Chapter 4

Comparative Advantage and Factor Endowments
Lecture Objectives

- Analyze the comparative advantage based on endowment differences
  - Heckscher-Ohlin model
  - Discuss the results of empirical tests of comparative advantage based on endowment differences.
- Present economic models on the impact of trade on income distribution
  - HO Model: Stolper-Samuelson theorem
  - Specific factors model
Recall that *comparative advantage* refers to the difference in autarky *relative prices* between countries.

Anything that produces different relative prices is a potential source of comparative advantage.

- The Ricardian ("Classical") model emphasized differences in *technology*;
- Differences in *endowments* of factors of production is the focus of the *Heckscher-Ohlin* model;
Introduction (continued)

- Differences in *tastes*;
  - Between countries,
  - Within countries,
- Preference for variety
- Non-constant returns technology; and
- *Institutional Differences*
  - Market institutions
  - Political Institutions
Modeling Strategy: focus on one element by holding the others constant

- The Ricardian model focuses on technology
- The *Heckscher-Ohlin model* focuses on endowment differences.
- We’ll see other approaches later
From Classical to
Heckscher-Ohlin Trade Theory

- Problems with the Ricardian Model
  - Strong Specialization/Discontinuous Adjustment
  - Indeterminacy of Final Terms of Trade
  - No Income Distribution Effects
  - Problems with the Labor Theory of Value
    - Demand is an important determinant of value
    - Other factors of production are important (at least proximately) in the production of value.
Increasing Opportunity Cost
- A “bowed out” (concave) production frontier
- This will yield a continuous price-output relationship.

Neoclassical Value Theory
- With increasing opportunity cost, we will need demand to determine autarky equilibrium price
- Demand also resolves the ToT indeterminacy
Eli *Heckscher* (1879-1952) and Bertil *Ohlin* (1899-1879) developed an analysis of trade based on endowment differences, assuming:

- Unlike the Ricardian model, countries have access to the *same technologies*; and
- Countries share the *same tastes*; but
- Countries differ in their *endowments* of productive factors.
Paul Samuelson, who pioneered the formalization of trade theory, developed a simple formal analysis of the HO theory, which is commonly called the HOS model:

- 2 final goods: Bread and Steel;
- 2 factors of production: Capital and Labor; and
- 2 countries: US and Canada.
Production functions:
- Require the use of both factors
  - \( y_j = f^j(K_j, L_j) \) for \( j = S \) and \( B \).
- Are constant returns to scale; but
- Diminishing returns to either factor when holding the use of the other fixed.
- One good, say steel, is always capital-intensive relative to the other ("no factor-intensity reversal")

\[
\frac{K_S}{L_S} > \frac{K_B}{L_B}.
\]
Under these assumptions, we can show that the production frontier is strictly concave.

That is, there are increasing opportunity costs in transformation.
Demand in the HOS Model, 1

- With a concave PPF, we will need demand to characterize an equilibrium.
- We will assume that aggregate preferences exist and are such that:
  - Both goods are good;
  - Both goods are normal;
  - Goods can be smoothly substituted; and
  - Diminishing marginal rate of substitution.
We can represent these preferences with an aggregate utility function whose indifference curves are:

- Increasing along any ray from the origin;
- Negatively sloped;
- Bowed in to the origin;
- Positively sloped income-expansion path; and
- Non-intersecting.
Demand in the HOS Model, 3

1) Increasing along any ray from the origin:

\[ \mu_2 > \mu_1 \]
Demand in the HOS Model, 4

1) Increasing along any ray from the origin
2) Negatively sloped
3) Smoothly bowed in to the origin
1) Increasing along any ray from the origin
2) Negatively sloped
3) Smoothly bowed in to the origin
4) Positively sloped expansion path
1) Increasing along any ray from the origin
2) Negatively sloped
3) Smoothly bowed in to the origin
4) Positively sloped expansion path
5) Non-Intersecting

\[ x \sim y \ & \ y \sim z \]

but \[ x \succ z \]
In a closed economy, equilibrium requires

- Prices are such that Supply = Demand in all markets; and

- All agents are optimizing:
  - Firms are choosing outputs to maximize profits; and
  - Households are choosing consumption to maximize utility.
Autarky Equilibrium in the HOS Model,

- Optimizing Behavior Implies:

\[ MRS_{BS} = \frac{P_S}{P_B} = MRT_{BS}. \]

- This is easily shown graphically
Autarky Equilibrium in the HOS Model, 3

\[ MRS_{BS} = \frac{P_S}{P_B} = MRT_{BS} \]
As with the Ricardian model, it is easiest to consider the effect of trade on the small HOS economy:

- The autarkic HOS economy will now observe given world trade prices.
- We assume, for the illustration that:

\[
\frac{P^*_S}{P^*_B} > \frac{P^*_A}{P^*_B} = MRS^*_A = MRT^*_B
\]
Illustrating Trade in the HOS Model, 1: Autarky again

\[ MRS_{BS} = \frac{P_S}{P_B} = MRT_{BS} \]
Illustrating Trade in the HOS Model, 2: Trade Prices

\[ \frac{P_s^*}{P_B^*} > \frac{P_s^A}{P_B^A} = MRS_{BS}^A = MRT_{BS}^A \]
Illustrating Trade in the HOS Model, 3: Production Adjusts

\[ \frac{P_S^*}{P_B^*} = MRT \]
Illustrating Trade in the HOS Model, 4: Consumption Adjusts

\[ \frac{P_S^*}{P_B^*} = MRS \]
Illustrating Trade in the HOS Model, 5: The Trade Triangle

\[ P_S y_S + P_B y_B = P_S x_S + P_B x_B \]

value of output (2) value of consumption (1)

\[ P_S (x_S - y_S) = P_B (x_B - y_B) \]

value of exports value of imports

\[ P_S X_S = P_B M_B \]
On the Equilibrium with Trade

- Note that the equilibrium with trade is an equilibrium
  - Consumers are optimizing: $p^* = MRS$
  - Producers are optimizing: $p^* = MRT$
  - Supply = Demand in all markets
  - Balanced Trade: value imports (M) = value exports (X)
- *Gains from trade*: the economy achieves a higher aggregate welfare (as represented by the higher indifference curve or larger consumption set)
Comparative Advantage: The Heckscher-Ohlin Theorem

- Comparative advantage in the HOS model derives from the interaction between factor-intensity (the relationship between industries) and factor abundance (a comparison between countries).
- A country is called capital-abundant relative to another country if its endowment of capital, relative to labor, is greater than that of the other country.
The Heckscher-Ohlin Theorem

- *The Heckscher-Ohlin Theorem*: Under the assumptions of the HOS model, a country will have a comparative advantage in the good whose production uses its abundant factor intensively.

- *The Law of Comparative Advantage*: a country will export the good in which it has a comparative advantage.
Applying the Heckscher-Ohlin Theorem

- Suppose we assume that the US is capital intensive relative to Canada:

\[
\frac{K^{US}}{L^{US}} > \frac{K^{Can}}{L^{Can}},
\]

- The Heckscher-Ohlin theorem predicts that the US will have a comparative advantage in steel production relative to Canada.
Empirical Research on the Heckscher-Ohlin Theorem, 1

- The H-O Theorem has the virtue, shared with the Ricardian model, that, under the assumptions of the theory, *knowledge of autarky prices is not necessary to predict trade patterns*:
  - Knowledge of endowments predicts to comparative advantage.
  - Not surprisingly, this has led to a large body of research on the predictions of the HO theorem.
Many different empirical frameworks

- *Leontief-type tests*: calculate implicit factor trade from input-output data;
- *Multi-Good, Multi-Factor, Multi-Country tests*: Sign and rank-order tests.
- *Regression-based tests*: predict export/import status from factors used in production.
  - Single country, cross-commodity
  - Multi country, aggregate trade flow
  - Multi country, multi commodity
Empirical Research on the Heckscher-Ohlin Theorem, 3

- Results are generally weak to poor
  - Share of trade explained by endowments small
  - Volume of trade under-predicted ("mystery of the missing trade")
  - AICs seem to be scarce in most factors and LDCs abundant in all factors
- Large share of world trade between countries with similar endowments (OECD countries)
- Large share of trade is intra-industry trade
Empirical Research on the Heckscher-Ohlin Theorem, 4

- What would we expect? We are ignoring:
  - Taste difference (Home bias in particular)
  - Technology differences
  - Transaction costs (transportation, protection, etc.)
  - Economies of scale
  - Institutional differences

- The results improve strongly when we include some of these factors.
The Ricardian model was unable to address income distribution issues within countries because there was a single, homogeneous factor of production. Because the HO theory is based on factor heterogeneity it does allow us to analyze income distribution.
Wolfgang Stolper and Paul Samuelson showed that, under the assumptions of the HOS model, there is a relationship between changes in commodity prices and changes in the real return to factors of production.

While households may own mixes of factors of production, this result clearly gives us a starting point for analyzing the distributional effects of trade.
Much of the recent interest in the link between trade and income distribution derives from the suspicious link between

- *Increased openness* in most countries over the last 25 years;
Evolution of Trade Openness
Evolution of the Trade Balance

Slide 4-39
Much of the recent interest in the link between trade and income distribution derives from the suspicious link between

- *Increased openness* in most countries over the last 25 years; and
- *Sharply increased skill premium* (the return to skilled labor relative to that of unskilled labor).
Evolution of the Skill Premium

Relative Wages: 1967-1996

Log Relative Wage

- LRelW3
- LRelW1
- LRelW2

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- *Sharply increased skill premium* (the return to skilled labor relative to that of unskilled labor).

*Stolper-Samuelson theorem* seems like a natural place to start an evaluation of this link.
Stolper-Samuelson Theorem: Setup, 1

- Derived from the HOS model

- Assumptions:
  - 2 goods, 2 factors of production
  - Constant returns to scale
  - Perfect competition in all markets means
    - Zero economic profits: \( p_j = wa_{Lj} + ra_{Kj}, j = B, S \);
    - Full employment: \( Z_i = a_iy_B + a_iy_S, i = K, L \); and
    - All factors earn the values of their marginal products
As in our lecture on the HO theorem, suppose that, when trade is opened, our reference country sees a higher relative price of steel:

\[ \frac{P_S^*}{P_B^*} := p^* > p := \frac{P_S}{P_B}. \]
Stolper-Samuelson Theorem: Setup, 3

World price: $p^* > p$

Production adjusts to reflect comparative advantage

Bread \((L\)-intensive) vs. Steel \((K\)-intensive)
Stolper-Samuelson Theorem: Intuition

- Responding to the new relative price, leads to an increase in the output of the $K$-intensive good.
- At initial relative factor-prices, this creates
  - Excess demand for $K$; and
  - Excess supply of $L$.
- This puts *upward pressure on* $r$ and *downward pressure on* $w$. 
The story we just told refers to adjustments in factor markets as a result of changes in world relative prices.

To get a bit of intuition on this, let’s look explicitly at demands for factors.

To do this we will make use of the isoquant diagram, a representation of production conditions.
The Two-Input, Neoclassical Production Function: \( y_j = f^j(K,L) \)

- Constant returns to scale;
  - Expansion path is a straight line;
  - Slope of expansion path gives \( k_j = K_j / L_j \).
- Slope of an isoquant gives the *marginal rate of technical substitution* between \( K \) and \( L \);
  
  \[
  \text{slope} = \frac{\frac{\text{MPP}_L^j}{\text{MPP}_K^j}}{\frac{\text{MPP}_K^j}{\text{MPP}_L^j}} := \text{MRTS}_{KL}^j.
  \]
The Isocost Line

All combinations of $K$ and $L$, given $w$ and $r$, worth a fixed amount—say $p_j$: $p_j = rK_j + wL_j$

\[ K_j = \frac{p_j}{r} - \frac{w}{r} L_j \]

So the slope gives the equilibrium $w/r$ ratio.
The Isoquant Diagram

\[ MRTS_{KL} = \frac{MPP^B_L}{MPP^B_K} \equiv \frac{P_B \cdot MPP^B_L}{P_B \cdot MPP^B_K} = \frac{w}{r} \]

\[ k_B = \frac{K_B}{L_B} \]

\[ y_B = f^B(K_B, L_B) \]
Stolper-Samuelson Theorem: Factor-Market Adjustment, 1

\[ y_S = f^S(K_S, L_S) \]

\[ y_B = f^B(K_B, L_B) \]
Stolper-Samuelson Theorem: Factor-Market Adjustment, 2

At initial \( w/r \), the increase in \( p \):

1) \( S \) producers seek to expand

2) \( B \) producers seek to contract
Stolper-Samuelson Theorem: Factor-Market Adjustment, 3

This creates:

1) excess demand for $K$, pushing up $r$; and

2) Excess supply of $L$, pushing down $w$. 
So the $w/r$ ratio must fall, causing both sectors to substitute $L$ for $K$. 
Stolper-Samuelson Theorem: Some Simple Analytics

- We can provide a graphical illustration of the Stolper-Samuelson theorem using the *Lerner-Pearce diagram*.
- To do this we need to recall some details about the neoclassical production function and it’s graphical representation (the *isoquant*).
The Two-Input, Neoclassical Production Function: $y_j = f^j(K,L)$

- Constant returns to scale;
  - Expansion path is a straight line;
  - Slope of expansion path gives $k_j = K_j / L_j$.
- Slope of an isoquant gives the *marginal rate of technical substitution* between $K$ and $L$;

$$\text{slope} = \frac{MPP^j_L}{MPP^j_K} := MRTS^j_{KL}.$$
The Lerner-Pearce Diagram, 1

- The *Lerner-Pearce diagram* illustrates equilibrium in the HOS model using *unit-value isoquants*.
  - *Unit value isoquants* show all combinations of inputs that efficiently produce $1 of output.
  - Any good being produced at zero profits must have an isoquant tangent to the $1 isocost line.
The Lerner-Pearce diagram, 2

\[ \frac{1}{p_s} = f^S(K_s, L_s) \]

\[ \frac{1}{p_b} = f^B(K_b, L_b) \]
The Lerner-Pearce diagram, 3

1) Price of *Steel* rises
2) Relative factor price adjusts
3) Relative inputs adjust
Proving the Stolper-Samuelson Theorem, 1

- Note that the slope of the unit isocost line gives the equilibrium $w/r$ ratio:

$$1 = wL_j + rK_j$$

$$K_j = \frac{1}{r} - \frac{w}{r}L_j.$$ 

- Note also that the vertical intercept is the inverse of the rental rate and the horizontal intercept is the inverse of the wage rate.
The Lerner-Pearce diagram showed that an increase in the price of the $K$-intensive good made the slope of the isocost flatter.

- But that means that the $w/r$ ratio falls.
- That is, the return to labor, relative to that of capital, goes down.
- In fact, under the assumptions of the HOS model, the result is even stronger.
We can be more specific:

- Recall our assumption that the relative price changes because the price of steel rises and the price of bread stays constant:

\[ \hat{P}_S > \hat{P}_B = 0; \]

- Now we can use the diagram to find the effects of this change on factor prices.
Proving the Stolper-Samuelson Theorem, 4

1) The wage rate clearly falls;

2) The rental rate clearly rises.

\[ y_S = \frac{1}{P_S} \]

\[ y_S = \frac{1}{P_S'} \quad P_S < P_S' \]

\[ y_B = \frac{1}{P_B} \]
Proving the Stolper-Samuelson Theorem, 5

- From the graph, it is straightforward to see that the wage rate actually falls, so:

\[ \hat{P}_S > \hat{P}_B = 0 > \hat{w}; \]

- The same reasoning allows us to see that the rental rate rises, but we can actually say more.
Proving the Stolper-Samuelson Theorem, 4

Measuring along the $K$ axis:

1) The proportional change in $P_S$ is:

$$\hat{P}_S = \frac{0A - 0B}{0A} = \frac{AB}{0A}.$$
Proving the Stolper-Samuelson Theorem, 4

Measuring along the $K$ axis:

2) The proportional change in $r$ is:

$$\hat{r} = \frac{0A - 0C}{0A} = \frac{AC}{0A};$$
Proving the Stolper-Samuelson Theorem, 4

Measuring along the $K$ axis:

3) Thus the proportional rise in $r$ exceeds the rise in $P_S$;

$$\hat{r} = \frac{AC}{0A} > \frac{AB}{0A} = \hat{P}_S;$$
Stolper-Samuelson Theorem, Formal Statement, 1

- **Theorem**: Under the assumptions of the HOS model, an increase in the relative price of a good will raise the return to the factor used intensively in the production of that good *relative to all other prices*, and lower the return to the other factor, *relative to all other prices*.

\[ \hat{r} > \hat{P}_S > \hat{P}_B = 0 > \hat{w}; \]
Stolper-Samuelson Theorem, Formal Statement, 2

- Note three parts of the theorem:
  - *Friends and Enemies*: For each factor, there is a good such that if its price goes up the price of the factor will rise (a *friend*), and another good such that if its price goes up the price of the factor will fall (an *enemy*);
  - *Global*: The identity of friends and enemies is fixed for all relative commodity prices; and
  - *Magnification*: The effects of price changes on income are *real* effects (i.e. they do not depend on the mix of goods in consumption).
The S-S theorem is a very strong result, but it should be noted that in this strong form it is true only of a 2-factor x 2-good, perfectly competitive model.

Weaker results are available $m$-factor x $n$-good model, but they are not this strong:
- Local friends and enemies; and
- Correlation generalizations.
There has been a sizable quantity of empirical research on the S-S theorem:

- Checks for consistency;
- Implicit trade in factors (equivalent to Leontief-type tests of the HO Theorem);
- Mandated wage regressions; and
- Computational studies.
Most of the empirical research suggests that trade, at least via Stolper-Samuelson channels, explains only a small amount of change in relative wages.

Most economists think *technological change* is a more important source of change in relative wages;

However, some economists think that other forms of globalization—e.g. *foreign direct investment, outsourcing, and effects on unions and welfare state*—may be very important (Samuelson Vs Bhagwati debate on outsourcing, *Journal of Economic Perspectives*, 2004).
If Stolper-Samuelson effects are zero to small, why are so many people concerned about trade?

- People could just be wrong; but
- Un-modeled factors might be important.

One relatively straightforward source of concern is *adjustment costs*

- A simple representation of adjustment costs is the *specific factors model* in which (at least some) factors are completely immobile.
In the very short-run, it seems reasonable to assume that virtually all factors of production are immobile.

But this means that the proportions in production are fixed, so

- Marginal physical products are fixed, so
- If commodity prices are fixed factor payments will be fixed, and
- If commodity price changes, the returns to all factors in an industry change by the same proportion as the price change.
Some factors fixed, others mobile: The Ricardo-Viner Model, 1

The idea here is that some factors are mobile, while other factors are fixed.

- *Land* is pretty fixed in its broad occupation;
- *Capital* (i.e. *machines*, etc.) is also quite fixed;
- *Labor* can be assumed mobile.
- Are some kinds of labor more mobile than others?
What happens in the Ricardo-Viner model when relative commodity prices change?

*Theorem*: An increase in the price of a good raises the return to the specific factor(s) used in the production of that good, and lowers the return to all other specific factors.

*Neoclassical ambiguity*: the effect of relative commodity price changes on mobile factors is dependent on consumption shares.
General Adjustment Costs in an HOS World

- The Cairnes-Haberler and Ricardo-Viner models have the virtue of simplicity, but
- We can also consider a variant in which all factors are mobile, but at differential adjustment costs.
- The previous models are all variants of this model.
- For our purposes, there is little additional analytical or empirical gain from this generality.
One way of thinking about the models we have been considering is to treat them as referring to different time horizons:

- Cairnes-Haberler: very short run;
- Ricardo-Viner: medium run; and
- HOS: long run.

Choosing models then will be related to the time horizon relevant for analysis.
Adjustment Costs, Empirical

- Estimates on costs of adjustment vary:
  - $80,000 average loss in lifetime earning;
  - 12% average lifetime pay cut.
- These averages hide very asymmetric effects:
  - Young workers experience relatively small costs; but
  - Older workers experience large costs.
Adjustment Costs, Implications

- *Static Gains from Trade are Overestimates*
- *Securing Gains from Trade Depends on Well-Constructed Trade-Adjustment Schemes*
  - Note that this is independent of long-run distributional effects.
  - Note, also, that this applies as much to increases in protection as to liberalization.
- *Securing Political Support for Liberalization May Also Depend on Trade-Adjustment Schemes*
Extensions of the HO Model

- There are several alternative trade models that elaborate on the theory of comparative advantage
  - **Product cycle model** – focuses on the speed of technological change and life history of many manufactured items through periods of innovation, stabilization, and standardization
  - **Intra-firm trade model** – allows for comparative advantage but incorporates industrial organization
Developed by Raymond Vernon

Argument: Production of a good is cyclical

- When a manufactured good is developed, producers experiment and seek consumers’ reactions
- When production leaves the early stage, the good begins to be standardized in terms of size, features, and manufacturing process
- Finally, consumption of the good in a high-income country exceeds its production: production moves where labor costs are lower
Product Cycle (cont.)

Figure 4.5
Product Cycle (cont.)

Figure 4.6
Outsourcing and Intra-Firm Trade

- Much of international trade is intra-firm trade – trade between the parent company in the home country and its affiliate in a foreign country.

- Reasons for intra-firm trade
  - Firms take advantage of cross-country differences in the prices of inputs.
  - A firm may obtain cheaper and better inputs through its foreign affiliate rather than independent foreign firms.
  - Similarly, a firm may reduce distribution costs in a foreign market by operating through an affiliate.
Intra-Firm Trade (cont.)

- Intra-firm trade is growing in importance
  - In the mid-1990s, 2/3 of U.S. merchandise exports and 2/5 of U.S. merchandise imports carried out within firms

- Intra-firm trade may have important economic benefits
  - Expansion of multinational corporations (MNCs) helps diffuse technology across national borders
An alternative to intra-firm trade is outsourcing: arms-length transactions to provide inputs and/or processing.

Many firms do both outsourcing and intra-firm trade.

More broadly, we can refer to globalization of production.
Implications of Outsourcing and Intra-Firm Trade

- Outsourcing looks like technological change in the data.
  - Thus, empirical results on the Stolper-Samuelson theorem may need to be rethought.
  - In addition, clean theoretical results in an environment with outsourcing are hard to come by (dimensionality problems).
- Outsourcing in models with distortions (unions or welfare states) may produce large welfare effects.