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

Introduction

- 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 e*ndowments* 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

Introduction (3)

- 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.

From Classical to Heckscher-Ohlin Trade Theory, 2

- **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

Introduction to Heckscher-Ohlin Trade Theory

- 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.

The Hecksher-Ohlin-Samuelson (HOS) Model

- 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*.

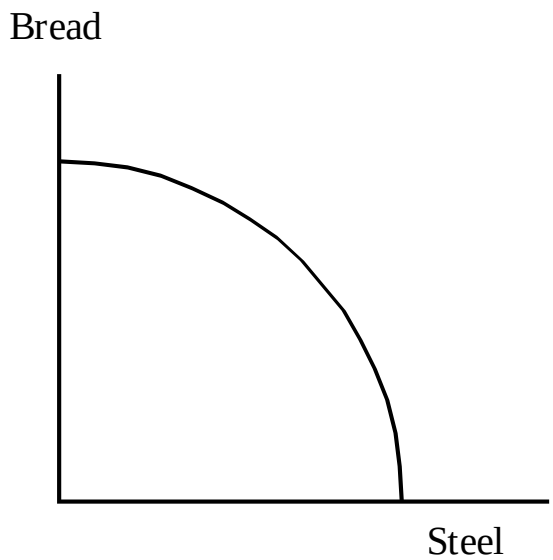
Production in the HOS Model, 1

- 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*")

$$\frac{K_S}{L_S} > \frac{K_B}{L_B}.$$

Production in the HOS Model, 2

- Under these assumptions, we can show that the production frontier is strictly concave.
  - That is, there are increasing opportunity costs in transformation



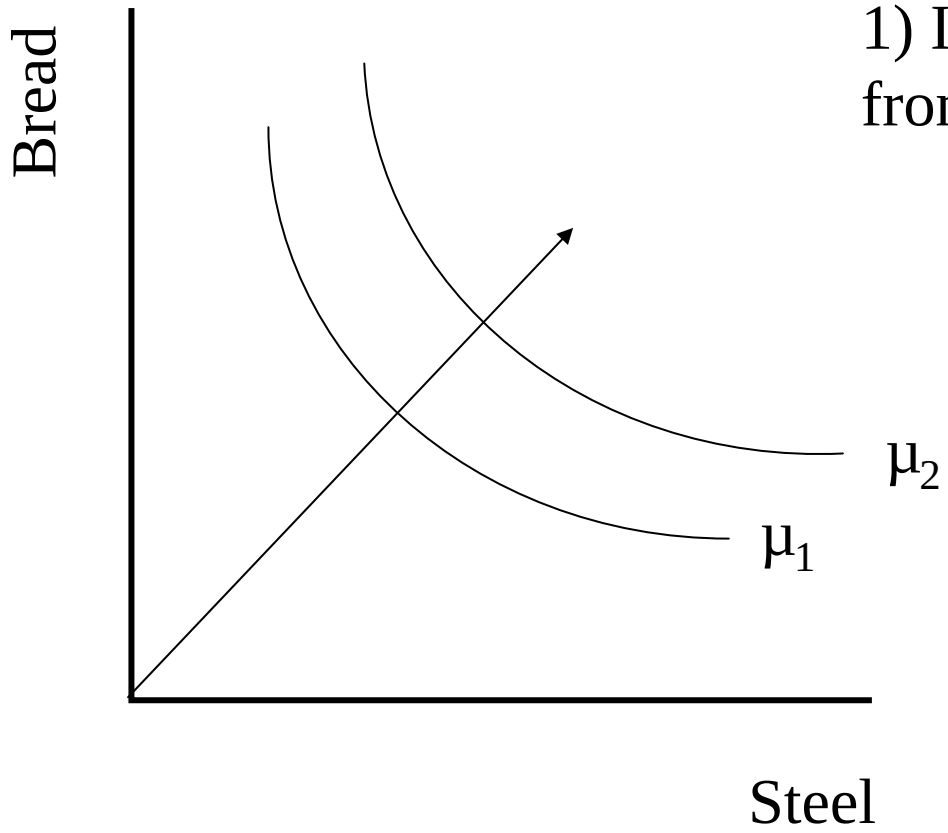
Demand in the HOS Model, 1

- 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*.

Demand in the HOS Model, 2

- 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.*

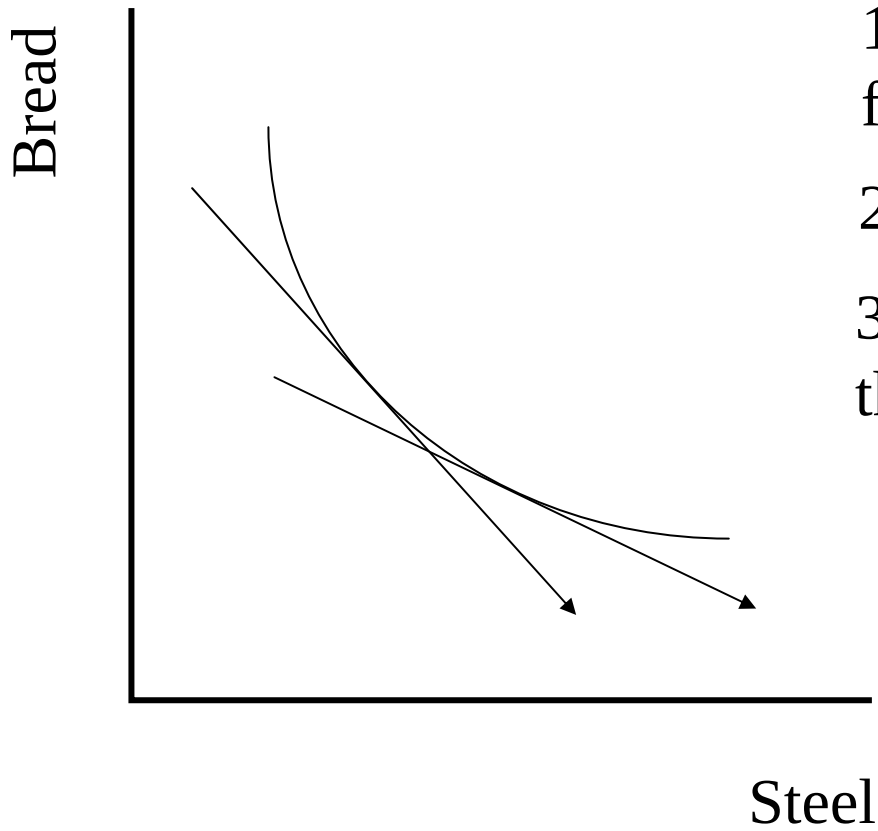
Demand in the HOS Model, 3



1) Increasing along any ray from the origin:

$\mu_2 > \mu_1$

Demand in the HOS Model, 4

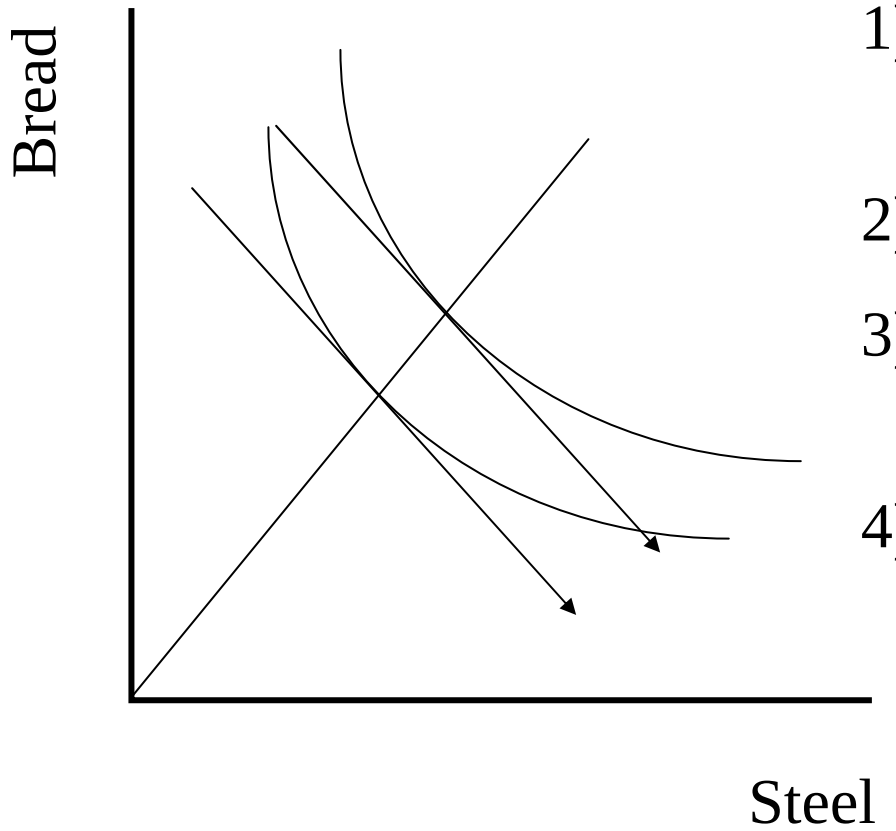


1) Increasing along any ray from the origin

2) Negatively sloped

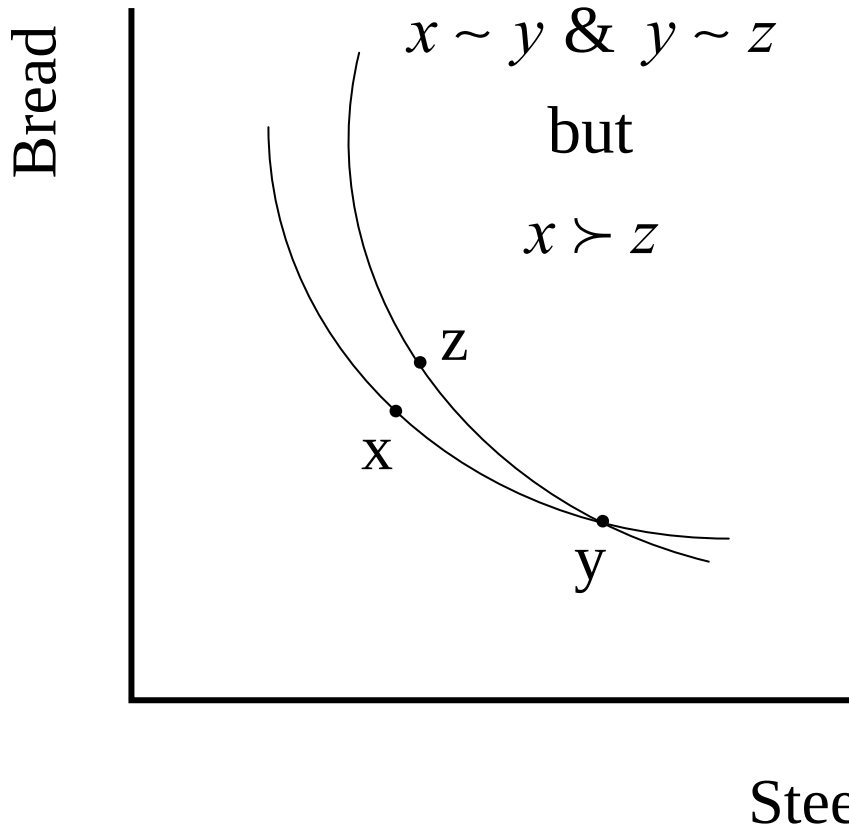
3) Smoothly bowed in to the origin

Demand in the HOS Model, 5



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

Demand in the HOS Model, 6



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

Autarky Equilibrium in the HOS Model, 1

- 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.

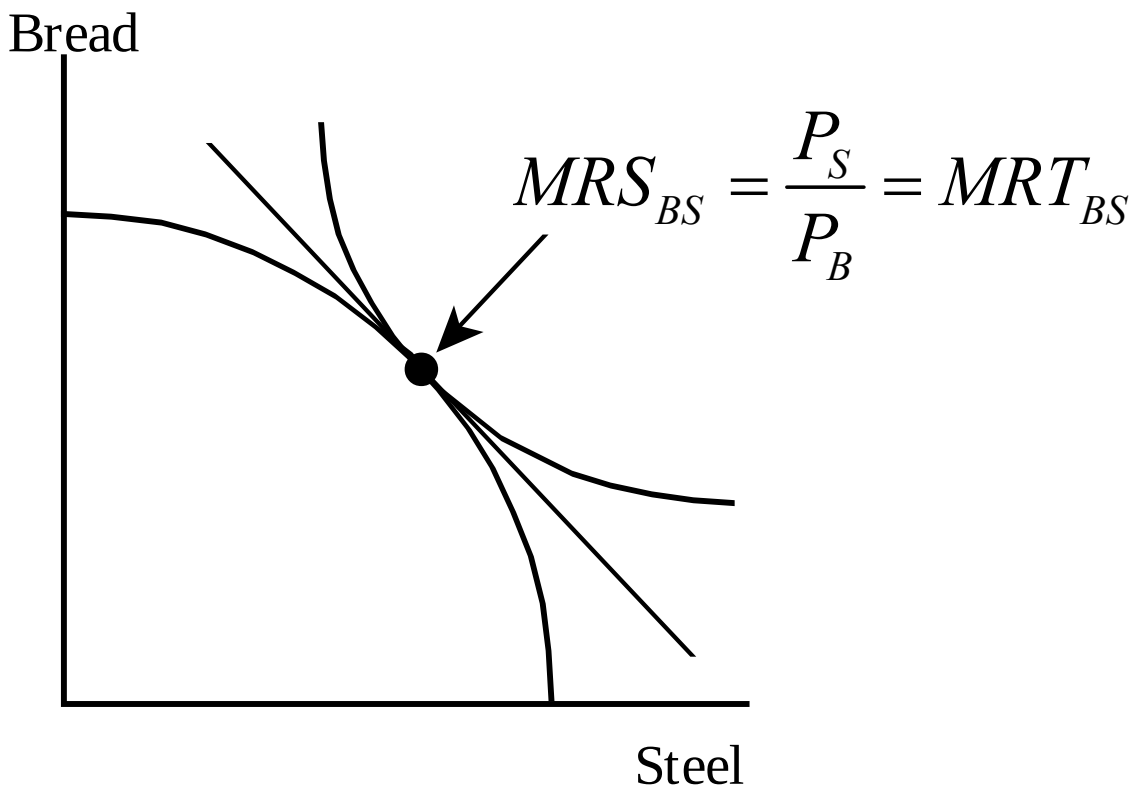
Autarky Equilibrium in the HOS Model,

- Optimizing Behavior Implies:

$$MRS_{BS} = \frac{P_S}{P_B} = MRT_{BS}.$$

- This is easily shown graphically

Autarky Equilibrium in the HOS Model, 3

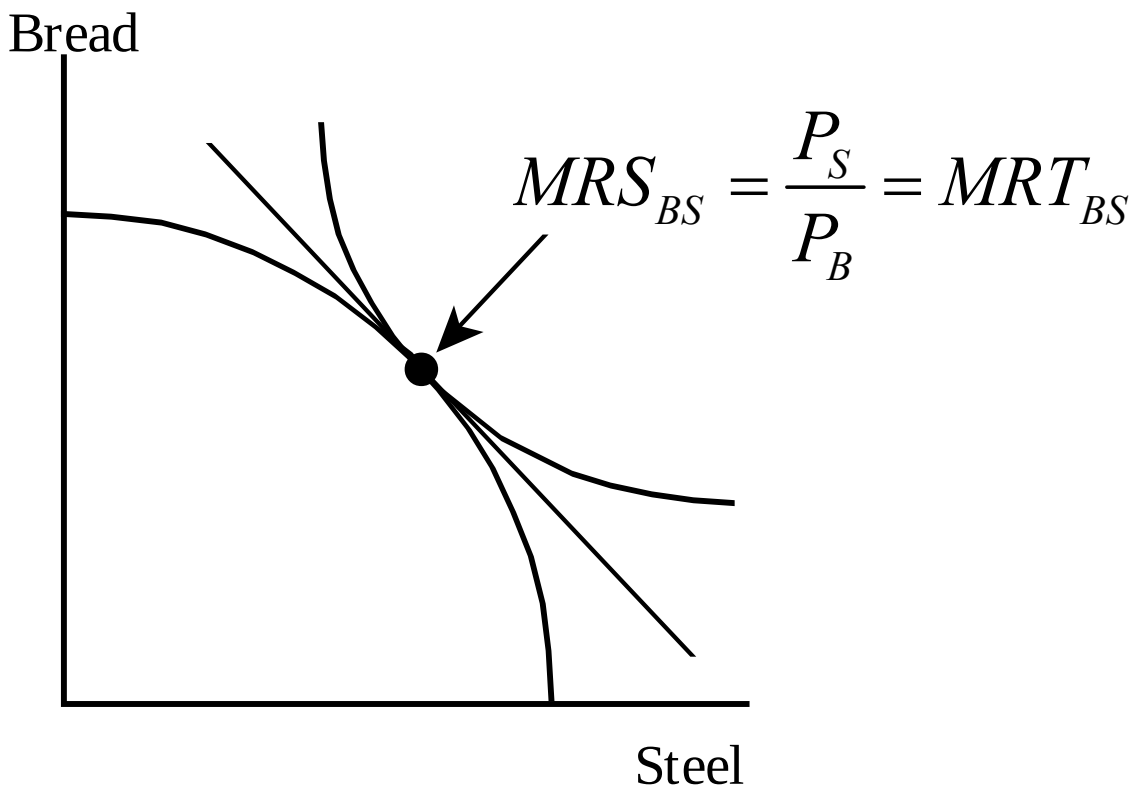


Illustrating Trade in the HOS Model

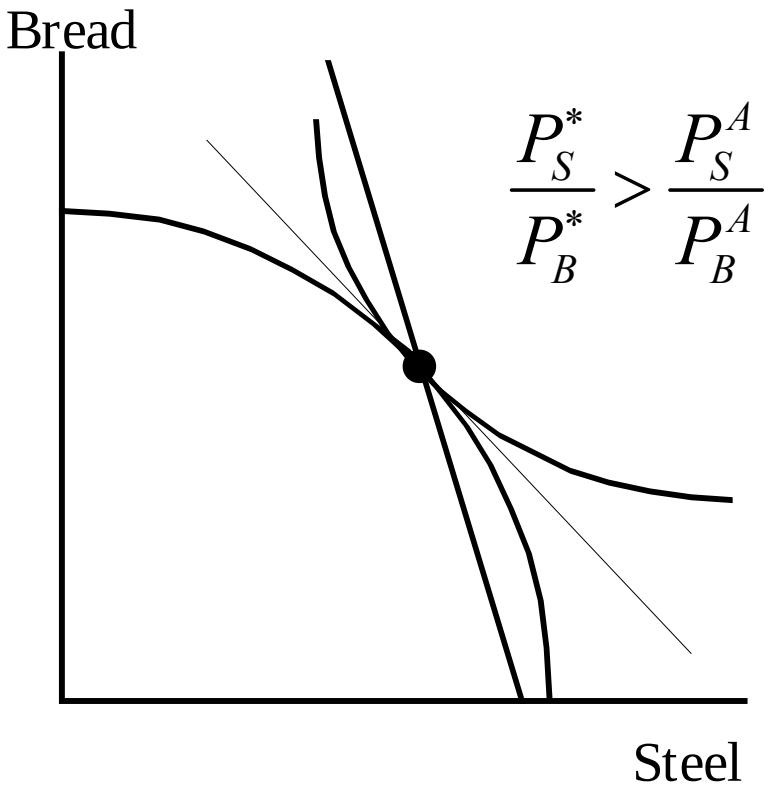
- As with the Ricardian model, it is easiest to consider the effect of trade on the *small* HOS economy:
  - The autarkic HOS economy will now observe *given* world trade prices.
  - We assume, for the illustration that:

$$\frac{P_S^*}{P_B^*} > \frac{P_S^A}{P_B^A} = MRS_{BS}^A = MRT_{BS}^A$$

Illustrating Trade in the HOS Model, 1: Autarky again

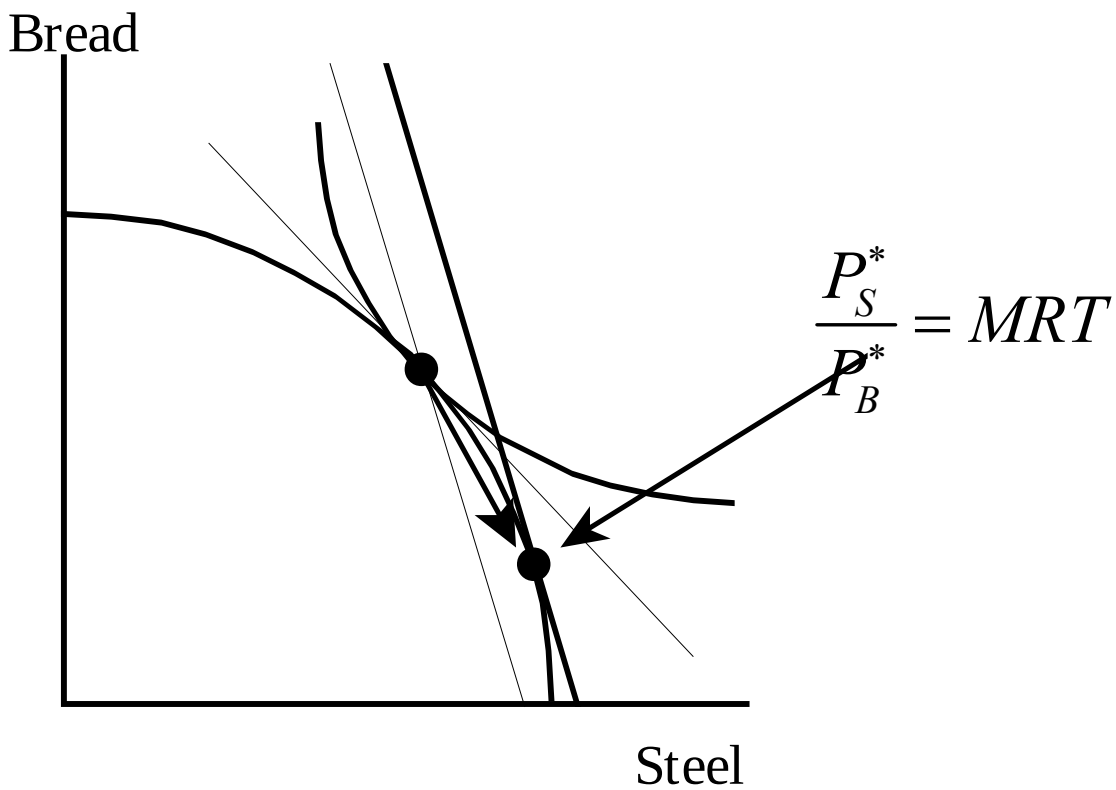


Illustrating Trade in the HOS Model, 2: Trade Prices

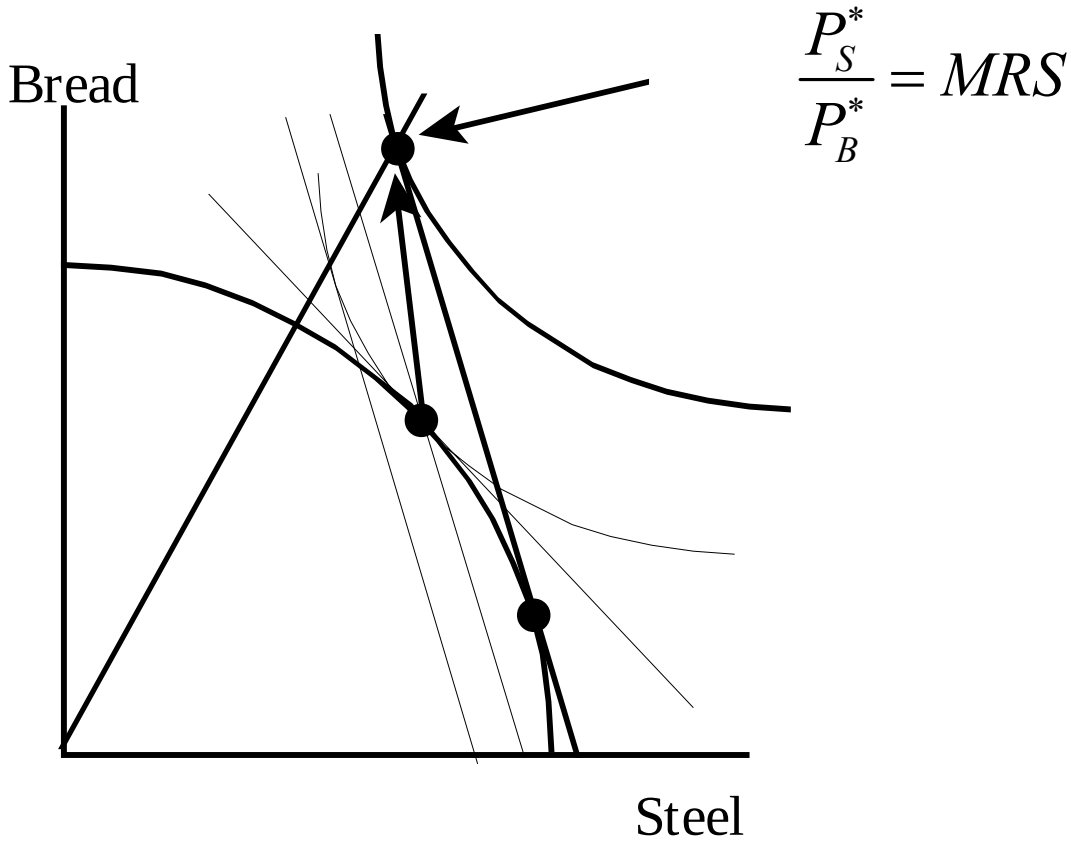


$$\frac{P_S^*}{P_B^*} > \frac{P_S^A}{P_B^A} = MRS_{BS}^A = MRT_{BS}^A$$

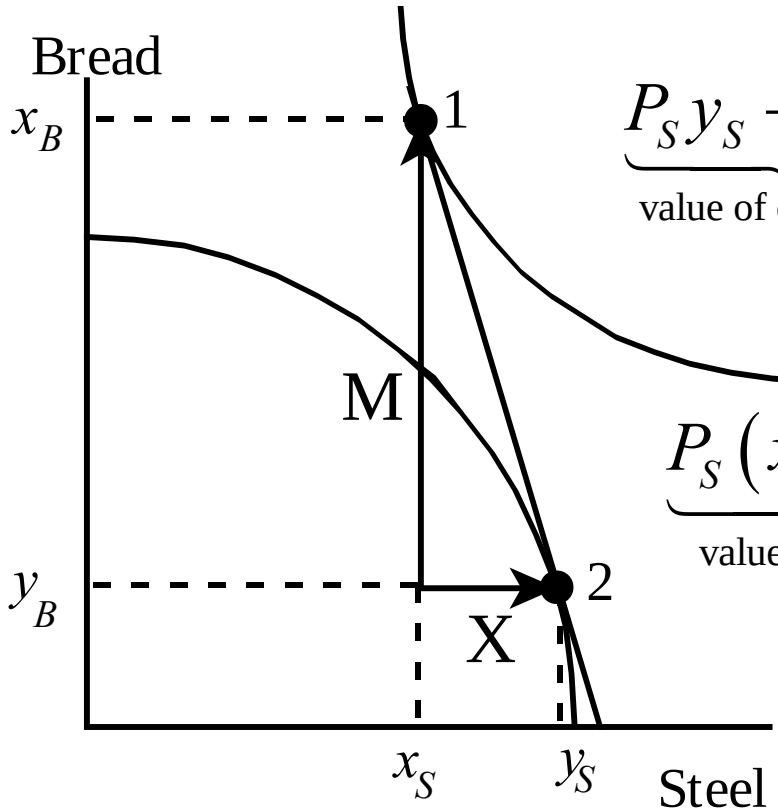
Illustrating Trade in the HOS Model, 3: Production Adjusts



Illustrating Trade in the HOS Model, 4: Consumption Adjusts



Illustrating Trade in the HOS Model, 5: The Trade Triangle



$$\underbrace{P_S y_S + P_B y_B}_{\text{value of output (2)}} = \underbrace{P_S x_S + P_B x_B}_{\text{value of consumption (1)}}$$

$$\Updownarrow$$

$$\underbrace{P_S\left(x_S - y_S\right)}_{\text{value of exports}} = \underbrace{P_B\left(x_B - y_B\right)}_{\text{value of imports}}$$

$$P_S \mathrm{X}_S = P_B \mathrm{M}_B$$

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:

$$\frac{\bar{K}^{US}}{\bar{L}^{US}} > \frac{\bar{K}^{Can}}{\bar{L}^{Can}},$$

- 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.

Empirical Research on the Heckscher-Ohlin Theorem, 2

- 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.

Trade and Income Distribution, 1

- 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.

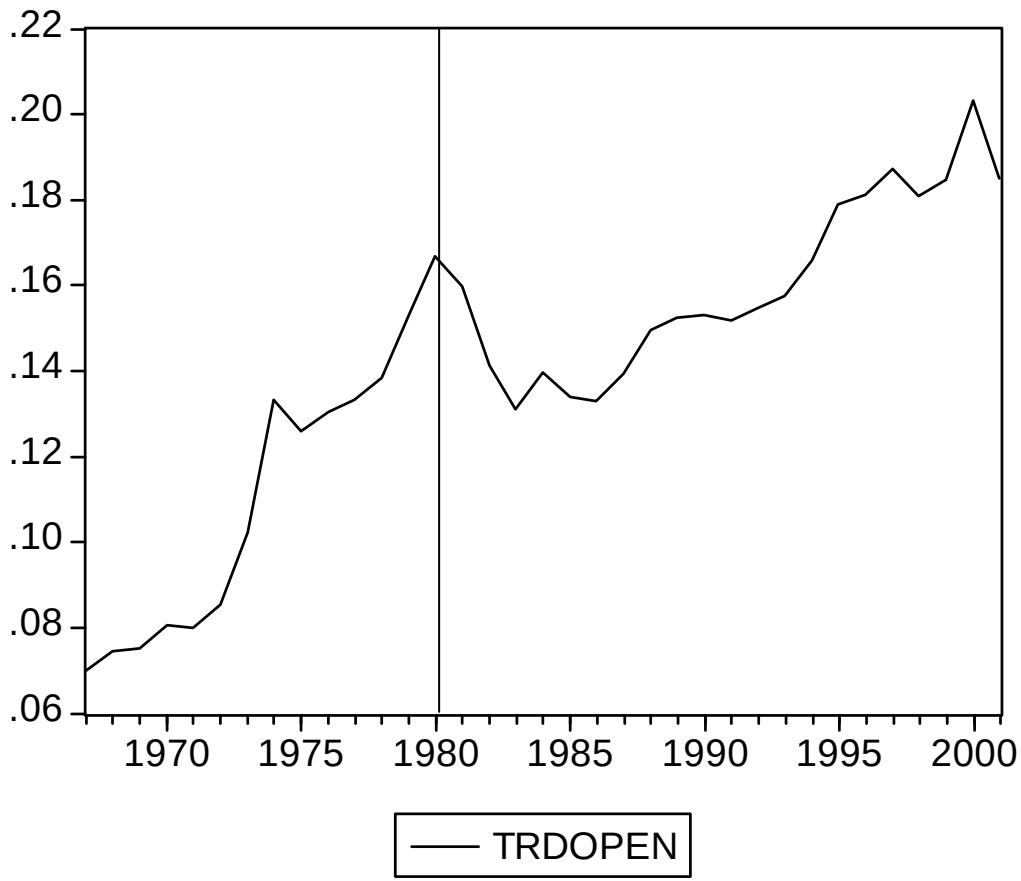
Trade and Income Distribution, 2

- 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.

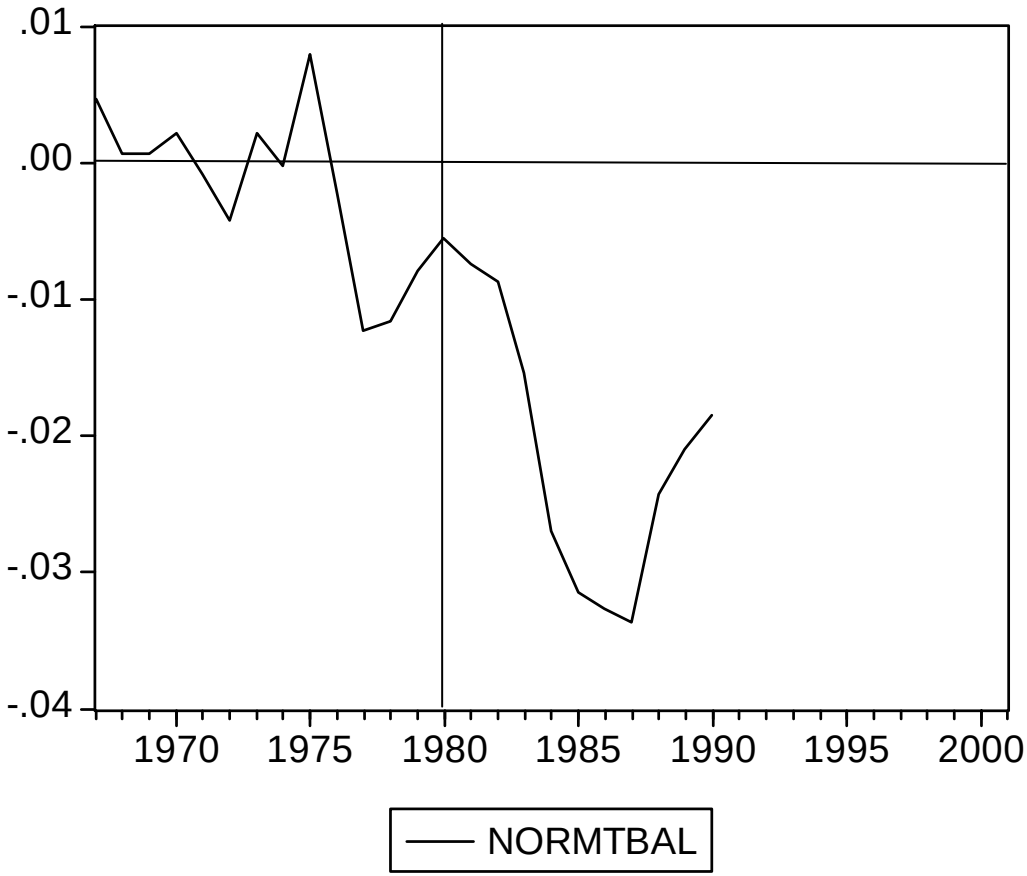
Trade and Income Distribution, 3.1

- 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



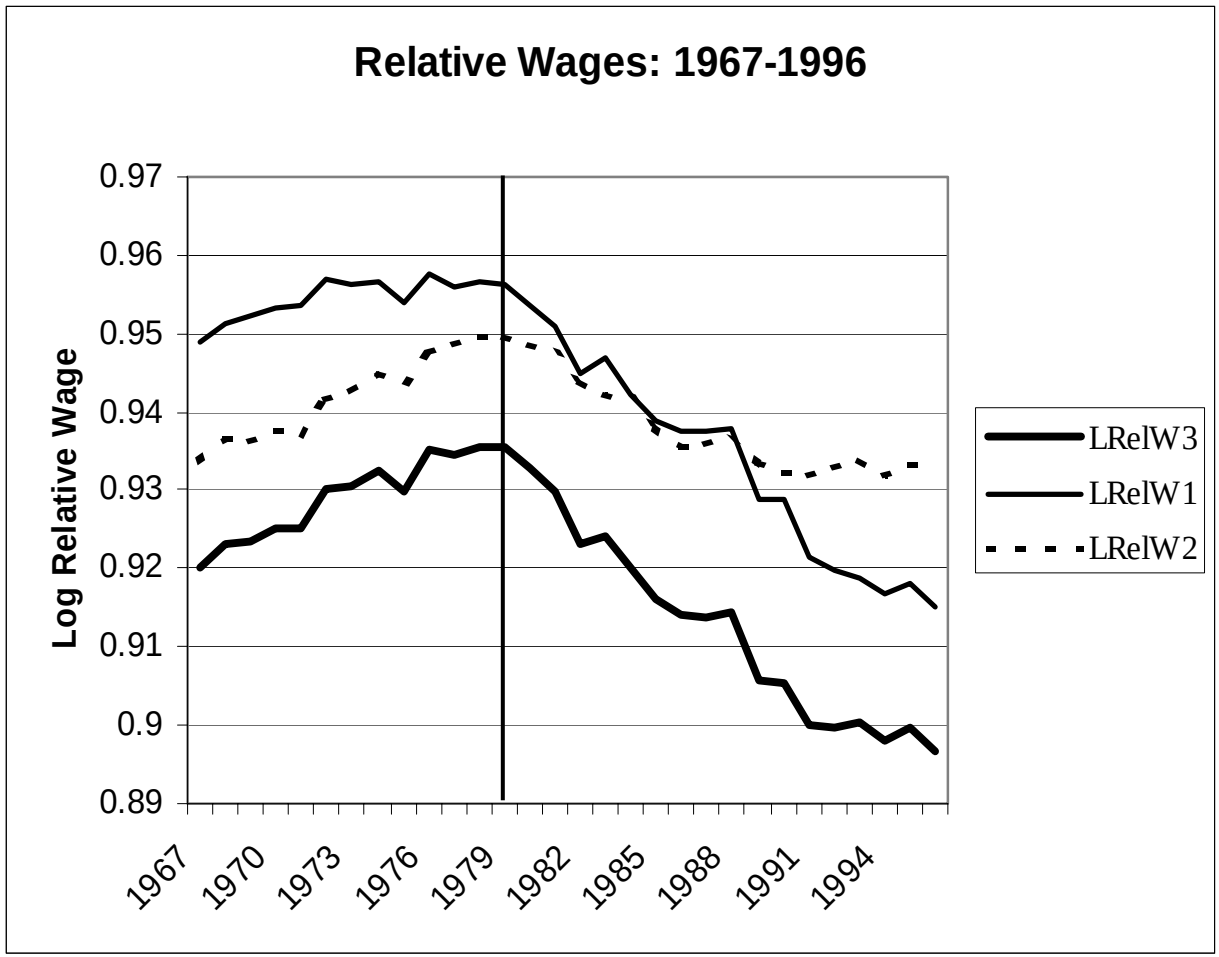
Evolution of the Trade Balance



Trade and Income Distribution, 3.2

- 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



Trade and Income Distribution, 3.3

- 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).
- *Stolper-Samuelson theorem* seems like a natural place to start an evaluation of this link.

Stolper-Samuelson Theorem: Setup, 1

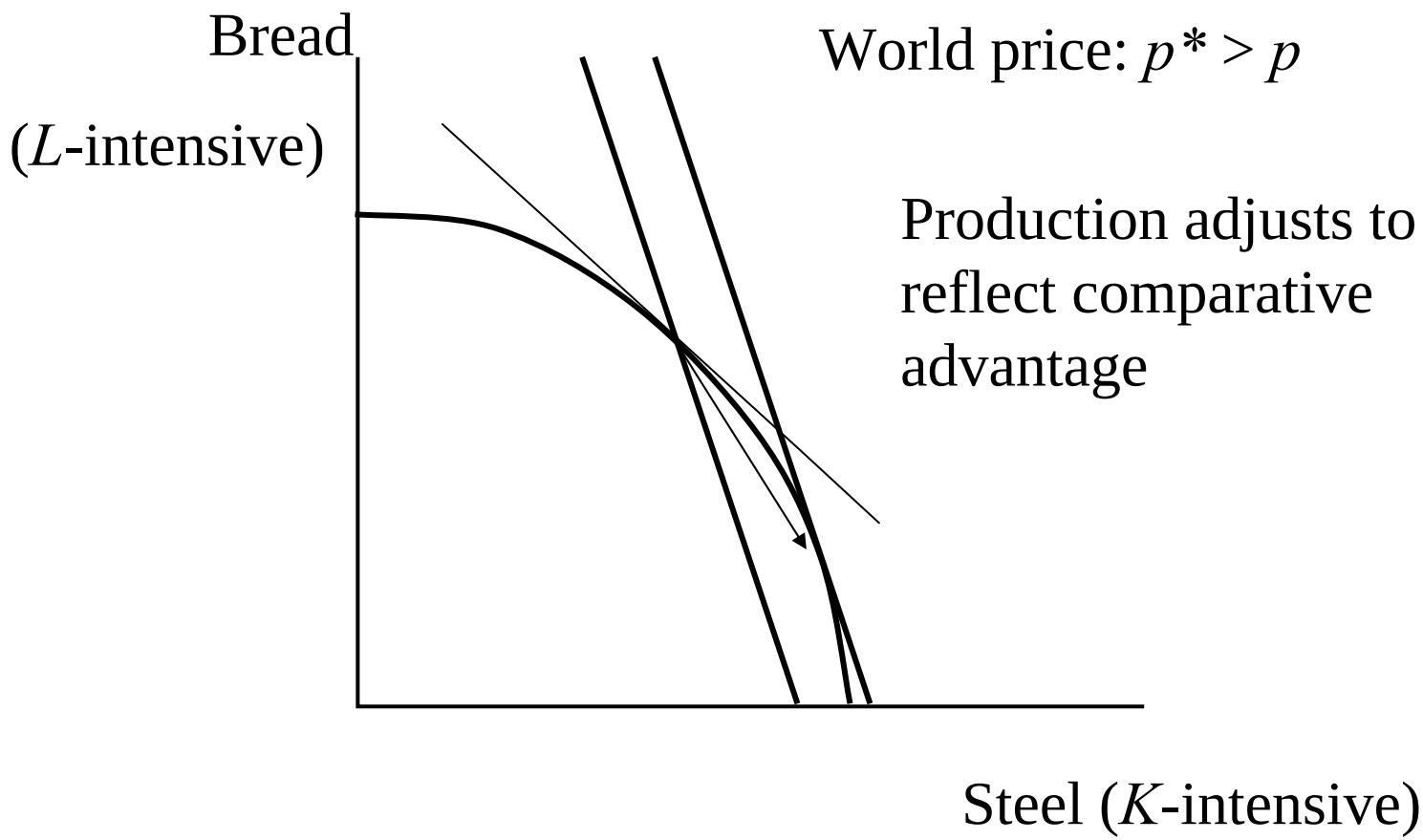
- Derived from the HOS model
- Assumptions:
  - 2 goods, 2 factors of production
  - Constant returns to scale
  - Perfect competition in all markets means
    - Zero economic profits: $p_j = wa_{Lj} + ra_{Kj}, j = B, S$;
    - Full employment: $Z_i = a_{iB}y_B + a_{iS}y_S, i = K, L$; and
    - All factors earn the values of their marginal products

Stolper-Samuelson Theorem: Setup, 2

- 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



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* $\mathbf{r}$ and *downward pressure on* $\mathbf{w}$.

Stolper-Samuelson Theorem: Picturing the Intuition

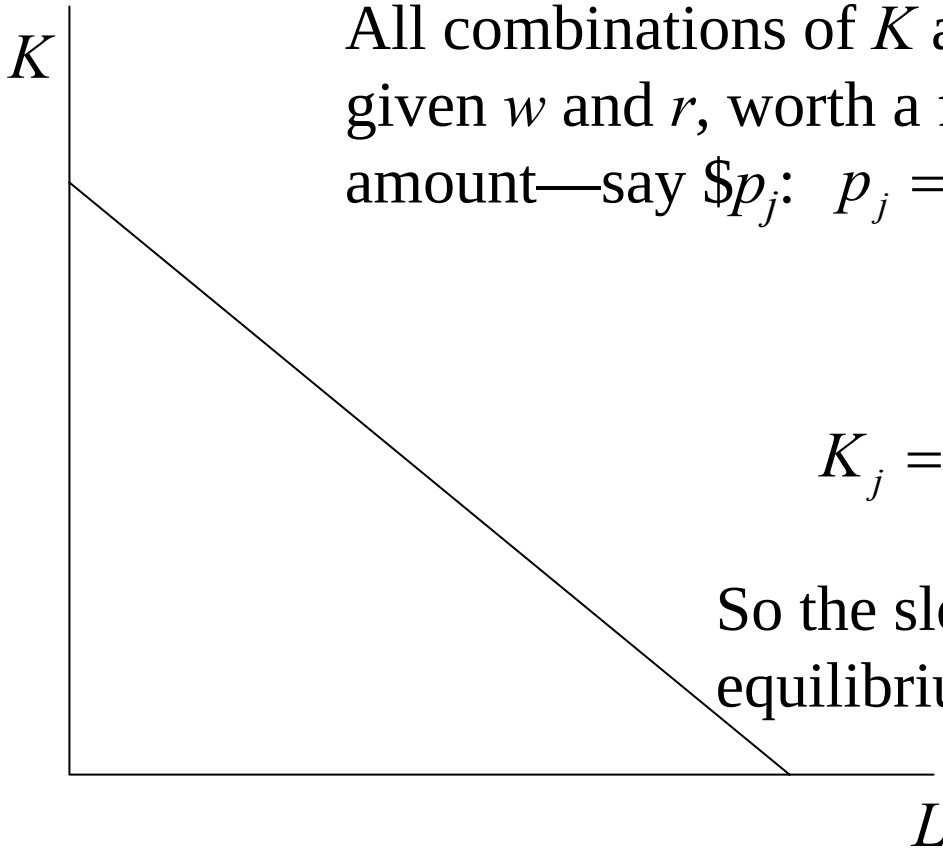
- The story we just told refers to adjustments in factor markets as a result of changes in world relative prices.
- To get a bit of intuition on this, let's look explicitly at demands for factors.
- To do this we will make use of the *isoquant diagram*, a representation of production conditions.

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;

$$\text{slope} = \frac{MPP_L^j}{MPP_K^j} := MRTS_{KL}^j.$$

The Isocost Line



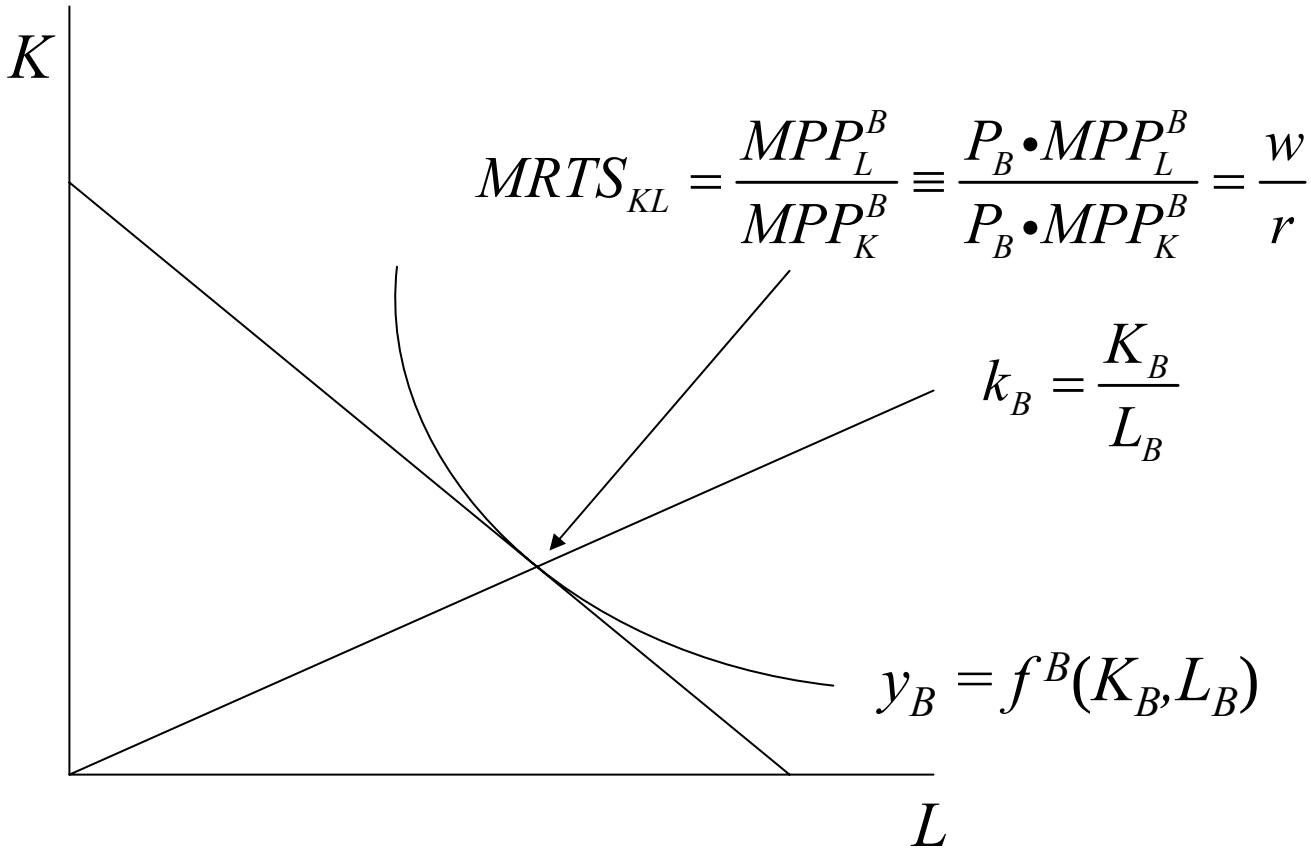
All combinations of K and L, given w and r, worth a fixed amount—say $\$p_j$: $p_j = rK_j + wL_j$

$$\Downarrow$$

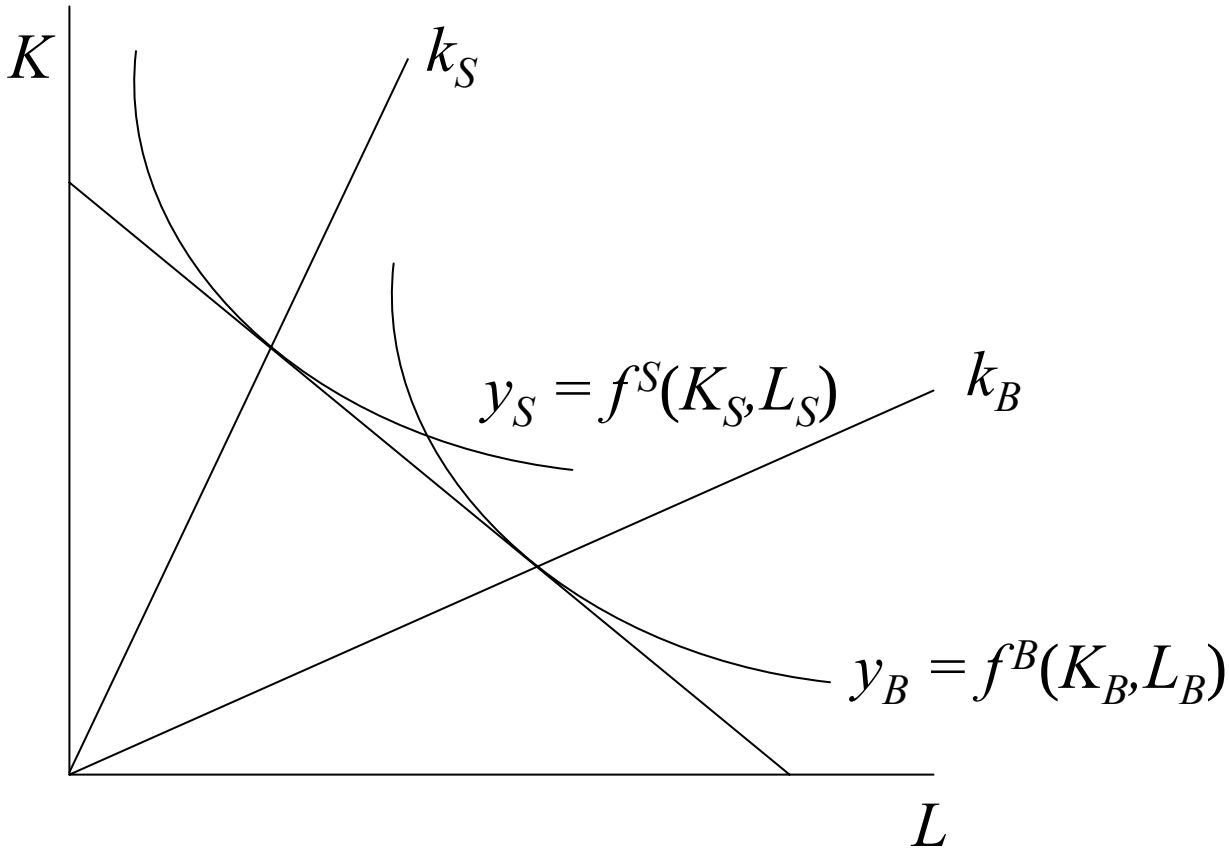
$$K_j = \frac{p_j}{r} - \frac{w}{r} L_j$$

So the slope gives the equilibrium w/r ratio.

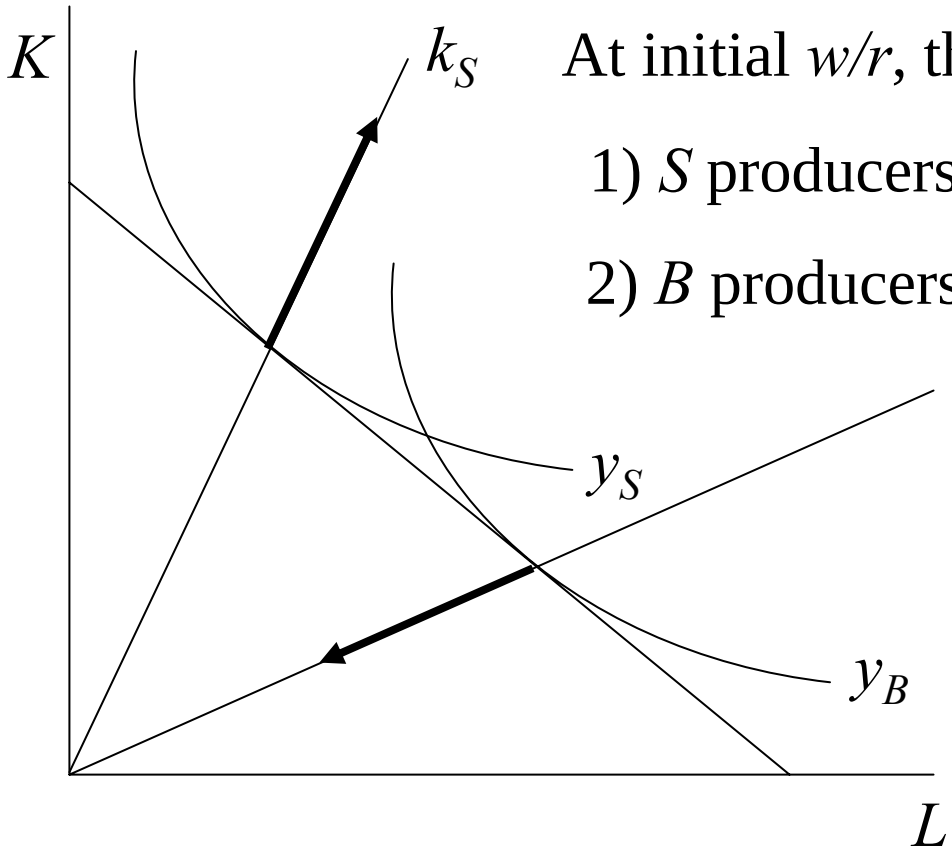
The Isoquant Diagram



Stolper-Samuelson Theorem: Factor-Market Adjustment, 1



Stolper-Samuelson Theorem: Factor-Market Adjustment, 2

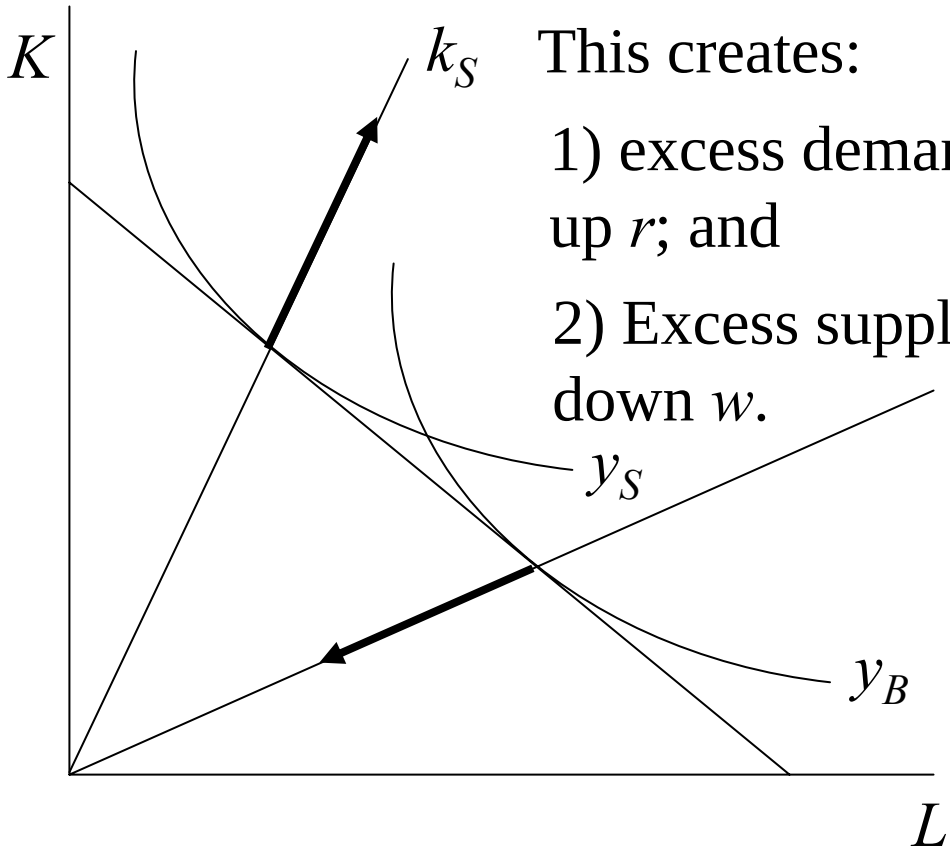


At initial *w/r*, the increase in *p*:

1) *S* producers seek to expand

2) *B* producers seek to contract

Stolper-Samuelson Theorem: Factor-Market Adjustment, 3

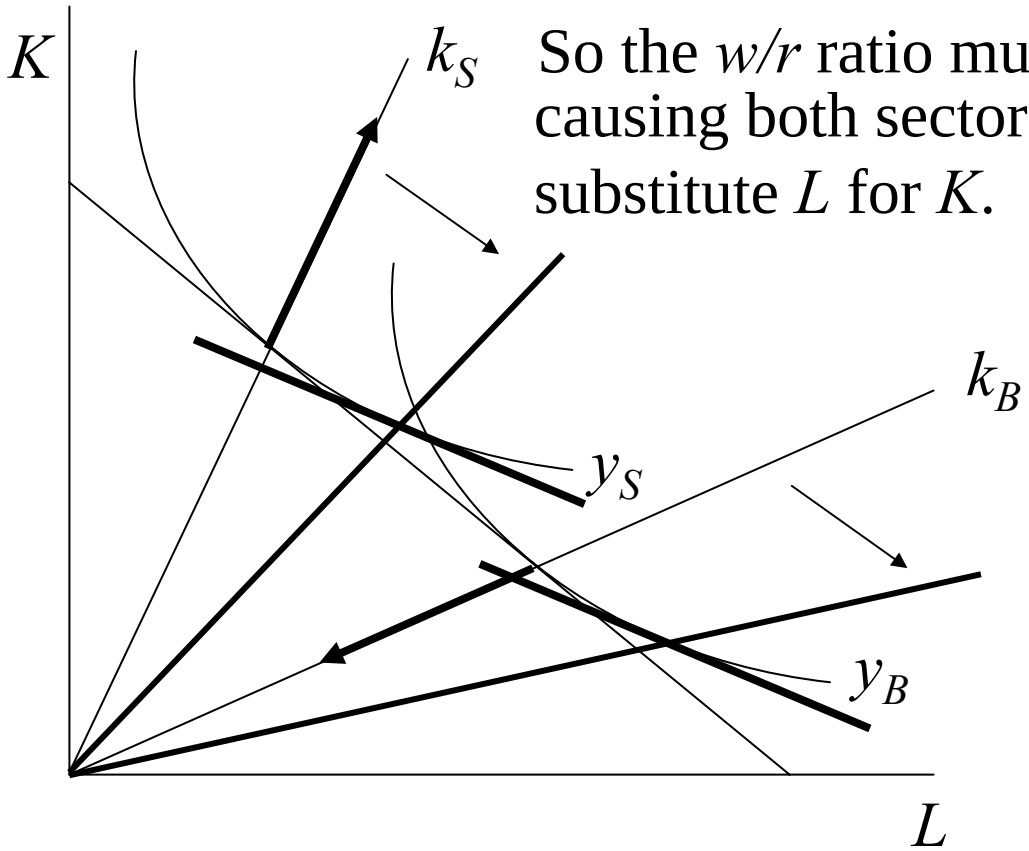


This creates:

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

2) Excess supply of *L*, pushing down *w*.

Stolper-Samuelson Theorem: Factor-Market Adjustment, 4



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: $y_j = f^j(K,L)$

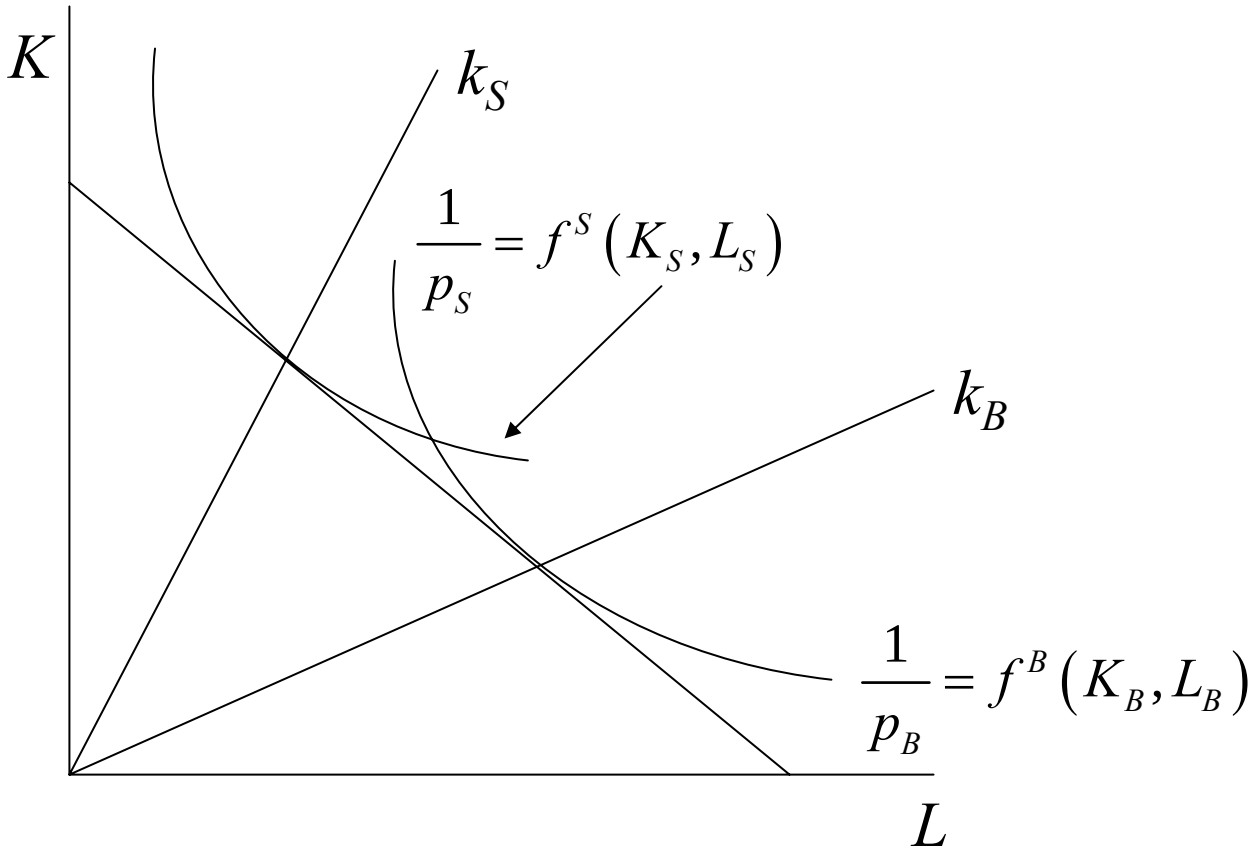
- Constant returns to scale;
  - Expansion path is a straight line;
  - Slope of expansion path gives $k_j = K_j / L_j$.
- Slope of an isoquant gives the *marginal rate of technical substitution* between K and L;

$$\text{slope} = \frac{MPP_L^j}{MPP_K^j} := MRTS_{KL}^j .$$

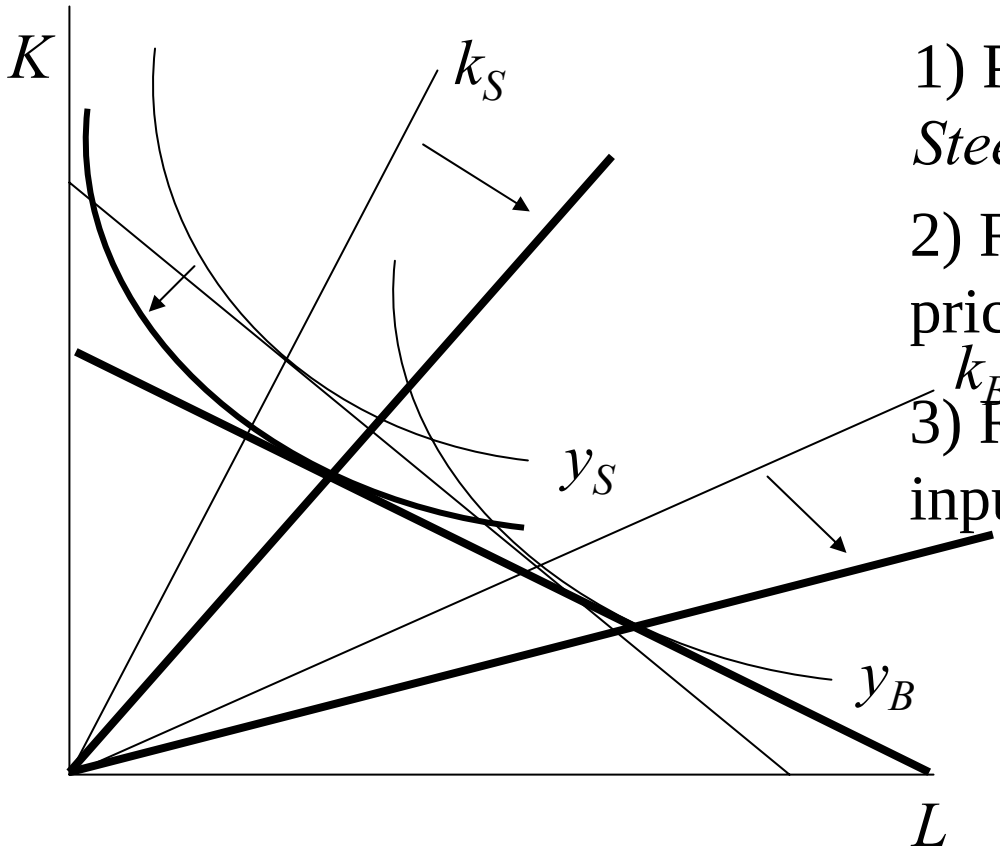
The Lerner-Pearce Diagram, 1

- 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



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.

Proving the Stolper-Samuelson Theorem, 2

- 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.

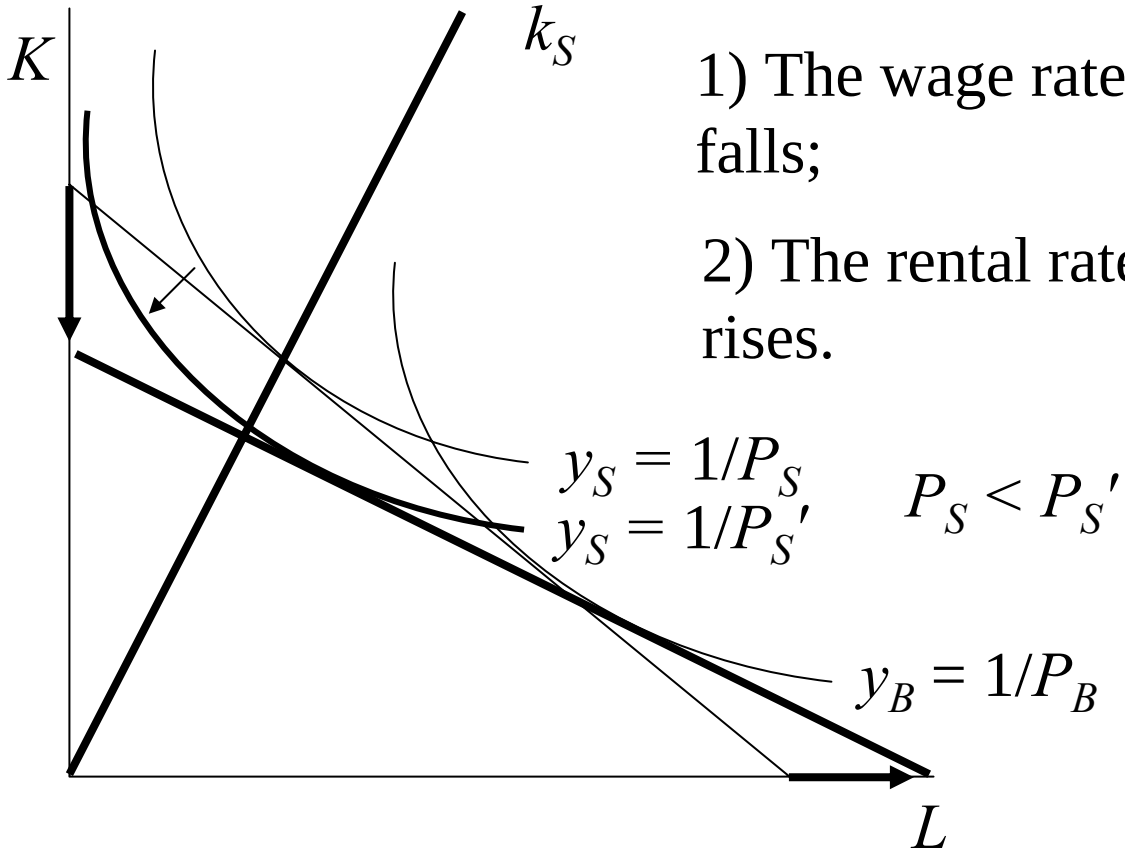
Proving the Stolper-Samuelson Theorem, 3

- 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.

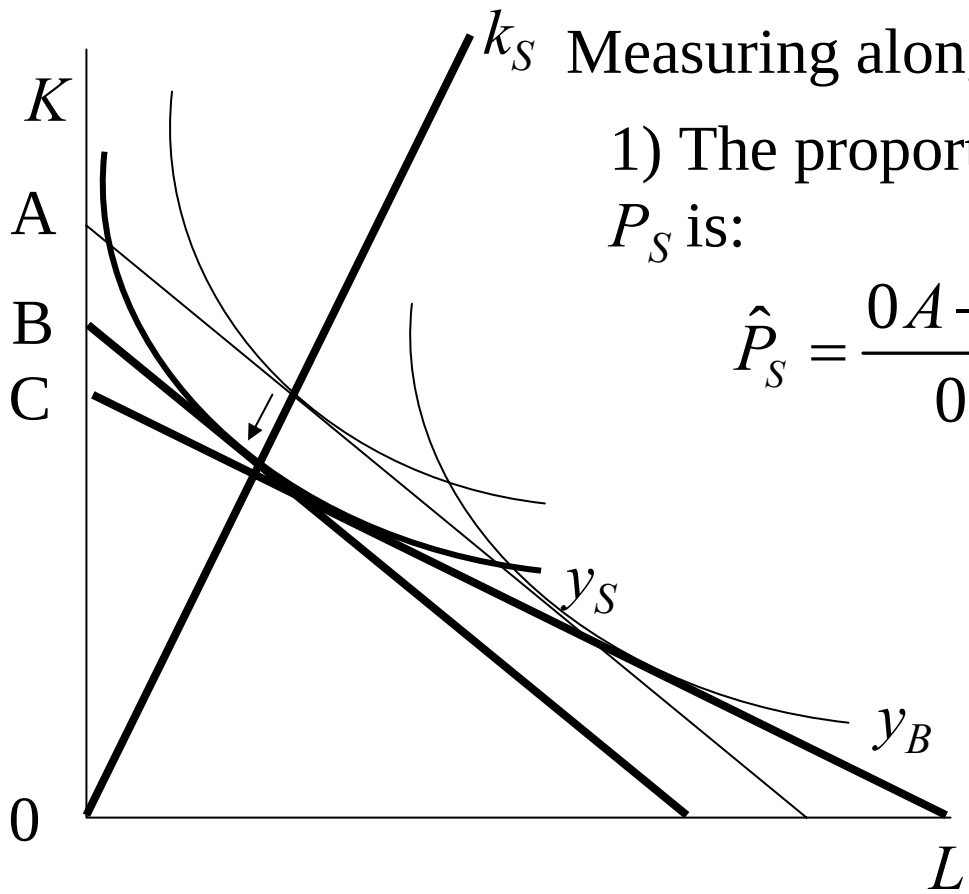
Proving the Stolper-Samuelson Theorem, 5

- 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

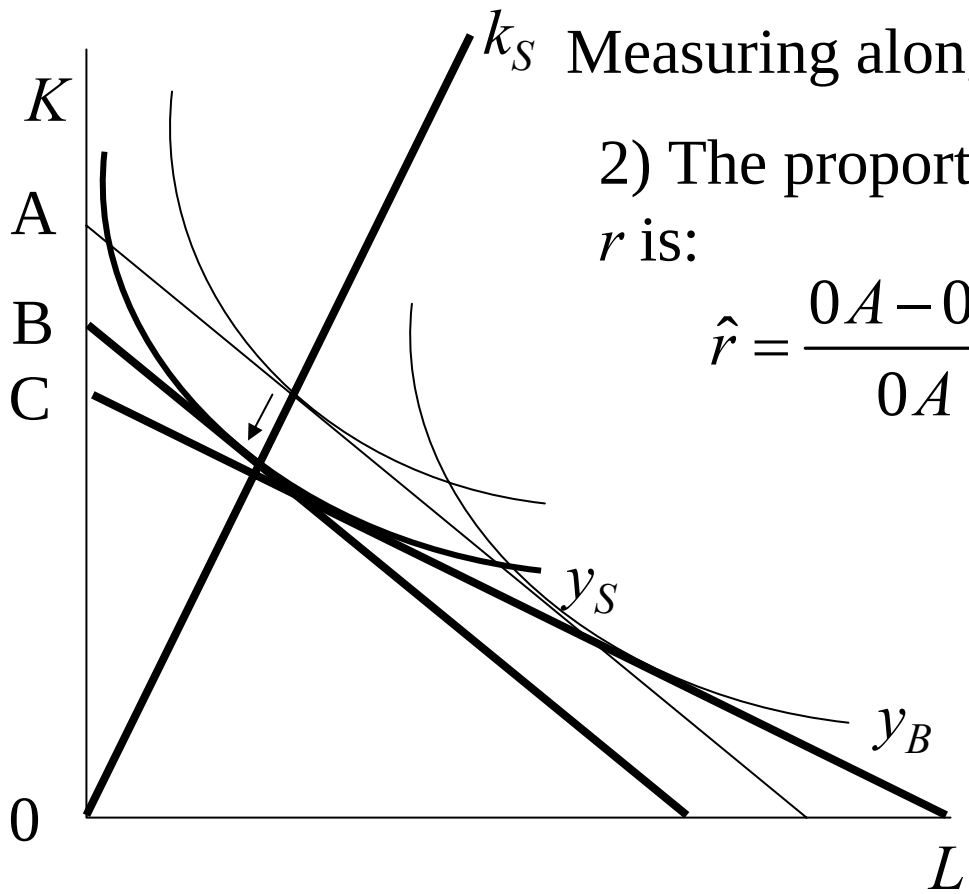


Measuring along the K axis:

1) The proportional change in P_S is:

$$\hat{P}_S = \frac{0A - 0B}{0A} = \frac{AB}{0A};$$

Proving the Stolper-Samuelson Theorem, 4

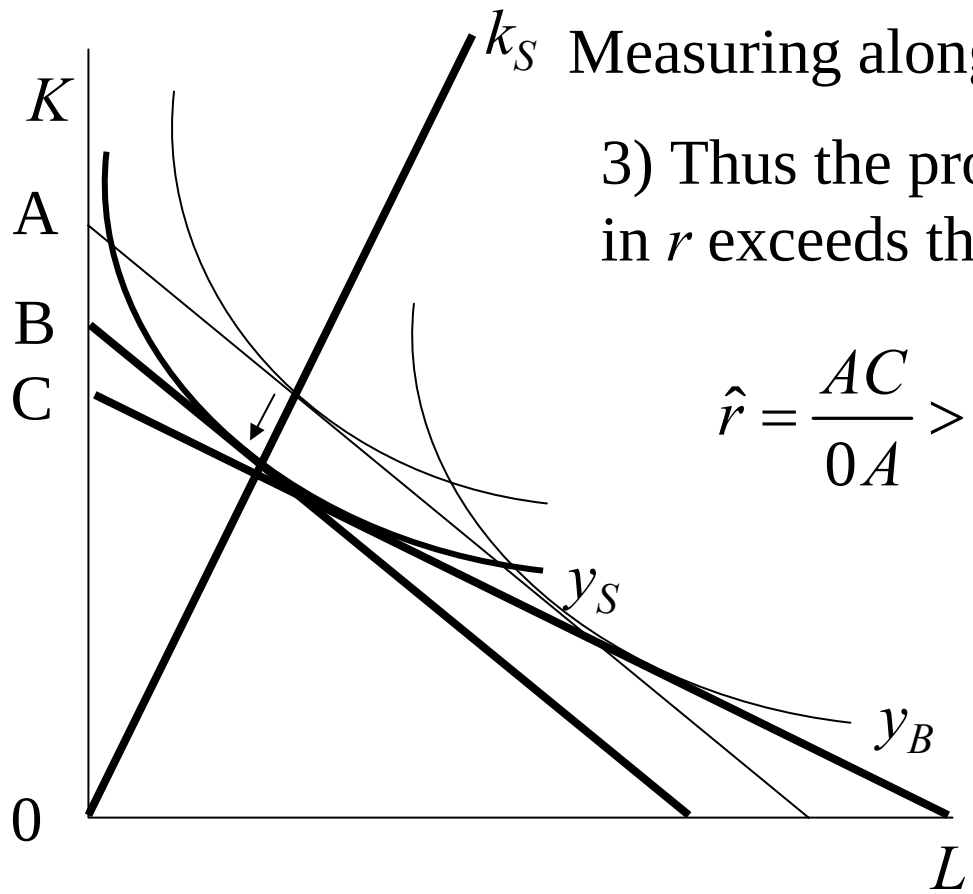


Measuring along the *K* axis:

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).

Stolper-Samuelson Theorem, Formal Statement, 3

- 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*.

Stolper-Samuelson Theorem: Empirical Research, 1

- 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*.

Stolper-Samuelson Theorem: Empirical Research, 2

- 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).

Stolper-Samuelson Theorem: Empirical Research, 3

- 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.

All Factors Fixed: The Cairnes-Haberler Model

- 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?

Some factors fixed, others mobile: The Ricardo-Viner Model, 2

- 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.

Fixity and Mobility as Temporal Phenomena

- 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

Product Cycle

- 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.)

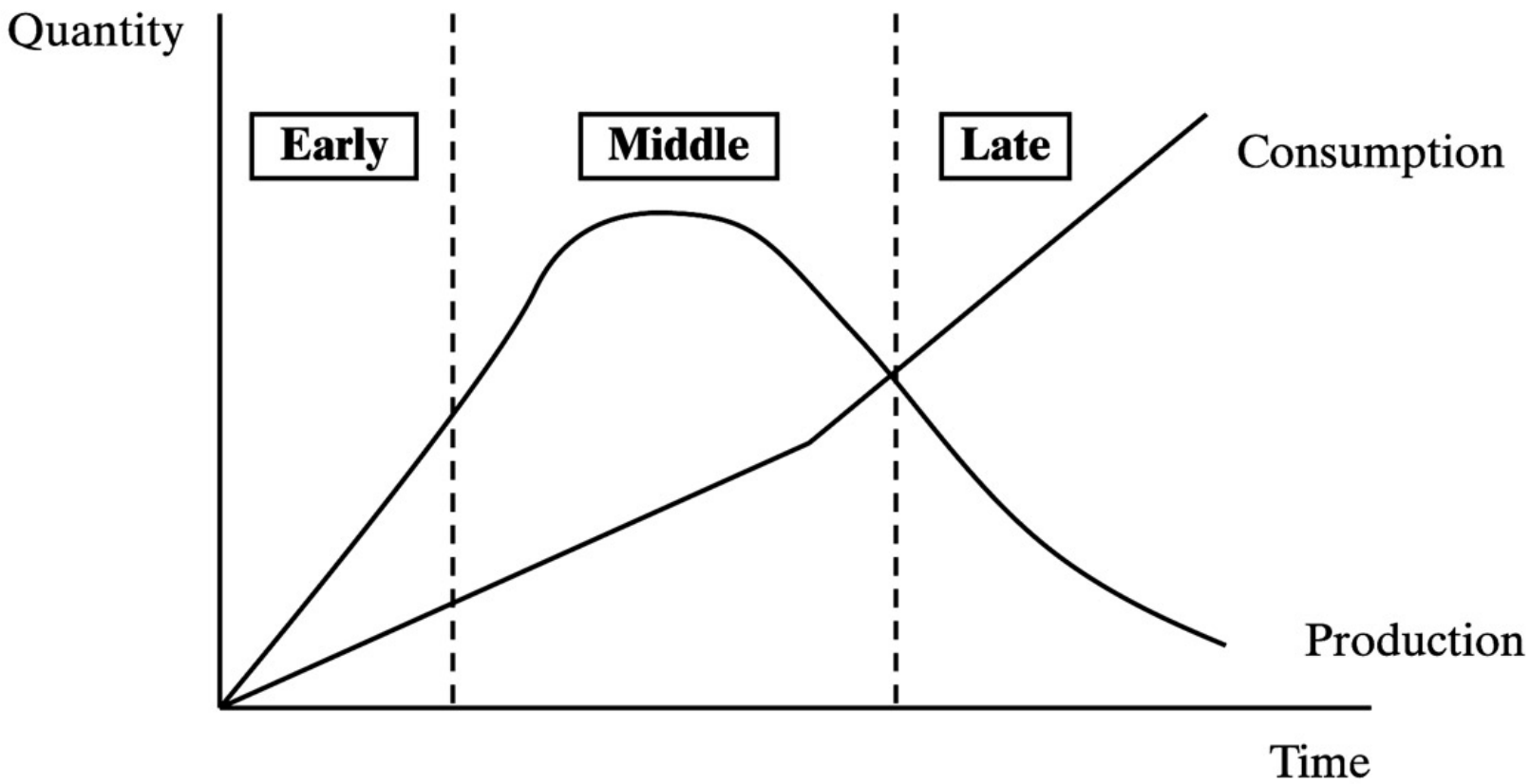


Figure 4.5

Product Cycle (cont.)

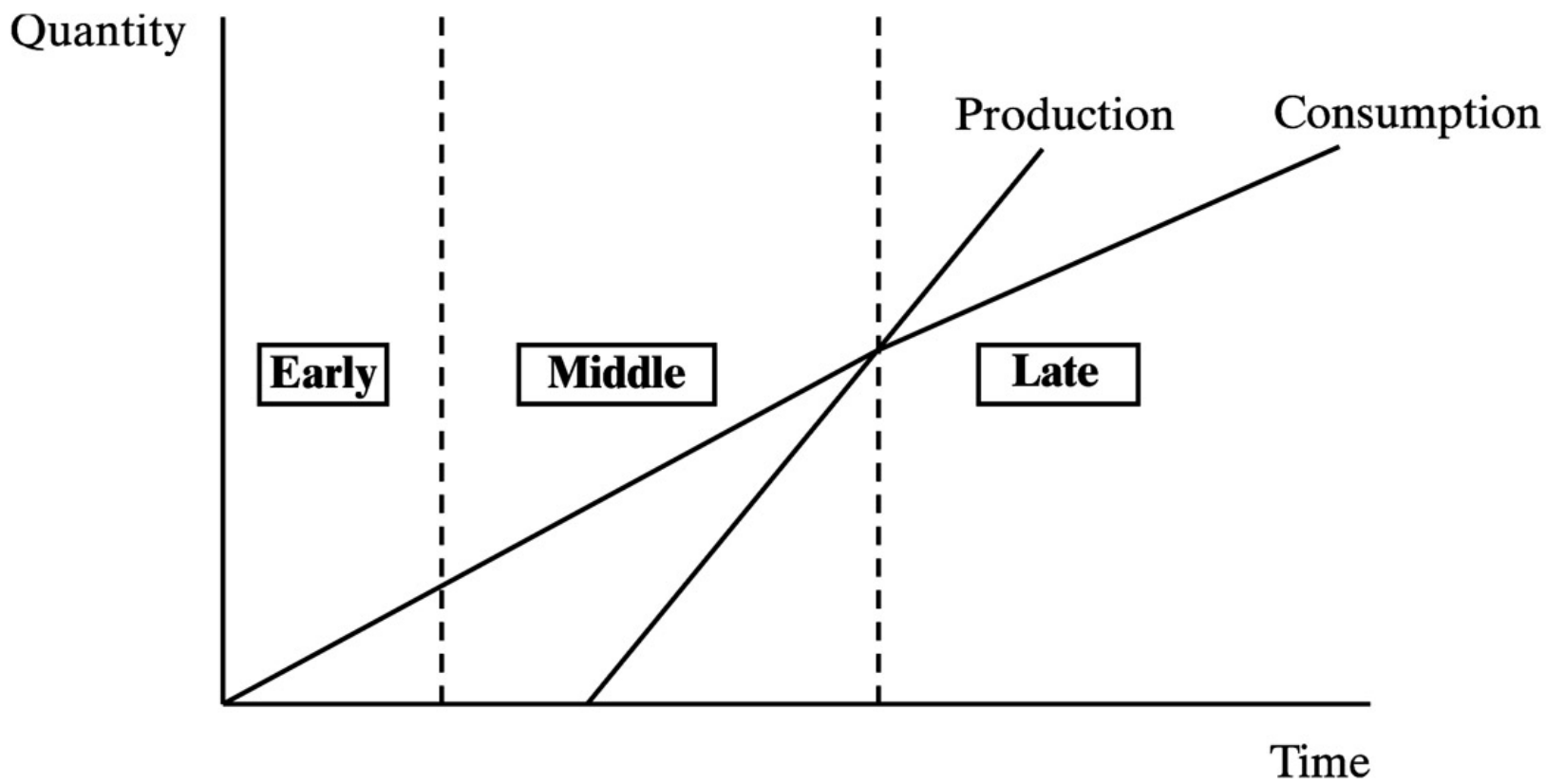


Figure 4.6

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

Outsourcing v. Intra-Firm Trade

- 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.