1. The No-Trade Model Revisited

(a) Countries have identical technologies
(b) Countries have identical relative factor endowments
(c) Constant returns to scale in production
(d) Identical and homogeneous preferences in all countries
(e) No distortions (e.g., imperfect competition, taxes, etc.)

The Ricardian model drops assumption (a).

Factor endowments models drop assumption (b) (reinstate (a)).

2. The Heckscher-Ohlin Model

Two goods, X_1 and X_2
Two factors, V_1 and V_2: V_{ij} is industry i's use of factor j
Two countries, h and f

Identical technologies
Constant returns, perfect competition
Identical homogeneous demand

3. Factor Intensities - *characteristics of technologies*

Definition of factor intensities: If at a given factor-price ratio w_1/w_2,

optimal factor input ratios are $$\frac{V_{11}}{V_{12}} > \frac{V_{21}}{V_{22}}$$

X_1 is said to be V_1 *intensive* and X_2 is V_2 *intensive*.

Let overbars give total endowments and let $\bar{V}_{kj}$ give country k's endowment of factor j. Then if

$$\frac{\bar{V}_{h1}}{\bar{V}_{h2}} > \frac{\bar{V}_{f1}}{\bar{V}_{f2}}$$

country h is said to be V_1 *abundant*, f is V_2 *abundant*

5. <u>Heckscher-Ohlin Theorem</u>

Each country will export the good using intensity its abundant factor.

Figure 8.1

Table 8.1 Measures of Factor Intensity for US Manufacturing Industries

	2000					2005				
Industry	Value Added	Production	Capital Exp.	Nonproduction		Value Added	Production	Capital Exp.	Nonproduction	Evident
	($ millions)	Labor (000)	per PL	labor per PL		($ millions)	Labor (000)	per PL	labor per PL	Intensity
Petroleum and coal products	$ 45,748	67	$ 74,624	0.51		$ 117,541	65	$ 169,501	0.58	Capital, Skill
Chemical products	$ 235,614	508	$ 41,112	0.75		$ 328,440	433	$ 38,971	0.76	Capital, Skill
Computer & electronic products	$ 291,125	848	$ 33,227	0.94		$ 226,319	465	$ 33,972	1.16	Capital, Skill
Mineral products	$ 55,722	408	$ 14,820	0.28		$ 64,545	360	$ 14,334	0.29	Capital
Transportation equipment	$ 240,989	1,349	$ 12,529	0.36		$ 254,665	1,104	$ 13,842	0.41	Capital, Skill
Food, beverages & tobacco	$ 255,245	1,244	$ 11,714	0.35		$ 316,389	1,177	$ 13,090	0.34	Capital, Skill
Wood & paper products	$ 114,260	914	$ 12,234	0.24		$ 120,651	765	$ 11,268	0.27	Capital
Miscellaneous products	$ 70,621	501	$ 8,219	0.49		$ 92,974	422	$ 11,044	0.61	Skill
Plastic & rubber products	$ 92,333	862	$ 10,086	0.26		$ 96,348	688	$ 10,127	0.29	Capital
Machinery	$ 148,798	920	$ 10,116	0.52		$ 142,488	683	$ 9,947	0.56	Skill
Printing	$ 63,446	597	$ 7,398	0.39		$ 58,930	457	$ 9,510	0.41	Skill
Metal products	$ 215,545	1,839	$ 8,729	0.30		$ 232,106	1,418	$ 8,545	0.33	Skill
Electrical equipment & appliances	$ 62,991	431	$ 9,069	0.37		$ 54,318	294	$ 6,551	0.43	Skill
Textile products	$ 35,225	475	$ 5,130	0.20		$ 32,395	285	$ 4,633	0.23	Labor
Leather products	$ 4,510	55	$ 2,813	0.25		$ 2,865	29	$ 3,527	0.29	Labor
Furniture & related products	$ 42,267	515	$ 4,011	0.25		$ 46,801	414	$ 3,404	0.29	Labor
Apparel	$ 28,210	423	$ 2,302	0.24		$ 16,319	171	$ 2,882	0.31	Labor

Source: Compiled by authors from US Department of Commerce, *Annual Survey of Manufactures*

Table 8.2 Measures of Relative Factor Endowments								
	2000				2005			
Country	Capital Stock per worker	Arable land per worker (HA)	R&D Scientists per 1000 people		Capital Stock per worker	Arable land per worker (HA)	R&D Scientists per 1000 people	Evident Abundance
Singapore	$ 239,044	0.00	8.08		$ 247,608	0.00	10.45	Capital, R&D
Japan	$ 182,196	0.07	9.55		$ 194,375	0.07	10.55	Capital, R&D
USA	$ 153,689	1.19	8.64		$ 181,856	1.13	8.97	Capital, R&D
Australia	$ 149,347	4.91	6.86		$ 169,374	4.68	6.76	Capital, Land
Germany	$ 160,918	0.29	6.38		$ 162,214	0.29	6.71	Capital, R&D
Canada	$ 142,345	2.82	6.69		$ 156,814	2.55	6.55	Capital, Land
Finland	$ 149,338	0.84	13.42		$ 155,699	0.85	15.00	Capital, R&D
Rep. of Korea	$ 102,235	0.08	4.80		$ 123,959	0.07	7.56	Capital, R&D
UK	$ 102,447	0.20	5.43		$ 117,232	0.19	5.86	R&D
Mexico	$ 48,140	0.64	1.12		$ 50,827	0.58	1.11	Labor
Brazil	$ 39,311	0.70	0.77		$ 37,885	0.63	0.77	Labor
South Africa	$ 31,060	0.95	0.96		$ 30,532	0.86	0.99	Labor
China	$ 13,183	0.18	0.95		$ 20,090	0.18	1.44	Labor
India	$ 7,556	0.42	0.29		$ 9,465	0.37	0.31	Labor

Sources: computed by authors with data available from World Bank, *World Development Indicators*; Food and Agricultural Organization, *FAO-Stat Database*; and Penn World Tables version 6.2.

Table 8.3 Proportions of World GDP and World Factor Endowments, 2000							
				Primary	Secondary	Post-secondary	R&D Research
	GDP	Capital Stock	Arable Land	School	School	School	Scientists
USA	27.10%	23.89%	19.42%	2.25%	11.96%	30.22%	29.20%
Canada	2.45%	2.43%	5.07%	0.80%	0.76%	1.65%	2.49%
Germany	6.18%	6.83%	1.31%	2.15%	4.13%	3.69%	5.89%
UK	4.22%	3.20%	0.65%	2.02%	1.54%	2.43%	3.69%
Australia	1.36%	1.51%	5.24%	0.48%	0.74%	1.19%	1.51%
Japan	8.91%	12.97%	0.50%	3.29%	4.92%	7.63%	14.78%
Rep. of Korea	2.16%	2.44%	0.19%	1.29%	3.10%	3.10%	2.49%
Mexico	2.90%	2.00%	2.78%	2.61%	1.98%	1.77%	1.01%
Brazil	3.39%	3.42%	6.39%	2.87%	1.49%	2.84%	1.46%
China	8.26%	10.11%	14.75%	32.62%	33.33%	9.79%	15.80%
India	4.29%	3.11%	18.02%	16.93%	9.84%	9.00%	2.57%
Countries	43	43	43	43	43	43	36

Sources: computed by authors with data available from World Bank, *World Development Indicators*; Food and Agricultural Organization, *FAO-Stat Database*; and Penn World Tables version 6.2. Figures for GDP are measured with PPP exchange rates at constant 2005 $US.

Steps in proving the Heckscher-Ohlin theorem

1. The slopes of each countries production frontier will reflect its relative factor endowment (combined with factor intensities).

2. In the absence of trade, each country will have a relatively low price for the good using intensively its abundant factor.

3. In free trade, each country exports the good using intensively its abundant factor.

Step 1: Comparative advantage is *indirect*.

Differences in relative endowments between countries

+

Differences in relative factor intensities between goods

=

Comparative advantage

Step 2: autarky prices reflect comparative advantage

$p_h^a < p_f^a$: each country has a relatively low price for the good using intensively its abundant factor

Step 3: free trade prices must lie between the two autarky prices ratios.

In free trade, each country exports the good using intensively its abundant factor.

Figures 8.3, 8.4

Figure 8.1

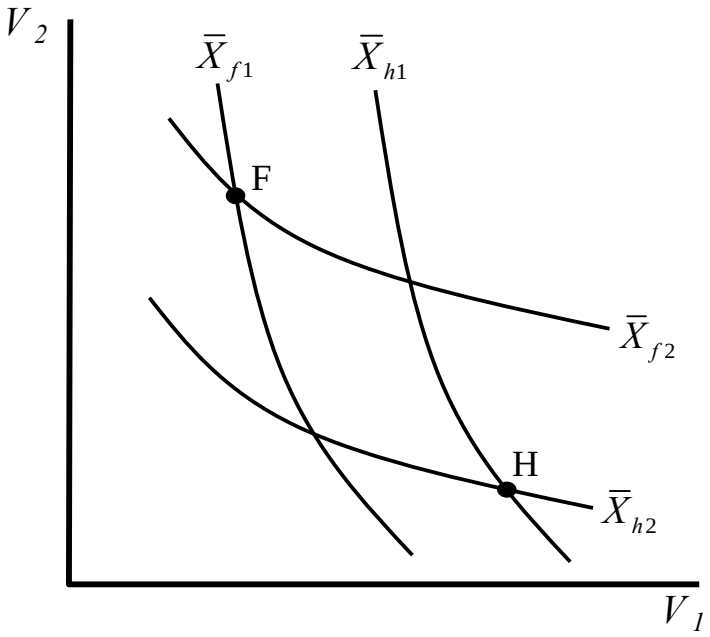


Figure 8.2

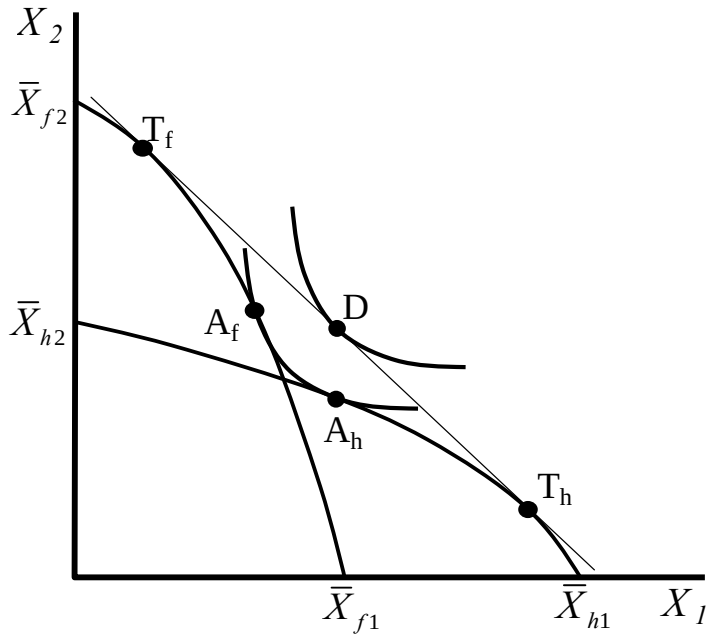


Figure 8.3

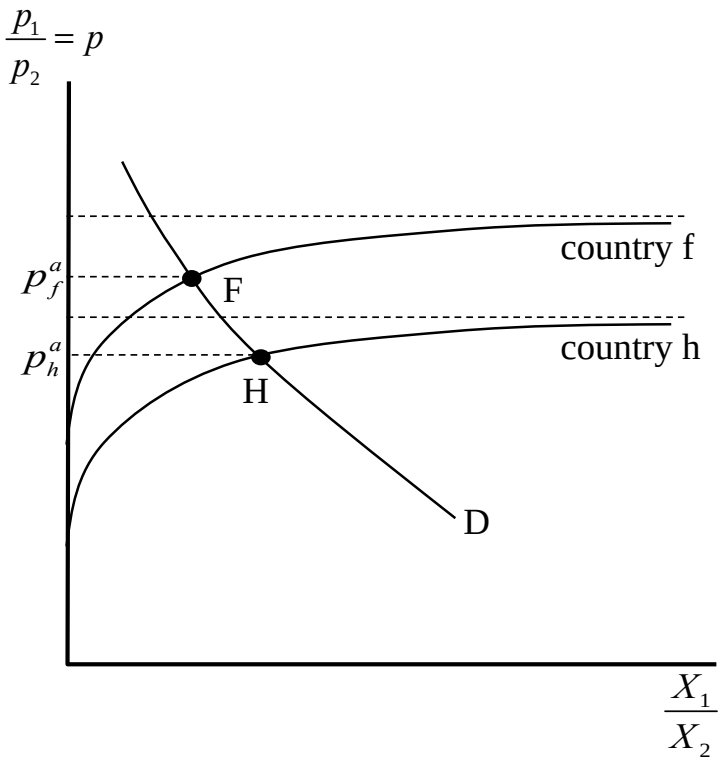


Figure 8.4

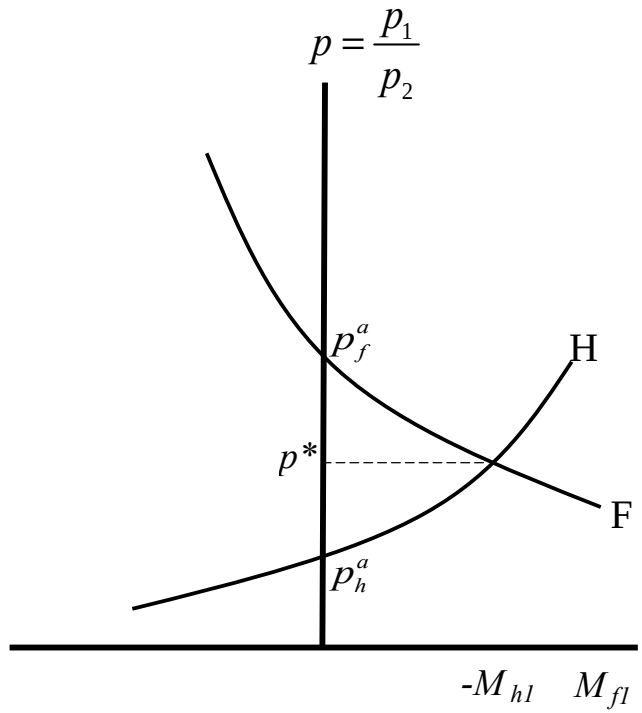


Figure 8.3

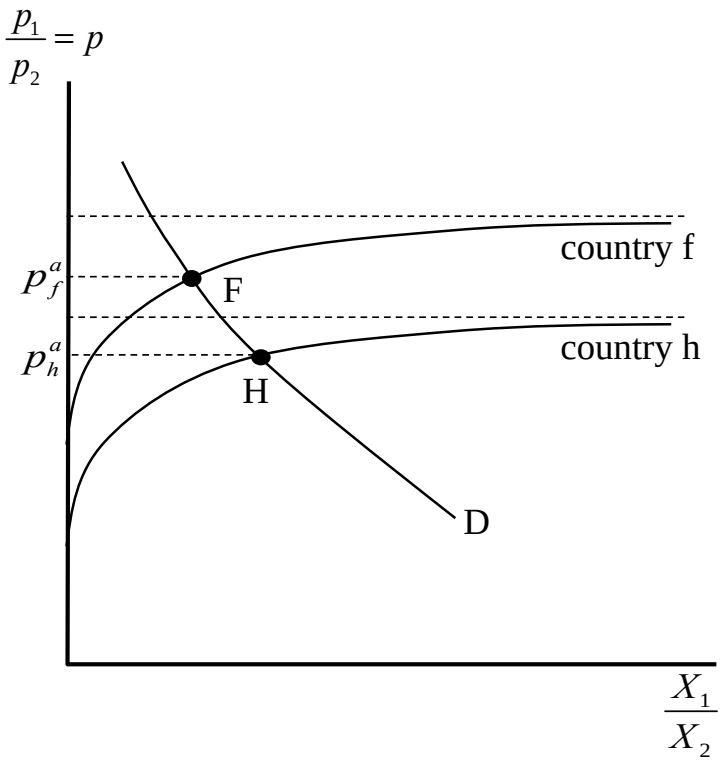
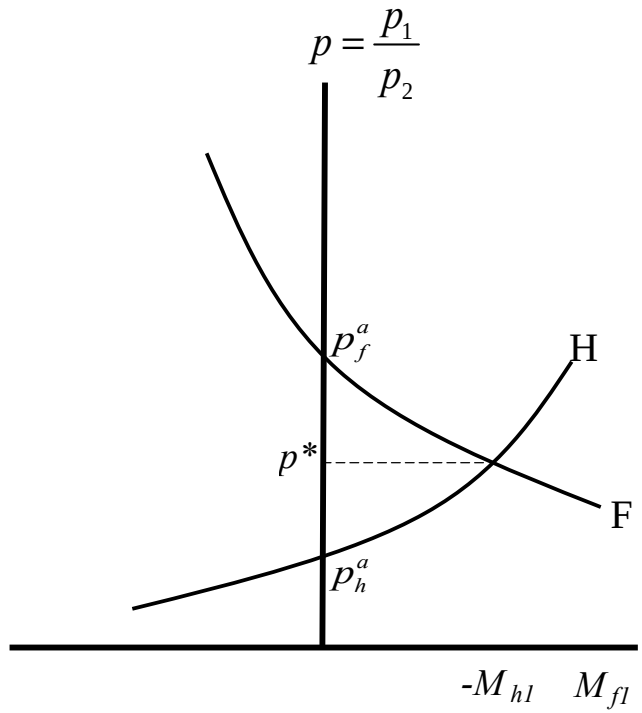


Figure 8.4



The scarcity of one factor make the good using that factor intensively expensive.

Trade makes that good cheaper, leads the country to produce less of that good and more of the good which does not use that factor intensively.

This is going to lower the demand for the scarce factor, and this will drive down its price in equilibrium.

The reverse argument can be made about the abundant factor.

Trade increases the return to the abundant factor, lowers the return to the scarce factor.

Under very strong (restrictive) assumptions, trade equalizes the price of each factor across countries.

Trade is similar to indirectly pooling all of the world's countries and endowments into one country.

The Factor-Price-Equalization Theorem

(A) if trade is costless such that trade equalizes commodity prices between countries and

(B) if countries are not "too different" such that both continue to produce both goods after trade,

then the price of each factor is equalized across countries.

Unit value isoquants and unit value isocost line. Figure 8.5

If countries have identical technologies, and commodity prices are equalized through free trade,

then the unit-value isoquants are exactly the same in the two countries.

If the unit value isoquants are the same, then the isocost line tangent to them is the same,

thus the price of each factor must be the same across countries.

However, this is only true if the country's endowment point is between the optimal V_2/V_1 ratios used in the two industries. Figure 8.5.

Figure 8.5

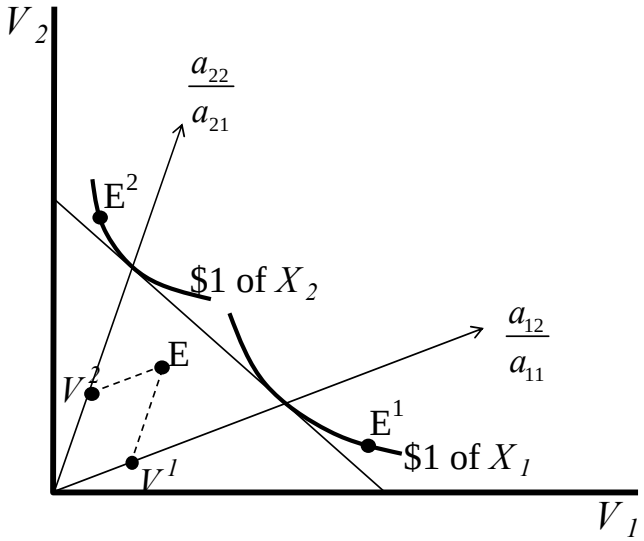
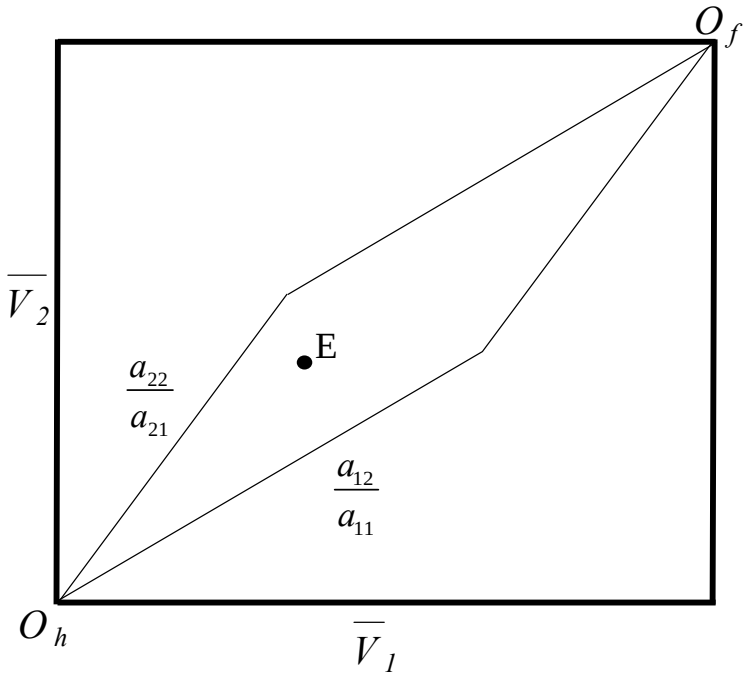


Figure 8.6



Let a_{ij} be the optimal amount of factor j to use in producing one unit of good X_i. If

$$\frac{a_{22}}{a_{21}} > \frac{\bar{V}_1}{\bar{V}_2} > \frac{a_{12}}{a_{11}}$$ For both countries

Then factor-price equalization is the actual outcome in equilibrium. Figure 8.6

Subject to the assumptions of the model, free and costless trade in goods results in the same outcome as when occur if factors themselves were freely traded.

An important consequence of the above:

subject to producing both goods:

hold commodity prices constant =>

hold factor prices constant =>

hold optimal a_{ij}*'s* constant =>

Changes in endowments can be absorbed through changes in the *composition of output* rather than through *changes in factor prices*.

The Rybczynski Theorem

Holding commodity prices constant, an increase in the endowment of factor i leads to a more than proportion increase in the output of the good using that factor intensively, and to a fall in the output of the other good.

Figures 8.7, 8.8

Figure 8.7

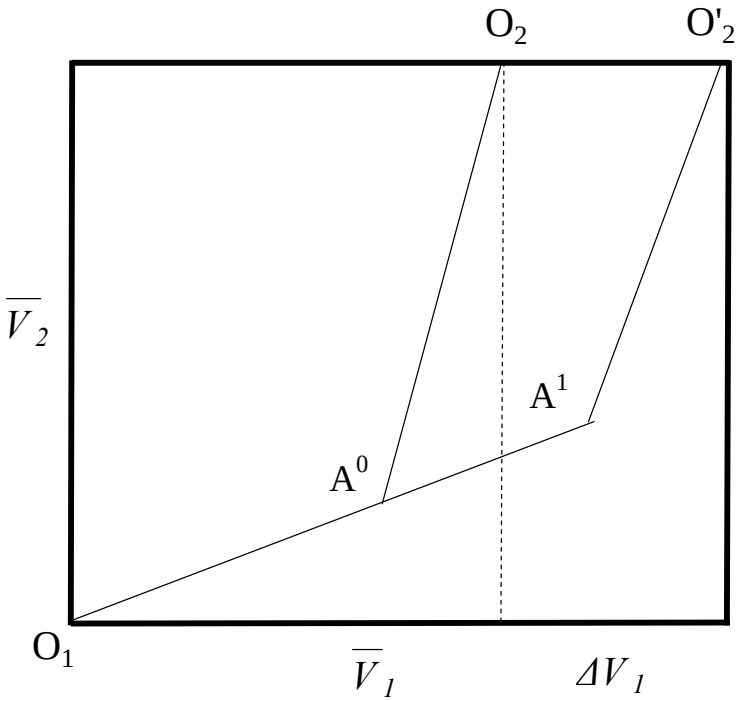
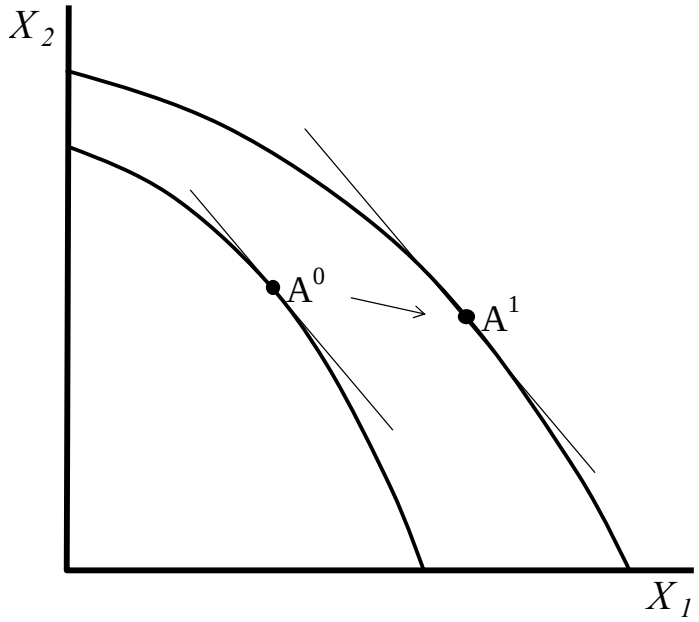


Figure 8.8



Rybczynski Theorem: Biased changes in factor endowments lead to even more biased changes in production.

Let a "hat" over a variable denote proportional change: $\hat{X} \equiv \frac{dX}{X}$

$$\hat{X}_1 > \hat{V}_1 > 0 > \hat{X}_2 \qquad \hat{X}_2 > \hat{V}_2 > 0 > \hat{X}_1 \tag{8.19}$$

This is helpful for explaining some of the dramatic changes that have occured in East and South-East Asia over the last few decades.

Very high savings and investment rates (and falling birth rates) have dramatically increased the relative capital abundance of these countries, leading to very strong sectoral shifts toward manufacturing.

The effect of the opening on trade on factor prices and the distribution of income and gains from trade.

Note that the opening of trade shift production in each country toward the sector which uses intensively the country's abundant factor. Fig 8.2

The problem is that, at *constant factor prices*, the expanding sector is going to demand factors in different proportions to those being release by the contracting sector.

Relative to the contracting sector, the expanding sector will demand "too much" of the abundant factor and "too little" of the scarce factor.

Figure 8.9: X_1 expands, X_2 contracts

At constant factor prices, X_2 *releases* factors in the proption a_{22}/a_{21} , X_1 *demands* factors in the proportion a_{12}/a_{11}: $a_{22}/a_{21} > a_{12}/a_{11}$

Price changes due to the opening of trade =>

Changes in outputs =>

Excess demand for the abundant factor
Excess supply of the scarce factor. =>

Increased price of abundant factor
Decreased price for scarce factor

Figure 8.10

Figure 8.9

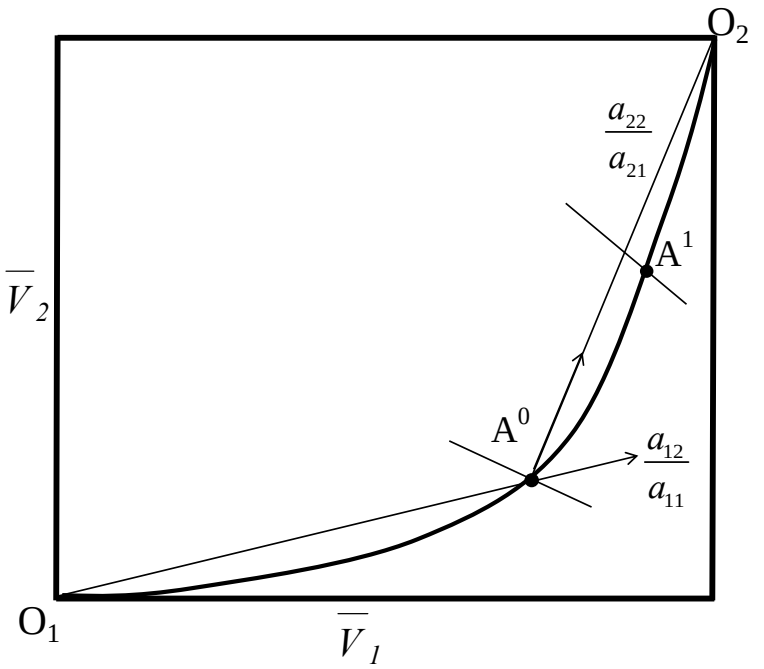
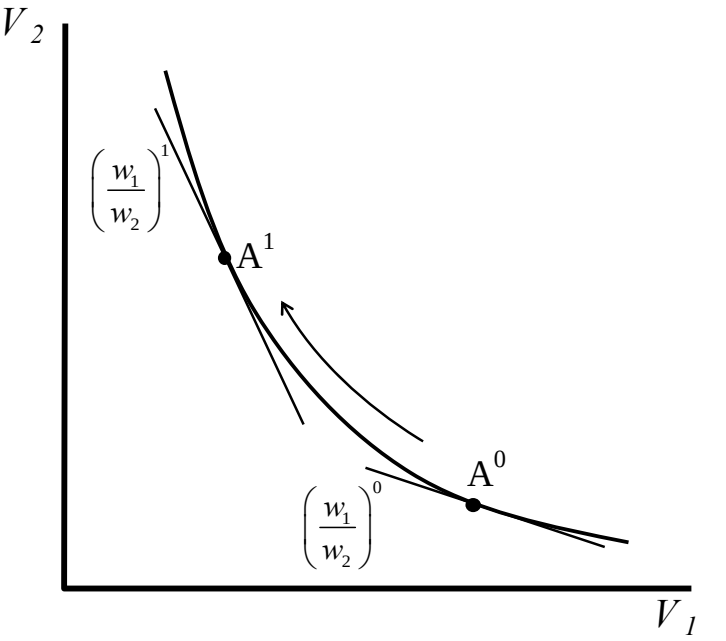


Figure 8.10



But commodity prices are changing as well. What about real factor income?

The Stolper-Samuelson Theorem

An increase in the price of good i leads to an increase in the real income of the factor used intensively in good i, and to a fall in the real income of the other factor.

Value of marginal product conditions for competitive equilibrium.

$w_1 = p_1 MP_{11} = p_2 MP_{21}$ $\quad w_1/p_1 = MP_{11}, \quad w_1/p_2 = MP_{21}$

$w_2 = p_1 MP_{12} = p_2 MP_{22}$ $\quad w_2/p_1 = MP_{12}, \quad w_2/p_2 = MP_{22}$

Note from our previous diagram that an increase in $p = p_1/p_2$ raises w_1/w_2, and therefore raises the ratio of V_2/V_1 in both industries. Figure 8.10

This must mean that the marginal product of labor rises in both industries, and that the marginal product of capital falls in both industries.

w_1/p_1 rises w_1/p_2 rises

w_2/p_1 falls w_2/p_2 falls.

Wage of V_1 rises relative to both commodity prices.

Wage of V_2 falls relative to both commodity prices.

$$\hat{w}_1 > \hat{p}_1 > 0 > \hat{w}_2 \qquad \hat{w}_2 > \hat{p}_2 > 0 > \hat{w}_1 \tag{8.24}$$

Policy Implication: There will be political fights over changes in trade policy.

Heckscher-Ohlin Model: Summary and Policy Implications

1. A country's comparative advantage, production and trade are determined by underlying factor endowments intersected with technologies.

   Relative factor endowments across countries

   \+ relative factor intensities across industries

   = comparative advantage.

2. Changing the underlying factor endowment can have very biased effects on production and trade (Rybczynski). Higher savings rates and capital formation in Asia naturally lead to a shift in capital intensive manufacturing toward Asia.

3. While free trade results in aggregate gains in income, those gains are very unevenly distributed. Some factor owners generally lose (Stolper-Samuelson).

4. This is in turn the source of considerable political controversy over protection and liberalization.

5. A country's scarce factors may lose following trade liberalization. There is a sense in which American unskilled workers compete against workers in the developing world.

6. However, the policy options are not just free trade versus restricted trade, but possibly include free trade versus various measures to help adversely affected workers (education, training, relocation assistance).

Table 8.4 Results of Statistical Testing in Davis-Weinstein				
			HOV	HOV
	HOV	HOV-HN	non-FPE	non-FPE & gravity
Statistic	H1	H2	H3	H4
Slope	-0.002	-0.05	0.43	0.82
Standard Error	0.005	0.02	0.02	0.03
R^2	0.01	0.31	0.96	0.98
Sign Test	32%	50%	86%	91%
Observations	22	22	22	22

Source: I

Suppose that there are three factors of production, labor, which is used in both sectors and two "sector-specific" factors, each of which is only used in one sector.

The X sector uses L and K_1 (capital), and the Y sector uses L and K_2
Each type of K is of no use (zero productivity) in the other sector..

$$X_1 = F_1(L_1, K_1) \qquad X_2 = F_2(L_2, K_2)$$

$$\bar{L} = L_1 + L_2, \quad K_1 = \bar{K}_1, \quad K_2 = \bar{K}_2 \tag{9.1}$$

The production frontier for this economy is strictly concave. This reflects the diminishing marginal product of labor.

Figure 9.1

Figure 9.1

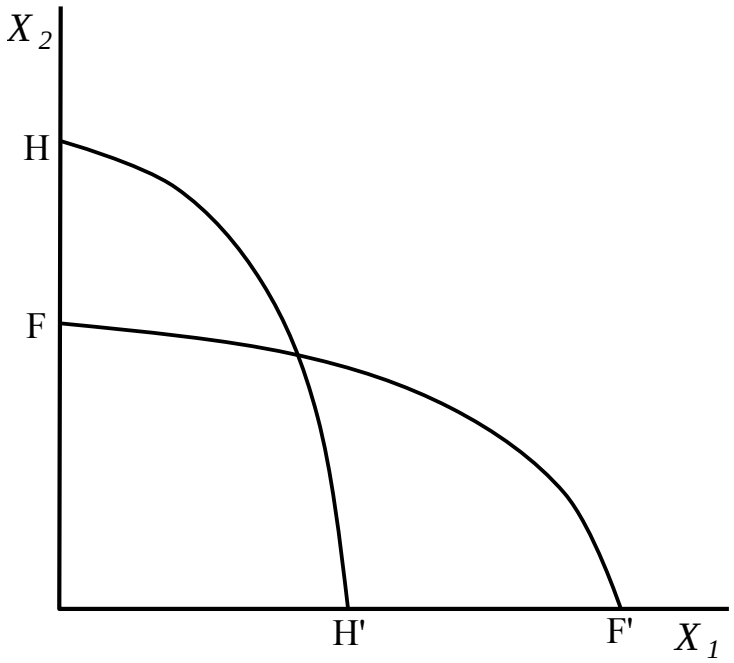
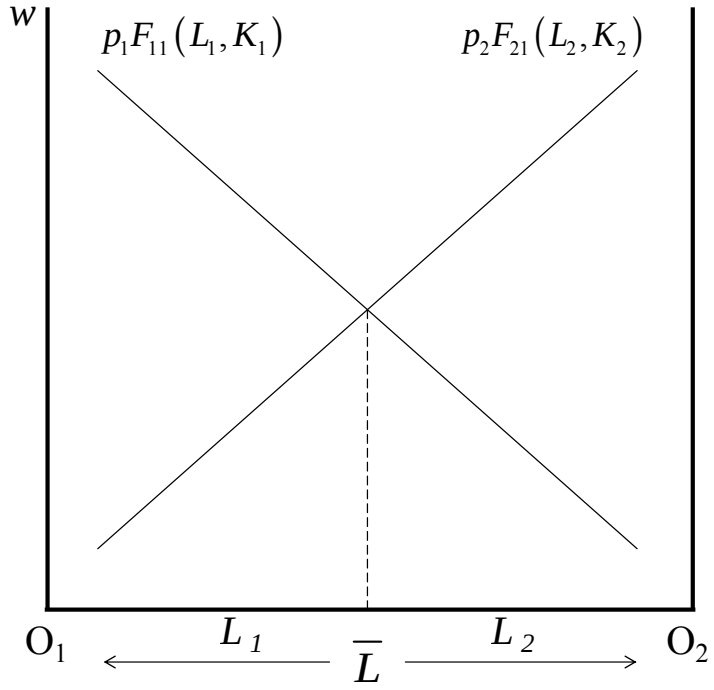


Figure 9.2



As we move down the production frontier, we are adding more labor to a fixed factor in X_1, so ΔX_1 gets smaller with each additional unit to labor transferred from Y.

Conversely, ΔX_2 gets bigger (i.e., more negative) with each unit transferrred.

Suppose that we have two countries that have the same endowment of labor.

However, country h has more K_2 than country f, and country f has more K_1 than country h.

Their respective production frontiers look like the following.

Figure 9.1

Comparative advantage is thus determined by relative factor endowments.

Each country has a comparative advantage in the good that uses "intensively" its abundant factor.

Suppose that consumers in both countries have identical preferences (the same indifference curves).

Then in the absence of trade (autarky), prices will differ in the two countries.

Autarky prices are given by the slope of the intersection of the production possibility frontier and the indifference curve.

Each country will have a relatively high price for the good using the scarce factor, and a relatively low price for the good using the abundant factor.

Differences in factor endowments show up as commodity price differences.

Now let the countries trade.

Each country will export the good for which it has a low price and import the good for which it has a high price.

Each country exports the good which uses “intensively” its abundant factor.

This is closely related to the Heckscher-Ohlin theorem.

Trade and Factor Prices (income distribution) in the specific-factors model

Factor market allocations determined by the intersection of the value-of-marginal-product curves of labor: Figure 9.2.

The opening of trade causes a rise in the price of each country's export good. Figure 9.3 shows result for country f, which exports X_1

Consider country f: labor is transferred from X_2 to X_1. This implies

$$\frac{L_1}{K_1} \quad rises, \qquad \frac{L_2}{K_2} \quad falls \qquad in\ country\ f$$

Let r_1 and r_2 and w be the prices of K_1, K_2, and L respectively.

Figure 9.3

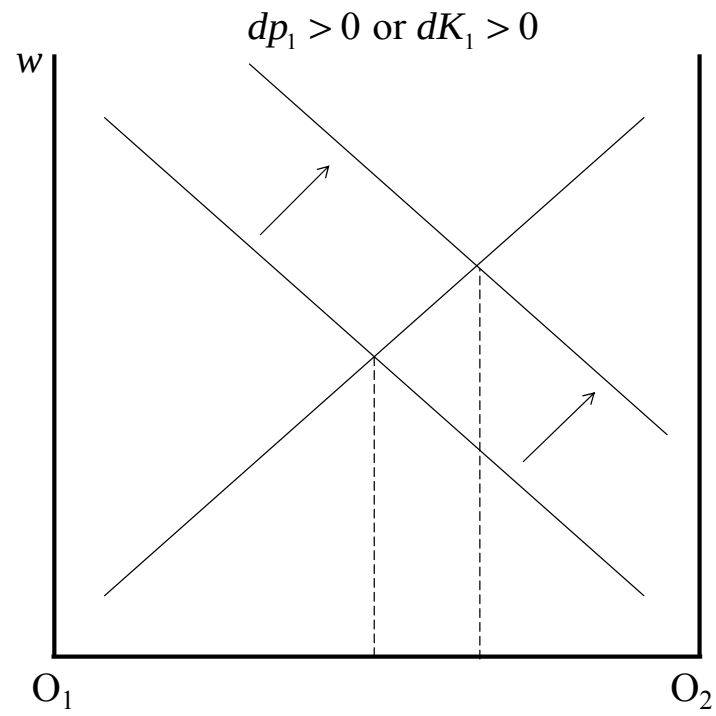
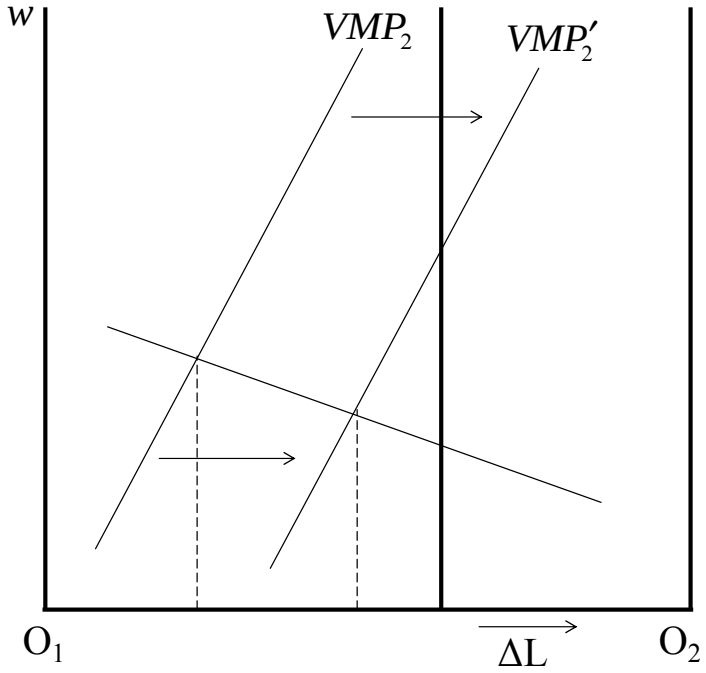


Figure 9.4



Given the "usual" assumptions about marginal productivity, marginal products depend on the ratio of factors, this implies that

$$d(w/p_1) = d(F_{11}) < 0 \qquad d(w/p_2) = d(F_{21}) > 0$$
$$d(r_1/p_1) = d(F_{12}) > 0 \qquad d(r_2/p_2) = d(F_{22}) < 0 \tag{9.4}$$

Refer back to the first step in the argument, the process begins with the price of the export good Y rising, think of the price of X as fixed.

Then the above results imply that

$$\hat{r}_1 > \hat{p}_1 > \hat{w} > 0 > \hat{r}_2 \qquad \hat{r}_2 > \hat{p}_2 > \hat{w} > 0 > \hat{r}_1 \qquad \hat{r}_1 \equiv \frac{dr_1}{r_1} \tag{9.5}$$

This result says that the opening of trade leads to an increase in the real return (real income) of the specific factor used intensively in the export industry and a fall in the real return to the factor used intensively in the import-competing industry.

This result is a “pessimistic” result for the politics of trade policy. It says that freer trade is going to make some groups worse off. Conversely, protection against imports makes some groups better off.

The country gains “overall” from trade, but the gains are very unevenly distributed.

Owners of specific factors (including workers with skills only useful in one sector) have big vested interests in trade policy, either for or against liberalization.

Table 9.1 Positions on Protection and Free Trade of Capital and Labor

	Labor: Protection	*Labor: Free Trade*
Capital: Protection	Distilling Textiles Apparel Chemicals Plastics Rubber Leather Shoes Stone products Iron and steel Cutlery Hardware Bearings Watches	Tobacco products
Capital: Free Trade	Petroleum products	Paper Machinery Tractors Trucks Aviation

Source: Magee (1980).

Table 9.2 Estimates of the Determinants of Individual Trade-Policy Preferences					
Variable	*Model 1*	*Model 2*	*Model 3*	*Model 4*	
Constant	**1.567**	**1.552**	**1.596**	**1.578**	
Occupation wage	**-1.766**	**-1.759**	**-1.746**	**-1.738**	
Sector tariff		1.828		2.275	
Sector net ex share	-0.624		-0.653		
County exposure 1	-0.334	-0.301			
County 1*House	**2.195**	**2.182**			
Country exposure 2			-0.146	-0.136	
County 2*House			**0.780**	**0.779**	
No. of observations	1736	1736	1736	1736	
Note: coefficients in boldface type are significantly positive or negative at the 5 percent level.					
Source: Scheve and Slaughter (2001)					

n 21% of GDP that
. But the same thing
very OECD country,
stimulus, bail-outs,

ng to wind down. Mr
investments in banks
st enough. Multiple
oyment-insurance
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expire soon. Around
art a multi-year climb.
ely to Mr Obama
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but rising interest on
built-in health and
s are more important.