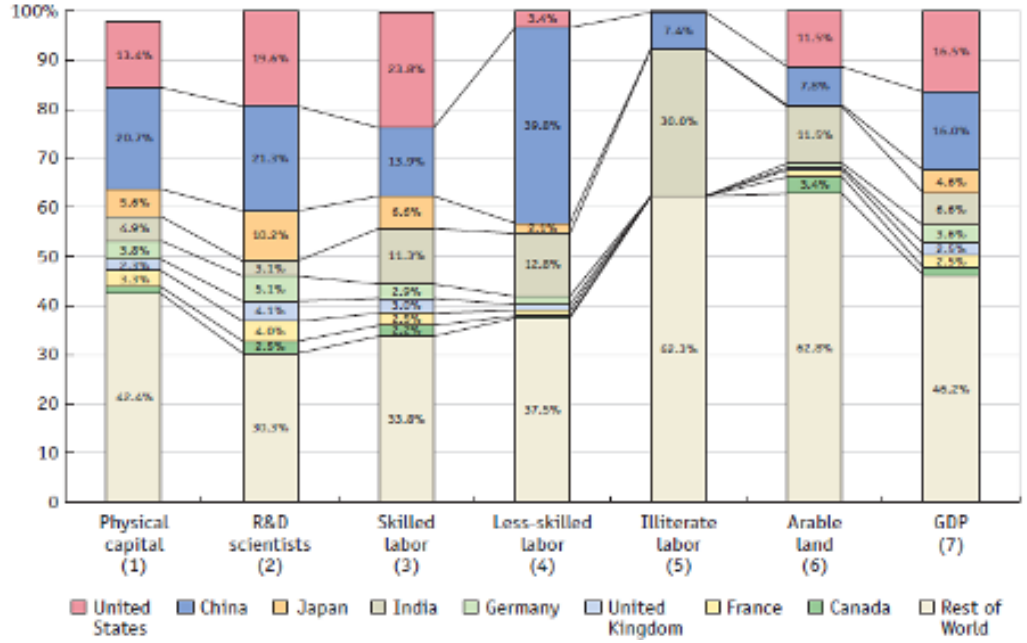
- economies of scale (endogenous comparative advantage regardless of factor endowments)
- imperfect competition
- transaction (transportation) costs
- differing technologies internationally

Testing the H-O Theory

Measuring Factor Endowments

- Measuring factor endowments in countries
- Assumed definitions:
  - A country is **abundant** in a factor if its share in that factor exceeds its share in world GDP
  - A country is **scarce** in a factor if its share in that factor is less than its share in world GDP
  - Allows us to use multiple factors and multiple countries

Country Factor Endowments (2013)

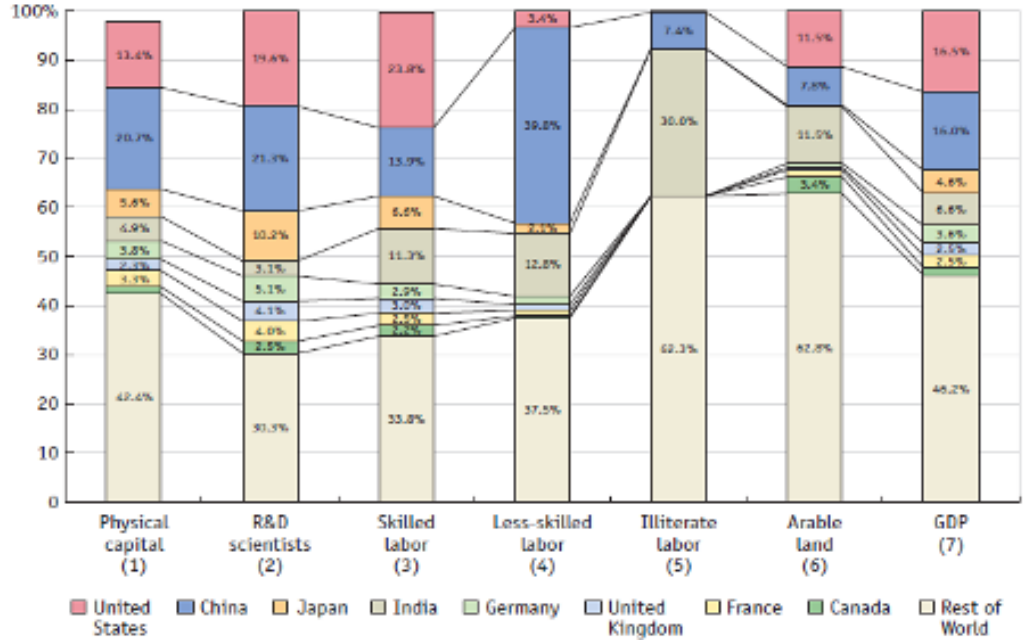


Feenstra and Taylor (2017, p.103)

Measuring Factor Endowments

- Taking physical capital as example:
- U.S. has 13.4% of world's physical capital; 16.5% of world GDP
  - U.S. is **physical capital scarce (!)**
- China has 20.7% of world's physical capital; 16.0% of world GDP
  - China is **physical capital abundant (!)**

Country Factor Endowments (2013)



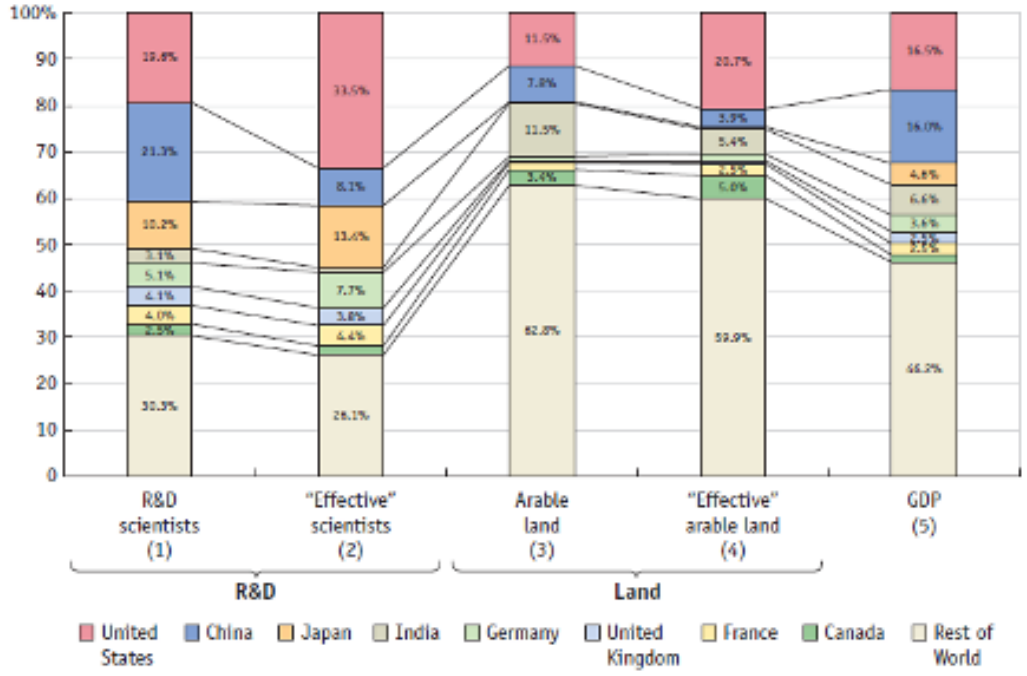
Feenstra and Taylor (2017, p.103)

Measuring Factor Endowments

- But absolute numbers of physical factors are often not relevant
- Some countries may have few physical factors, but they may be very productive!
- So we care about **effective factor endowment**:

effective factor endowment = actual endowment $\times$ factor productivity

Country *Effective* Factor Endowments (2013)

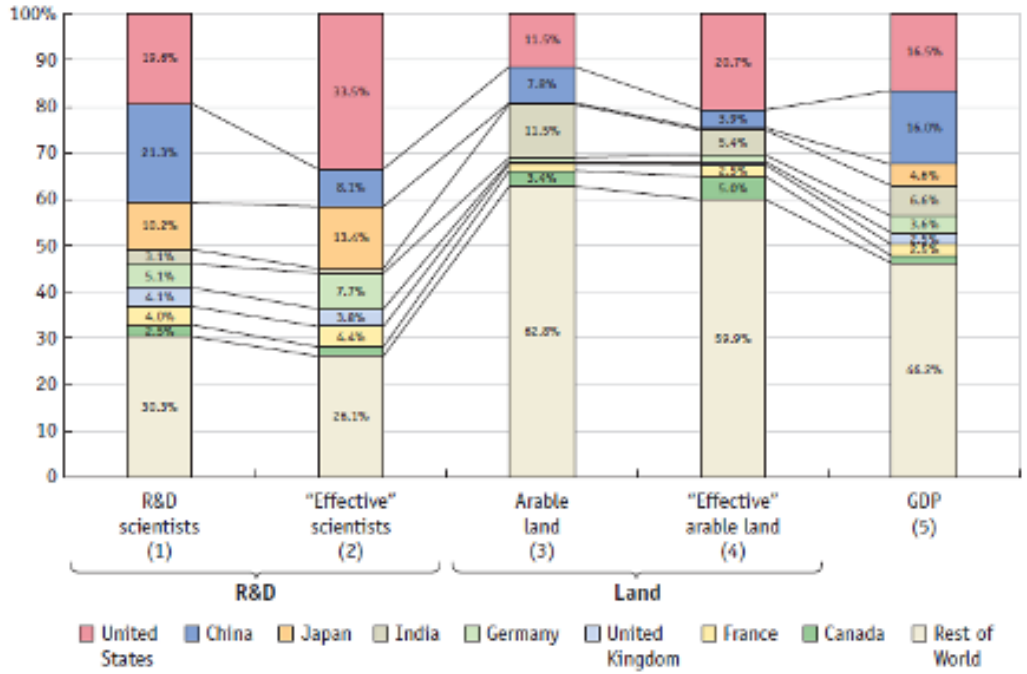


Feenstra and Taylor (2017, p.106)

Measuring Factor Endowments

- Examples:
  - U.S. is scarce in *absolute* R&D but abundant in *effective* R&D
  - U.S. is scarce in *absolute* land, but abundant in *effective* land
  - China is abundant in both in *absolute* terms, but scarce in both in *effective* terms

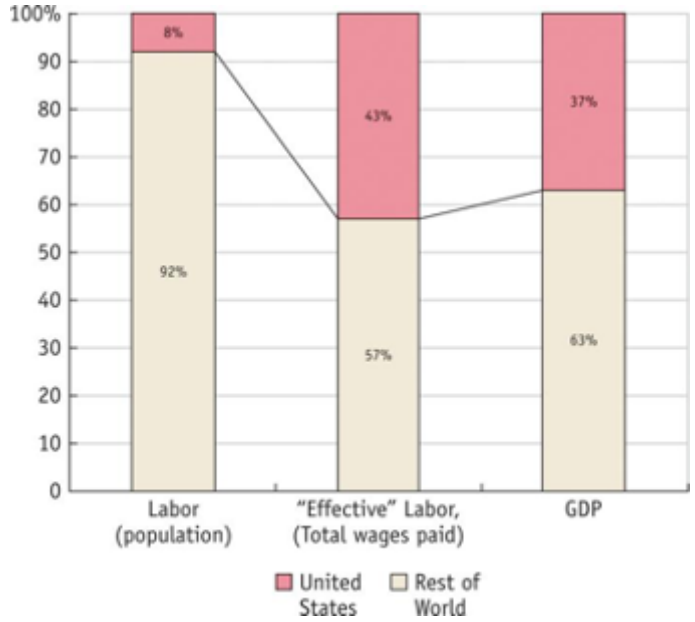
Country *Effective* Factor Endowments (2013)



Feenstra and Taylor (2017, p.106)

Was The U.S. Labor Abundant?

U.S. Labor in 1947

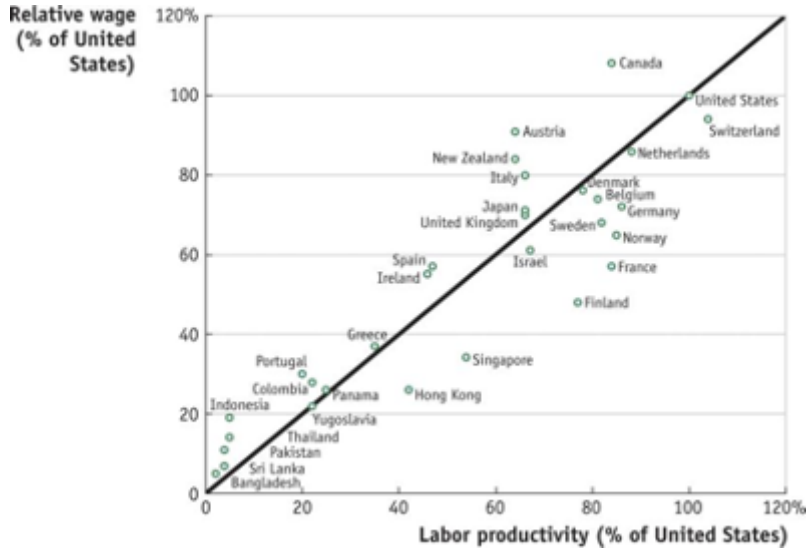


While the U.S. in 1947 may have been labor scarce in absolute terms, it was labor abundant in effective terms, consistent with Leontief's finding.

Feenstra and Taylor (2017, p.109)

Was The U.S. Labor Abundant?

Labor Productivity and Wages (Relative to the U.S.) in 1990



Labor productivity and wages are highly correlated, further suggesting Leontief's findings and H-O Theory are not necessarily inconsistent when considering *effective* labor.

Feenstra and Taylor (2017, p.110)

Measuring Factor Content in Trade

	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

While U.S. food imports occasionally exceed food exports, agricultural exports have always exceeded agricultural imports, consistent with finding that U.S. is land abundant.

Feenstra and Taylor (2017, p.108)

Other Tests of H-O Theory: Bowen et. al (1987)

- Strong version of H-O Theory is a poor predictor of exports/imports
- Weaker versions do much better - is a country relatively more abundant in a factor than the world average?
    - **Sign test**: does a country export goods that are more-intensive in the factor that they have relatively more than the world average?
    - About 60% of the time: yes

Bowen, Harry P., Edward E. Leamer, and Leo Sveikauskas (1987), "Multicountry, Multifactor Tests of Factor Abundance Theory," *American Economic Review* 77(5): 791-809

Other Tests of H-O Theory: Bowen et. al (1987)

TABLE 5-3 Testing the Heckscher-Ohlin Model

Factor of Production	Predictive Success*
Capital	0.52
Labor	0.67
Professional workers	0.78
Managerial workers	0.22
Clerical workers	0.59
Sales workers	0.67
Service workers	0.67
Agricultural workers	0.63
Production workers	0.70
Arable land	0.70
Pasture land	0.52
Forest	0.70

*Fraction of countries for which net exports of factor runs in predicted direction.

Source: Harry P. Bowen, Edward E. Leamer, and Leo Sveikauskas, "Multicountry, Multifactor Tests of the Factor Abundance Theory," *American Economic Review* 77 (December 1987), pp. 791–809.

Krugman and Obstfeld (2011, p.100)

Other Tests of H-O Theory: Bowen et. al (1987)

- **Rank test**: rank countries based on relative abundance of factors (e.g. rank countries based on Labor, on Capital, etc)
    - Does that country also rank similarly in terms of exports of those factor-intensive goods
- Doesn't predict very well!
    - e.g. a country ranking high in labor abundance might be exporting more capital intensive goods than expected!

Bowen, Harry P., Edward E. Leamer, and Leo Sveikauskas (1987), "Multicountry, Multifactor Tests of Factor Abundance Theory," *American Economic Review* 77(5): 791-809

Other Tests of H-O Theory: Bowen et. al (1987)

> "The Hecksher-Ohlin model does poorly, but we do not have anything that does better. It is easy to find hypotheses that do as well or better in a statistical sense, but these alternatives yield economically unsatisfying parameter estimates"

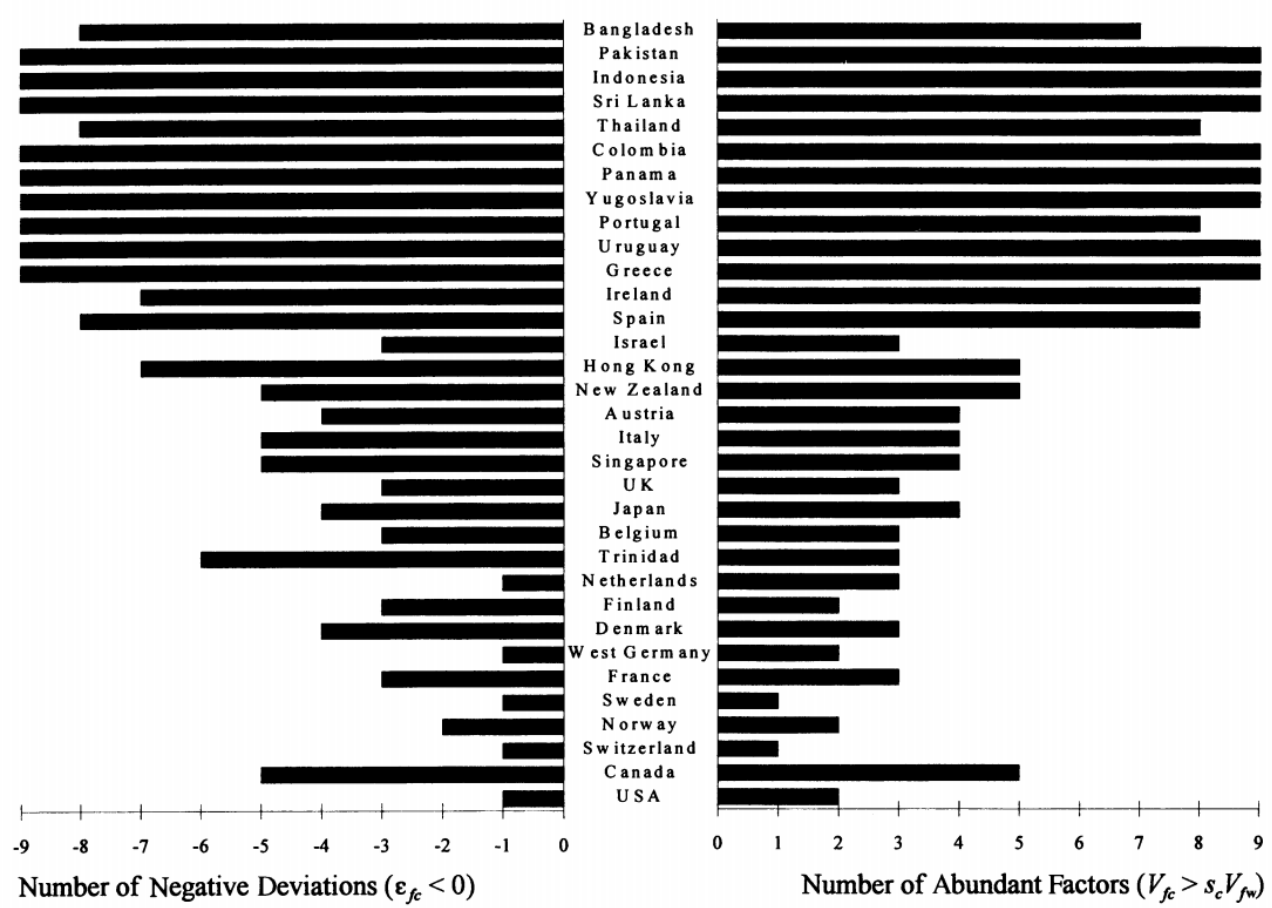
Bowen, Harry P., Edward E. Leamer, and Leo Sveikauskas (1987), "Multicountry, Multifactor Tests of Factor Abundance Theory," *American Economic Review* 77(5): 791-809

Other Tests of H-O Theory: Trefler (1995)

- Given there are big differences in factor endowments across countries, we should expect to see much more trade than we observe!
- Trade we do see on net doesn't really send much embodied capital to labor-intensive countries and vice versa!
    - e.g. barely any trade in “net factor content”!

Trefler, Daniel (1995), “The Case of the Missing Trade and Other Mysteries,” *American Economic Review* 85(5): 1029-1046

Other Tests of H-O Theory: Trefler (1995)



Trefler, Daniel (1995), "The Case of the Missing Trade and Other Mysteries," *American Economic Review* 85(5): 1029-1046

Other Tests of H-O Theory: Trefler (1995)

TABLE 5-4 Estimated Technological Efficiency, 1983 (United States = 1)

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

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

Trefler, Daniel (1995), "The Case of the Missing Trade and Other Mysteries," *American Economic Review* 85(5): 1029-1046

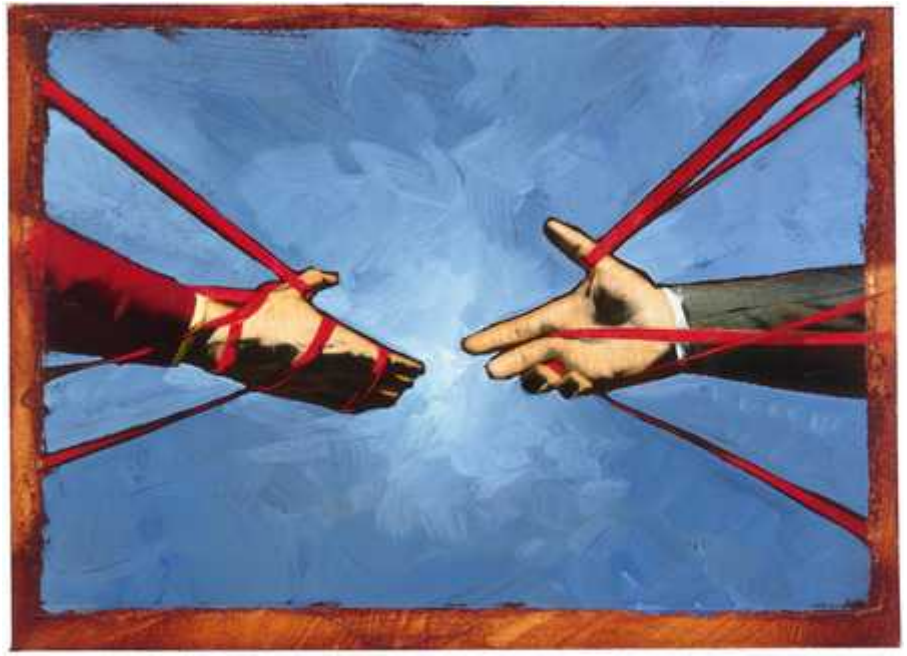
Institutions or Transaction Costs?

- Perhaps these deviations from H-O Theory are really asking the question:

> "Why are transaction costs so high to prevent mutually beneficial trades?"

- However, comparing exports of labor-abundant nations in the Third world with the exports of capital-abundant nations do fit the theory quite well

- Also, changing comparative advantage over time is also reflected well



Better Results of H-O Theory

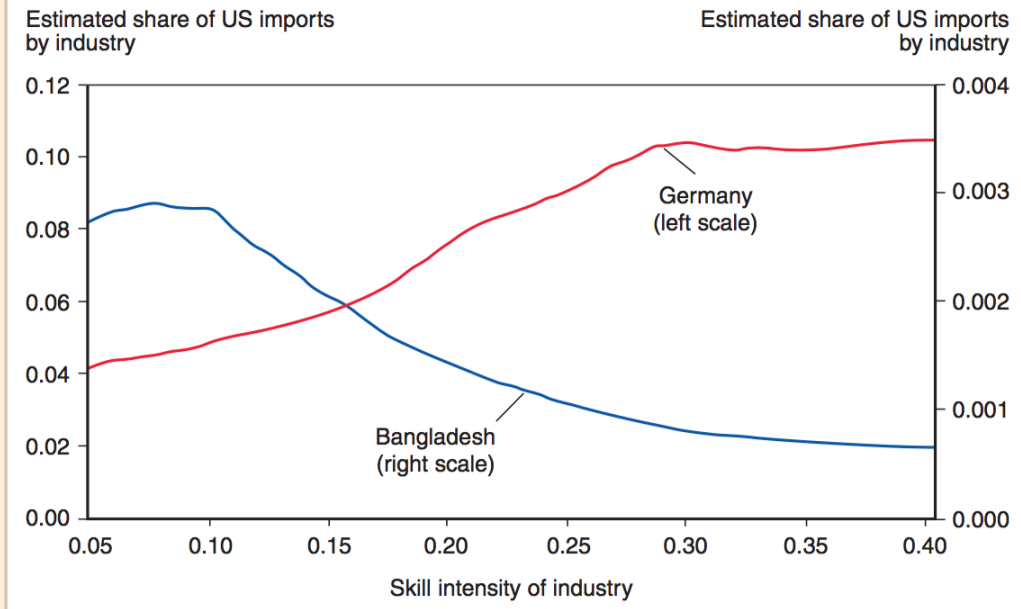


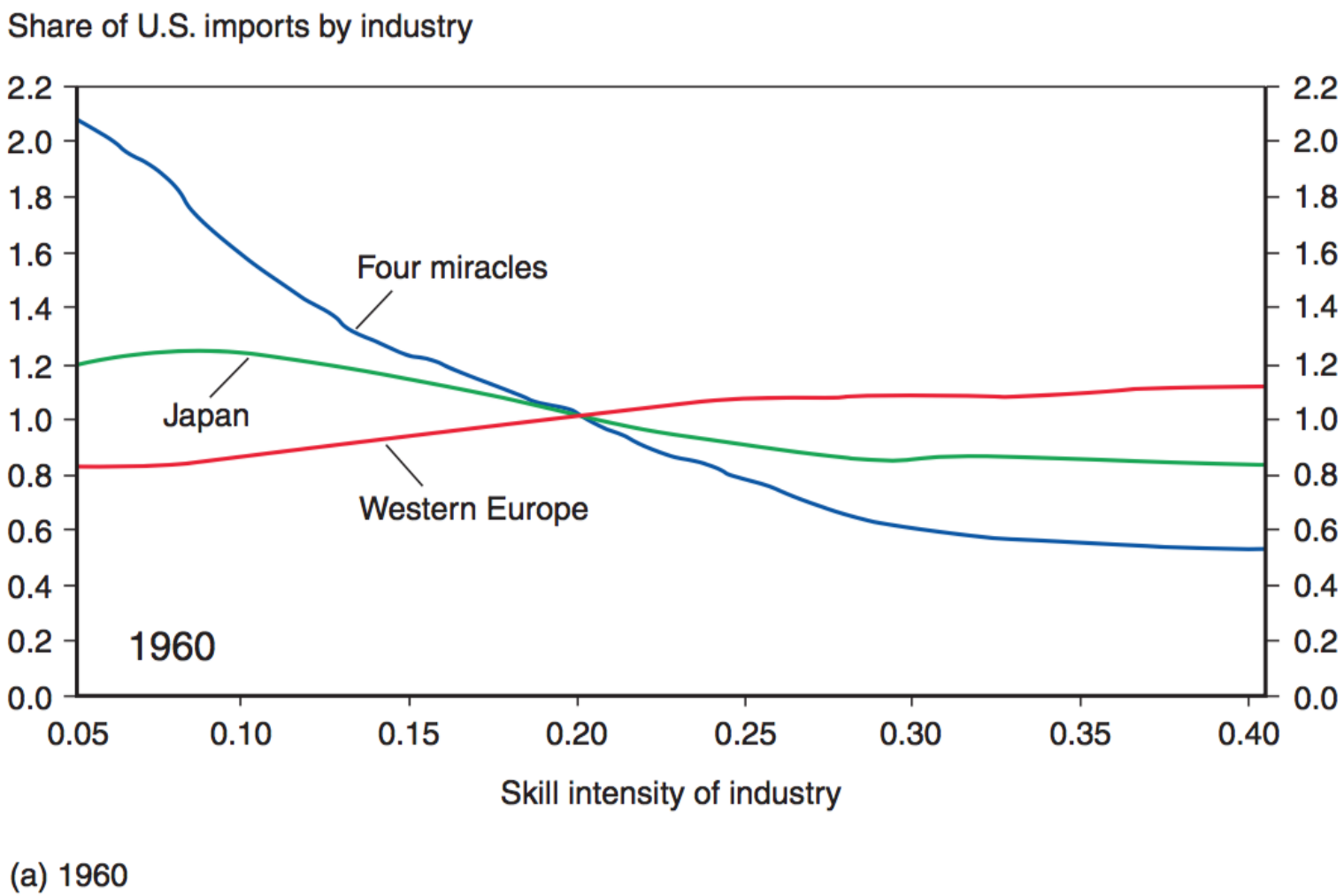
Figure 5-12

Skill Intensity and the Pattern of U.S. Imports from Two Countries

Source: John Romalis, "Factor Proportions and the Structure of Commodity Trade," *American Economic Review* 94 (March 2004), pp. 67–97.

Krugman and Obstfeld (2011, p. 101)

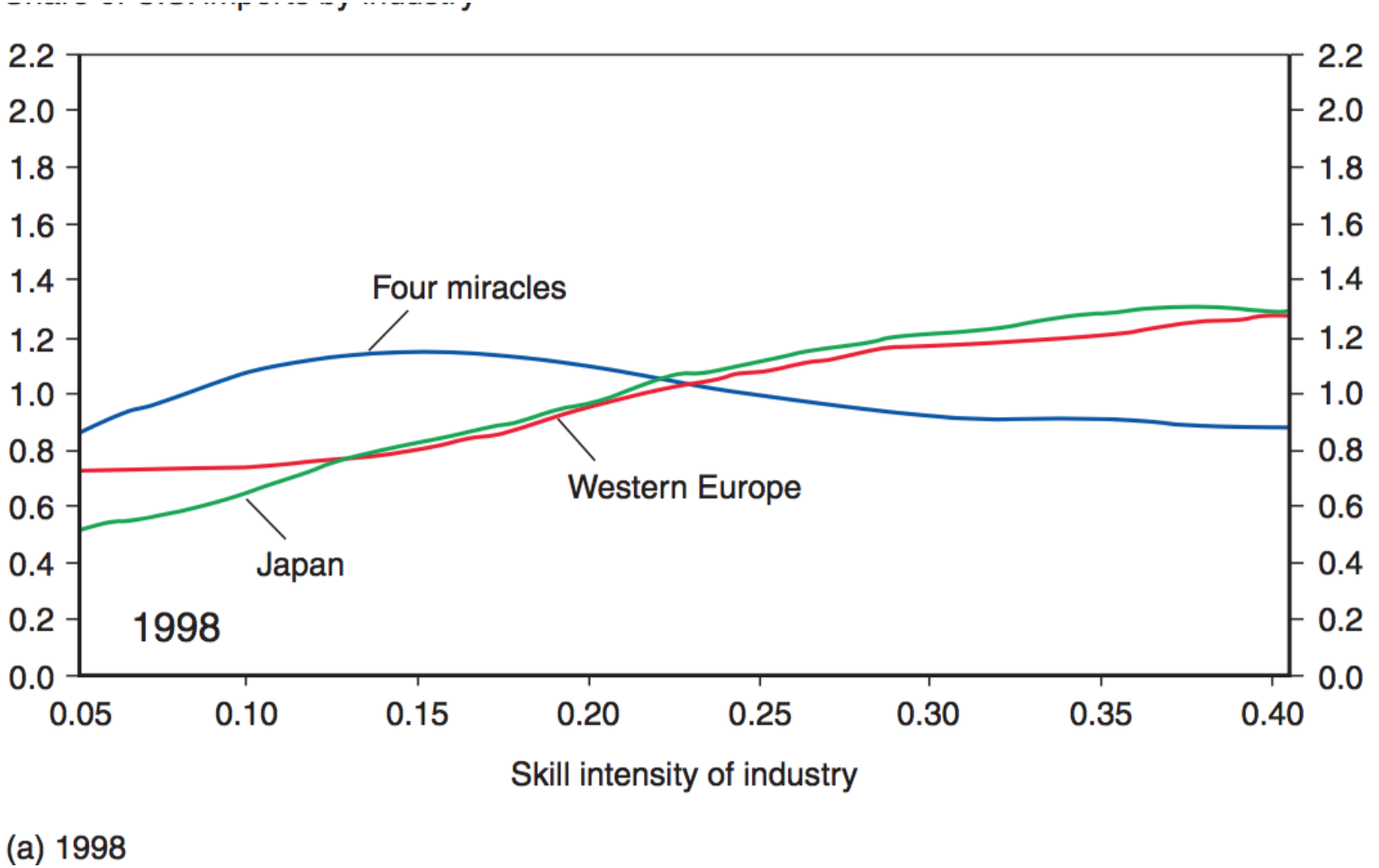
Better Results of H-O Theory



(a) 1960

Krugman and Obstfeld (2011, p. 103)

Better Results of H-O Theory



(a) 1998

Krugman and Obstfeld (2011, p. 103)

H-O Theory and Attitudes Towards Free Trade

H-O Theory and Attitudes Towards Free Trade

- In the **specific factors model** (1.8), we saw:
  - labor can gain or lose from free trade
  - specific factor in exporting industry gains
  - specific factor in importing industry loses

H-O Theory and Attitudes Towards Free Trade

- If labor earns some of the income from the specific factor, then **the industry workers work in may affect their attitudes towards free trade**
  - e.g. some farmers may own their land
  - e.g. some manufacturing workers may earn bonuses from high output, or share in capital profits, etc.

H-O Theory and Attitudes Towards Free Trade

- In the **H-O model**, what industry one works in should not affect one's position on free trade
    - in long run, labor & capital are mobile, move across industries to best opportunities
- **Stolper-Samuelson theorem** predicts an increase in relative price in exports (and decrease in relative price of imports) from trade benefits factor used intensively in exports and harms factor used intensively in import-competing industry, **regardless of which industry the factors actually work in**

H-O Theory and Attitudes Towards Free Trade

- In U.S., export industries often use high-skilled labor and research & development
- An increase in exports will benefit skilled labor in the long-run, regardless of what industry they are working in
- Prediction: in long run, the *skill level* of workers should determine their attitudes about free trade!

H-O Theory and Attitudes Towards Free Trade

- 1992 survey by National Election Studies asking people about their attitudes on trade
- Industry of employment was only somehwat important in explaining different attitudes
    - Workers in export-oriented industries somewhat more likely to favor free trade than workers in import-competing industries

H-O Theory and Attitudes Towards Free Trade

- Skill-level was much more important!
    - High-skilled workers were *much more likely* to support free trade than low-skilled workers
- Consistent with predictions of H-O and SS theorems!