Theory and Policy of International Trade

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Sommersemester 2013

The Ricardian Model

*The Ricardian Model analyses the trade of two goods between two countries with **different production technologies (1 input, generally Labor),** but same preferences. The model shows that by participating in free trade, each country fully specializes in the good for which they have a comparative advantage (lower opportunity cost) in production and the relative world market price will lie between the respective autarky prices. If there are significant size differences between the two countries where the smaller country cannot satisfy the import demand of the larger country, there will be diversified production. Free trade does not always lead to wage equalization – more productive countries will receive a better wage rate.*

Detailed Explanation →

Free Trade:

We consider the case for trade between two countries with different production technologies (whether it be Labor, Land, or Capital—usually represented by Labor). By examining the countries' production possibilities (Figure 1.A), we can identify the comparative advantage each country has in the production of the two goods. The opportunity cost is given by the slope of the PPF and, due to the assumption of perfect competition, is equal to the autarky price. From the opportunity cost, we can determine which the good for which a country has a comparative advantage. A lower opportunity cost (or autarky price) signals that a country has a comparative advantage in that good (to produce one more unit of the good in the denominator, they sacrifice less of the good in the numerator than the other country must sacrifice). Each country will export the good for which it has a comparative advantage (can produce more efficiently, lower opportunity cost).

The price of each good in the two countries will be equal in international trade equilibrium, assuming each country ***fully specializes*** in the good for which they have a comparative advantage (Figure 1.B). The good which Home exports will be sold in lower quantities at Home, causing the price at Home to rise. Conversely, that same exported good will be sold in higher quantities than previously in Foreign, causing the price in Foreign to fall. The prices will normalize until they reach a world equilibrium price which lies in between Home and Foreign's autarky prices. This will also happen to the good which Foreign exports and Home imports. Both countries will reach a higher level of utility.

Thus, Home (Foreign) will be receiving a higher price for the good it can produce most cheaply, and the wages for the production of that good will increase, causing all of the labor to migrate to that sector. Production of the other good will cease.

We can observe this by multiplying the world price of each good by the respective country's MPL for each product. Here, we see that the Price times the MPL will be higher for the good for which the country has a comparative advantage:

$$\frac{P_1 \times MPL_1}{P_2 \times MPL_2}$$

If Home has a comparative advantage in good 1, the numerator will be bigger than the denominator, and vice versa. This equation can also be used for Foreign by inserting the foreign MPLs.

The resulting world price, $\frac{P_1}{P_2}$, multiplied by -1 is the slope of the world price line. This line lies above Home and Foreign's PPFs, representing the new consumption possibilities for Home and Foreign. Utility increases, representing gains from trade. Trade will occur on the world price line at the point which represents the ratio of world quantities.

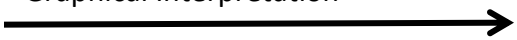
In trade equilibrium, the relative world demand determines which countries produce which good. If the demand curve intersects with the supply curve (Figure 1.C) at the home country's autarky price, Home will produce and indeterminate amount of both goods and foreign will produce only the good for which it has a comparative advantage. If the demand curve lies between Home and Foreign's autarky prices, this signals that Home and Foreign have opposite comparative advantages, and each country will ***fully specialize*** in the good for which it has a comparative advantage. If the demand curve intersects the supply curve at Foreign's autarky price, Foreign will produce an indeterminate amount of both goods 1 and 2, and Home will produce only the good for which it has a comparative advantage. Where the demand curve intersects the supply curve is dependent on the size of the countries. Thus, when Home is bigger and has a higher demand, it will produce and undeterminable amount of each good while Foreign produces just the good for which it has a comparative advantage, and vice versa. In cases such as this (without full specialization), small countries will always gain from trade, but large countries not necessarily.

Relative Wage in Free Trade:

Relative wage in free trade is determined by multiplying the (ratio of the) world price by the MPL in each country and sector with the comparative advantage. The country with lower wages has a lower absolute advantage. That is, the other country has better technology in the production of both goods.

The world wage (ratio of Home's wage to Foreign's wage) will lie between the opportunity costs (autarky prices) of the two countries in the case of full specialization.

Graphical Interpretation



Example: Trade and Technology – The Ricardian Model

Consider two countries, Home and Foreign (*). Both economies produce two goods, clothes and shoes with the supplied quantities being denoted by y_c, y_s, y_c^*, y_s^*. The sectoral technologies are characterized by constant labor input coefficients: $a_c = 5, a_s = 2, a_c^* = 4, and\ a_s^* = 1$.

The total number of workers available in Home and Foreign is given by $L = 100$ and $L^* = 60$ respectively. It is assumed that workers can freely move between the sectors within each economy, while inter-country migration is not possible. Consumers always want to consume both goods. The utility function of the representative consumer is given by $U = x_c^{\alpha} x_s^{1\alpha}$ ($U^* = x_c^{*\alpha} x_s^{*1\alpha}$) with $\alpha = 0.5$ and x_i (x_i^*) denoting the amount of good $i = C, S$ consumed.

The markets for the two goods and for labor are assumed to be perfectly competitive.

a) Derive the production possibility frontier (PPF) for both countries. Illustrate the PPF for Home and explain what the PPF depicts. How can you interpret the slope of the PPF?

Home PPF:

$L_i = a_i y_i.$ *with* $i = C, S\ and\ L = L_c + L_s$

$L_c = a_c y_c. \rightarrow L_C = 5y_c.$
$L_s = a_s y_s. \rightarrow L_s = 2y_s.$

$100 = 5y_c + 2y_s \rightarrow y_c = -\frac{2}{5} y_s + 20$

Foreign PPF:*

$L_i = a_i y_i.$ *with* $i = C, S\ and\ L^* = L_c^* + L_s^*$

$L_c^* = a_c^* y_c^*. \rightarrow L_c^* = 4y_c^*.$
$L_s^* = a_s^* y_s^*. \rightarrow L_s^* = 1y_s^*$

$60 = 4y_c^* + 1y_s^* \rightarrow y_c^* = -\frac{1}{4} y_s^* + 15$

The PPFs represent all of the possible combinations each country is capable of producing. The slope of the PPFs represent the opportunity cost for the countries as well as the autarky prices for Shoes.

b) Formally derive the condition for a country's production to be diversified under autarky. Then use the parameter values given above to determine the relative autarky prices of clothes in the two countries.

In order to have product diversification under autarky, there must be labor in each sector, which means wages in the sectors must be equal.

$w_i = MPL_i p_i$

$w_c = MPL_c p_c \rightarrow w_c = \frac{1}{5} p_c$

$w_s = MPL_s p_s \rightarrow w_s = \frac{1}{2} p_s$

$w_c^* = MPL_c^* p_c^* \rightarrow w_c^* = \frac{1}{4} p_c^*$

$w_s^* = MPL_s^* p_s^* \rightarrow w_s^* = \frac{1}{1} p_s^*$

The wages are equalized, and the resulting price is equal to the slope of the PPF! In autarky, the relative price is determined by technology only. This ratio tells us the price of the good on the horizontal axis.

$\frac{1}{5} p_c = \frac{1}{2} p_s \rightarrow \frac{p_c}{p_s} = \frac{a_c}{a_s} = \frac{5}{2} = 2.5 = p_c^a$

$\frac{1}{4} p_c^* = 1 p_s^* \rightarrow \frac{p_c^*}{p_s^*} = \frac{a_c^*}{a_s^*} = 4 = p_c^{*a}$

c) Formally derive the proportion in which consumers want to consume the two goods. Which conditions ensure equilibrium between production and consumption in either country under autarky? Derive the equilibrium total quantities of the two goods in Home and illustrate the autarky equilibrium for Home.

I'm not actually sure how to solve this, but look at the utility function and use some common sense to see in what proportion consumers want to consume the good. Then us that in this equation (change proportion accordingly):

$p_c x_c = \frac{1}{2} wL$

$p_s x_s = \frac{1}{2} wL$

$\frac{p_c}{p_s} = \frac{x_s}{x_c} = \frac{5}{2} = MRS$

$p_c x_c = p_c y_c$

$\alpha \left(\frac{p_c}{a_c}\right) L = p_c y_c$

$y_c = \frac{\alpha L}{a_c} = \frac{.05(100)}{5} = 10$

$y_s = \frac{\alpha L}{a_s} = \frac{.05(100)}{2} = 25$

d) Explain why it is possible that Home exports one good to Foreign even though it has an absolute technological disadvantage in the production of both goods. Relying on the concept of comparative advantage and the parameter values given above, determine the trading pattern of the two countries if they open up to free trade.

Although Home has an absolute technological disadvantage in both goods, it has a comparative advantage in the production of cloth (Home's opportunity cost for the production of cloth is lower than Foreign's). Thus, if the countries open up to free trade, Home will fully specialize in the production of cloth and Foreign will fully specialize in the production of Shoes.

e) Assume that both countries fully specialize their production under free trade. Formally set up the goods market equilibrium condition for clothes and derive the relative price and quantity of clothes in the trade equilibrium. Illustrate the world market for clothes and the computed

equilibrium values in the trade equilibrium with full specialization using relative supply and demand curves.

In the goods market equilibrium, the relative world demand for clothes must equal the relative world supply of clothes. The demand will be defined by the proportion of income consumers (in the entire world) want to spend on clothes:

$$\alpha(wL + w^*L^*) = \alpha(\frac{p_c^w}{a_c}L + \frac{p_s^w}{a_s^*}L^*)$$

World supply is given by the price of clothes multiplied by the amount of labor divided by clothing technology:

$$\frac{p_c^w L}{a_c}$$

Setting these equations equal and substituting in the corresponding quantities, we find the world price.

$$\alpha\left(\frac{p_c^w}{a_c}L + \frac{p_s^w}{a_s^*}L^*\right) = \frac{p_c^w L}{a_c}$$
$$.5\left(\frac{p_c^w}{5}100 + \frac{p_s^w}{1}60\right) = \frac{p_c^w 100}{5}$$
$$\left(\frac{p_c}{p_s}\right)^w = 3$$

To find the free trade quantity, we take the ratio of the total quantity of clothes produced to the total quantity of shoes produced:

$$\frac{y_c}{y_s^*} = \frac{\frac{L}{a_c}}{\frac{L^*}{a_s^*}} = \frac{\frac{100}{5}}{\frac{60}{1}} = \frac{1}{3}$$

Since the free trade price lies between the two autarky prices, each country is fully specialized in a good. This can be shown graphically:

The Specific-Factors Model

The Specific-Factors Model investigates trade between two sectors (usually Agriculture and Manufacturing) of two countries with different technologies (production functions) and different factor endowments, which are immobile between sectors. From the model, we learn that the different autarky prices are a basis for trade and each country will specialize—but not fully— in the good for which it has a comparative advantage. Both countries gain from trade.

Detailed Explanation →

Free Trade:

In the Specific Factors Model, the Home country is discussed in great detail and the foreign country isn't really elaborated on. It is only assumed that the autarky prices differ between the two countries. Two sectors are examined, each of which requires two inputs, or factors of production. In the model used in class as well as in the Feenstra and Taylor book, each sector used labor as an input, whereas one sector additionally used capital and the other sector used land additionally. There are diminishing returns to labor in both sectors (that is, as more labor is used, the marginal product of labor decreases). Both sectors have neoclassical production functions. Labor is mobile between sectors, while land and capital are not. Therefore, the wage must be equal in both sectors for labor to be freely mobile. As demonstrated above in the Ricardian Model, slope of the PPF (which is the ratio of the MPLs of each sector) is the relative price of the good represented on the X-axis.

$$\frac{MPL_y}{MPL_x} = relative\ price\ of good\ produced\ in\ sector\ \boldsymbol{x} = \frac{p_x}{p_y}$$

As in the Ricardian Model, differing comparative advantages are the basis for trade. In the Specific Factors Model, however, there will typically not be full specialization and both countries will gain from trade. This model explores the earnings of the inputs of the factors used in the sectors. Capital and Land earnings will fluctuate the most due to changes in relative prices (which occur due to trade) because in the short run they are stuck in a sector and cannot be employed elsewhere.

With free trade, the world trade line is again determined by the relative world prices (Figure 2.A). It lies tangent to the PPF, and this point of tangency is it's point of production in free trade. The utility function moves outward to become tangent with the new world trade line, and that is the point at which the country consumes.

Earnings of Labor:

Free trade causes a change in relative prices (Figure 2.B). Price movements will affect the real wage. An increase in the price in one sector with a static price in the other sector, for example, will cause the wage to increase. The real wage, however, depends on the ability of the worker to purchase the goods. If the wage increase amounts to less than the overall price increase, the real wage has decreased. Since the overall real wage is a product of the change in prices within the two sectors in combination with the increase/decrease in the wage, the resulting effect on the real wage/well-being of workers is ambiguous in this case.

Earnings of Capital and Land:

The earnings of capital and land can be measured in different ways. It's important to recognize that the rentals paid to capital and land will be the leftover revenue from the sector after wages are paid. Thus,

$$Payments\ to\ capital\ (land) = P_{M\ (A)} \times Q_{M\ (A)} - W \times L_{M\ (A)}$$

The rental would then be calculated by taking the payments to capital/land and dividing them by the quantity of capital/land used in each sector respectively. Another way to calculate rentals on capital and land looks similar to the calculation of wage:

$$R_K = P_K \times MPK_M$$

Rental on capital is equal to the price of capital times the marginal product of capital in the manufacturing sector.

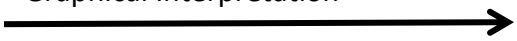
An increase in the quantity of labor used in an industry will raise the marginal product of the factor specific to that industry, and a decrease in labor will lower the marginal product of the specific factor. This is because the amount of the specific factors (other than labor) in each industry stay the same, so when labor leaves one sector, the sector is less efficient due to the lack of labor available to work with that specific factor. On the other hand, when there is more labor to work with the specific factors, productivity increases. For example, an increase in the price of manufacturing increases labor in the manufacture sector, and…

$$P_M = L_M \uparrow, so\ that\ MPK_M = R_K/P_M \uparrow$$

The increase in the rent on capital is greater than the increase in the price of manufacture because it is scaled by the MPK (as demonstrated in the equation above).

The purchasing power of each factor is measured by the rent of the factor divided by the price of the sector. An increase in the price of a sector causes a more than proportional increase in the rent to that sector, thus, the purchasing power of that factor for that sector has increased. If the price in the other sector has stayed the same (or decreased), purchasing power for that sector will have also increased, showing us that the factor in the sector which experienced a price increase is better off because of trade → ***An increase in the relative price of an industry's output will increase the real rental earned by the factor specific to that industry , but will decrease the real rental of factors specific to other industries.***

Graphical Interpretation



The Heckscher-Ohlin Model

*The Heckscher-Ohlin Model investigates trade of two goods with different **capital-labor intensities** between two countries, which have **different relative factor endowments**, and factors can move freely between industries. Differing autarky prices are the basis for trade, countries will specialize according to comparative advantage, and both countries will experience and overall gain from trade. According to the **Stolper-Samuelson Theorem**, "the abundant factor gains from trade, and the scarce factors loses from trade."*

Detailed Explanation →

From Autarky to Free Trade:

The Heckscher-Ohlin Model deals with two different countries which produce goods X and Y. Both goods require the same two factors of production (usually Labor and Capital), but in different ratios, or different ***capital-labor intensities*** (Figure 3.A). The factors can move freely between industries, but NOT between countries. Countries have different relative factor endowments (that is, the amount of capital and labor found in each country is different). Technologies are the same across countries.

In autarky, the country with the higher capital supply will also produce a relatively higher quantity of the capital-intensive good (Figure 3.B). The price of the capital-intensive good in the relatively capital-rich country will, therefore, be lower than in the relatively labor-rich country. The relatively capital-rich country has a comparative advantage in the capital-intensive good, while the relatively labor-rich country has a comparative advantage in the labor-intensive good.

In terms of the PPFs of each country, the PPF will be concave and unevenly skewed toward the good for which the country has a comparative advantage (Figure 3.B).

In the case of free trade, the different autarky prices will be the basis for trade, the world price will lie between country-specific autarky prices, and countries will specialize according to their comparative advantage. (Figure 3.C)

"With two goods and two factors, each country will export the good that uses intensively the factor of production it has in abundance and will import the other good."
–Heckscher-Ohlin Theorem

Goods Prices and Factor Returns:

In the case of trade, the trade sector (the sector requiring a higher intensity of the relatively abundant factor) will grow within a country. Each sector's factor intensity requirement for the relatively abundant factor will decrease so that more of that abundant factor can migrate to the trading sector. ($\frac{L_i}{K_i}$ increases in both sectors *if K is the abundant factor* → you can only expand an industry using a capital-intensive good when both sectors use a little bit less capital) (Figure 3.D). The w/r will fall to restore equilibrium. The marginal products of the relatively abundant factor (the one used intensively in the trading sector) will increase in both sectors, while the marginal product of the other factor will fall in both sectors.

"An increase in the relative price of a good will increase the real return to the factor used intensively in the production of that good and decrease the real return to the other factor."
–Stolper-Samuelson Theorem

The Lerner Diagram:

(Figure 3.E)

Isoquant: L-K combinations generating a revenue of one unit

Isocost Curve: L-K combinations generating a cost of one unit

→When the isocost curve is tangent to the unit value isoquants for both sectors, there are zero profits in both sectors. The tangency points determine factor intensities and factor returns (w and r).

When the price for a sector increases (the traded sector), the isoquant for that sector shifts inward and the unit value isocost line re-establishes zero-profits in both sectors. This readjustment results in the more than proportional increase in the factor return of the factor used intensively in that sector and a decrease in the return of the other factor. Production in both sectors will become less-intensive in regard to the factor which is used intensively in the trading sector (more intensive in the other factor).

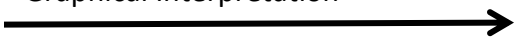
Endowments, Outputs, and the Patter of Trade:

"An increase in the endowment of one factor leads to a more than proportionate increase in the output of the sector using this factor intensively. The output of the other good declines."
–Rybczynski Theorem

Factor content of trade: With more than two factors of production, how do we determine relative factor abundance? *The factor content of trade in factor k is positive for country i if the endowment of k relative to world endowment exceeds country i's share in world GDP.* In this case, country i is called "abundant in factor k" and exports the sector which uses factor k intensively.

→Taking technology capabilities into account would improve the predictive powers.

Graphical Interpretation



Example: The Heckscher-Ohlin Model

Consider an economy (let's call it home) with two sectors, agriculture (A) and manufacturing (M), that produces under autarky using two factors of production, capital (K) and labour (L). Factor endowments are fixed at $\overline{K}$ and $\overline{L}$. Both sectors use both factors of production. The latter are freely mobile across sectors. The sectoral production functions are given by:

$$y_A = K_A^{\alpha} L_A^{1-\alpha}$$

$$y_M = K_M^{\beta} L_M^{1-\beta}$$

$$with\ \alpha, \beta\ \in (0,1)\ and\ \beta > \alpha$$

Firms produce under perfect competition. Goods prices are denoted as p_i with $i = A, M$ and factor prices as w, r for L, K, respectively. Consumers exhibit homothetic preferences.

a) Derive the optimal capital intensities in both sectors [hint: start with the profit maximisation problem of the representative firm in each sector]. Which of the two sectors is labour intensive, and which one is capital intensive? What is the effect of a change in the relative factor price on the optimal capital intensities?

Just from the production functions, we can see that Agriculture is labor-intensive, and Manufacturing is capital-intensive (because alpha is less than beta..).

Profit Maximization Problems:

$$max\pi_{L_A,K_A} = p_A y_A - wL_A - rK_A = p_A(K_A^{\alpha} L_A^{1-\alpha}) - wL_A - rK_A$$
$$\pi_{L_A} = (1-\alpha) p_A K_A^{\alpha} L_A^{-\alpha} - w = 0$$
$$\pi_{K_A} = \alpha p_A K_A^{\alpha-1} L_A^{1-\alpha} - r = 0$$
$$(1-\alpha) p_A K_A^{\alpha} L_A^{-\alpha} - w = \alpha p_A K_A^{\alpha-1} L_A^{1-\alpha} - r$$
$$\frac{K_A}{L_A} = \frac{\alpha}{1-\alpha} \times \frac{w}{r}$$

$$max\pi_{L_M,K_M} = p_M y_M - wL_M - rK_M = p_M \left(K_M^{\beta} L_M^{1-\beta}\right) - wL_M - rK_M$$
$$\pi_{L_M} = (1-\beta) p_M K_M^{\beta} L_M^{-\beta} - w$$
$$\pi_{K_M} = \alpha p_M K_M^{\beta-1} L_M^{1-\beta} - r$$
$$(1-\beta) p_M K_M^{\beta} L_M^{-\beta} - w = \beta p_M K_M^{\beta-1} L_M^{1-\beta} - r$$
$$\frac{K_M}{L_M} = \frac{\beta}{1-\beta} \times \frac{w}{r}$$

We see here that an increase in the price of r or a decrease in the price of w will lead to a lower capital-labor intensity (less capital used in relation to labor). This is a ***substitution effect.***

b) Illustrate the relation between the unit value isoquants and the unit isocost curve in the diversification equilibrium using a Lerner diagram. Please explain what you are doing. Now additionally consider a second economy (let's call it foreign, denoted by *), differing from the home economy only with respect to its endowment with the two factors of production:

$$\overline{K}^* > \overline{K} \; and \; \overline{L}^* = \overline{L}$$

Unit value isoquants are the combinations of input factors that generate a value of i:
$p_i y_i(K_i, L_i) = 1 \; with \; i = (A, M)$

The unit isocost curve is the combinations of input factors that cost one:
$wL_i + rK_i = 1 \rightarrow K_i = \frac{1}{r} - \frac{w}{r} L_i$

In an equilibrium with diversification (production in both sectors), both sectors make zero profits. Therefore the unit isocost curve must be tangent to both isoquants. Factor prices have to adjust such that the unit isocost line can meet these two tangency conditions.

c) Graphically illustrate the production possibility frontiers (PPFs) as well as the relative autarky prices ($p^a = \frac{p_M}{p_A} \; and \; p^{a*} = \frac{p_M^*}{p_A^*}$) and the autarky equilibria of the two economies in one diagram. Explain the differences in your illustrations for the two economies. Comment on the concept of comparative advantage.

Since Foreign is endowed with the same amount of labor but more capital than Home,it can produce more of both goods comparatively. Foreign's PPF, thus, has intercepts farther from the origin point than Home. Since capital yields a larger output in sector M compared to A, Foreign is able to produce significantly more in M.

<u>Indifference Curves:</u> consumer tastes are the same across countries → same utility preferences influence respective utility curves.

<u>Condition for Autarky Equilibrium:</u> MRS (slope of U) =relative autarky price = MRT (slope of PPF)

Since Foreign is capital abundant and Home is labor abundant, $\frac{K^*}{L^*} > \frac{K}{L}$, the relative price for the manufacturing good in Home will be higher than in Foreign. The varying relative autarky prices resulting in differing comparative advantages act as the incentive for trade.

d) Assume that the two economies engage in free trade. What is the relationship between the relative world market price $p^f = \frac{p_M^f}{p_A^f}$ and the economies' autarky prices. Graphically illustrate the economies' production, consumption, and trading structure in one diagram with the output quantities of both goods on the axes.

$$p^a = \frac{p_M}{p_A} > p^f = \frac{p_M^f}{p_A^f} > p^{a*} = \frac{p_M^*}{p_A^*}$$

Home exports the agricultural good and imports the manufacturing good. Foreign exports the manufacturing good and imports the agricultural good.

$$M^* = X \text{ and } X^* = M$$

e) Reproduce the Lerner diagram for the home economy under autarky, treating good A as the numeraire. Add the trading equilibrium to the diagram and describe the nominal and real factor price effects in the home economy. Comment on the Stolper-Samuelson theorem.

(1) M isoquant shifts
(2) New isocost curve tangent to y_M^f and y_A
(3) K/L ratios adjust to fit new points of tangency

Nominal Factor Price Effects:

- *Can be read off axes*
- *Nominal wage increases*
- *Nominal interest rate decreases*

Real Factor Price Effects:

- *Follow from change in capital intensities*
- *Capital intensities in both sectors increase*
- *As a consequence, MPL in both sectors increases and so does the real wage ($\frac{w}{p_i} = MPL_i$)*
- *MPK in both sectors decreases (because capital intensity in both sectors increases), and so does the interest rate ($\frac{r}{p_i} = MPK_i$)*

Stolper-Samuelson Theorem:
The link between good price change and factors price change is what the SST covers. Namely, a decrease in the relative price of good (M) decreases return to factor intensively used in production of that good (r) and vice versa.

f) Reproduce the Lerner diagram for the free trade case. Add the endowment points for home and foreign to the diagram. Determine the output quantities of the two sectors for both economies graphically. Comment on the Rybczynski theorem. Explain the pattern of trade between these economies drawing on the Heckscher-Ohlin theorem.

The increase in capital endowment of foreign increases the manufacturing output of foreign more than proportionately, while the output of agriculture declines, according to the Rybczynski Theorem. Thus, drawing on the Heckscher Ohlin Theorem, Foreign will export M, as manufacturing uses its abundant good, K, intensively, and vice versa.

The Standard Trade Model

The Standard Trade Model investigates comparative statics in the open economy and assumes identical preferences across countries, which have country-specific PPFs. It investigates the resulting TOT effects resulting from shocks which affect trade. Export-biased growth (growth biased toward a country's export sector) worsens a growing country's TOT but benefits the rest of the world. The opposite is true for import-biased growth.

Detailed Explanation →

The Standard Trade Model combines the common features of the trade models discussed thus far to establish a "standard" model for trade situations. It is based on four key relationships: (1) the relationship between the PPF and relative supply curve, (2) the relationship between relative prices and relative demand, (3) the determination of world equilibrium by world relative supply and world relative demand, and (4) the effect of the Terms of Trade (TOT) on a nation's welfare.

As always, the country produces at a point on the isovalue line which is tangent to the country's PPF. The PPF is all of the combinations of quantities a country can produce given its resources (all of the possible combinations of supply a country can produce). A change in price of one of the goods causes the slope of the isovalue line to change, as it is defined by $Q_y = \frac{V}{P_y} - (\frac{P_x}{P_y})Q_x$. Thus, the production and consumption points of the goods adjust. Here we also see that a higher V leads to a higher isovalue line (a higher utility).

When the price of a good increases, this increases the slope of the country's isovalue line (which is effectively the relative price). The isovalue line is then tangent to the PPF at a different point, which means that different quantities of the good are being produced. This phenomenon translates, then, to the country's relative supply curve. (Figure 4.A)

Indifference curves belong in the Lerner Diagram. Indifference curves are all of the combinations of the two goods that will leave an individual (who is representative for the preferences of the entire economy) equally well off. Different indifference curves can be achieved at different isovalue lines.

When the price of a good increases, this causes an ***income effect*** which induces more production of that good. With a higher price of the good, however, a ***substitution effect*** ensues, which causes consumers to shift consumption away from the relatively more expensive good toward the relatively less expensive good. If the income effect is large enough, the substitution effect will not ensue. (Figure 4.A)

Terms of trade are defined as $\frac{Price\ of\ Exports}{Price\ of\ Imports}$. An increase in the TOT make a country better off and the rest of the world worse off. (Clearly, if the relative price of exports increases – or the relative price of imports decreases – it will be beneficial for a country.) Conversely, a decrease in the TOT make a country worse off and the rest of the world better off. In general, a change in the TOT redistribute income internationally. A change in the TOT, however, can never decrease a country's welfare level to a point below its welfare level in the absence of trade. The TOT functions as the slope of the isovalue line in the PPF diagram. From this we see that an increase in the terms of trade (an increase in the price of exports or decrease in the price of imports) causes a change in the slope of the isovalue line which leads to a higher utility level.

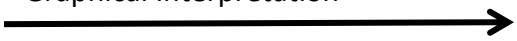
Economic growth at home or abroad and trade policy can affect the TOT. Supply shocks will shift the RS curve and demand shocks will shift the RD curve. Supply shocks will likely increase the production possibilities unequally across sectors. The relative world supply of the good toward which growth is biased will grow, leading to a shift in the world RS curve. The world price (determined by the intersection of relative world supply and relative world demand) will lie between the country prices). (Figure 4.B) It is irrelevant in which country this growth occurs. If this growth is biased toward a country's import sector (import-biased growth), it will improve a country's TOT (and harm the rest of the world). If the growth is biased toward a country's export sector (export-biased growth), it will worsen a country's TOT (and benefit the rest of the world).

Trade Policy:

An import tariff (a tax on imports) leads to an increase in the RS of the imported good, as domestic firms are incentivized to produce more, while the relative demand of the import good falls. This increases the TOT of the importing country.

An export subsidy occurs when no one wants to sell outside the domestic market because they receive more money inside the domestic market. In this case, the relative supply of the export good increases and the relative demand of the export good falls, which worsens the TOT for the exporting country.

Graphical Interpretation



Example: The Standard Trade Model

Consider a stylized world economy with two countries, Home and Foreign (*), that produce food (F) and cloth (C). Both economies have strictly concave production possibility frontiers. Goods markets are perfectly competitive and there is full employment of all factors. The relative price of cloth is denoted $p = \frac{p_C}{p_F}$. The relative price of the Home country that would prevail under autarky exceeds the one of Foreign: $p^a > p^{a*}$. Assume that there is free trade between the two economies. Since consumers have identical homothetic preferences, you can consider a representative consumer.

a) Suppose that Home experiences growth in its import sector (due to improvements in technology). Graphically illustrate the e_ect on the relative world price of cloth. What does this mean for Home's terms of trade (TOT)? Illustrate the welfare effect for Home in a suitable diagram.

(1) Growh in the import sector gives us a new PPF
(2) p' must be flatter (more elastic) because the supply increase causes p to fall

- *pure growth effect: consumers at Home can consume more of both goods after growth in the import sector*
- *income effect: due to the increase in Home's TOT, consumers in Home can consume even more of both goods in post-trade equilibrium*
- *substitution effect: movements along one indifference curve, showing that consumers now consume more of the good that has become cheaper. (ratio of consumption)*

b) Now consider the case in which Home experiences growth in its export sector (due to improvements in technology). How does this impact on Home's TOT? Graphically illustrate the specific case in which Home experiences immiserizing growth".

After Home has experienced growth in its import sector, its PPF is more wide-stretched toward C. The welfare effect can be decomposed as follows:

- *The relative supply curve of cloth shifts to the left, so the relative world market price of cloth has increased ($p^{f\prime} > p^{f}$) and Home's TOT have increased.*
- *If the negative TOT is stronger than the pure growth effect, you experience immiserizing growth since consumers reache a lower utility level in post-growth trade equilibrium compared to pre-growth trade quilibrium.*

International Migration

International migration occurs when a significant wage differential exists between two countries, which is greater than the cost of migration. In the short/medium run which is analyzed by the Specific-Factors model, wage rates fall and capitalists/land owners benefit from migration. In the long run, however, which is analyzed by the Heckscher-Ohlin model, capital is free to move between sectors, which allow the L/K ratios to balance out and welfare is neutral in the case of immigration.

Detailed Explanation →

In examining exogenous immigration, we model immigration as an exogenous increase in the domestic labor force. The short- and medium-run are modeled by the Specific-Factors framework, which the long-run is modeled by the Heckscher-Ohlin model, as it allows capital to be mobile.

An exogenous increase in Labor, L, occurs when w is higher than w*, causing labor to migrate to the Home country in order to receive a higher wage. The excess labor in the Home country, then, drives down w to a point where w and w* are equal. This leads to an expansion of both sectors at Home and the workforce increases by "change in" L. Immigration reduces the wage rate of domestic workers and increases incomes of domestic capitalists/land owners. (Figure 5.A)

Exogenous immigration in the Heckscher-Ohlin Model: (Figure 5.B)

With an increase of labor in the Home country, all additional L will be allocated to the labor-intensive industry (1). As a result, some K from the capital-intensive industry will move to the labor-intensive industry to try to balance the L/K ratios (2). Excess labor, then, in the capital-intensive industry will migrate to the labor-intensive industry in order to keep the L/K ratios constant (3).

Thus, the allocation of excess incoming labor to the labor-intensive industry only results in reallocation of factors to keep K/L ratios constant, which means ***the MPL and MPK remain***

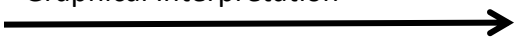
unchanged and the rentals (w and r) do not change. Output of the labor-intensive product will expand, while output of the relatively capital-intensive product will contract.

Effects:

(Figure 5.C)

- Wage equalization across countries
- Migrants gain
- Immigration country gains (land owners' gains overcompensate workers' losses)
- Emigration country loses (land owners' losses overcompensate workers' gains)
- → Welfare gains for the world (migrant gains exceed immigration country's losses)

Graphical Interpretation



Example: Endogenous Migration

Consider a stylised world economy consisting of two countries, Home and Foreign (*). The size of the labour force in either country amounts to $L = 6000$ and $L^* = 10000$, respectively. Since both countries produce the same good, there is no incentive for trade. The price of the good is normalised to one. Production in both countries requires labour (L) and land (T) as inputs, which are remunerated according to their value marginal product. Land is immobile internationally. The marginal products of labour are given as: $MPL = 12 - \frac{3}{4000}L$ and $MPL^* = 9 - \frac{3}{4000}L^*$.

a) Assume that both countries have very tight migration restrictions, preventing workers to move from one country to the other. Calculate the wage rates in Home and Foreign and illustrate the labour markets of both economies in one diagram.

$$MPL = 12 - \frac{3}{4000}(6000) = 12 - \frac{18000}{4000} = 7.5$$
$$MPL^* = 9 - \frac{3}{4000}(10000) = 9 - \frac{30000}{4000} = 1.5$$

Thus, the pre-migration situation is characterized by a large inter-country wage gap.

b) Now suppose that the two economies liberalize their migration legislations. Using your diagram from a), determine the new equilibrium that will establish and comment. Then use your diagram to identify the welfare and distribution effects that arise from moving to the new equilibrium.

Workers will immigrate from Home to Foreign until wage rate equalize at a point between "autarky wages" (where the MPL curves intersect graphically).

$$w = 4.5 \qquad L = 10000 \qquad L^* = 6000$$

Welfare Effects:

FOREIGN

Workers remaining:	*+D*
Landowners	*-C*
	-D
	-C

HOME

Native Workers:	*-E*
Landowners:	*+A*
	+E
	+A

MIGRANTS

	+B
	+C
	+B+C

OVERALL

Foreign	*-C*
Home	*+A*
Migrants	*+B*
Migrants	*+C*
World Gain	*+A+B*

The Krugman Model – Non-Comparative Advantage Trade

The Krugman Model investigates the existence of intra-industry trade (IIT) between countries. With increasing returns to scale and imperfect competition, countries' only incentive for trade is increasing returns to scale. Trade between such countries works because of consumers' love for variety. IIT results lower prices, higher quantities, and more consumption options (although the number of firms in each country decreases, trade allows consumers to access the firms in other countries).

Detailed Explanation →

The Krugman Model investigates the case of intra-industry trade (IIT), where similar countries trade similar goods. In contrast to the models explained thus far, it assumes imperfect competition and increasing returns to scale. This type of trade cannot be explained by previous models because all previous models functioned *because* the countries were different and therefore had comparative advantage in the production of specific goods. Therefore, the goods the countries imported and exported were different. In this model, economically comparable countries import and export similar goods.

The **Grubel-Lloyd Index** is used to measure "industry." In other words, it categorizes goods according to industry and tells how similar the goods within industry categories are to one another. A five-digit GL Index represents a very narrowly defined industry, which means that the goods within the industry are extremely similar. The GL Index in the H.O. Model, for example, is zero because the goods are exactly the same.

$$GL_i = 1 - \frac{|EX_i - IM_i|}{EX_i - IM_i} = \frac{2\min[EX_i, IM_i]}{EX_i + IM_i}$$

where $GL_i \in (0,1)$

In the Krugman Model, the basis for trade is increasing returns to scale. That is, it is more costly for a firm to produce different varieties than to specialize in a single variety.

Important is that as the number of product varieties increases (whether with or without trade engagement), the elasticity of demand increases, as more close substitutes for the product are

being offered. A drop in price from one firm would result in very inelastic demand, as more consumers would substitute away from similar goods to buy the cheaper good. Conversely, when all firms drop their price by the same amount, demand is very elastic because the all of the substitutable goods still cost the same, so consumers have no incentive to buy a different good. (Figure 6.A)

Informal Explanation

When engaging in free trade, the number of consumers available to each firm doubles, while the number of varieties available to each consumer doubles. (Figure 6.B) This doubling in the number of substitutable varieties causes the demand curve of a firm to become even more elastic, to the point which it is no longer tangent to the AC curve (at the LR equilibrium without trade), but above the AC curve. By lowering the price they charged in autarky to the price at which the firm's MC curve intersects with the MR curve, the firm has an opportunity to earn monopoly profits. However, due to the assumption of imperfect competition, all firms have an incentive to lower their price to this point. Therefore, the elasticity will not be as elastic as expected by the firm (since all the firms with substitutable products are simultaneously lowering their prices) and firms will actually end up selling a lower quantity than expected at the post-autarky-seemingly-attractive price point, which results, actually, in them selling at a price below average cost in the short run. ***With the engagement of free trade, firms sell at a lower price in the short run expecting to make monopoly profits, but they actually incur losses.*** These losses bankrupt some firms and cause them to leave the industry, which results in some firms leaving the industry, and thus less product varieties (less firms in each country than pre-autarky, but still more overall than in autarky). Long run equilibrium occurs when the demand drops to a point at which MR=MC and demand is tangent to the AC.

Results of trade:

- Product selection has increased overall, despite the exit of some firms (the final demand curve is more elastic than the initial demand curve)
- Lower free trade price than autarky price
- More quantity being sold in free trade than in autarky
- For firms specifically:
    - Quantity produced per firm increases
    - AC falls due to increasing returns to scale
    - Prices fall
- For consumers specifically:
    - Lower prices
    - More selection (and consumers <3 selection)

Formal Explanation

Utility Function:

$$u = \sum_{i=1}^{N} v(x_i)$$

where, $v'(x_i) > 0$ and $v''(x_i) < 0$

$$v(x_i)\ is\ the\ utility\ a\ consumer\ derives\ from\ variety\ i$$

- The utility a consumer derives is the same for all varieties *i* (there is no preference for a particular variety if all prices are equal)
- The concavity of the sub-utility function shows variety and that products are imperfect substitutes in consumption (product differentiation)

The elasticity of the utility function is

$$\varepsilon_x = \frac{\hat{v}}{\hat{x}} = \frac{v'(x)}{\frac{v(x)}{x}} = \frac{marginal\ utility}{average\ utility} < 1$$

demonstrating that elasticity of the products is less than one, and that they are not perfect substitutes. (Figure 6.C)

Love of Variety:

1. **Rewrite utility function in terms of rate of change/growth rate/proportional changes.**

Utility function becomes $u = Nv(x)$ in symmetric equilibrium, showing that the utility a consumer derives from a certain variety is dependent upon the number of varieties available.

Written in terms of rate of change, it becomes $\hat{u} = \hat{N} + \hat{v}$. With $\varepsilon_x = \frac{\hat{v}}{\hat{x}}$ it becomes $\hat{u} = \hat{N} + \varepsilon_x \hat{x}$.

2. **Show how utility varies with the number of varieties.**

We accept the budget constraint $Npx = I$, which means the number of varieties times the price times the quantity is equal to the budget constraint (where p and I are constant).

Written in terms of rate of change, $-\hat{N} = \hat{x}$.

Substituted into the utility function from step 1,

$$\hat{u} = \hat{N} + \varepsilon_x(-\hat{N}) \rightarrow \boldsymbol{\hat{u} = (1 - \varepsilon_x)\hat{N}}$$

Here we see that utility increases with N, as $\varepsilon_x < 1$. Therefore, consumers prefer diversity/they <3 variety!

Demand and Goods Market Equilibrium:

- Demand function given by $x_i(p)$ with elasticity $\sigma(x_i)$
  - $\sigma'(x_i) < 0$ ….The elasticity of demand decreases as more of a variety is consumed.
- Goods market given by

$$\boldsymbol{y_i = kLx_i} \quad \textbf{(GM)}$$

  - Where y_i is the aggregate supply of good i, k is the national labor supply (which is the same in all countries and also equal to the number of consumers in each country), and L is the number of identical countries.

Supply:

- Labor is the only factor of production and technology is the same across countries.
- With increasing returns to scale, the labor requirement and cost functions are (for variety *i*):
  - Labor requirement: $l_i = f + ay_i$
    - Where a is the additional workers that have to be added per unit
  - Cost function: $C_i = w(f + ay_i)$ ….in other words, the wage rate multiplied by the labor requirement is equal to the cost

Price-Setting:

- Profit Maximization: $total\ revenue - total\ cost$

$$max_{y_i} p(y_i)y_i - w(f + ay_i)$$

- First-order condition: $marginal\ revenue - marginal\ cost$

$$\boldsymbol{\frac{p}{w} = \frac{\sigma(x)}{\sigma(x)-1}a} \quad \textbf{(PM)}$$

Free Entry:

- Zero profits in equilibrium: $total\ revenue = total\ cost$

$$py = w(f + ay)$$

$$\frac{p}{w} = \frac{f}{y} + a \qquad \textbf{(FE)}$$

Labor Market:

$$L = n(f + ay) \text{ with } n = N/k \qquad \textbf{(LM)}$$

Solving for Equilibrium:

1. PM and FE in *p/w – y* space, using GM to substitute *x*
    - With free trade, the number of countries, k, increases, so there is more demand in the goods market. Holding output per firm, y, and Labor, L, constant, consumption per variety, x, must fall in order to maintain goods market equilibrium. This decrease in output causes the profit maximization function to shift downward, resulting in a higher demand elasticity for every y. The new equilibrium results in higher output per firm, y, with a lower price/wage ratio, p/w. Taking the increase in y into consideration with the labor market equilibrium condition, an increase in the number of firms, n, must result.
2. PM and FE in *p/w – x* space, using GM to substitute *y* (Figure 6.D)
    - With free trade, the number of countries, k, increase, so there is more demand in the goods market. Holding consumption per variety, x, and labor, L, constant, output per firm, y must increase in order to maintain goods market equilibrium. This increase in output per firm causes the free entry condition to shift downward, resulting in a new equilibrium with lower consumption per variety and a lower price/wage ratio, p/w. Taking the increase in y into consideration with the labor market equilibrium condition, an increase in the number of firms, n, must result.

The Krugman Model with Constant Elasticity of Substitution (CES)

The CES model adds the feature of constant elasticity of substitution to the Krugman Model, which means that the elasticity of demand is constant and the elasticity of substitution, σ, is greater than one. θ is a measure of substitutability and is closely related to the elasticity of substitution, σ.

$$\theta \equiv \frac{\sigma - 1}{\sigma}$$

The CES utility function differs slightly from the normal Krugman utility function:

$$u = \left(\sum_{i=1}^{N} x_i^{\theta} \right)^{\frac{1}{\theta}}$$

with $0 < \theta < 1$

Modified equilibrium conditions:

$$y = kLx \quad \textbf{(GM)}$$

$$\frac{p}{w} = \frac{\sigma}{\sigma - 1} a \quad \textbf{(PM)}$$

$$\frac{p}{w} = \frac{f}{y} + a \quad \textbf{(FE)}$$

$$L = n(f + ay) \quad \textbf{(LM)}$$

The new profit-maximizing condition demonstrates that p/w is no longer a function of the consumer demand per variety. In other words, with higher consumer demand per variety, the mark-up does not increase in the CES extension, in contrast to the normal model.

Explicit solutions for endogenous variables:

$$y = \frac{(\sigma - 1)f}{a} = output\ per\ firm$$

$$x = \frac{(\sigma - 1)f}{akL} = consumption/demand\ per\ variety$$

$$n = \frac{L}{\sigma f} = number\ of\ firms$$

$$N = \frac{kL}{\sigma f} = number\ of\ varieties\ consumed$$

In the Krugman Model with CES, an increase in the number of countries, k, will cause an increase in the output per firm, which will, in turn, cause the free entry condition to shift downward in the diagram, just as in the regular Krugman Model. (Figure 6.D) However, the decrease in x with CES is much greater than in the normal Krugman Model due to the different profit-maximization condition. In this model, the endogenous variable, y, is unaffected by the change in number of countries, k, and stays constant instead of decreasing in the case of trade. The extreme decrease in x in the CES model is compensated for by the increase in the number of varieties consumed. In other words, with CES, in exchange for consuming many more varieties, consumers consume much less from each variety.

In this model, (1) there is a constant mark-up which does not fluctuate depending on the demand from consumers, (2) firm size/output per firm does not change with international trade, (3) the number of consumed varieties by each individual increases proportionally with the number of countries, (4) and individual consumption of each variety decreases proportionally with the number of countries. ***All gains from trade come from the demand side.***

Extension 1: Krugman and Heckscher-Ohlin Model →

The combination of the Krugman and Heckscher-Ohlin models can be used to explain the coexistence of inter- and intra-industry trade. It assumes the normal assumptions of the Heckscher-Ohlin model, except that one of the goods is produced with increasing returns to scale while the other good is produced with constant returns to scale. Just as in the typical model, one good is labor-intensive and one good is capital-intensive.

With identical relative factor endowments, 100% of trade between the two economies is intra-industry and occurs within the sector that experiences increasing returns to scale. This is because with identical relative factor endowments, there would be absolutely no incentive for trade in the Heckscher-Ohlin Model, so all incentive for trade lies within the Krugman Model, where the basis for trade is solely increasing returns to scale.

With differing relative factor endowments, however, inter- and intra-industry trade can coexist. The Heckscher-Ohlin-based trade will occur in both sectors, while the sector that experiences increasing returns to scale will experience additional trade. (Figure 6.E)

Extension 2: Krugman with Firm-Specific Technology →

The Krugman Model carries empirically implausible assumptions (A) and results (R):

- All firms have identical technology (A)
- All firms export part of their output (R)
- Individuals in both countries consume all varieties (R)

Melitz Model

The Melitz Model is the Krugman CES Model with two key modifications: (1) firms different in their marginal cost [labor productivity], and (2) fixed transport costs [market access].

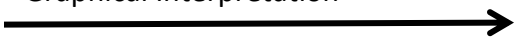
In a closed economy…

With varying marginal costs resulting from different labor productivities, the assumption in the Krugman CES model that all firms charge the same mark-up means that firms with lower marginal costs would charge lower prices. High-productivity firms would, therefore, have higher output and charge lower prices. Because of R&D (a "fixed entry fee to participate in the productivity lottery" or, in other words, "you try to invent something nice"), as well as consumers' love of variety, the market will not automatically be taken over by the cheapest supplier, but medium-productivity firms also have an opportunity to stay in the market. Still, high-productivity firms will make the highest profits and low-productivity firms will make losses → #noproduction.

In an open economy…

Only the countries with a low marginal cost will be able to export due to an assumed export cost. All domestic firms are hurt by import competition (but mostly those that do not additionally export). The lease productive firms (those who aren't benefitting from the export market), are therefore driven out of the market and their market shares are re-allocated to the most productive firms. This results in an increase in the average industry productivity.

Graphical Interpretation



Example: The Krugman Model

Consider a stylized world of k identical countries. Individual demand for each variety i in every country is given by $x_i(p)$ with price elasticity (in absolute value) $\sigma(x_i)$. It is assumed that $\sigma'(x_i) < 0$. There are L individuals per country, each supplying one unit of labor. All varieties are produced with an identical production technology, where labor is the only input. Labor requirement per variety produced is given by $l_i = f + ay_i$, where f and a are parameters and y_i is output of variety i. Trade liberalization is modeled as an increase in the number of countries k from 1 to 2.

a) Set up and explain the goods market equilibrium (GM) condition, the profit maximization (PM) condition, the free entry (FE) condition and the labor market equilibrium (LM) condition.
b) Using the PM condition and the FE condition, illustrate the effect of trade liberalization on the level of individual consumption of one variety and the relative price, $\frac{p}{w}$. Explain your illustration.
c) Having derived the effect of trade liberalization on $\frac{p}{w}$, what can you say about the induced change in output per firm? Use the FE condition to illustrate your answer.
d) Derive the effects of trade liberalization on the number of firms in each economy and on the total number of varieties that are available to consumers, resorting to the LM condition in either case.
e) Assuming that $\sigma(x) \equiv \sigma = 2$, express the endogenous variables of the model as functions of the model parameters. Interpret the equations obtained and derive the effects of trade liberalization.

Reciprocal Dumping

Investigates the motive for two-way trade of identical products (reciprocal dumping) where exporters have an incentive to enter a market that was previously dominated by a monopolist (strategic interaction).

Detailed Explanation →

Reciprocal dumping occurs in the case of segmented markets, where firms treat Home and Foreign as different markets and therefore make different quantity decisions for each. Although pure waste exists in the form of transport costs, the pro-competitive effect of having more firms and a larger overall market with lower prices than in a monopoly market dominates, and reciprocal dumping is, thus, overall welfare-improving in this second-best imperfectly competitive world.

Simple Explanation:

Firms treat Home and Foreign as two separate markets. While the domestic demand curve is downward sloping, the Foreign demand curve (for exports from the domestic country) is horizontal (incredibly elastic, as the firm faces more competition in entering the other market), and the outside firm cannot charge more for the product in the other market as that market's domestic firm would charge. The export demand curve is, thus, the export price, meaning that as the firm sells more units, neither the price nor the extra revenue will deflate, making the demand curve also equal to the MR curve. (Figure 7.A)

The total amount of units the firm will produce is found at the intersection of the outside demand curve and the marginal cost curve. This will also be the price charged in the outside market for the good (this price is lower than the average cost). The amount of that good that will be sold in the domestic market is found at the intersection of the outside demand (MR) curve and the domestic marginal revenue curve. The price charged for this good is determined by the domestic demand curve (as a monopoly would price) and is higher than the average cost.

It seems illogical that the firm would export to a market at a price that is below their average cost, but it is actually profitable in the end. Since goods are sold at a price that exceeds the marginal cost of their production (and is also less than the price charged for the good in the export market), each unit exported will increase profits by the difference between the price and the marginal costs. This increase in profit is what makes dumping attractive for firms.

In the case of *reciprocal dumping*, we see that the foreign firm is incentivized to export to the home market as long as the marginal revenue they would receive in the home market exceeds their marginal cost of production plus the transport costs for exporting the good. Equilibrium for reciprocal dumping is determined using the demand curve, w here price is equal to some equation minus a specific quantity. The quantity is defined by the quantity produced for home plus the quantity produced for foreign. The quantity produced for home is determined by the price minus the MC, where quantity produced for foreign is determined by the price minus the MC plus transport costs.

Formal Explanation:

Each country makes quantity decision for the two separate markets (countries) with a Cournot perception. That is, it assumes the other firm will hold output fixed in each country. With the domestic firm producing good x in the Home country and good x* for the foreign country and iceberg transport costs (c/g where 0<g<1), its profit-maximizing condition is:

$$\pi = xp(Z) + x^*p^*(Z^*) - c\left(x + \frac{x^*}{g}\right) - F$$

The foreign firm, in contrast, has output y* of good Z* in Foreign and y of good Z in Home. It faces the same type of marginal cost for export (iceberg transport costs).

$$\pi^* = yp(Z) + y^*p^*(Z^*) - c\left(y^* + \frac{y}{g}\right) - F^*$$

The profit-maximizing condition of each firm is only dependent on one of the quantity decisions (segmented markets allows firms to maximize profits in each market with different quantities). We consider only the Home country. The profit-maximizing conditions follow.

$$\pi_x = xp' + p - c = 0$$

$$\pi_y^* = yp' + p - \frac{c}{g} = 0$$

When price elasticity of demand and foreign's share in the home market are rewritten as follows,

$$\varepsilon \equiv -\frac{p}{Zp'}$$

Price Elasticity of Demand

$$\sigma \equiv \frac{y}{Z}$$

Market Share of Importing Firm (which is F in this case)

….the profit-maximizing conditions are rewritten as….

$$p = \frac{c\varepsilon}{\varepsilon+\sigma-1} \quad \rightarrow \quad p = \frac{c\varepsilon(1+g)}{g(2\varepsilon-1)}$$ Price in Home Market

$$p = \frac{c\varepsilon}{g(\varepsilon-\sigma)} \quad \rightarrow \quad \sigma = \frac{\varepsilon(g-1)+1}{1+g}$$ Market Share of Foreign Firm

If price exceeds the marginal cost of exports ($p > c/g$) and ($\sigma > 0$), then $\varepsilon < \frac{1}{1-g}$, which means that the above equations result in positive solutions showing that two-way trade occurs. The above equations are only in equilibrium if the second-order conditions are <0:

$$\pi_{xx} = xp'' + 2p' < 0$$

$$\pi^*_{yy} = yp'' + 2p' < 0$$

Additionally, domestic marginal revenue must decline when the non-domestic firm increases output. This has the effect that the production functions are downward-sloping. At equilibrium, each firm has a smaller market share of its export market than of its domestic market. Therefore, perceived marginal revenue is higher in the export market. The effective marginal cost of delivering an exported unit is higher than for a unit of domestic sales, because of transport costs, but this is consistent with the higher marginal revenue. Thus, perceived marginal revenue can equal marginal cost in both markets at positive output levels.

The Case of Constant Elasticity of Demand:

In the case of constant elasticity of demand, if the domestic monopoly price is higher than the marginal cost plus transport costs of the foreign firm, dumping will occur. An increase in the marginal cost of trade leads to an increase in price and, thus, a lower share of foreign in the domestic market. This can be shown graphically on a p-σ axis, where the profit-maximization

conditions in terms of p are graphed, and the intersection of the domestic monopoly price on the vertical axis ($\frac{c\varepsilon}{\varepsilon-1}$) is higher than the transport costs ($\frac{c}{g}$). (Figure 7.B)

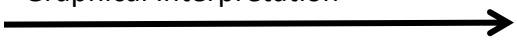
$$p = AZ^{\frac{-1}{\varepsilon}} \qquad \varepsilon > 1$$

Welfare Effects:

(Figure 7.C)

Trade is, on one hand, wasteful, that identical products are being shipped back and forth between countries and costs exist to transport the goods. On the other hand, trade is welfare-increasing, in that it creates competition within a monopoly market (→ duopoly), which decreases prices and increases consumption. The overall welfare effect is, however, ambiguous, and depends on the actual cost of transport costs. If transport costs are very high, but not prohibitive, welfare decreases. If transport costs are prohibitively high, welfare is constant. Low transport costs lead to an increase in welfare.

Graphical Interpretation



Example: Reciprocal Dumping

Consider a stylized world with two symmetric countries, Home and Foreign (*). In each country, a single firm produces a homogeneous good. Let $x\ and\ x^*$ $(y\ and\ y^*)$ denote the quantities sold by the home (foreign) firm in the market of Home and Foreign, respectively. The consumed quantities of the good in each country, consisting of the amounts sold by both firms, are denoted z and z^*, respectively. The inverse demand functions that the two firms face are given by:

$$p = 60 - \frac{1}{3}z\ and\ p^* = 60 - \frac{1}{3}z^*$$

Marginal costs amount to c = 20 per unit of the good. If a firm in one country exports its good to the other country, this entails transport costs of the "iceberg type" with τ= 1.5. Once some units of the good have been sold to either market, these units cannot be resold again internationally.

a) Consider both countries in the autarky situation. Explain the optimization problem of the two firms and determine the equilibrium prices and quantities.

$$p = 60 - \frac{1}{3}z$$
$$MR = 60 - \frac{2}{3}z$$
$$MC = 20$$

$$20 = 60 - \frac{2}{3}z$$
$$z = 60 = z^*$$

$$p = 60 - \frac{1}{3}(60)$$
$$p = 40 = p^*$$

In autarky, both firms act as monopoly firms in their Home markets. They optimize profits by producing at the point where marginal revenue equals marginal cost, but charging the price where that quantity intersects with the market demand curve. In both Home and Foreign, the monopoly equilibrium quantity will be 60 and the monopoly price will be 40. They are the same due to symmetry.

b) Now assume that the two economies open up to international trade. Set up the optimization problems of the two firms and explain their behavior in this new situation. Determine the quantities that the firms will choose for the market in Home as functions of the other firm's output for the market in Home and illustrate the reaction functions in a diagram.

Profit Maximization Problems:

$$max\pi_{x,x^*} = (p(z) - c)x + (p^*(z^*) - c\tau)x^* - F$$
$$max\pi^*_{y,y^*} = (p(z) - c\tau)y + (p^*(z^*) - c)y^* - F^*$$

FOCs for Home Market:

$$\frac{\partial \pi}{\partial x} = p'(z)x + p(z) - c = 0$$
$$= -\frac{1}{3}x + 60 - \frac{1}{3}(x + y) - 20 = 0$$
$$y = 120 - 2x \rightarrow$$ *Home's reaction function in the Home market*

$$\frac{\partial \pi^*}{\partial y} = p'(z)y + p(z) - c\tau = 0$$
$$= -\frac{1}{3}y + 60 - \frac{1}{3}(x + y) - 30 = 0$$
$$y = 45 - \frac{1}{2}x \rightarrow$$ *Foreign's reaction function in the Home market*

c) Using your results from b), calculate the price as well as the quantities sold by either _rm in the market of Home in the trade equilibrium.

The two reaction functions from Part B can be used to calculate the equilibrium quantity sold by either firm in Home in the trade equilibrium.

$$120 - 2x = 45 - \frac{1}{2}x$$
$$x^t = 50$$
$$y^t = 20$$
$$p^t = 36.\overline{66}$$

d) Is reciprocal dumping occurring in the international trade equilibrium characterized in b) and c)? Explain your answer.

Yes, reciprocal dumping is occurring because (1) transport costs exist, and each firm's MC of serving its export market exceed the MC of serving its domestic market, and (2) prices are equalized across countries, so each firm charges a lower mark-up in its export market than in the domestic market.

The Gravity Equation

The gravity equation tells us about the total amount of trade that takes place between two countries. The amount of trade is influenced by the size of the countries and the distance between the countries.

Detailed Explanation →

In 1962 Tinbergen proposed the following trade/gravity equation:

$$Trade = B \times \frac{GDP_1 \times GDP_2}{dist^n}$$

Where "trade" is the total exports and import in units, "B" stands for all other effects that might influence trade between countries, and trade is dependent on the size (GDP) of the two countries in relation to the distance between the countries. Larger countries are more likely to import because their demand is higher (Ricardian Model), and they're more likely to export because they produce more varieties (IIT).

Formal Derivation of the Simple Gravity Equation (w/o trade costs):

In the formal derivation of the simple gravity equation, we assume (1) countries are specialized in different products, (2) consumption is proportionally sealed to income (homothetic utility function), and (3) free trade and no transport costs lead to identical prices across countries.

With balanced trade, country j's share of world expenditure is equal to its share of world GDP:

$$s^j = \frac{Y^j}{Y^w}$$

And with identical homothetic preferences, exports of good k from country i to country j are given by:

$$X_k^{ij} = s^j y_k^i$$

The summation over all products k shows us that the total exports from i to j are equal to the total exports from j to i.

$$X^{ij} = \sum_k X_k^{ij} = s^j \sum_k y_k^i = s^j Y^i = s^j s^i Y^w = X^{ji}$$

(exports from country I to country j = the summation of all goods k being exported from country I to country j = country j's expenditure multiplied by the summation of country i's income for good k = expenditure of country j multiplied by the GDP of country I = country j's expenditure times country i's expenditure times world GDP = exports from country j to country i)

Bilateral trade between countries i and j:

$$\boldsymbol{X^{ij} + X^{ji} = 2s^i s^j = \left(\frac{2}{Y^w}\right) Y^i Y^j}$$

Bilateral trade between countries i and j is proportional to the product of their GDPs, but distance is not accounted for in this equation.

Border Effects in the Gravity Model:

Border effects are additional barriers to trade and can take the form of tariffs, quotas, administrative rules and regulations (time to pass customs), geographic factors, and cultural factors (language). These are all included in the constant *B*.

When adding border effects into the equation, all goods are equally substitutable (CES utility function), so country i consumes equal amounts of all products (N) imported from j and vice versa. The price of a certain good, k, in the destination market is dependent on the marginal costs of production plus the marginal cost of transportation.

Demand for each product c_k^{ij} is given by:

$$c^{ij} = \left(\frac{p^{ij}}{P^j}\right)^{-\sigma} \left(\frac{Y^j}{P^j}\right)$$

Where P^j is the price index of all goods consumed in country j

Total export value for all goods exported from i to j:

$$X^{ij} = N^i p^{ij} c^{ij} = N^i Y^j \left(\frac{p^{ij}}{P^j}\right)^{1-\sigma}$$

Plus transport costs (substitute price of good exported from i to j with transport cost i to j multiplied by price in i):

$$X^{ij} = N^i Y^j \left(\frac{T^{ij} p^i}{P^j}\right)^{1-\sigma}$$

The gravity equation isn't yet complete because the GDP of country i is not accounted for. To bring this factor into the equation, we solve for the number of products in country i according to the free entry condition. With a single factor of production and constant elasticity of substitution (where the number of firms stays fixed, but the number of firms grows) the number of products in country i is equal to a certain proportion of country i's GDP : $N^i = \alpha Y^i$

$$X^{ij} = \alpha Y^i Y^j \left(\frac{T^{ij} p^i}{P^j} \right)^{1-\sigma}$$

Recent developments by Anderson and van Wincoop (2003) introduce trade barriers to the equation which represent multilateral resistance. ***This shows that bilateral trade depends on the easiness to trade with all potential partners. There is higher bilateral trade if average trade costs for importer or exporter are higher.***

Trade Policy under Perfect Competition

A tariff is a tax on an imported good. In a small country, tariffs are unambiguously welfare-decreasing. In large countries, a tariff has the capacity to change world prices and the welfare effects are ambiguous. Import quotas in small countries effect welfare the same way as tariffs, except that there is no tariff revenue (unless rent revenue is collected).

Detailed Explanation

A tariff imposed in a small country could be intended to increase production for local firms. The price and consumption distortion a tariff in a small country, however, unambiguously reduces welfare. The cost of the tariff causes less foreign firms to import, decreasing overall supply and increasing the proportion of domestic supply. The overall increase in domestic supply is a loss to both consumers and foreign firms. Domestic producers gain slightly from the tariff, but economy-wide losses outweigh these gains. This can be shown using domestic supply and demand curves, where we can see who specifically gains and loses from a tariff (Figure 9.A), or by using the import demand curve where we just observe the total gains and losses (Figure 9.B).

An import tariff for a large country has the potential to affect world prices. When a tariff is imposed, the price, naturally, increases, and the demand, therefore, decreases. The import demand of a large country will then shift to the left, resulting in higher domestic prices and lower world prices (Figure 9.C). The welfare effect is ambiguous. (Figure 9.D)

The Optimum Tariff:

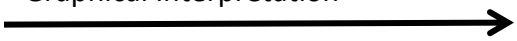
(Figure 9.E)

To derive the optimum tariff, which exists somewhere between free trade and autarky, we use the MCM (marginal cost of imports) curve. The MCM curve *has twice the slope* as the import demand curve The optimum tariff exists at the point which true revenue of the tariff minus the losses to the domestic economy is equal to the benefit of not importing another good (what is "not lost" or "gained" by using the tariff rather than free trade). This is the price where MCM intersects ID minus the price at which that quantity intersects the export supply (ES) curve.

Import Quotas for a Small Country:

Import quotas directly limit the quantity of a good that may be imported. The welfare effects are exactly the same as an (equally effective) tariff, except there is no tariff revenue (unless the license rights are auctioned – in which case the willingness to pay for the rights would be equal to the value of what the tariff would be in order to effect welfare in the same capacity of the quota that was imposed. Revenue would then be rent revenue).

Graphical Interpretation



Example: Import Tariff for a Large Country

Consider a large economy (Home) that imports cars from Foreign. The market for cars is perfectly competitive and is characterized by the following inverse import demand and export supply functions:

$$p = 130 - m$$

$$p = 10 + \frac{1}{2}m$$

(1) Graphically illustrate the equilibrium world price for cars (p^f) and the equilibrium import quantity (m^f) under free trade.

$$130 - m = 10 + \frac{1}{2}m$$
$$\frac{240}{3} = m$$
$$m = 80$$

(2) Assume that Home introduces a tariff t = 15 on car imports. Analytically determine the new world price for cars that will establish (p_t^w), the price that consumers in Home must pay (p_t), as well as the new level of car imports (m_t).

$$t = 15$$
$$p_t^w + t = 115 - m = 10 + \frac{1}{2}m$$
$$m_t = 70$$
$$p_t^w = 45$$
$$p_t = 60$$

(3) Using your diagram from a), explain which tariff Home would optimally choose on car imports. Analytically derive the optimal tariff (t^*), the new world price for cars (p_{t*}^w), the price that consumers in Home will face (p_{t*}), as well as the level of imports (m_{t*}) that consumers in Home will demand at this price. Compare your results to those from b).

$MCM = 10 + m$
$10 + m = 130 - m$

$m = 60$
$p = 10 + 60 = 70$

$p = 10 + \frac{1}{2}(60) = 40$ $\qquad 70 - 40 = 30$

Home's optimal tariff is the price difference between where the MCM curve intersects the ID curve and where the ES intersects the quantity derived from the intersection of the MCM and ID curves.

$t^* = 30$
$p_{t*} = 70$
$p_{t*}^w = 40$
$m_{t*} = 60$

(4) Using your diagram from a), identify and explain the welfare and distribution effects that Home's optimal tariff has for both economies, as well as for the world as a whole.

The gains compared to having no tariff amount to:

- *Gains to domestic economy = 400*
- *Tariff revenue*
- *Loss to entire world = 300*
- *Loss to the foreign economy = 100*

Trade Policy under Imperfect Competition

Under imperfect competition, a tariff in a small country has the same effect as it would in perfect competition, unless the magnitude of the tariff exceeds the monopoly price in autarky. A quota in a small country in imperfect competition leads to a greater welfare loss than a tariff due to the ability for the monopoly to continue exercising market power.

Detailed Explanation →

Tariff in a small country:

A monopolist in a small country under autarky will set MR equal to MC to determine quantity and charge the corresponding price on the market demand curve. In free trade, the small economy takes on the world price and can, therefore, not charge a higher price in the home economy, otherwise the goods will not sell. The market demand curve then becomes the horizontal world price, and quantity demanded is determined at the point where this price intersects with the old monopoly demand curve. The home firm will produce at the point where the world price/MR/export demand equals MC. The remaining quantity demanded will be imported. (Figure 10.A) Under free trade, then, a monopolist's market power is eliminated by the power of trade and it ends up producing the same quantity and charging the same price as in perfect competition.

With the introduction of a tariff in a small country which already engages in free trade, the world price will increase to the world price plus the value of the tariff, causing the export demand curve to shift upward. Home will then produce the good at a higher quantity than it did before the tariff, but a lesser quantity all in all will be demanded from the market. Imports will decrease. (Figure 10.B) This is the same outcome as takes place in perfect competition. The only case in which a tariff in a small country would have a different effect than in perfect competition is if the tariff causes the world price to rise above the price that the monopolist firm would charge in autarky. This has the effect that the demand and supply in the market would be lower than in autarky, and there would be no imports. The monopolist will charge the maximum possible price, as long as it is greater than or equal to the new world price caused by the tariff.

Quota in a small country:

A quota in a small economy under imperfect competition will have a different effect than a tariff, in that the monopolist is still allowed to exercise its monopoly power after the maximum amount of imports are imported at the import price.

With a quota, the demand curve for the economy shifts to the left by the amount of the quota. The economy will import at the world price up to the amount of the quota. The home monopoly will then produce at the profit-maximizing equilibrium and charge monopoly prices. (Figure 10.C) The welfare losses in a small country are always greater in the case of a quota as compared to a tariff. This is because the monopoly is still able to exercise its monopoly power with a tariff AND consumers consume less of the good because of the tariff.

Rent extraction from a foreign monopolist:

Here we assume that the importing monopolist has no domestic competition. It faces linear demand, which is equal to import demand, and constant marginal cost. The importing firm sets price according to monopoly conditions. With the introduction of a tariff, the increase in the marginal cost will be greater than the increase in the price charged in the home market. (Figure 10.D) The welfare effect is dependent upon the size of the TOT gain in relation to the deadweight loss resulting from the lower quantity consumed and price increase from the tariff.

Graphical Interpretation