

**Economics 4413
International Trade
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Problem Set #2

Keep in mind that problem sets will not be graded. I will circulate answers to problem sets in advance of the examinations.

Ricardian Model

There are no more important concepts in international trade than those of comparative advantage and the gains from trade (GFT). Because these are so fundamental, I want you to work through several of these kinds of problems. The first 3 questions below are examples. In the first case I provide answers as the question unfolds. In the other cases no answers are provided (for now). PLEASE TAKE THESE QUESTIONS SERIOUSLY. THERE WILL BE ONE LIKE IT ON THE NEXT EXAM. YOU MIGHT ALSO FIND IT USEFUL TO MAKE UP YOUR OWN EXAMPLES; DOING SO REALLY HELPS GET THESE IDEAS DOWN.

1. Suppose that the following technologies exist for the production of X and Y in countries H and F.

Output per unit of Labor:

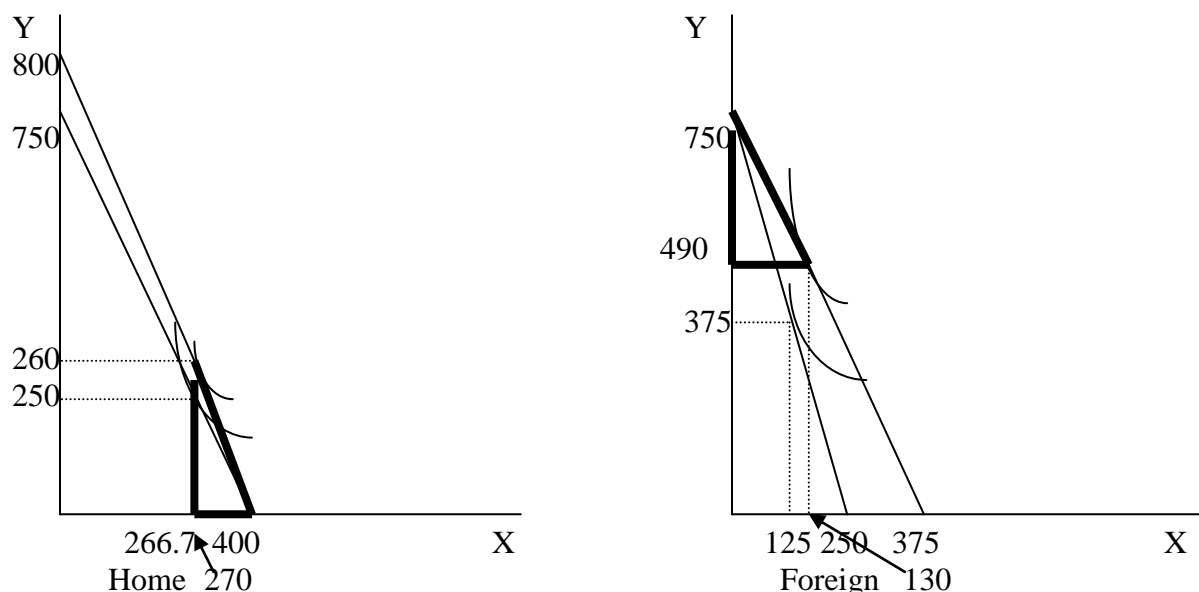
	X	Y
H	8	15
F	10	30

- A. Determine absolute advantage and comparative advantage in each good. Also determine the relative price ratios (price of X over price of Y) in autarky.

Answers: Because labor is more productive in both X and Y in F, F has the absolute advantage in both goods. However, F is only 5/4 times as productive in X but 2 times as productive in Y. So F has a comparative advantage in Y and H has a comparative advantage in X. $p^F = 30/10 = 3.0$. $p^H = 15/8 = 1.875$. Note in both cases that the price of X is higher than the price of Y because each worker can produce fewer X's or more Y's for her unit of time. Note also that the limits to the terms of trade are $15/8 \leq p^ \leq 3.0$*

- B. Suppose the home country has a labor endowment of 50 workers and foreign has a labor endowment of 25 workers. Draw the PPFs. Suppose that H allocates 2/3 of its workforce to X and 1/3 to Y in autarky, while F allocates 1/2 of its workforce to Y and 1/2 to X in autarky. Show the autarky equilibrium points.

Answers: Home's PPF extends from 400 X to 750 Y and has a slope (absolute value) of 1.875. Foreign's PPF extends from 250 X to 750 Y and has a slope of 3.0. In autarky, Home produces and consumes 266.7 X and 250 Y. Foreign produces and consumes 125 X and 375 Y. Note that the PPF's are straight lines by virtue of the assumption that marginal products of labor are constant. (THIS IS NOT THE CASE IN THE HECKSCHER-OHLIN MODEL WITH TWO FACTORS OF PRODUCTION AND DIMINISHING MARGINAL PRODUCTS OF LABOR AND CAPITAL. IN THAT CASE WE GET A CONCAVE PPF EVEN THOUGH THERE ARE CONSTANT RETURNS TO SCALE IN BOTH GOODS.)



- C. Suppose the international price ratio in free trade between H and F is $p^* = 2.0$ and that 130 X are exported. Determine which country exports X, how many Y are exported (and by which country) and draw the new equilibrium points in free trade. Calculate gains from trade.

Answers: $p^* = 2.0$ means that each X is worth 2 Y in international trade. Because 2.0 lies strictly between the H and F autarky price ratios, both H and F will completely specialize. We know H has a comparative advantage in X so it will produce 400 X and could trade these for up to 800 Y. So H's trade possibility frontier (TPF) is the straight line from 400 to 800. F has a comparative advantage in Y and will produce 750 Y. It could trade these for up to 375 X (because each Y is worth 1/2 X); I have also drawn its TPF. If H exports 130 X it gets back 260 Y (and F exports 260 Y and imports 130 X). Trade equilibrium points are shown, with the "trade triangles" in bold lines. You can see that H produces 400 X and 0 Y, it exports 130 X and imports 260 Y, making its consumption 270 X and 260 Y. F produces 750 Y and 0 X, it exports 260 Y and imports 130 X, making its consumption 130 X and 490 Y.

Gains from trade (GFT) are calculated in terms of higher consumption in free trade than in autarky. H gains 2.3 X and 10 Y. F gains 5X and 115 Y. As you SHOULD KNOW, the reason F gets the larger share of the GFT is that the change in its price ratio from autarky to free trade is relatively larger than is the change in price ratios for H. That is, H price went from

1.875 to 2.0, an improvement in its terms of trade of 6.67%. The F price went from 3.0 to 2.0, a reduction in the relative price of the good it imports (X) of 33%.

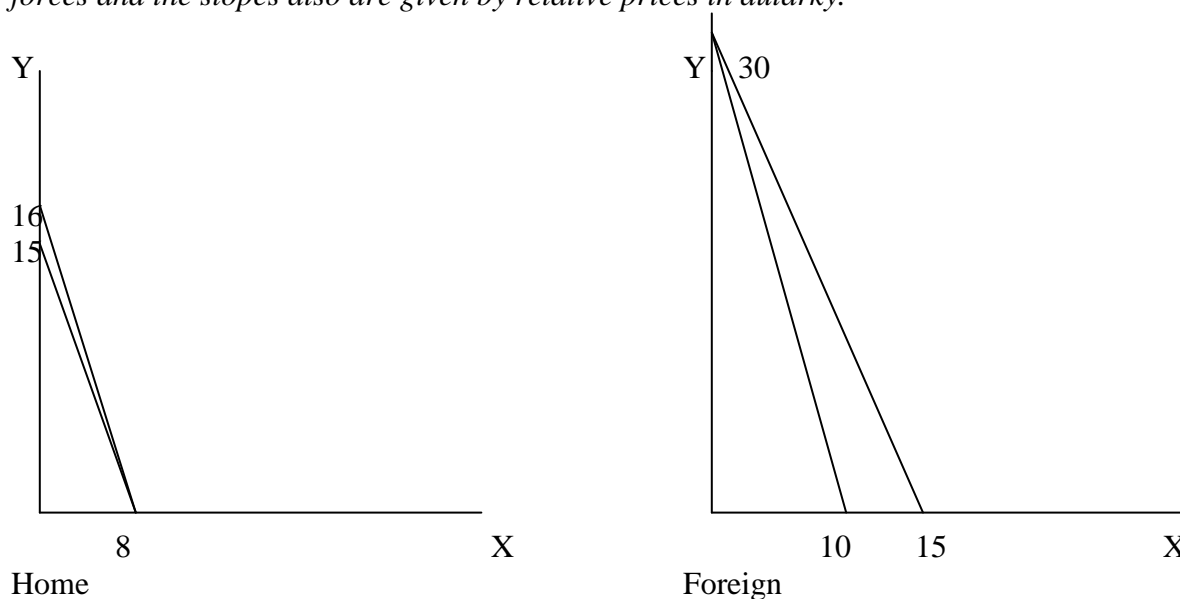
- D. Compute the real wages for each country and draw a budget constraint for an individual worker in each country. Compute real wages for each country in free trade and draw budget constraints for an individual worker in each country.

Answers: In perfectly competitive labor markets (which we assume exist here), real wages are equal to the marginal products of labor for any good that is actually produced. In autarky both goods are produced in both H and F, so their real wages are given by MPLs. But these are just the "output per labor" figures in the beginning of the problem, which are held constant in the Ricardian model by assumption. So we have:

*Real wages in autarky: Home: 8 X, 15 Y
 Foreign: 10 X, 30 Y*

Pretty easy, yes? But if you want to compute these by knowing that real wages are wages divided by prices, here it is. In H in autarky, $p_x = w^h / \alpha^h = w^h / 8$ (because one worker costs w^h but generates 8 units of X, so the average cost = marginal cost is $w^h / 8$; but price equals marginal cost in a perfectly competitive economy). Therefore, $w^h / p_x = 8$. Same theory for other real wages in H and F. PLEASE UNDERSTAND WHAT A REAL WAGE IS -- IT INDICATES HOW MANY UNITS OF X OR Y A UNIT OF LABOR CAN BUY WITH THE WAGE IT EARNS.

This means in turn that the budget constraint for an individual worker has endpoints that are real wages (how many units of X and Y it can buy at most with its wage income). These are drawn for H and F below. Note that the endpoints are just the PPFs above divided by labor forces and the slopes also are given by relative prices in autarky.



Now in free trade, each worker in H specializes in X, producing 8 X. She could export these for up to 16 Y at $p^ = 2.0$. So her budget constraint goes from (8X, 0Y) to (0X, 16Y). Each worker*

in F specializes in Y, producing 30 Y. She could export these for up to 15 X at $p^* = 2.0$. Her budget constraint goes from (0X, 30Y) down to (15X, 0Y). As it happens, these endpoints also are real wages for workers in both countries in free trade. You can see that workers in F gain more than do workers in H because there is a relatively larger price gain for F than for H. To see that these are real wages in free trade, consider the following.

H produces X in free trade, so its real wage in X remains its MPL, which is 8X (real wage remains constant in the export good in the Ricardian model). H imports Y and we can see that

$(w^{h*}/p_y^* = p_x^* \alpha^h / p_y^* = p^* \alpha^h = (2.0)8 = 16$. Similarly, F's real wage in good Y remains 30 but its real wage in good X is $30/(2.0) = 15$.

Note finally that real wages in free trade are higher in F than in H. This arises because the productivity of labor in both goods is higher in F than in H. In fact, the limits to the relative wage ratio w^{f*}/w^{h*} are given by the amounts by which F is more productive than H:

$$\text{Min } w^{f*}/w^{h*} = 10/8 = 5/4$$

$$\text{Max } w^{f*}/w^{h*} = 30/15 = 2$$

FINALLY, THERE IS AN INCENTIVE HERE FOR LABOR TO MIGRATE FROM H TO F BECAUSE REAL WAGES ARE HIGHER IN F.

2. a. Suppose that output per labor in good X and good Y in countries A and B are:

Country	X	Y
A	4	4
B	3	9

- Explain which country has the absolute advantage in X and Y and which country has the comparative advantage X and which country has it in Y.
- Define the price ratio as $p = p_x/p_y$, or the relative price of X. What are the limits to the international price ratio, and why?
- Suppose country A has 200 units of labor available and country B has 150 units of labor. Draw the PPFs for A and B. Assuming each country splits its labor force in half between X and Y in autarky, show the autarky equilibrium points.
- Suppose the free-trade price ratio settles at $p^* = 3/2$ and assume that 333.33 X are exported in return for 500 Y. Draw the associated trade possibility frontiers and show the trade equilibrium points. Calculate the gains from trade for both countries. Which country seems to achieve the larger gains from trade and why? What would you expect if country A had been much smaller, say with only 20 laborers?
- Calculate real wages in H and F in autarky and in free trade. Also calculate the limits to the international wage ratio w^{f*}/w^{h*} . Suppose that the nominal wage rate in country A is \$20 per hour and in B it is \$10 per hour. If these wages are flexible, what must happen to them in free trade?

3. a. Assume the following technologies exist for production of X and Y in the home country: $X = 25L$, $Y = 40L$; and in the foreign country: $X = 50L$, $Y = 50L$. Identify which country has an absolute advantage in X, which has an absolute advantage in Y, and which has a comparative advantage in X and which in Y. What are the limits to the equilibrium relative price ratio (defined as p_x/p_y) when trade takes place?
- b. Suppose the home country has an endowment of 100 labor units and the foreign country has an endowment of 60 labor units. Draw the PPFs. Suppose that home allocates 1/4 of its labor force to X and 3/4 to Y in autarky, while foreign allocates 3/4 to X and 1/4 to Y. Draw autarky equilibrium points and the resulting excess demand curves.
- c. Let the free-trade price ratio be $p^* = (p_x/p_y)^* = 1.2$. Show the trade equilibrium using both PPFs and excess demand curves. If foreign exports 700 X, how many Y does it get in return? Show this equilibrium and compute gains from trade. Which country gained more, and why?
- d. Calculate the real wages of labor in autarky and free trade in both nations. Why does one country have higher real wages than the other in free trade?
- e. Find the limits to the international wage ratio $(w_F/w_H)^*$. Why do these limits exist? What would happen to nominal wages in F and H if this ratio were too high to be sustainable?
4. Graphically analyze a Ricardian model in which two countries of approximately equal size have different relative labor productivities. Beginning in free trade, suppose the foreign country experiences economic growth. Show the gains or costs of this growth in both countries where the growth is caused first by an increase in the productivity of labor in the export sector and then, alternatively, by growth in the labor force.
5. Two countries can gain from trade even if one country has an absolute advantage in the production of all goods. True/false, explain.

Heckscher-Ohlin Model

6. State and prove the Heckscher-Ohlin theorem with two goods, two factors, and two countries. Be clear on assumptions you make and indicate why these assumptions are important for your proof.
- *7. (Here's another interesting puzzle.) Suppose a country has an endowment of 30 K and 20 L. If under current factor prices faced by both of two industries, X and Y, the K/L ratio in X is 1 and in Y is 2, how much K and L are employed in X and Y, respectively? (Hints: you can try this graphically with a very careful ruler, or you can use the following relationships: $K = K_x + K_y$; $L = L_x + L_y$ and divide K by L to show $K/L = k_x(L_x/L) + k_y(L_y/L)$. *Note that this means the overall endowment ratio is a weighted average of the sectoral capital-labor ratios, with the weights given by labor usages in X and Y -- a key relationship in the economy.*)
8. Which of these things are held constant by assumption in the Rybczynski Theorem? K/L ratios in an industry; K/L endowments for a country; Factor prices; Commodity prices; Industry outputs.

9. Construct one careful example to show how one individual can lose from trade even if the country as a whole gains from trade relative to autarky (use someone's budget constraint for this purpose). How does this help us understand controversies over trade liberalization?
10. State and prove the factor-price equalization theorem. What is its implication for the wage of unskilled labor in the US following trade liberalization?
11. Suppose that there are three goods (software, shirts, wheat) and three factors (skilled labor, unskilled labor, land). Software is intensive in skilled labor, shirts are intensive in unskilled labor, and wheat is intensive in land. The US is land-abundant and skilled-labor-abundant relative to the rest of the world. Discuss intuitively the effects of moving from autarky to free trade on
- (1) The outputs of the three goods in the US;
 - (2) The distribution of income in the US;
 - (3) The incentives to get a university education;
 - (4) The degree of disparity in the income distribution (the ratio of the incomes of the high income workers to the incomes of the low income workers).
12. In the neoclassical trade model based on identical technologies and different factor endowments, capital accumulation in any country engaged in free trade has no effect on its relative factor prices. True, false or uncertain, and explain.

Specific Factors Model

13. Suppose there are two goods (X and Y) and three factors (R, S, and L, where R is the specific factor in good X and S is the specific factor in good Y). Consider a country that imports good X. Analyze which factors gain real income and which lose, in both nominal and real terms, from the imposition of a tariff on X (hint: this will raise the domestic price of X). Contrast the short-run results with the long-run results (Stolper-Samuelson theory).
14. Draw a graph like Figure 9.3 and suppose the price of good 2 falls (you can think of good 2 as Y and good 1 as X if that helps). Show the changes that result to the allocation of labor and the equilibrium wage.
15. Consider a model with 2 goods, X (labor-intensive) and Y (capital-intensive) where the intensity rankings refer to a long-run equilibrium. In the short run, there are 3 factors (mobile labor and sector-specific capital types). Suppose a small open economy facing fixed international goods prices is relatively capital abundant. Analyze the short-run and long-run impacts of the following separate changes on domestic outputs, factor prices and income distribution:
- a. an export tax on Y (hint: this tax will drive down the domestic price of Y);
 - b. an increase in the labor endowment;
 - c. a decline in the Y-sector capital stock.