

November 8, 2006

## Notes on Ricardian model

These notes describe the Ricardian model, and explain the meaning of the following terms: opportunity cost, comparative advantage, and absolute advantage. The model illustrates the source of gains from trade in a general equilibrium model, i.e. one in which factors of production move across sectors. We begin by describing a single economy ("Home") in autarchy. We then see how production and consumption – and thus, welfare – change as a consequence of opening up to trade with the Rest of World (ROW). I will describe this model using specific numerical values, for clarity.

The description of the economy requires a description of technology, market structure and "tastes". The technology tells you what is technically feasible. The market structure tells you how producers and consumers behave; "tastes" tell you the relation between consumption and welfare.

Technology: There are two commodities, beer and soyburgers, produced using a single input, labor. A unit of beer ( $B$ ) requires one unit of labor and a unit of soyburger ( $S$ ) requires 2 units of labor. Labor can move from one sector to another. There are 100 units of labor available. (You can define units any way you want. For example, you can think of a unit of beer as a keg, and a unit of labor as a year's worth of a person's working time.) The production constraint is

$$1B^s + 2S^s = 100 \tag{1}$$

(The superscript  $s$  denotes supply, or production.) Figure 1 illustrates the production constraint. For example, the economy is capable of producing 50 units of soyburger or 100 units of beer, or at any point on the line shown in the figure.

Market structure: Firms hire workers to produce products, which firms sell in the market place. Firms are perfectly competitive. In equilibrium – i.e. where there is no incentive for firms to enter or leave a sector, and no incentive for workers to move from one sector to another, profits (in each sector) are non-positive, and the wage is the same in both sectors.

Why must profits be non-positive in equilibrium? If any firm was making profits, other firms would enter the sector. In order to produce, these other firms would hire labor, thus increasing the total demand for labor and driving

up the wage. In addition, the new firms' increased production increases supply, causing price of the product to fall. The result of this entry would be a fall in profits. In equilibrium profits are not positive. If the profit from production is strictly negative, then no firm operates, and production in the sector is 0. (No one produces at a loss.) If output is positive, profits are zero in a sector.

Denote prices by  $P$  and the wage by  $w$ . The equilibrium conditions are

$$P^b \leq 1w \tag{2}$$

$$P^s \leq 2w \tag{3}$$

In each sector, the equilibrium price of a unit of a commodity is less than or equal to the cost of producing that unit: profits are non-positive.

If production of both beer and soyburgers is positive the above two inequalities hold as equalities, i.e.

$$P^b = 1w \tag{4}$$

$$P^s = 2w. \tag{5}$$

In equilibrium, there is full employment of labor. The supply of labor is fixed at 100 (by assumption). If the demand for labor were less than 100, the wage would be bid down, encouraging firms to hire more workers.

Suppose that production of both beer and soyburgers is positive. In this case we can take the ratio of the above two equations to write

$$p^A = \frac{P^b}{P^s} = \frac{1}{2} \tag{6}$$

Equation (6) shows that the autarchic relative price (the price of beer over the price of soyburgers) depends only on the RELATIVE productivity of labor in the two sectors. For example, if we had another economy that needs 6 units of labor to produce a unit of beer, and 12 units of labor to produce a unit of soyburgers, it would have exactly the same relative autarchic price as our economy.

The economy's opportunity cost of "something" is what the economy gives up to obtain this thing. In this setting, the opportunity cost of one beer is half a soyburger, because to obtain an extra unit of beer the economy needs to move one worker from the soyburger sector (resulting in the loss of half a unit of soyburger.)

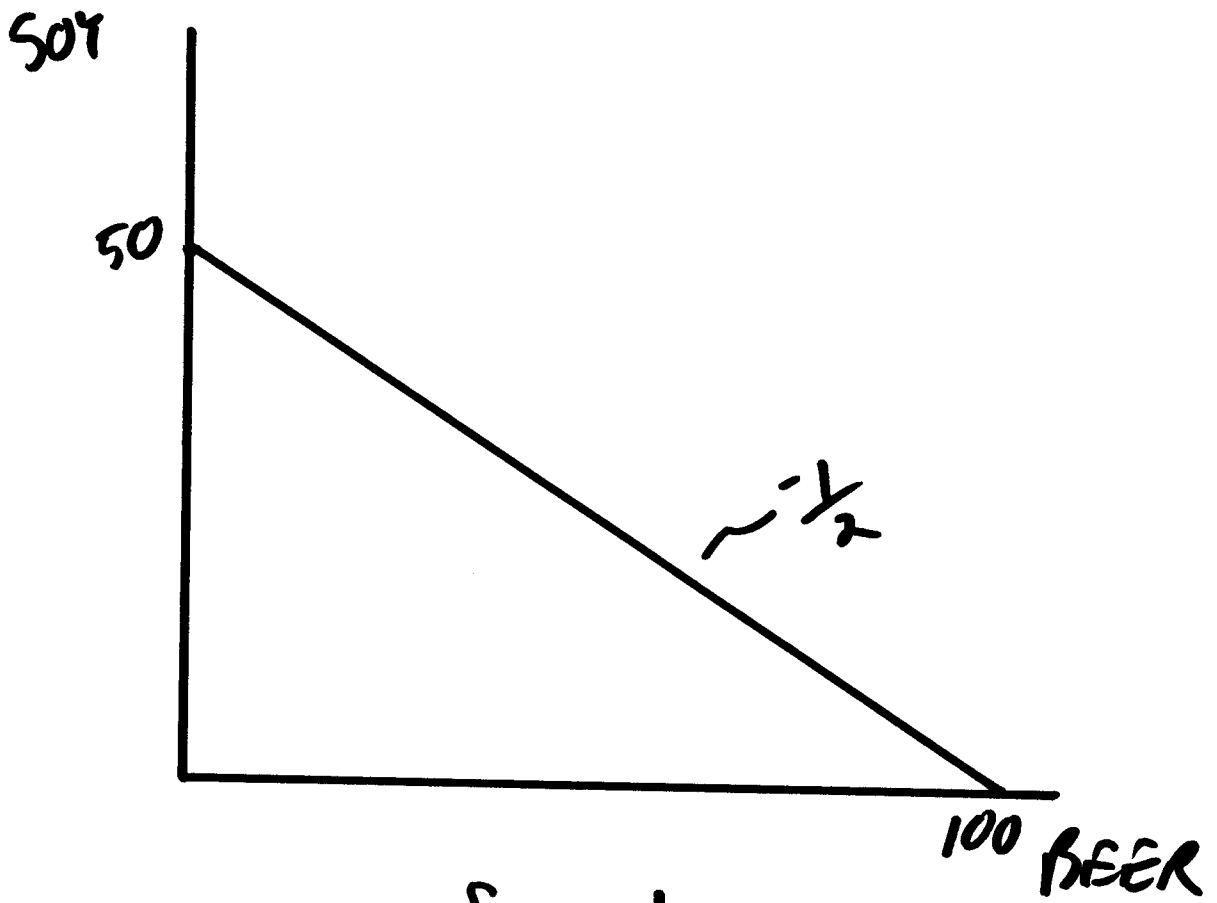


fig 1

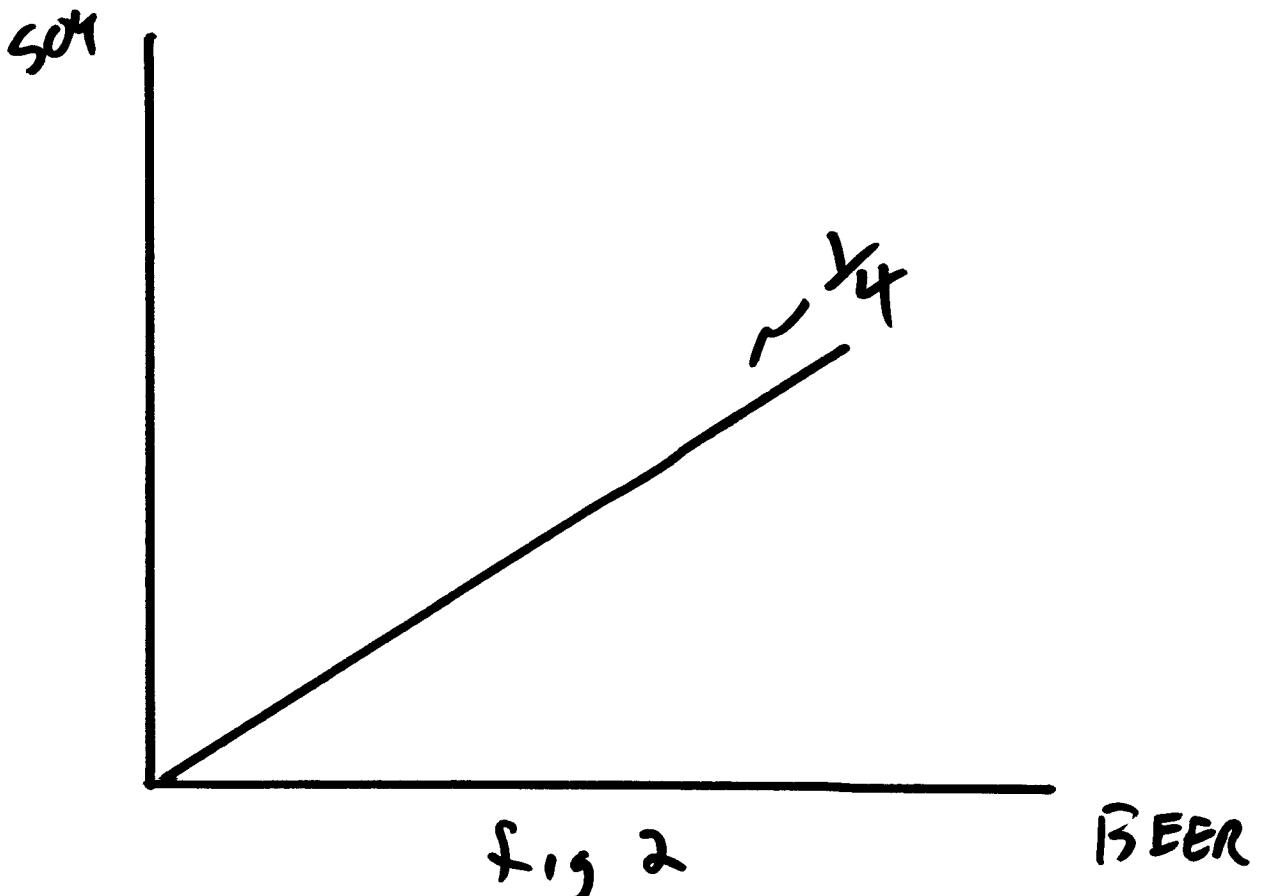


fig 2

A country has a COMPARATIVE ADVANTAGE in a commodity if its OPPORTUNITY COST of producing that commodity is lower than the opportunity cost in the rest of the world. The country's comparative advantage depends on its relative (as opposed to absolute) labor requirements in the two sectors.

Tastes: To complete the description of the economy we need to know peoples' preferences. In order to make the story very simple, suppose that people always consume the two commodities in fixed proportions: they always consume four units of beer per unit of soyburger. (This assumption is not part of the Ricardian model. I am using it to make the story simple.) Figure 2 shows the relation between soyburger and beer consumption, the "income expansion path". The assumption about preferences tells us that consumption occurs somewhere on this line. Higher levels of consumption result in higher welfare, so a movement Northeast on the income expansion path results in higher welfare.

An equilibrium requires that demand equal supply in both sectors. That is, the economy must be on the line shown in figure 1 (the production constraint) and also on the line shown in figure 2 (the income expansion path). Figure 3 shows the equilibrium, point A.<sup>1</sup>

Another way to think about the equilibrium is that it must be the case that the value of consumption equals national income. In this model, the only source of income is from wages (since labor is the only factor of production and there are no profits). Since each unit of labor earns  $w$  (the wage) and since there are 100 units of labor, national income is  $100w$ . Each consumption bundle costs  $1P^s + 4P^b$ . If the economy consumes  $x$  consumption bundles, the total cost is  $(1P^s + 4P^b)x$ . The requirement that national income equal the value of consumption is

$$(1P^s + 4P^b)x = 100w.$$

It is possible to solve this equation, together with the two equilibrium conditions, to find the value of  $x$  and any two of the following three variables:  $P^b, P^s, w$ . (We can set the remaining variable equal to 1; this is referred to as a "normalization".)

Now we open Home to trade. Suppose that the (fixed) ROW price of beer is 3 and the world price of soyburger is 1, so that the relative price of

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<sup>1</sup>You should be able to work out that at point A the economy produces and consumes  $\frac{50}{3} = 16.7$  units of soyburger and  $16.7(4) = 66.8$  units of beer. I obtain these by solving the two equations:  $S = 50 - \frac{1}{2}B$  and  $B = 4S$ .

beer is<sup>2</sup>

$$p^w = \left( \frac{P^b}{P^s} \right)^{world} = \frac{3}{1} = 3.$$

Just as was the case for our single economy, this ROW relative price reflects the opportunity cost of beer production; the ROW relative price depends on the RELATIVE production costs of the two commodities in the ROW. In this example, Home has a lower opportunity cost of beer – its opportunity cost of beer is 1/2 a soyburger, while the opportunity cost of beer is 3 soyburgers in ROW. This information tells me nothing about whether Home has an ABSOLUTE advantage in the production of either good. For example, it might be the case that in ROW they need 3/10 unit of labor to produce a beer and 1/10 units of labor to produce a soyburger. In that case, ROW has an ABSOLUTE advantage in the production of both commodities, but Home still has a COMPARATIVE advantage in the production of beer.

What happens when Home begins to trade at the world prices,  $P^b = 3$ ,  $P^s = 1$ ? We use the equilibrium conditions (2) and (3), with the particular ROW prices:

$$3 = P^b \leq 1w \tag{7}$$

$$1 = P^s \leq 2w \tag{8}$$

Notice that it is impossible for both of these inequalities to hold as strict equalities. That is, it is not possible that  $w = 3$  (from the first relation) and also that  $w = \frac{1}{2}$  (from the second relation). It is also not possible that both (7) and (8) hold as strict inequalities, as that would imply that there were negative profits in both sectors; with negative profits in both sectors, no firms would operate, and there would be no demand for labor. Remember that in equilibrium the wage adjusts so that there is full employment of labor. In short, the only way that both (7) and (8) can hold (consistent with full employment) is

$$3 = w \tag{9}$$

$$1 < 2w \tag{10}$$

Equation (9) gives us the value of the wage under trade, and equation (10) simply tells us that the soyburger sector closes down under trade: all labor works in the beer sector.

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<sup>2</sup>What matters is the world relative price. The absolute price levels is of no significance in this model. By picking absolute levels, I have implicitly used a normalization.

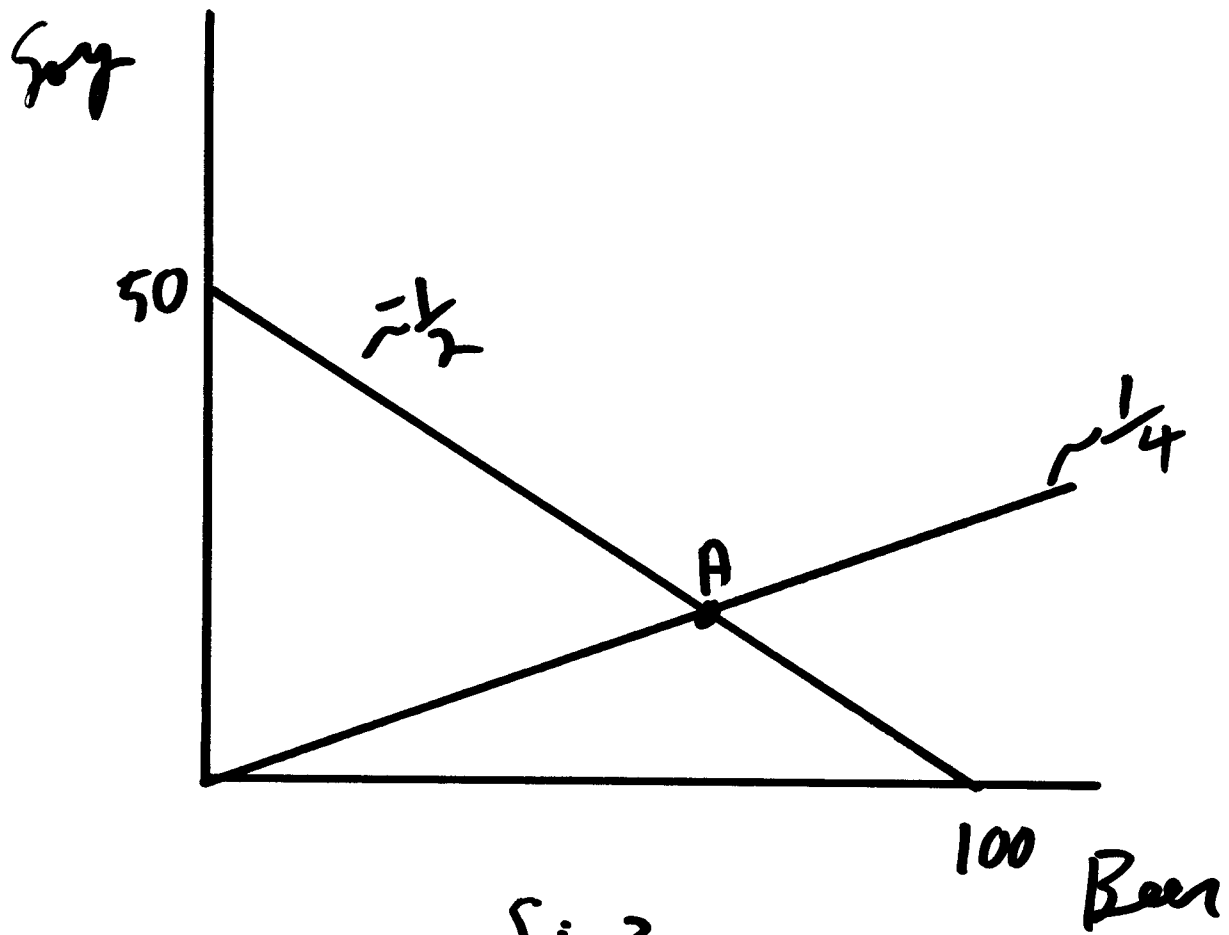


fig 3

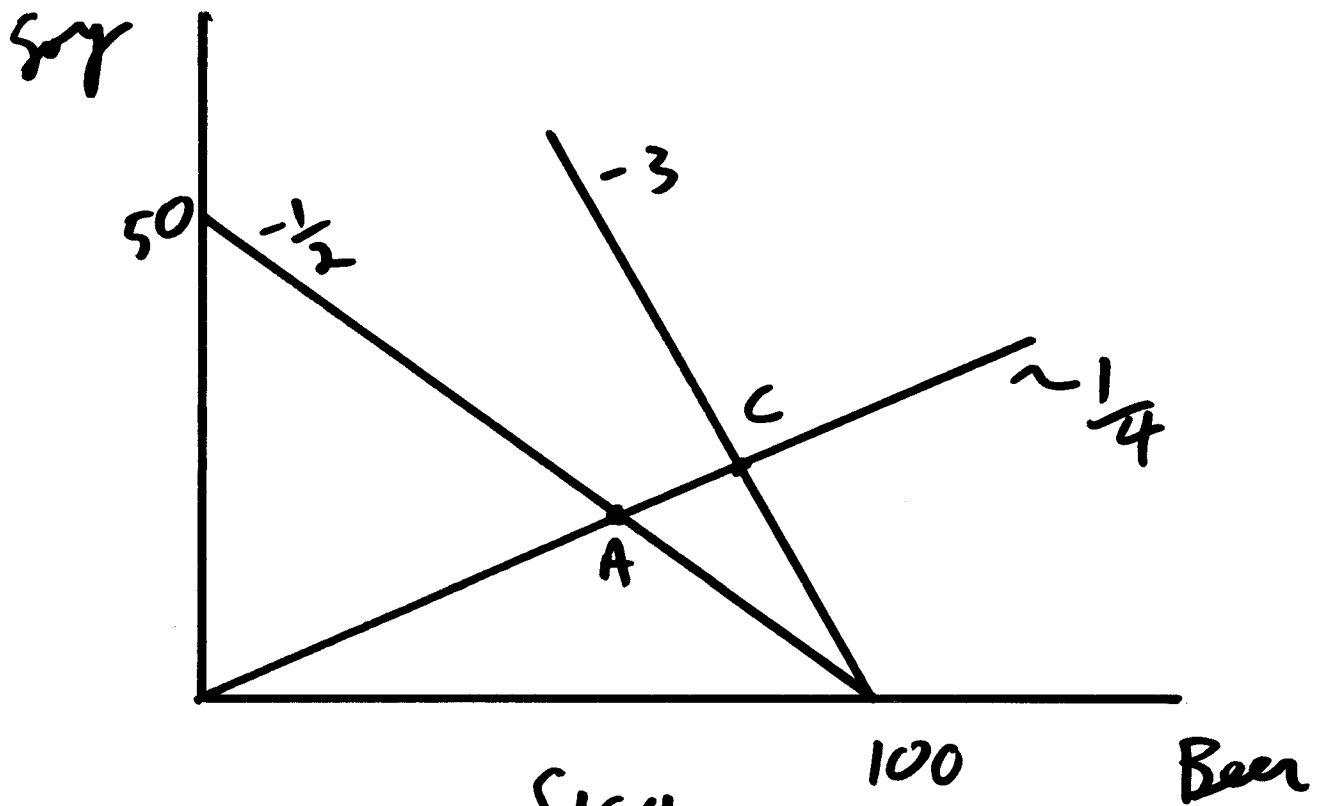


fig 4

It must still be the case (in the absence of trade) that demand equal supply in equilibrium. However, with trade, supply is equal to domestic production plus imports (or minus exports). With trade, it need not be the case that domestic demand equal domestic production in each sector. In this example, the soyburger sector closes down; all labor is in the beer sector, so beer production is  $B = 100$ . National income (the return to labor) is  $100 \cdot 3 = 300$ . The cost of consuming  $(B^c, S^c)$  at the world prices is  $3B^c + S^c$ . (The superscript  $c$  denotes consumption.) The constraint that the value of consumption equals income is

$$3B^c + S^c = 300.$$

Figure 4 graphs this "balance of payments constraint" (the line with slope equal to -3). The requirement that the value of consumption equal national income is equivalent to the requirement that the value of exports equal the value of imports. The equilibrium Consumption point under trade is point  $C$  in figure 4. (Recall that under trade equilibrium production involves specialization in Beer.) The figure also shows point  $A$ , the equilibrium production and consumption point under autarchy.

Trade increases Home's welfare because its opportunity cost of producing a commodity is DIFFERENT than the ROW's opportunity cost of producing that commodity. The gain from trade has nothing to do with the absolute costs in Home and in ROW.