The Ricardian Trade Model

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This chapter marks the beginning of the the second section of the course, in which we discuss the determinants of trade. In other words we try to develop theories which will help us understand "WHO SELLS WHAT TO WHOM". Before we get into the thick of things it is important to understand the stylized world of "no-trade", that we are going take as our starting point.

The no-trade world is one where the following is true:

1. Countries have identical production functions, i.e. production technology is the same.
2. Countries have same relative endowments of production factors (labor and capital).
3. Production technology is constant returns to scale.
4. Consumers across countries have identical and homogeneous tastes.
5. There are no distortions, i.e. taxes, subsidies,imperfect competition.

These five conditions are sufficient to guarantee a world without any international trade. In this chapter we consider a scenario where the first condition is not satisfied, though the other four are.

1 The Ricardian Trade Model

The model is associated with David Ricardo (18 April 1772 to 11 September 1823), who was an English political economist. Ricardo is considered one the most influential figures in the development of economic thinking and economic theory of all times, especially during the nineteenth century[1].

The key concept to understand is that of **comparative advantage**. However, in order to understand comparative advantage we should start with the concept of **absolute advantage**. When a country has the best technology for producing a good, it has an absolute advantage in the production of that good. But, absolute advantage is actually not a good explanation for trade patterns because it would imply that U.S. should not import anything from China since U.S. has better technology than China to produce most goods. Comparative advantage is the primary

[1]He was also a member of Parliament, businessman, financier and speculator, and amassed a considerable fortune. To know more about him and his work you can visit http://cepa.newschool.edu/het/profiles/ricardo.htm.

explanation for trade among countries. A country has a comparative advantage in producing those goods that it produces best compared with how well it produces other goods. Thus, comparative advantage is nothing but a comparison of the opportunity cost of one good in terms of the other good(s) across countries.

Now, let us formalize the idea of comparative advantage and show that it leads to gains from trade. Consider a world with two countries, home (H) and foreign (F), two goods, X and Y, and one factor of production - labor. The production technology is constant returns to scale, which with one factor of production implies that the production functions are linear.

$$\begin{aligned} X = F_x(L_x) &= \alpha L_x \ \ (Production \ \ function \ \ for \ \ X) \\ Y = F_y(L_y) &= \beta L_y \ \ (Production \ \ function \ \ for \ \ Y) \\ \overline{L} &= L_x + L_y \ \ (Resource \ \ Constraint \ \ for \ \ Labor) \end{aligned}$$

where $\alpha,\ \beta > 0$ are the marginal products of labor (increase in output due to an additional unit of labor) for each good. Since we have allowed the production technology to be different in the two countries, α and β are not equal. Table 1 gives the value of α and β for the two countries. Country H can produce 20 units of X with one unit of labor whereas country F can produce 30 units with one unit of labor. Similarly, H can produce 20 units of Y with one unit of labor as compared to 10 units produced in F.

Table 1: Marginal Products of Labor and World Output

	Home	Foreign
X	$\alpha_h = 20$	$\alpha_f = 30$
Y	$\beta_h = 20$	$\beta_f = 10$

Which country has absolute advantage in which good?

- H has absolute advantage in Y ($\beta_h > \beta_f$).
- F has absolute advantage in X ($\alpha_f > \alpha_h$).

What is the pattern of comparative advantage?

- H has comparative advantage in Y ($\beta_h/\alpha_h > \beta_f/\alpha_f$).
- F has comparative advantage in X ($\alpha_h/\beta_h < \alpha_f/\beta_f$).

Let us reallocate labor in line with the comparative advantage of countries, i.e. H specializes in production of Y and F specializes in production of X. Move 1 worker from production of X to Y in country H, and 1 worker from production of Y to X in country F. Table 2 shows that such a reallocation of labor results in an increase in the world output of both goods. What this example illustrates is that there are gains from specialization to be captured if there is a pattern of comparative advantage, i.e. the ratio of the marginal products of labor differ in the two countries.

Table 2: Output Reallocation Due to Comparative Advantage

	Home	Foreign	Total World Output
X	-20	$+30$	$+10$
Y	$+20$	-10	$+10$

- **CLASS EXERCISE: Construct an example in which there is one country has absolute advantage in both goods and yet there are gains from specialization to be captured.**

Let us analyze this example graphically. To do that we need to plot the production possibility frontiers (PPF) of the two countries. Remeber, the PPF tells us how an economy transforms one good into another. Since $X = \alpha L_x$, and $Y = \beta L_y$ it implies that

$$\Delta X = \alpha \Delta L_x \ \ ,\Rightarrow \frac{\Delta X}{\Delta L_x} = \alpha = \frac{\partial X}{\partial L_x} = \mathbf{MP_{Lx}} \ \ ,\text{and} \tag{1}$$

$$\Delta Y = \beta \Delta L_y \ \ ,\Rightarrow \frac{\Delta Y}{\Delta L_y} = \beta = \frac{\partial Y}{\partial L_y} = \mathbf{MP_{Ly}} \ \ . \tag{2}$$

$\mathbf{MP_{Lx}}$ and $\mathbf{MP_{Ly}}$ stand for marginal product of labor in sector X and sector Y, respectively. Since $\overline{L} = L_x + L_y$ it implies that

$$\Delta L_x + \Delta L_y = 0 \ \ ,\Rightarrow \Delta L_x = -\Delta L_y \ \ . \tag{3}$$

Using this implies that

$$\frac{\frac{\Delta Y}{\Delta L_y}}{\frac{\Delta X}{\Delta L_x}} = -\frac{\Delta Y}{\Delta X} = \frac{\beta}{\alpha} = \mathbf{MRT} \ \ . \tag{4}$$

Thus, the PPF has a constant marginal rate of transformation which means that the PPF is going to be a downward sloping straight line with slope β/α. Notice that this result is simply coming from the fact that labor has a constant marginal product in both sectors, i.e. each additional unit

of labor gives the same additional output. Other way to say this is that there are no diminishing returns to labor. This means that as the economy keeps on moving labor from one sector to another, say from Y to X to produce more X, the productivity of labor does not decline and, hence, the output produced from the additional units of labor does not fall.

Figure 1 shows that autarky equilibrium for the two countries. HH' is the production possibility frontier for country H while FF' is the production possibility frontier for country F. Given the labor endowments of the two countries - $\overline{L}_h$ and $\overline{L}_f$ - and the labor productivities, the maximum amount of good X produced in the two countries is $OH' = \alpha_h \overline{L}_h$ and $OF' = \alpha_f \overline{L}_f$, respectively while that of good Y is $OH = \beta_h \overline{L}_h$ and $OF = \beta_f \overline{L}_f$, respectively. These maximum amounts reflect the absolute advantage.

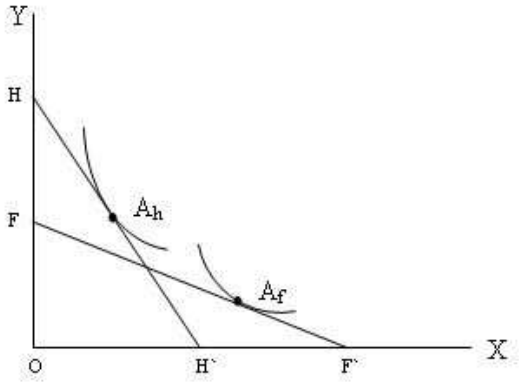

Figure 1: Autarky Equilibrium

The slope of the production possibility frontier depends on the ratio of marginal productivities. Since in our example $\beta_h/\alpha_h > \beta_f/\alpha_f$, the production possibility frontier of H is steeper than that of F. The autarky equilibrium for the two countries are represented by A_h and A_f. Note that with the linear production technology the autarky price line is the as same the production possibility frontier. Since the slope of the production possibility frontier reflects that pattern of comparative advantage, autarky price ratios reflect comparative advantage.

1.1 Partial Equilibrium

The response of each country to the opportunity to engage in trade will depend on the world price ratio. Consider country H in Figure 2. If the autarky price ratio of H, p_h^a, is smaller than the world price ratio, p_1^*, it will mean that good X is relatively cheaper in country H. Therefore, H will

specialize in X at point H', exporting X and importing Y, and consume at point C_1. On the other hand, if the world price ratio is p_2^*, which is smaller than p_h^a, then H will export Y and import X, producing at point H and consuming at point C_2.

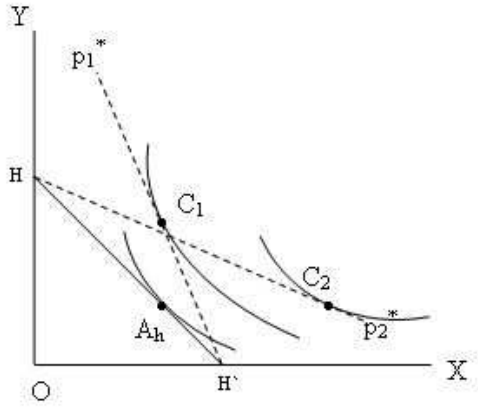

Figure 2: Trade Equilibrium: Different Points of Specialization

To refresh your memory, equilibrium requires that $MRT = MRS = world\ price\ ratio$. Therefore, if the world price ratio is p_1^*, then

$$p_1^* = \frac{p_x^*}{p_y^*} > MRT = \frac{MP_{Ly}}{MP_{Lx}} = \frac{\beta}{\alpha}$$

$$\Rightarrow p_x^*\alpha > p_y^*\beta \quad ,$$

which means that the value of marginal product of labor for good X is greater than the value of marginal product for good Y. Thus the only way equilibrium can be established is to produce X with equilibrium wage, w, equal to value of labor's marginal product for good X. As a result $w > p_y^*\beta$, which implies that it is unprofitable to produce Y.

Following the same logic, when the world price ratio is p_2^*, country H will specialize in the production of Y.

Notice that if the world price ratio is equal to the autarky price ratio, then country H will consume at point A_h but can produce at any point on the production possibility frontier HH', including H and H'. Figure 3 represents the same analysis with the excess demand curve.

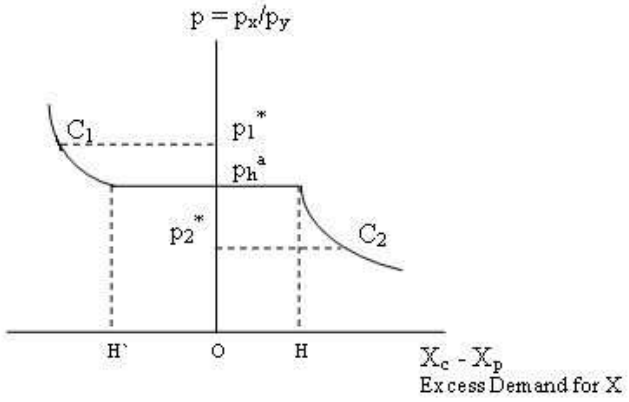

Figure 3: Trade Equilibrium: Excess Demand Schedule

1.2 General Equilibrium

Now, we look at the general equilibrium picture by bringing in country F. The excess demand curve for country H is labeled as E_h while that of country F is labeled as E_f. The equilibrium world price ratio lies between the autarky price ratios of the two countries, and at these prices the world excess demand for good X (and by Walras' Law, also for good Y) is zero, i.e. excess demand in country H is exactly offset by excess demand in country F.

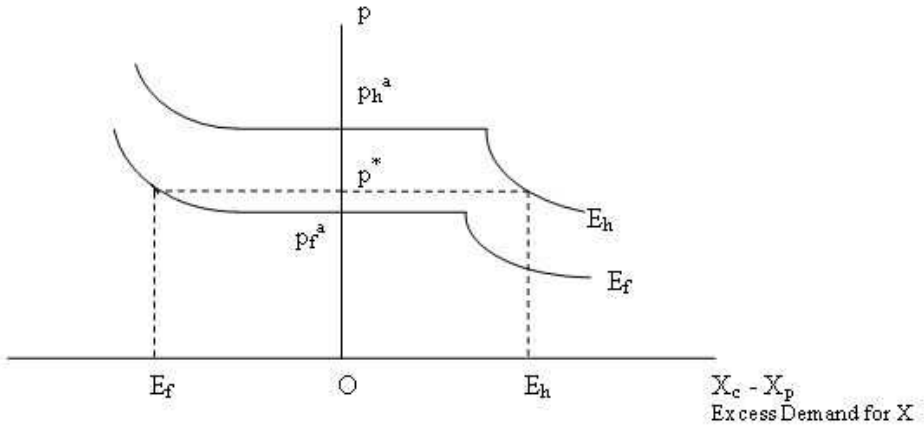

Figure 4: Trade Equilibrium: General Equilibrium

- **CLASS EXERCISE: Can there be an equilibrium if the world price ratio does not lie between the autarky prices.**

1.3 Role of Wages

In this era of globalization, we increasingly here about the fears of the developed economies about the competition from low wage developing economies. So, what happens to wages once countries engage in trade?

Under the autarky equilibrium, because of perfect competition and freely mobile labor, the value of marginal product of labor must be equalized across the two goods, i.e.

$$p_x^a \alpha_h = p_y^a \beta_h = w_h \quad .$$

In other words the autarky price ratio must be equal to be the ratio of marginal products of labor: $p_h^a = \beta_h/\alpha_h$. Then real wage in terms of the prices of the two goods are given by:

$$\frac{w_h}{p_x^a} = \alpha_h \qquad \frac{w_h}{p_y^a} = \beta_h$$

Now, lets us bring in country F and allow the two countries to trade. Take our existing example, where H exports Y and F exports X, i.e. $p_f^a < p* < p_h^a$. Then for the home country, $p* < \beta_h/\alpha_h \Rightarrow \beta_h/p* > \alpha_h$. Since under free trade, H produces Y

$$\Rightarrow w_h = p_y^* \beta_h \quad or \quad w_h/p_y^* = \beta_h \quad .$$

Dividing both sides of this equation by p_x^* gives

$$w_h/p_x^* = \beta_h/p^* > \alpha_h \quad .$$

This analysis shows that once countries engage in trade, there is no change in a country's real wage in terms of its export good but there is an increase in its real wage in terms of its import good. This is because the country's import price is lower than than the autarky price of the good being imported. Therefore, for an individual worker overall welfare increases due to increase in real income.

It is quite possible that under free trade real wages are higher in one country than in another. A clear case when this would happen is one where one country has absolute advantage in both goods. So, if $\alpha_h > \alpha_f$ and $\beta_h > \beta_f$, then

$$w_h/p_x^* = \beta_h/p^* > \alpha_h > \alpha_f = w_f/p_x^*$$

Thus *absolute advantage is important in determining the real wages whereas comparative advantage is important in determining the pattern of trade.* As countries engage in trade, the Ricardian model predicts that their real wages will rise. Also, as a country develops better technology (it raises its absolute advantage), its wages will rise. We can see this in the real world. Per capita income in China in 1978 was estimated at $925. In 2000, per capita income in China had risen to $3750. Per capita income in India more than doubled from $1180 in 1978 to $2480 in 2000. It is strongly believed that the opportunity for these countries to engage in international trade has been crucial in raising their standard of living.

1.4 Distribution of Gains from Trade: Big Versus Small Countries

Up until now we have not said anything about how the gains from trade will be distributed between the trading partners. The only thing we have concluded is that in case of differences in technology/productivity across two countries there are gains from trade to be captured. Are the gains equally distributed or does one country gain more than the other?

In order to answer this question let us analyze a case where country F grows bigger. This could happen because of an increase in the size of its labor force or because of an improvements in productivity of labor (increasing α and β in the same proportion). At the end of the day the effect is to shift the production possibility frontier of F outwards. As a result the maximum amount of good X and good Y that country F can produce is going to increase proportionally. Then at the initial world price ratio, say p_0^*, country F would want to export more X and import more Y (we are assuming the the utility function is homogeneous). However, at the current world price ratio of p_0^*, country H would still demand the same amount of good X and would be willing to export the same amount of good Y as before the expansion of country F. In order to move to a new world equilibrium, the world price ratio will have to adjust such that the amount of a good a country is willing to export is equal to the amount of the same good the other country is willing to import. In other words excess demand for a good by one country is exactly offset by the excess demand for that good by the other country. In this case, for country F to export more X the price of X must fall. At the same time, since country F's demand for Y also increases, due to growth in country F, the price of good Y increases. The overall impact of these changes is a decline in the equilibrium price ratio to p_1^*. This is depicted in Figure 5.

- **CLASS EXERCIZE: Graphically, show the improvement in welfare of country H and F?**

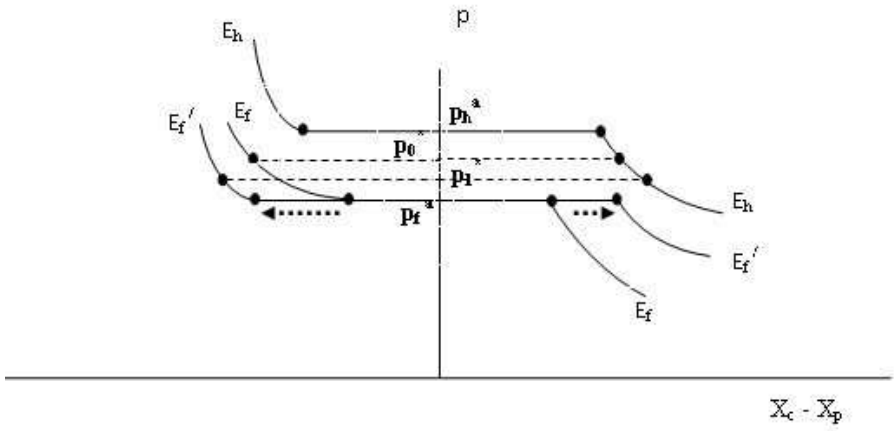

Figure 5: Distribution of Trade Gains When One Country Grows

Notice that the price of country F's exports (good X) has decreased while the price of its imports (good Y) has increased. We refer to this as a *deterioration in terms of trade*. On the other hand, country H experiences an *improvement in its terms of trade* because the price of its exports (good Y) goes up and price of its imports (good X) declines.

- **CLASS EXERCIZE: Is it possible that all the gains from trade go to the small country and the big country is as well off as it was in autarky?**

This exercise tells us that smaller countries are likely to gain more from free trade. Secondly, a country may benefit from productivity growth in its trading partners. Both lessons can be applied to begin to understand some of the trade issues. For example, did Mexico and Canada gain more from NAFTA as compared to the U.S.? Another example is the rapid rise of China as a major economic power house and the world's workshop. Should China's trading partners be scared of China's rapid growth in productivity or are they benefiting from it?

2 Can Comparative Advantage be Created?

In general we think of a country having a comparative advantage in a good. Can a country create a comparative advantage?

For example, certain countries have a comparative advantage in the production of wine. Areas that get very cold are not good wine producers because the vines get too cold. The Niagara Falls

region of Canada began producing a product called “icewine” in 1983; its now made in British Columbia, too. The grapes are allowed to freeze on the vine before they are picked. The unique flavor of the wine has led to a relatively high demand - half-bottles often sell for $50 or more. This has created a comparative advantage in a certain type of wine, even though Canada does not have the advantage in traditional wine production.

Figure 6: Icewine Grapes

This example, tell us that new technologies can allow countries to develop comparative advantage in goods where they tradionally did not have a comparative advantage. Thus, the pattern of comparative advantage can change over time, which means that the pattern of trade can change over time.

3 Empirical Evidence on the Ricardian Model

The key prediction of the Ricardian model is that countries export the goods in which they are most productive. The extreme scenario is that countries completely specialize in goods they export. This will most likely not hold in the data. However, the prediction that countries should export those goods in which they have the highest labor productivity is confirmed in the data.

1. Seminal work to test this prediction was done by *G. MacDougall* in the 1950s for the U.S. and Britain. His hypothesis was that given the U.S. wage rate in 1937 was approximately twice that in Britain, U.S. firms should have an export advantage in manufacturing sectors in which U.S. labor productivity exceeded twice the level in U.K.. Using simple measures of labor productivity, he found that, for the exports of U.S. and U.K. to the same third world countries, for 20 of the 25 products considered the ratio of U.S. exports to U.K. exports exceed one, while in the rest of the cases this ratio was less than one. Thus, this simple prediction was confirmed for the bulk of the products in the study.

2. *Robert Stern*, who compared U.S. and British trade in 1950 and 1959, found that the average U.S. wage was 3.4 times that average U.K. wage in 1950. The Ricardian model would suggest that the ratio of U.S. exports to U.K. exports should exceed unity in those sectors in which the ratio of outputs per worker (labor productivities) exceeded 3.4 and less than unity in other cases. Of the 39 sectors considered, this prediction was confirmed for 33 sectors in 1950.

3. *Bela Balassa* also confirmed these findings.

4. More recent evidence on the Ricardian model has been less clear-cut. This is because of the growth of world trade and the resulting specialization of countries, which prevents us from deciphering what is that the countries do badly. However, there are still several pieces of evidence suggesting that differences of labor productivity continue to play an important role in determining world trade patterns.

   (a) One study found that the average productivity of labor in Japanese manufacturing in 1990 was 20 percent lower than the average labor productivity in the U.S.. But in the automobile and auto parts industries Japanese productivity was 16 to 24 percent higher than the U.S. productivity. Not surprisingly, Japanese automakers have been able to export millions of automobiles to the U.S..

   (b) In 1992 the average U.S. manufacturing worker was about 5 times as productive as the average Mexican worker. But in the clothing industry the productivity advantage was only 50 percent. This means that U.S. had comparative advantage in other manufacturing sectors as compared to clothing, which is what can explain the large export of clothing from low-wage countries like Mexico to high-wage countries like the U.S.

4 Critique

The ricardian model of international trade is a highly stylized view of the world, where trade takes place because of differences in technology. It makes some simplyfying assumptions, which in turn lead to stark predictions.

- Assumes a single factor of production, labor, which combined with constant productivities implies that the opportunity cost is constant (in other word the production possibility frontier is linear).
  - What about a second factor - capital?
  - The opportunity costs usually increases - concave production possibility frontier.
- Constant opportunity cost and single factor of production imply that under "free trade" there is complete specialization, i.e. each country produces one good. An exception to this would be the case where one country is much larger than the other country and therefore does not specialize completely.
  - You hardly see complete specialization in the real world.
- In case of complete specialization, workers in both countries gain from trade. Again, in the case where one country is much larger than the other, the larger country may not corner any gains from trade.
  - If trade is always beneficial, why do we hear about trade unions opposing free trade?