

Econ 2203 | International Trade and Policy in Agriculture

Department of Development Economics

Recap: The Missing Piece in Ricardo

Last lecture: Comparative advantage — trade is driven by *relative* opportunity costs.

What Ricardo established: India has lower opportunity cost in Rice → exports Rice; World has lower opportunity cost in Wheat → exports Wheat; both gain from specialisation and trade.

What Ricardo left unanswered:

Why do opportunity costs differ across countries in the first place?

The Heckscher-Ohlin answer: Opportunity costs differ because countries differ in their **endowments** of factors of production (labour L , capital K , land T). And goods differ in **factor intensity** — how much of each factor they require.

The Heckscher-Ohlin Framework

The H-O model is the workhorse of international trade theory. It explains *why* comparative advantages arise from factor abundance.

Setup: Two countries (India I , USA U), two goods (Rice R , Machines M), two factors (Labour L , Capital K); identical technologies across countries.

Factor intensity: Rice is **labour-intensive** relative to Machines if:

$$\left(\frac{K}{L}\right)_R < \left(\frac{K}{L}\right)_M$$

Factor abundance (physical definition): India is **labour-abundant** if:

$$\left(\frac{K}{L}\right)^I < \left(\frac{K}{L}\right)^U$$

Factor abundance (price definition):

$$\left(\frac{w}{r}\right)^I < \left(\frac{w}{r}\right)^U \quad (\text{labour is relatively cheaper in India})$$

Assumptions of the H-O Model

Assumption	Role in the model
2 countries, 2 goods, 2 factors (2×2×2)	Tractable analytical framework
Identical technologies across countries	Comparative advantage comes <i>only</i> from endowments
Different factor endowments	This is the sole source of trade
Constant returns to scale	Concave PPF; no scale effects
Perfect competition	Prices equal marginal costs; zero profits
Factors mobile <i>within</i> countries	Labour/capital shift freely between sectors
Factors immobile <i>across</i> countries	No international migration or capital flows
No transport costs or trade barriers	Goods prices equalise across countries
Incomplete specialisation	Both goods produced in both countries
Identical, homothetic preferences	Demand differences cannot explain trade

H-O Theorem: Formal Statement

Theorem (Heckscher 1919; Ohlin 1933):

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

Applied to India and USA:

$$\left(\frac{K}{L}\right)^I < \left(\frac{K}{L}\right)^U \quad (\text{India is labour-abundant})$$

$$\left(\frac{K}{L}\right)_R < \left(\frac{K}{L}\right)_M \quad (\text{Rice is labour-intensive})$$

∴ India exports Rice; USA exports Machines

Intuition: Labour-abundant India faces a low relative wage \Rightarrow labour-intensive Rice is *relatively cheaper* to produce there.

In autarky, India's abundant labour \Rightarrow low $w/r \Rightarrow$ low relative price of Rice:

$$\left(\frac{P_R}{P_M}\right)_{\text{autarky}}^I < \left(\frac{P_R}{P_M}\right)_{\text{autarky}}^U$$

Opening to trade raises P_R/P_M in India – India's Rice sector expands, Machines sector contracts.

The Edgeworth Box: Factor Allocation

The **Edgeworth box** shows all efficient ways to allocate \bar{L} and \bar{K} between two sectors.

- Origin O_R : Rice sector
- Origin O_M : Machines sector (rotated 180°)
- **Contract curve**: locus of tangencies of Rice and Machine isoquants

$$\frac{MPL_R}{MPK_R} = \frac{MPL_M}{MPK_M}$$

- All efficient allocations lie on the contract curve
- The contract curve bows toward the labour axis (Rice is labour-intensive)

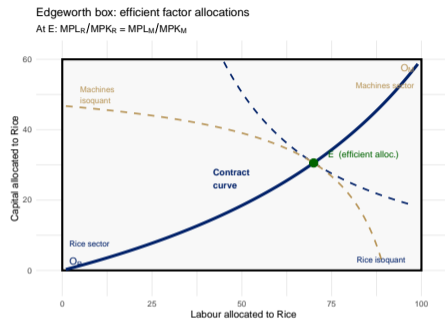


Figure 1: Edgeworth Box: Efficient Factor Allocation Between Rice and Machines
Source: Author's illustration.

fig-edgeworth

The **Production Possibility Frontier** is derived from the contract curve:

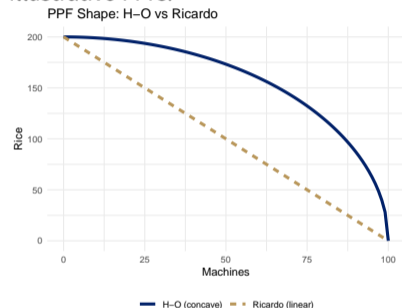
Key insight:

- Every point on the contract curve corresponds to a point on the PPF
- Moving along the contract curve (reallocating factors) traces out the PPF
- The **slope of the PPF** at any point equals the negative of the relative price P_R/P_M

Factor intensity and PPF shape:

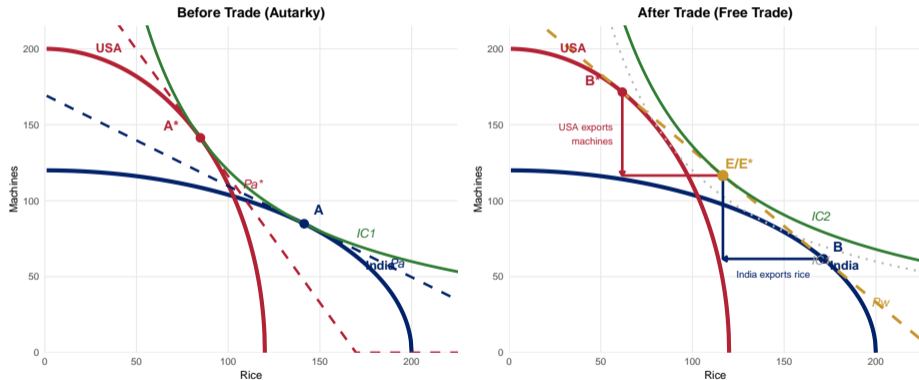
Because Rice is labour-intensive: - Moving labour from Machines → Rice: output of Rice rises fast (labour goes to its intensive use) - PPF is **concave** (bowed outward) – increasing opportunity costs

Illustrative PPFs:



Basis for and Gains from Trade: H-O Model

- India (labor-abundant) exports Rice; USA (capital-abundant) exports Machines; both reach higher IC
- Production: $A/A^* \rightarrow B/B^*$ along PPF; consumption: $A/A^* \rightarrow E/E^*$ on trade line (above PPF)



After Salvatore, Fig. 5.4

Figure 2: Basis for and Gains from Trade: H-O Model (after Salvatore, Fig. 5.4)

Theorem 1: Factor Price Equalisation (FPE)

Theorem (Samuelson 1948):

Under H-O assumptions, free trade in goods **completely equalises factor prices** across countries – even without factor mobility:

$$w^I = w^U \quad (\text{wages equalise})$$

$$r^I = r^U \quad (\text{returns to capital equalise})$$

Intuition:

- Trade in goods is an indirect form of trading factors
- India exporting Rice is equivalent to exporting embedded labour
- As India expands Rice production, labour demand rises → Indian wages rise
- As USA imports Rice, labour demand in USA Rice sector falls → US wages fall
- In equilibrium: $w^I = w^U$

! The FPE insight

Free trade is a **perfect substitute** for factor mobility. This explains why labour migration and goods trade are strategic complements in policy debates.

FPE requires very strong assumptions:

Assumption	Status in reality
Identical technologies	Violated (TFP gaps are large)
Free trade in all goods	Violated (tariffs, NTBs)
No factor intensity reversal	Usually holds
Incomplete specialisation	Often violated
No transport costs	Violated

Theorem 2: Stolper-Samuelson Theorem

Theorem (Stolper and Samuelson 1941):

A rise in the relative price of a good raises the real return to the factor used intensively in that good's production, and lowers the real return to the other factor – **more than proportionally**:

$$\hat{P}_R > 0 \Rightarrow \hat{w} > \hat{P}_R > 0 > \hat{r}$$

where $\hat{x} \equiv d \ln x$ denotes percentage change, and Rice is labour-intensive.

Formal result:

$$\hat{w} > \hat{P}_R > \hat{P}_M > \hat{r}$$

This is the **magnification effect**: factor price changes are magnified relative to goods price changes.

Applied to India opening to trade:

$$P_R \uparrow \Rightarrow w \uparrow\uparrow, \quad r \downarrow \quad (\text{Indian workers gain; Indian capital owners lose})$$

$$P_M \uparrow \Rightarrow r \uparrow\uparrow, \quad w \downarrow \quad (\text{US capital owners gain; US workers lose} \rightarrow \text{political economy of protectionism!})$$

Why does Stolper-Samuelson matter for policy?

It explains *who lobbies for and against trade liberalisation*:

- Labour in labour-abundant countries → **pro-trade**
- Capital in labour-abundant countries → **anti-trade** (or sector-specific)
- Labour in capital-abundant countries → **anti-trade** (e.g., US manufacturing unions)

India's agricultural trade policy: When India raises rice export prices via MSP increases: $P_R \uparrow \Rightarrow w_{\text{agri}} \uparrow \Rightarrow$ rural wages rise — Stolper-Samuelson in action.

The compensation principle: Even when aggregate welfare rises, there are **distributional losers**. A country could use the gains to compensate losers, but in practice: compensation schemes are costly, political constraints prevent redistribution, short-run adjustment costs fall unevenly. This is why **trade adjustment assistance** (TAA) programs exist.

Theorem 3: Rybczynski Theorem

Theorem (Rybczynski 1955):

At constant goods prices, an increase in the endowment of a factor causes:

$$L \uparrow \Rightarrow Q_R \uparrow\uparrow \text{ and } Q_M \downarrow$$

More precisely:

$$\hat{Q}_R > \hat{L} > 0 > \hat{Q}_M$$

- Output of the labour-intensive good rises **more than proportionally** to the labour increase
- Output of the capital-intensive good **falls absolutely**

Intuition: Expanding Rice output (to absorb new labour) requires withdrawing capital from Machines, even though capital endowment is unchanged. At constant prices, the only way to re-equate factor ratios is to pull capital into Rice and contract Machines.

India application: India's rural-to-urban migration (labour inflow to manufacturing):

$$L_{\text{mfg}} \uparrow \Rightarrow Q_{\text{mfg}} \uparrow\uparrow, \quad Q_{\text{agri}} \downarrow$$

Structural transformation is partly a Rybczynski phenomenon.

Rybczynski Effect: PPF Diagram

An inflow of labour **rotates** the PPF outward, but asymmetrically:

- The Rice (labour-intensive) intercept expands greatly
- The Machines (capital-intensive) intercept contracts

At the **original price ratio**, the economy moves from A to B:

- More Rice produced ($Q_R \uparrow\uparrow$)
- Fewer Machines ($Q_M \downarrow$)

This is the **Rybczynski line** — locus of output combinations at constant prices as labour endowment varies.

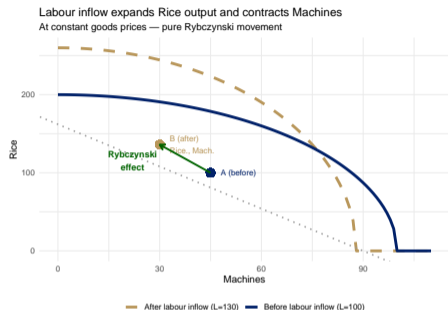


Figure 3: Rybczynski Effect: Labour Inflow Shifts PPF Source: Author's illustration.

fig-rybczynski

The Leontief Paradox (1953)

The test: Wassily Leontief (1953) used US input-output tables to measure the capital and labour content of US exports and imports.

The prediction (H-O): The USA, being capital-abundant, should export capital-intensive goods and import labour-intensive goods.

The finding: US exports were *more labour-intensive* than US imports — **the opposite of H-O!**

Formal statement of the paradox:

$$\left(\frac{K}{L}\right)_{\text{US exports}} < \left(\frac{K}{L}\right)_{\text{US imports}}$$

This contradicts the basic H-O prediction for a capital-abundant country.

Factor Intensity of India's Trade

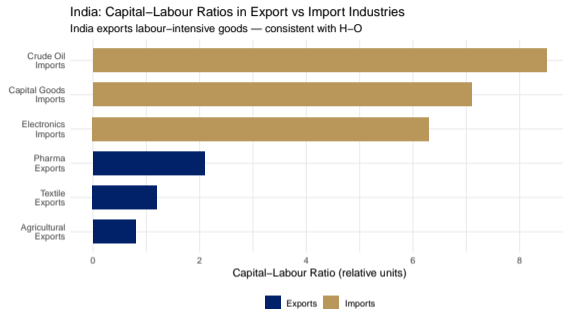


Figure 4: Factor Intensity of India's Exports vs Imports (illustrative) Source: Author's illustration based on DGCI&S / World Bank data.

India does NOT exhibit a Leontief paradox — it exports labour-intensive goods, consistent with H-O.

Explanations for the Leontief Paradox

Several resolutions have been proposed:

1. **Human capital:** US labour is highly skilled – skill-adjusted, US workers embody large amounts of human capital (Effective $K/L = (K + K_H)/L$)
2. **Factor intensity reversals:** Same good can be labour-intensive in one country and capital-intensive in another (different factor prices → different techniques)
3. **Natural resource abundance:** US imports include oil and raw materials – these are capital-intensive; excluding natural resource industries resolves much of the paradox
4. **Demand bias:** US consumers have stronger preference for capital-intensive goods; demand effects can offset supply-side comparative advantage
5. **Trade barriers:** US tariff structure historically protected labour-intensive industries (agriculture, textiles), distorting trade flows

Lewis (1954): Structural Transformation

While H-O focuses on *between-country* differences, the **Lewis model** explains how factor endowments evolve *within* a developing country:

Two sectors: Traditional sector (agriculture) with large labour surplus ($MPL_A \approx 0$); Modern sector (industry/services) with higher wages.

Lewis's key assumption: $MPL_A < \bar{w}_{\text{subsistence}}$ – a pool of “surplus labour” in agriculture can be absorbed by industry **without raising agricultural wages**.

Implications for agricultural trade during Lewis transition:

- Low rural wages → comparative advantage in labour-intensive agricultural exports
- As industrialisation proceeds → rural wages rise → agricultural comparative advantage erodes
- Eventually: Rybczynski-type shift away from agricultural exports

East Asia's trajectory: Japan (1950s–70s) → South Korea (1970s–90s) → China (2000s–) each followed this path: strong agricultural/labour-intensive exports early, shifting to capital-intensive manufactures.

Lewis Model: Diagrammatic Analysis

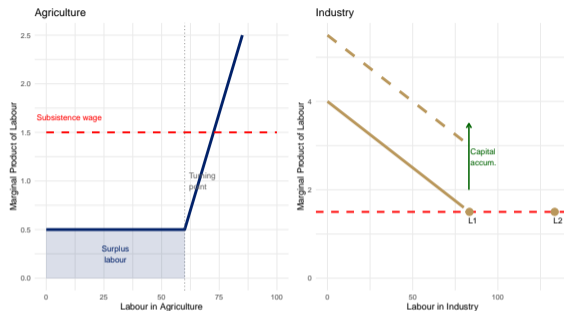


Figure 5: Lewis Model: Surplus Labour Transfer and Structural Transformation Source: Author's illustration after Lewis (1954).

H-O, Lewis, and India's Agricultural Exports

Connecting the models:

Mechanism	H-O	Lewis
Source of CA	Factor endowments	Wage dualism
Key variable	K/L ratio	MPL_A vs \bar{w}
Trade prediction	Export labour-intensive goods	Export goods with surplus-labour content
Dynamics	Static	Dynamic (transition)

Combined implication for India: India currently sits at an early Lewis stage — large agricultural labour surplus (~40% of workforce); low rural wages → comparative advantage in labour-intensive agri exports.

India's agricultural export performance (FY2024): Total \$43.7B; Rice \$10.4B; Marine \$7.6B; Spices \$3.7B — H-O predicts labour-intensive crops dominate (confirmed); Lewis explains low rural wages underpin price competitiveness.

India should invest in agricultural productivity to maintain competitiveness even as wages rise — moving up the value chain rather than defending low-wage advantage.

The Modern Theory of Trade: Summary

Three pillars of the H-O framework:

1. **H-O Theorem:** countries export goods intensive in their abundant factor
2. **Factor Price Equalisation:** $w^I = w^U, r^I = r^U$ (free trade substitutes for factor mobility)
3. **Stolper-Samuelson:** $\hat{P}_R > 0 \Rightarrow \hat{w} > \hat{P}_R > 0 > \hat{r}$ (trade has stark distributional effects)
4. **Rybczynski:** $\hat{L} > 0 \Rightarrow \hat{Q}_R > \hat{L} > 0 > \hat{Q}_M$ (factor accumulation biases production)

Empirical evidence: Factor content of trade is mixed (Trefler 1995); India's labour-intensive export pattern is confirmed; wage convergence is partial (direction correct); Stolper-Samuelson distributional effects are strong in the long run; Rybczynski structural change is well-supported by East Asian data.

What H-O cannot explain: Intra-industry trade; trade between similar countries; scale economies → **New Trade Theory** (Lecture 6)

Why do we need a theory beyond H-O?

- $\approx 60\%$ of world trade is **intra-industry** (exchanging similar goods)
- Large share of trade is **between similar, high-income countries**
- **Scale economies** matter — firms, not just countries, have comparative advantages

Krugman's (1979) insight:

Even with identical factor endowments, countries gain from trade because:

Specialisation \Rightarrow Scale economies \Rightarrow Lower costs \Rightarrow More variety

Each country specialises in a *different* variety of the same good — gains arise from **love of variety**, not factor endowments.

Next lecture: Economies of scale, monopolistic competition, and the new economic geography — why do trade and production cluster? And what does this mean for India's agricultural processing sector?

Further Reading

- *International Economics* — Salvatore (Ch. 4-5)
- *International Economics* — Appleyard & Field (Ch. 4-5)
- RBI/DGCI&S/APEDA databases for latest data

Key Data Sources

- DGCI&S: India's merchandise trade
- RBI: Balance of payments data
- APEDA: Agricultural export statistics
- WTO: Tariff and trade databases