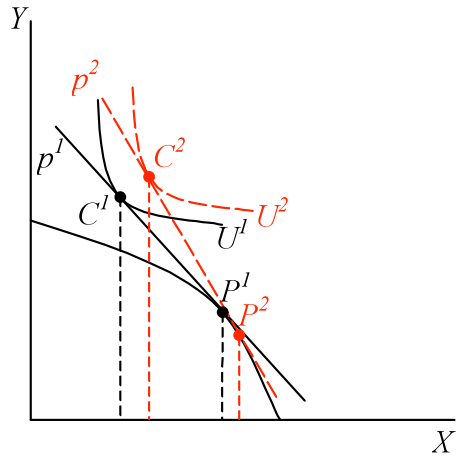
Problem Set 2 - *Answers*

Gains from Trade and the Ricardian Model

1. Use community indifference curves as your indicator of national welfare in order to evaluate the following claim: "An improvement in the terms of trade increases welfare only if the country increases its quantity of exports in response. If a country is unwilling or unable to increase exports when their price rises, then the price increase does it no good."
   This is false, which we can illustrate as follows:

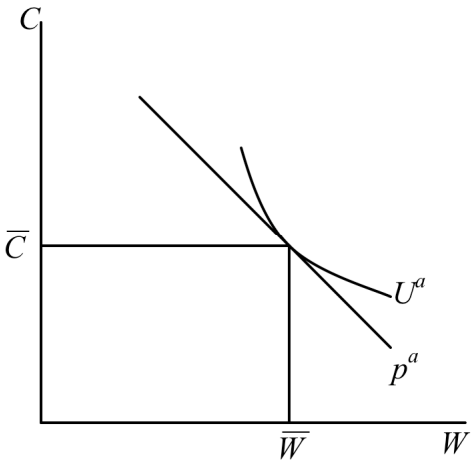


In the figure, the relative price of X rises from p^1 to p^2, causing production to move to the right, from P^1 to P^2. With the indifference curves shown, consumption also moves to the right, from C^1 to C^2, although this is not a necessary result. Indeed, as drawn, the consumption of good X rises by more than the production of X, so that exports of X fall. Nonetheless, the country moves to a higher indifference curve, indicating an improvement in welfare.

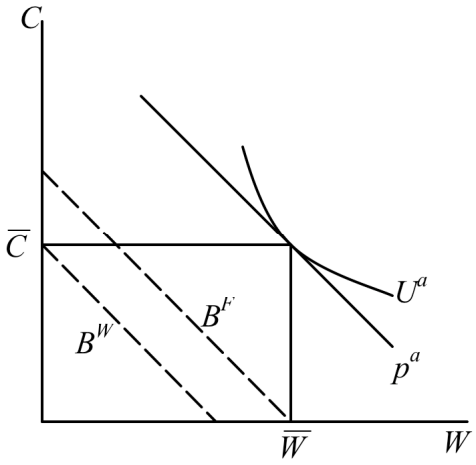
The reason this is possible without an increase in exports is that, when the price of the exported good rises, the country can buy and enjoy a larger quantity of imports in exchange for its exports, even if it keeps the quantity of exports fixed or even reduces that quantity somewhat.

(Here's a question for you: Is it possible for the quantity of <u>imports</u> to fall in response to such an improvement of the terms of trade? And if so, does welfare still increase? I'll leave that for you to ponder on your own.)

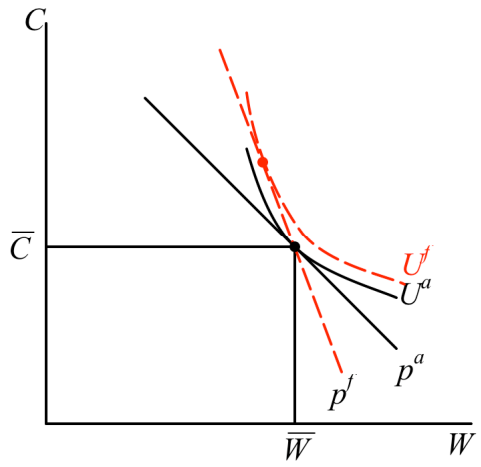
2. Consider an economy that does not produce goods, but is simply endowed with certain amounts of them, and in which the population consists of two groups: farmers who own only wheat and weavers who own only cloth. (Never mind that these people don't actually farm and weave – the names are just for convenience.) There are equal numbers of people in both groups, and they all share identical homothetic preferences for consuming wheat and cloth.
   a. Draw the production possibility frontier for this economy, and illustrate the autarky equilibrium.
   It is not really production, of course, but the maximum quantities of the two goods available to the country, $\overline{W}$ and $\overline{C}$, are now fixed. Since the country can consume these amounts or less, the PPF may be thought of as a rectangle with corner at $\overline{W},\overline{C}$. The autarky equilibrium is then at that corner, and the autarky prices appear as the price line tangent to a community indifference curve at that point:



   b. Is it possible to say who is better off in autarky, the farmers or the weavers? On what does that depend?
   It is not possible to say who is better off in general, since it depends on the quantities of their endowments and the community's preferences for the goods. But for given endowments and preferences, as in the diagram above, we can use the autarky price line to find the budget lines for the farmers and weavers as groups, and since we've assumed equal numbers of both, we can conclude that in the case drawn, the farmers are better off. The farmers' aggregate budget line is B^F and the weavers' budget line is B^W.

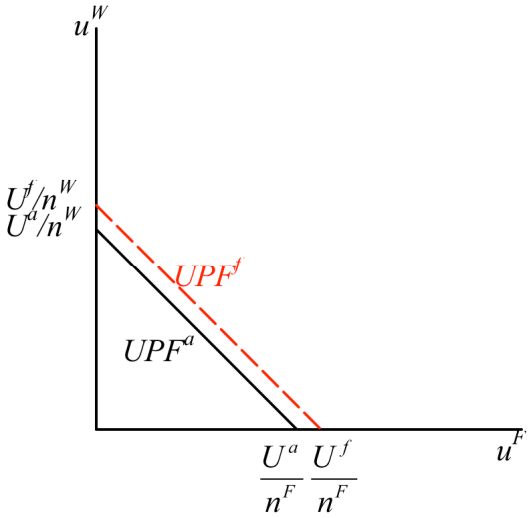


c. Suppose now that the country opens up to free trade at a relative price of wheat that is higher than its autarky price. Show the new equilibrium.

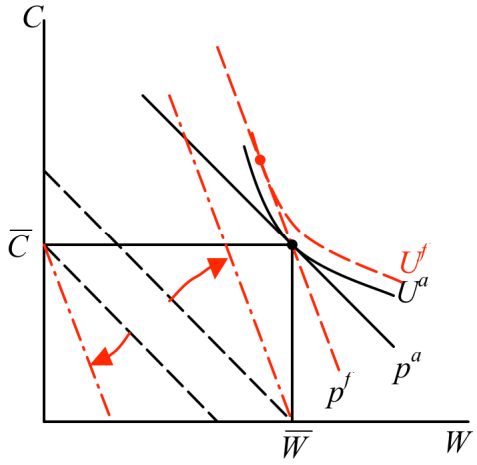


d. Construct the utility possibility frontiers for autarky and free trade, and indicate how the actual equilibria along these frontiers will compare. Who gains and who loses from trade? In what sense, if any, are there gains from trade in this case?

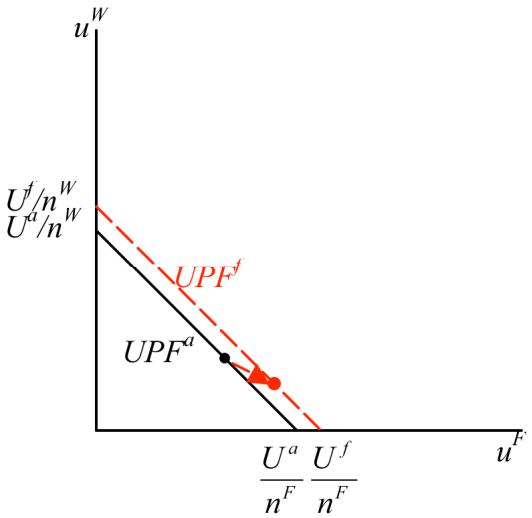
Since preferences are identical and there are the same numbers of farmers as weavers, the UPFs are downward sloping 45^o lines. Since the utility attainable with the income of the country as a whole rises with trade from U^a to U^f, as shown above, the UPF for free trade, UPF^f lies further from the origin that the UPF for autarky, UPF^a. Thus there are gains from trade in the sense that, if income were somehow redistributed between the groups, it would be possible with trade to make everybody better off.



To see who gains and loses without such redistribution, rotate the group budget lines in part (b) to reflect the change in prices from autarky to free trade:



From this it is clear that the farmers gain and the weavers lose. So the movement in the UPF diagram is as follows:



3. Which of the following characterize the Ricardian Model?
   a. Perfect mobility of factors across industries *Yes*
   b. Perfect mobility of factors across countries *No*
   c. Constant returns to scale *Yes (Almost trivially, since, with only one factor, a proportional increase in all factors is just an increase in labor. Since output is proportional to the labor input, this satisfies the definition of constant returns to scale: that a proportional increase in all inputs leads to an equal proportional increase in output.)*
   d. The law of diminishing returns *No (Or one could say that it does not apply. That is, an increase in one factor input does not lead to a fall in its marginal product, as the law of diminishing returns would predict. But in this case there is no other factor input to be held fixed, as required for that law to apply.)*
   e. Identical technologies across industries *No*
   f. Identical technologies across countries *No*
   g. Cournot competition *No*
   h. Perfect competition *Yes*

4. Suppose that a small open economy has 200 workers and that its technology requires 1 worker-hour per unit of food (thus 1 unit of food per worker-hour) and 3 worker-hours per unit of cloth (thus output per worker-hour = 1/3). In autarky, it employs 100 workers in each of the two industries. With free trade, it faces world prices of \$10 per unit of food and \$20 per unit of cloth.

   a. Suppose that in autarky, workers in both industries are paid \$8 per hour. What are the autarky prices of food and cloth?
   Prices of the goods are just their costs of production: $p_F = 8\times1 = \$8$ per unit of Food; $p_C = 8\times3 = \$24$ per unit of Cloth.

   b. When the country opens to free trade, under the normal assumptions of the Ricardian model, what will it produce, import, and export? From the information given, can you determine the quantities of any of these? What is the country's national income with trade, measured in dollars?
   The country has a comparative advantage in Food, since the autarky relative price of food is 8/24 = 1/3, which is less than the relative price of food on the world market, $p_F/p_C = 10/20 = 1/2$. It will therefore specialize completely in producing Food, moving all of its 200 workers there. Its output of food (per hour) will be 200 units, while its output of Cloth will be zero. Producing only Food, but demanding both goods, it will export Food and import Cloth. We cannot determine the quantities of exports and imports without more information about the structure of demand. National income is \$10×200 = \$2000 per hour.

   c. Suppose, contrary to the normal Ricardian Model assumptions, that when trade is opened, workers are unwilling or unable to change occupations, so that we continue to have 100 workers in each industry. What, then, is the national income of the country, in dollars, and how does it compare to the national income you got in part (b) when workers were mobile?

The 100 workers in the Food industry produce 100×1 = 100 units of Food per hour, while the 100 workers in Cloth produce 100×(1/3) = 33.3 units of Cloth per hour. At world prices, national income is therefore $10×100 + $20×33.3 = $1666.7. This is smaller than national income in part (b) by $333.3, which indicates the cost to the country of this labor immobility.

d. What are the wages of the two groups of workers in part (c)?
Workers are paid the value of their marginal product, which is also the value of their average product in the Ricardian Model. Thus in the Food industry, w_F = $10×1 = $10 per hour. In the Cloth industry, w_C = $20/3 = $6.67 per hour. Your can see why the workers would want to move to the Food industry if they were able, assuming that they only care about their wage.

e. Does the country gain from trade in part (c)? Who gains and who loses within it?
This is exactly the same situation as in question 2 above: since with employment in each industry fixed, so is output. And the workers in each industry earn the entire value of the goods they produce. So, as in question 2 above, the country has gains from trade in the sense that the value of its production is large enough to permit every person to gain, but only if some of that income were redistributed to the losers.

As for who gains and who loses, you can see – by comparing the answer to part (d) to the $8 wage in autarky – that the nominal wage has risen, due to trade, for workers in the Food industry and it has fallen for workers in the Cloth industry. This does not quite tell you that these groups have gained and lost, respectively, however, since they also face different prices as consumers. That is, the price of Food has gone up for them, while the price of Cloth has gone down. Comparing the sizes of these changes to the changes in wages, you may note that the wage in the Food industry has risen by the same percentage (25%) as its price, so that workers there are better off as long as they want to consume any at all of Cloth. Likewise, the wage in Cloth has fallen by the same percentage as its price (1/6=16.7%), so that workers there are worse off as long as they want to consume any at all of Food.

5. Using the same assumptions at the start of problem 4, but returning to the usual assumption that labor can move between industries, suppose now that the wage of labor in the country in autarky had been $15 per hour instead of $8.

a. Now what would be the autarky prices of Food and Cloth?
Now p_F = 15×1 = $15 per unit and p_C = 15×3 = $45 per unit.

b. When the country opens to free trade, what will happen? How will your answers to part (b) of problem 4 be changed?
Both prices will now fall, in dollar terms, from $15 to $10 for Food and from $45 to $20 for Cloth, and this will require a fall in the nominal wage, as shown below. But none of this actually matters for the answers to part (b) of problem 4, which asked only about real (not nominal) changes, except for national

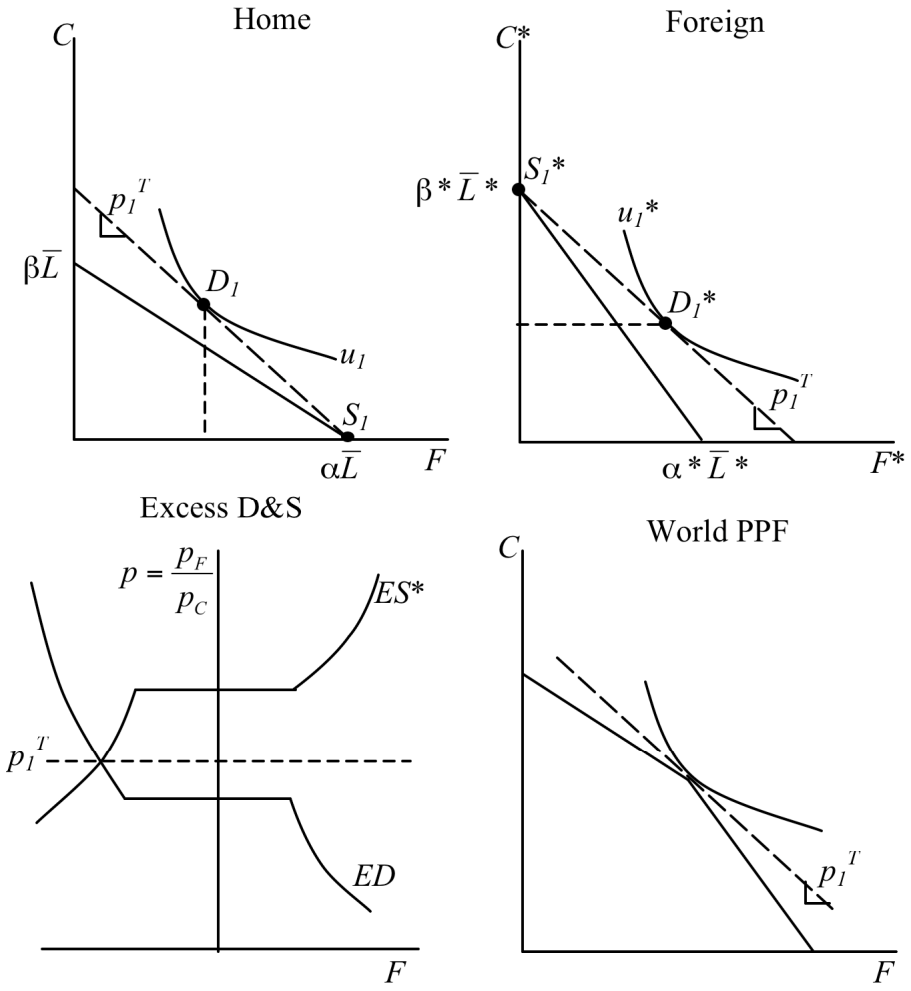
income. The higher nominal wage and prices in autarky have not changed the fact that the country has a comparative advantage in Food, and it will still, as a result, specialize completely in that sector. The quantities produced, exported, and imported will therefore all be the same. And since national income depends on the prices with trade, not without, its value is the same also.

c. What is the wage of labor with free trade, in dollars?
Labor is again paid the value of its marginal product, in the Food industry since that is all it is producing: $w = 10\times1 = \$10$ per hour. The nominal wage has therefore fallen by 1/3.

d. What has happened, as a result of trade, to the real wages of labor?
For this we must compare nominal wages to the prices of the two goods. The price of Food has fallen from \$15 per unit to \$10, the same as the wage, so workers are neither better nor worse off in terms of their ability to buy food. But the price of Cloth has fallen from \$45 to \$20 per unit, or by more than half, so they can now buy more Cloth with an hour of labor than before. So all but the nudists among them are better off.

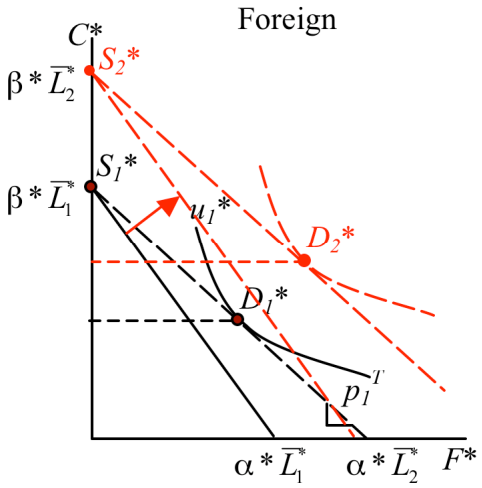
6. Use the 2-country Ricardian Model with free trade to work out the effects of the following changes (one at a time) on the Home country's terms of trade and welfare. Assume that the Home country has a comparative advantage in Food (the other good being Cloth), and that in the initial equilibrium, both countries specialize completely. You may assume, if it is helpful, that preferences are identical and homothetic in the two countries.

The initial equilibrium can be depicted several ways. The top panels below show PPFs for both countries, together with (parallel) world price lines and (identical) quantities traded. The bottom-left panel shows excess demand for Food (by Home) and excess supply of Food (by Foreign), intersecting at the initial equilibrium world relative price, p_1^T. The bottom-right panel shows the world PPF and equilibrium world consumption. Answers to the three parts of this question will be derived by introducing changes into some of these panels. Whether you use the lower-left or lower-right panels (relative demand and supply, versus world PPF) is up to you – there is no need to use both.

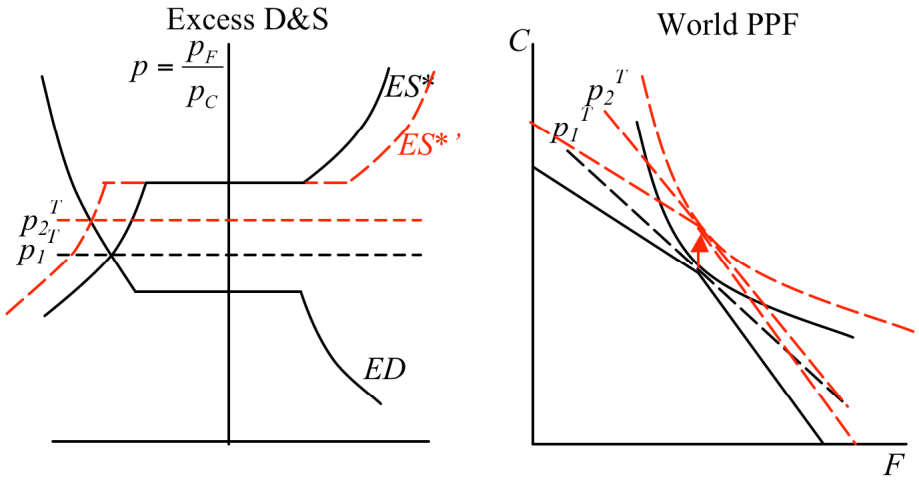


a. An increase in the Foreign labor force.

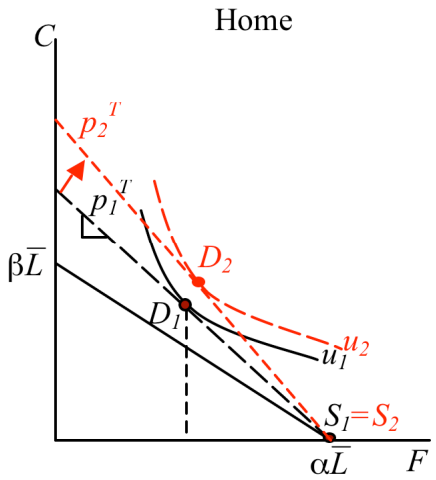
This increase in $\bar{L}^*$, from $\bar{L}_1^*$ to $\bar{L}_2^*$, shifts the Foreign PPF outward without changing its slope.



At the initial price, therefore, Foreign increases its exports of C and imports of F as shown. This causes the world relative price of F to rise (and of C to fall), as can be seen in the bottom panels below. In the ED-ES diagram, the foreign curve's horizontal portion expands to reflect its larger PPF, thus shifting the portion that intersects with ED to the left and raising the equilibrium price. In the World PPF diagram, the expansion of Foreign's PPF causes an upward movement of the kink of the world PPF, which moves consumption to a steeper part of a world indifference curve.

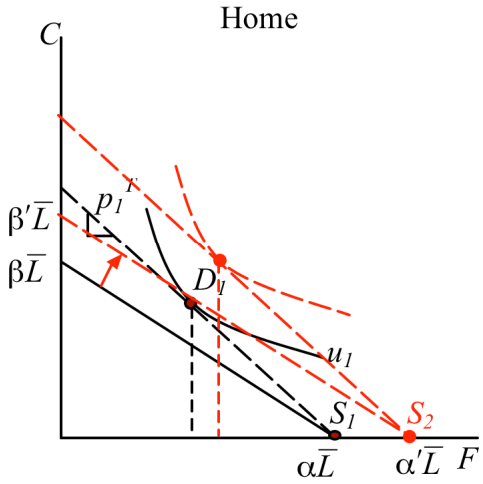


Turning to the Home PPF diagram from the original top-left panel, this rise in the world relative price of food is an improvement in Home's terms of trade, and it permits Home to trade its exports of Food for more Cloth, as shown below. Home reaches a higher indifference curve, indicating that its people have gained from this expansion of the foreign labor force.

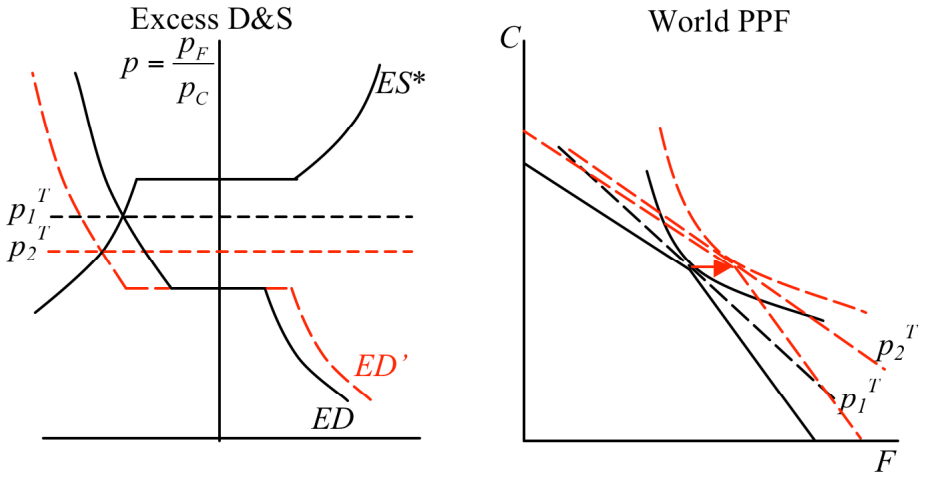


b. A increase, by the same percentage in both industries, in the Home country's productivity in producing both Food and Cloth.

This makes it possible for Home to produce more Food, more Cloth, or more of both, appearing as an outward shift of its PPF much like the one for Foreign in part (a):



As was the case in part (a) for Foreign, Home now will increase both its exports (of Food) and imports (of Cloth), if prices do not change. But they will change, and in the opposite direction from part (a). Since Home is now exporting more Food to the world market, its price will fall. This can be seen in either of the bottom-panel diagrams below:



This fall in the world price of Food is a worsening of Home's terms of trade, which must be added to the original PPF diagram to find the final effect on Home. The price change tends to make Home worse off, partially or wholly offsetting the benefit from the improved technology. In the case shown below, the offset is only partial, but you could easily draw it as leading to a lower indifference curve than the one that the country started on. This would be a case of "immiserizing growth," as we will study later in the course.