Contents

The Heckscher-Ohlin (HO) Model

> **Big Idea**: Trade is driven by differences in factor endowments (capital, labor, land). Capital-abundant countries export capital-intensive goods; labor-abundant countries export labor-intensive goods. Trade creates winners (abundant factor) and losers (scarce factor) along factor class lines, not industry lines.

Core Principles

Foundation

- **Factor Endowments Drive Trade**: Countries export goods that intensively use their abundant factors
  - USA (capital-abundant) exports aircraft; Bangladesh (labor-abundant) exports garments
  - Explains North-South trade patterns
- **Two Factors, Both Mobile**: Labor (L) and Capital (K) can move freely between sectors
  - Long-run assumption: workers can retrain, capital can be reallocated
  - Contrast: Specific Factors where factors are stuck
- **Long-Run Model**: All factors are mobile (contrast with Specific Factors short-run)
  - After adjustment period, factors find their most productive use
- **Identical Technologies**: Countries have access to the same production functions
  - Differences in trade come from endowments, not productivity
  - Strong assumption, but simplifies analysis

- **Factor Proportions**: Trade based on differences in relative factor endowments
  - Not absolute amounts, but K/L ratios matter

Key Insight

Source of comparative advantage: Differences in factor endowments (not technology as in Ricardian)

Political Economy: Trade benefits your class (capital vs. labor), not your industry - All capital owners support free trade in capital-abundant countries - All workers oppose free trade in capital-abundant countries - Creates class-based political coalitions

Model Assumptions

The "2×2×2" Framework

1. **Two countries**: Home and Foreign (Foreign denoted with *)
2. **Two goods**: Cloth (C) and Food (F)
3. **Two factors**: Labor (L) and Capital (K)

Additional Assumptions

1. **Identical homothetic preferences** across countries
2. **Constant returns to scale** in production
3. **Perfect competition** in all markets
4. **No trade barriers** or transport costs
5. **Factors mobile between sectors**, immobile between countries
6. **Full employment** of all factors
7. **Identical technologies** across countries
8. **Different factor intensities** across goods

Production Technology

Factor Intensities

Define factor intensity by capital-labor ratio:

Cloth is capital-intensive if: $K_c/L_c > K_f/L_f$

Food is labor-intensive if: $K_f/L_f < K_c/L_c$

This ranking **must hold at all factor prices** (no factor intensity reversals).

Production Functions

Cloth: $Q_c = F_c(K_c, L_c)$ **Food**: $Q_f = F_f(K_f, L_f)$

Both exhibit: - Constant returns to scale - Diminishing marginal products - Positive marginal products

Factor Market Clearing

Capital: $K_c + K_f = K$ (total capital endowment) **Labor**: $L_c + L_f = L$ (total labor endowment)

Production Possibilities Frontier (PPF)

Shape

- **Concave** (bowed out), reflecting increasing opportunity cost
- Smoother than Specific Factors PPF (both factors mobile)

Slope

Slope of PPF = -MCf/MCc = -Pf/Pc (in competitive equilibrium)

where MC denotes marginal cost.

Rybczynski Theorem

At constant goods prices, if one factor endowment increases: - Output of good using that factor intensively **increases more than proportionally** - Output of other good **decreases in absolute terms**

Example   If K increases (holding L constant and Pf/Pc constant): - Qc increases more than proportionally (cloth is capital-intensive) - Qf decreases in absolute terms

Intuition

- Additional capital must be employed
- To maintain factor-price equality, need complementary labor
- Labor drawn from food sector
- Food output falls; cloth output rises substantially

Factor Prices

Zero-Profit Conditions

Perfect competition implies zero economic profits:

Cloth: Pc = ac,k · r + ac,l · w **Food**: Pf = af,k · r + af,l · w

where: - ac,k, ac,l are unit factor requirements for cloth - af,k, af,l are unit factor requirements for food - r is rental rate of capital - w is wage rate

Factor Price Equalization (FPE)

Under HO assumptions, **free trade equalizes factor prices across countries**:

- w = w* (wage equalization)
- r = r* (rental rate equalization)

Conditions for FPE

1. Both countries produce both goods (incomplete specialization)
2. Identical technologies
3. No trade costs
4. No factor intensity reversals

5. Factor endowments not too different

Intuition

- Goods prices equalize through trade
- Goods prices determine factor prices (via zero-profit conditions)
- Therefore, factor prices equalize

"Trade in goods substitutes for trade in factors"

Stolper-Samuelson Theorem

If the price of a good rises, the real return to the factor used intensively in that good rises, while the real return to the other factor falls.

Mathematical Statement If Pc rises (holding Pf constant): - r/Pc rises and r/Pf rises (real rental rate increases) - w/Pc falls and w/Pf falls (real wage decreases)

(Assuming cloth is capital-intensive)

Magnification Effect The factor price changes are **magnified**:

If Pc rises by 10%: - r might rise by 20% (magnified) - w might fall by 5% (to maintain zero profits)

Proof Sketch From zero-profit conditions: - Pc = ac,k · r + ac,l · w - Pf = af,k · r + af,l · w

If Pc rises and Pf constant: - To maintain zero profit in cloth: r must rise and/or w must fall - But if w rises, then Pf = af,k · r + af,l · w would be violated - Therefore: r rises, w falls - Magnification occurs to satisfy both equations

Factor Endowments and Trade Pattern

Heckscher-Ohlin Theorem

A country exports the good that intensively uses its abundant factor and imports the good that intensively uses its scarce factor.

Defining Factor Abundance Two definitions (equivalent under HO assumptions):

Physical definition: Home is capital-abundant if K/L > K/*L*

Price definition: Home is capital-abundant if (r/w)autarky > (r/w*)autarky

Trade Pattern Prediction If Home is capital-abundant and cloth is capital-intensive: - Home exports cloth - Foreign exports food

Relative Supply and Demand

Relative Supply (RS) At any Pf/Pc: - Capital-abundant country produces higher Qc/Qf - RS curve for capital-abundant country lies to the right

Relative Demand (RD) With identical homothetic preferences: - RD curve is the same for both countries - Downward sloping

Autarky Prices

- Capital-abundant Home: (Pf/Pc)autarky higher (cloth relatively cheap)
- Labor-abundant Foreign: (Pf/Pc)autarky lower (food relatively cheap)

Trade Equilibrium

- (Pf/Pc)Home,autarky > (Pf/Pc)trade > (Pf/Pc)Foreign,autarky
- Home exports cloth (capital-intensive)
- Foreign exports food (labor-intensive)

Income Distribution Effects

Winners and Losers from Trade

Unlike Specific Factors, **factor type (not sector) determines gains/losses**:

Capital-abundant country (Home) opens to trade: - Pc rises (exporting capital-intensive good) - By Stolper-Samuelson: r rises, w falls - **Capital owners gain** - **Workers lose**

Labor-abundant country (Foreign) opens to trade: - Pf rises (exporting labor-intensive good) - By Stolper-Samuelson: w* rises, r* falls - **Workers gain** - **Capital owners lose**

Key Insight

Trade benefits the abundant factor and hurts the scarce factor in each country.

Political coalitions form along factor lines, not industry lines: - All capital owners support free trade in capital-abundant countries - All workers oppose free trade in capital-abundant countries

Leontief Paradox

The Paradox

Leontief (1953) tested HO predictions using US data: - US was capital-abundant - HO predicts US exports should be capital-intensive - **Finding**: US exports were labor-intensive!

Explanations for Paradox

1. **Human capital**: US abundant in skilled labor (human capital), not just physical capital
2. **Factor intensity reversals**: Some goods change factor intensity at different prices
3. **Natural resources**: Need to include land/resources as third factor
4. **Technology differences**: US had superior technology (violates HO assumption)
5. **Demand bias**: US consumers may prefer capital-intensive goods
6. **Trade barriers**: Tariffs and quotas distort patterns

Modern Evidence

More nuanced: - HO works better when including human capital - Works better for North-South trade (large endowment differences) - Less successful for North-North trade (similar endowments)

Extensions and Modifications

More Than Two Factors

With labor, capital, and land: - More complex predictions - Factor price equalization less likely - Specific Factors model may be more appropriate

More Than Two Goods

- Countries may export multiple goods
- Prediction: Export goods intensive in abundant factors
- Allows for incomplete specialization more naturally

More Than Two Countries

- Chain of comparative advantage
- Countries export different bundles based on endowments

Intermediate Inputs

- Trade in parts and components
- Vertical specialization
- Complicates factor content calculations

Increasing Returns to Scale

- Violates HO assumption
- Leads to "new trade theory" models
- Can generate trade between similar countries

Factor Price Equalization in Detail

The FPE Diagram

In factor price space (w, r): - Each zero-profit condition is a downward-sloping line - Intersection determines unique (w, r) - If goods prices equal, factor prices equal

FPE Cone

Range of factor endowments (K/L ratios) consistent with: - Both countries producing both goods - Factor price equalization

If endowments too different, countries specialize and FPE fails.

Empirical Evidence on FPE

Mixed: - Factor prices not fully equalized (wages differ greatly) - But convergence observed in some contexts (EU integration) - Trade costs, technology differences, and barriers prevent full FPE

Integrated World Equilibrium

Concept

Imagine world with: - Free factor mobility (not just goods mobility) - What would factor prices and allocation be?

Comparison with Trade

Factor price equalization: Trade replicates integrated equilibrium **Each country's production point** on its PPF matches factor employment in integrated equilibrium

Breaking FPE

If countries too different: - Specialization occurs - Factor prices diverge - Trade doesn't fully substitute for factor mobility

Gains from Trade

Production Gains

- Move to production point with higher value at world prices
- Exploit comparative advantage based on endowments

Consumption Gains

- Access to world prices, not just autarky prices
- Consume beyond PPF

National Income

- National income (measured at world prices) increases
- Total gains exceed total losses (potential Pareto improvement)

Distribution

- Abundant factor gains more than scarce factor loses
- Redistribution could make everyone better off
- But redistribution often doesn't happen (political economy)

Comparison Across Models

Feature	Ricardian	Specific Factors	Heckscher-Ohlin
Source of trade	Technology	Mixed	Factor endowments
Number of factors	1 (Labor)	3 (L, K, T)	2 (L, K)
Factor mobility	Between sectors	Labor only	Both factors
Time horizon	Long run	Short run	Long run

Feature	Ricardian	Specific Factors	Heckscher-Ohlin
PPF shape	Linear	Concave	Concave
Specialization	Complete	Incomplete	Often incomplete
Winners from trade	Everyone	Sector-specific factors	Abundant factor
Losers from trade	None	Import-sector factor	Scarce factor
Political coalitions	N/A	Industry-based	Factor-based

Mathematical Deep Dive

Production Functions (Cobb-Douglas Example)

Cloth: $Q_c = K_c^{\alpha} \cdot L_c^{(1-\alpha)}$ with $\alpha > \beta$ (capital-intensive) **Food**: $Q_f = K_f^{\beta} \cdot L_f^{(1-\beta)}$ with $\beta < \alpha$ (labor-intensive)

Cost Minimization

Minimize cost of producing one unit:

Cloth: $\min \{r \cdot k_c + w \cdot l_c\}$ subject to $k_c^{\alpha} \cdot l_c^{(1-\alpha)} = 1$ **Food**: $\min \{r \cdot k_f + w \cdot l_f\}$ subject to $k_f^{\beta} \cdot l_f^{(1-\beta)} = 1$

Yields unit cost functions: - $c(r, w)$ for cloth - $c_f(r, w)$ for food

Zero-Profit Conditions

- $P_c = c(r, w)$
- $P_f = c_f(r, w)$

These two equations determine r and w given P_c and P_f.

Factor Demands

From cost minimization: - $k_c/l_c = (\alpha/(1-\alpha)) \cdot (w/r)$ (capital-labor ratio in cloth) - $k_f/l_f = (\beta/(1-\beta)) \cdot (w/r)$ (capital-labor ratio in food)

Since $\alpha > \beta$: $k_c/l_c > k_f/l_f$ (cloth is capital-intensive).

Full Employment

- $K_c + K_f = K$
- $L_c + L_f = L$

Combined with factor demands, determines (K_c, L_c, K_f, L_f).

General Equilibrium

System of equations: 1. Zero profit in cloth: $P_c = c(r, w)$ 2. Zero profit in food: $P_f = c_f(r, w)$ 3. Capital market clearing: $K_c + K_f = K$ 4. Labor market clearing: $L_c + L_f = L$ 5. Goods market clearing: Supply = Demand (determined by preferences)

Solves for: (r, w, Kc, Lc, Kf, Lf, Qc, Qf, Dc, Df, Exports, Imports)

Policy Applications

Tariffs

A tariff on food imports (in capital-abundant Home): - Raises Pf - By Stolper-Samuelson: w rises, r falls - **Benefits scarce factor (labor)** - **Hurts abundant factor (capital)**

Political economy: Scarce factor may lobby for protection.

Immigration

Immigration of workers into capital-abundant Home: - L increases - By Rybczynski: Qf increases more than proportionally, Qc may fall - At constant world prices: w falls, r rises (more workers per unit capital) - **Capital owners benefit, incumbent workers hurt**

Foreign Aid

Transfer of capital from Home to Foreign: - Home K decreases, Foreign K* increases - Changes production patterns - May worsen Home's terms of trade if exports become scarcer

Factor Market Policies

Minimum wage in labor-scarce country: - Raises w above equilibrium - Reduces labor demand - Unemployment results - Magnifies losses to workers from trade

Empirical Testing

Approaches

1. **Factor content of trade**: Calculate K/L embodied in exports vs. imports
2. **Net exports and endowments**: Regress net exports on factor endowments
3. **Gravity models**: Incorporate factor endowments into gravity framework

Findings

Successes: - Countries abundant in skilled labor export skill-intensive goods - Natural resource endowments predict trade patterns - Works better for extreme endowment differences

Failures: - Simple $2 \times 2 \times 2$ model too restrictive - Need to account for technology differences - Trade costs matter - Increasing returns and product differentiation important

Modern Approaches

- Multi-factor, multi-good models
- Incorporate technology differences
- Allow for trade costs
- Combine HO with "new trade theory"

Key Takeaways

1. **Factor endowments drive trade** in the HO model
2. **Abundant factor gains from trade; scarce factor loses**
3. **Factor price equalization**: Trade can substitute for factor mobility
4. **Stolper-Samuelson**: Goods price changes have magnified effects on factor prices
5. **Rybczynski**: Factor endowment changes have magnified output effects
6. **Political economy**: Coalitions form along factor lines (capital vs. labor)
7. **Empirical evidence**: Mixed, works better with modifications
8. **Long-run model**: Both factors mobile (contrast with Specific Factors)

Problem-Solving Framework

Identifying Trade Patterns

1. Determine factor abundance: Compare K/L ratios
2. Determine factor intensity: Compare Kc/Lc vs. Kf/Lf
3. Apply HO theorem: Abundant factor's intensive good is exported

Analyzing Price Changes

1. Identify which good's price changes
2. Determine factor intensity of that good
3. Apply Stolper-Samuelson: Intensive factor gains, other loses
4. Calculate magnification effects

Analyzing Endowment Changes

1. Identify which factor increases
2. Determine which good uses that factor intensively
3. Apply Rybczynski: Intensive good output rises more than proportionally, other output falls

Welfare Analysis

1. Calculate production changes (Rybczynski effects)
2. Calculate factor price changes (Stolper-Samuelson)
3. Identify winners: Abundant factor owners
4. Identify losers: Scarce factor owners
5. Calculate net gains (national income effect)
6. Consider redistribution possibilities

Connection to Reality

Developed vs. Developing Countries

Developed (capital-abundant): - Export capital-intensive manufactures, services - Workers may oppose free trade - Capital owners support free trade

Developing (labor-abundant): - Export labor-intensive manufactures, agriculture - Workers may support free trade - Capital owners may oppose free trade

Globalization and Inequality

HO predicts: - Rising inequality in capital-abundant countries (w falls, r rises) - Falling inequality in labor-abundant countries (w rises, r falls)

Evidence partially supports this, but other forces matter: - Skill-biased technological change - Automation - Trade in tasks (offshoring)

Migration and Trade

HO suggests: - Trade in goods can substitute for migration - But FPE rarely perfect, so gains from migration remain - Political economy: Scarce factor opposes both trade and immigration