Notes on Ricardo's Model of International Trade

Virtually all economists, liberal or conservative, believe free (or free-er) trade is a good thing: good for consumers, good for workers. Why? Because consumers are able to buy products from the cheapest vendor, and workers are able to take jobs that offer the highest productivity and wages. But if trade is such a good idea, why do non-economists find the idea so puzzling, and even dangerous? This is one of the most important conclusions in economics, and a central support of the current trend toward globalization, so it's worth some effort to understand it.

Ricardo's theory of trade

David Ricardo was one of the most influential economists of his day, but he came to economics by a circuitous route. Born to a Jewish family in Amsterdam, he left the country and broke off relations with his family (and they with him) to avoid an arranged marriage – he married a Quaker instead. He set himself up in London as a government securities dealer and became, in his words, "sufficiently rich to satisfy all my desires and the reasonable desires of all those about me." Looking for something to occupy his time, he developed the modern theory of international trade.

Many people of Ricardo's day (and ours!) regarded trade as a zero-sum activity: if you gain from trade, then I must lose. His insight was that both sides typically benefit, even if it appears that one has an absolute productivity advantage over the other. In his words, each country has a "comparative advantage."

We'll develop Ricardo's theory in a particularly simple setting: two countries produce and consume two products, and both products are produced with labor alone. In many respects this version of the theory is unrealistic, but the lack of realism is exactly what makes the analysis simple and understandable. We'll discuss later whether the lack of realism plays an undue role in our conclusions. (For the most part, it does not.)

To be specific, let us call the countries the US (country 1) and Mexico (country 2) and the products apples and bananas. (Yes, we know neither the US or Mexico produces many bananas, but we like the letters "a" and "b".) The starting point is a set of productivities: the quantities of output of product x (either a or b) in country i (either 1 or 2) produced with one unit of labor. An example might be:

	Apples	Bananas	Labor
US (Country 1)	$\alpha_1 = 20$	$\beta_1 = 10$	$L_1 = 100$
Mexico (Country 2)	$\alpha_2 = 5$	$\beta_2 = 5$	$L_2 = 100$

We've used both numbers and letters in the table, since we'll want to use both later on. With the numbers listed, one unit of labor produces more in the US whether it's used to produce apples or bananas. A number of factors might play a role here: perhaps the weather is better, labor is better educated, or the distribution system is more efficient.

Whatever the reason, would Mexico and the US both benefit from completely free trade, relative to a position of no trade at all? The answer is yes, but let's run through the argument. Suppose Mexico had high enough tariffs or other barriers to kill off trade altogether. Then Mexico would likely produce both products. How much of each? If Mexico has $L_2 = 100$ units of labor total, then it could produce $L_2\alpha_2 = 100*5 = 500$ apples or $L_2\beta_2 = 100*5 = 500$ bananas. It could also produce any combination in between, as shown in Exhibit 1 (the solid red line). We call the red line the possibility frontier for Mexico, since every point on the line represents a possible consumption combination. In this example, the line has a one-for-one tradeoff between apples and bananas, implying a relative price of $q = p_b/p_a = \alpha_2/\beta_2 = 1$.

What happens if Mexico can export bananas at a relative price $q > 1$ apples for each banana? (We're guessing here that since the US is more productive in apples than bananas, trade will lead to cheaper apples than bananas, hence $q > 1$.) If $q > 1$, Mexico will produce only bananas. Why? Because it can produce each at the same cost (0.2 units of labor), but bananas sell for more on the world market. As a country, it faces strictly better possibilities if it trades rather than producing both goods itself. In that case it produces only bananas ($b = 500$), then trades some for apples at a rate of q apples for every banana, which is better than the one-for-one tradeoff it got from producing apples itself. (See the blue dashed line in Exhibit 1, which is above the red solid line.)
[*As a check on your understanding: How would this work if $q < 1$? What would Mexico produce? What would its possibility frontier look like? Does Mexico still benefit from trade?*]

In short, trade benefits Mexico, even though it is less productive than the US for both products. Similar reasoning shows that the US would benefit from trade, too.
[Another check: What is the possibility frontier for the US if there's no trade?]

Ricardo had a rationale for these gains from trade: even though Mexico is less productive absolutely, it is comparatively more productive in bananas than the US. Conversely, the US is comparatively more productive in apples. If each country produces the good for which it is comparatively most productive, then world productivity rises and both countries benefit. Ricardo referred to this as the theory of "comparative advantage."

Ricardo continued (optional)

We'd like to show that moving to free trade is similar to an increase in productivity: when you shift production to high productivity products, aggregate productivity rises. The impact is similar to our discussion of capital markets. Countries with good capital markets allocate capital more effectively to the high-return projects and increase aggregate productivity as a result. This is a natural feature of trade models, but it takes some effort to work out the details, even in a setting as simple as our two-country example.

Our goal is to compare production and consumption in two economies: one with no trade, and one with completely free trade (no tariffs or transportation costs). The comparison is somewhat extreme, but the hope is that it will give us the flavor of less extreme moves toward more open trade. In each case, we need to find the competitive equilibrium. Competitive means that consumers and producers are small, and take prices as given. (No monopolies allowed here!) Formally, a competitive equilibrium is a set of prices and quantities that satisfy three conditions:

(a) Consumers are on their demand curves: they buy what they want at the given prices.
(b) Producers make zero profits (the effect of competition).
(c) Total production equals total consumption for each product.

Finding an equilibrium can be difficult, but with these conditions we can readily verify a proposed equilibrium by checking the three conditions.

Consumers. The consumer in each country supplies labor to firms, getting a wage w (say) for each unit of labor. Total income is $Y = wL$. (Both w and L can differ across countries, but we'll skip the subscripts in an effort to maintain what's left of our sanity.) How do they spend their income? Let us say (this is an assumption about demand) that total consumption in each country is a composite of apples and bananas, given by the following function:

$$c(a,b) = a^s b^{1-s}.$$

With this "Cobb-Douglas" function, a consumer spends a fraction s of her income on apples, and the complementary fraction 1-s on bananas:

$$p_a\, a = s\, Y$$
$$p_b\, b = (1-s)\, Y.$$

These are (effectively) the demand functions for the two products. We'll assume below that $s = 0.75$ in both countries.

Producers. Labor in a given country sells for w per unit, with w potentially differing across countries. A producer of apples (say) will hire labor at cost w per unit and sell apples, getting a profit of

$$\text{Profit} = a\,(p_a\alpha - w).$$

If $p_a\alpha < w$, the price is too low and no apples will be produced. If $p_a\alpha > w$, competition among apple producers will drive the price down until $p_a\alpha = w$. In short, if apples are produced, the price satisfies $p_a\alpha = w$. If the price is lower, no apples will be produced. This is the consequence of condition (b) above. Similarly, if bananas are produced, their price will be $p_b\beta = w$. If both apples and bananas are produced (and they need not be), their relative price will be $q = p_b/p_a = \alpha/\beta$.

Equilibrium without trade. The question, however, is not what the equilibrium is with trade, but how trade affects the answer. By way of comparison, consider a world with no trade – what we refer to in economics as "autarky." If there's no trade, then each country will produce both products. Let us say that the wage rate is w = 1 in both countries (but not comparable, because they may be measured in different currencies). Since the consumer has L units of labor, her income is $Y = wL = 1*100 = 100$ in each country. In the US, prices will be $p_a = w/\alpha = 1/20 = 0.05$, $p_b = w/\beta = 1/10 = 0.10$, and $q = p_b/p_a = 2$. At these prices, demand for apples and bananas are, respectively, $a = sY/p_a = 0.75*100/0.05 = 1500$ and $a = (1-s)Y/p_b = 0.25*100/0.1 = 250$. Consumption is therefore $c = a^{0.75}b^{0.25} = 958$. What about Mexico? Using similar methods, we find prices $p_a = w/\alpha = 1/5 = 0.20$, $p_b = w/\beta = 1/5 = 0.20$, and $q = p_b/p_a = 1$. Demands are a = 375, b = 125, and c = 285. The numbers are summarized in Exhibit 2 for future reference.

Equilibrium with trade. This is a little more complicated, because we need to guess which countries are making which products. We'll guess (we made up the problem, so this is relatively easy for us): Mexico produces only bananas (recall: that's its comparative advantage) and the US produces only apples (its comparative advantage). If we're wrong, we'll find out shortly. We'll guess the following prices and see how they work: w = 1 for the US, and $p_a = 0.05$, $p_b = (4/3)p_a = 0.0667$, and q = 4/3 for both countries (since there's trade, any other prices in Mexico would lead to an arbitrage opportunity). At these prices, the US will produce $L\alpha = 100*20 = 2000$ apples and consume $a = sY/p_a = 1500$ apples and $b = (1-s)Y/p_b = 375$ bananas. Aggregate consumption is c = 1061.

What about Mexico? At these prices, Mexico produces only bananas, as we guessed. Total production is $L\beta = 500$ banana. The Mexican wage rate solves $p_b\beta = w$, or $w = 0.067*5 = 0.33$. (Why is it lower than in the US? Because productivity is lower.) Mexican income is therefore $Y = wL = 33.3$. Consumption of apples is a = 500, consumption of bananas is b = 125, and aggregate consumption is 353.6.

You should be able to verify that production and consumption are equal for both products.

Bottom line

We summarize the laborious calculations of the previous section in Exhibit 2. The numbers make several points that extend to more general settings:

- Consumers are better off in both countries with free trade. In the US aggregate consumption rises from 958 to 1061. In Mexico, it rises from 285 to 354. In more realistic models, the increases are generally small (less than one percent), but theory tells us that consumers are better off with access to international markets than without. It's a byproduct of Adam Smith's invisible hand (aka known as the first theorem of welfare economics).

- Free trade changes the distribution of production. In this case, Mexico shifted out of apples into bananas, and the US did the reverse. In other models, the change in production may not be so extreme, but it's generally true that they predict that every country will stop producing some products, and import them instead. The result is a far more efficient system of production, as each country produces those goods for which its relative productivity is the highest.

- Both effects show up in macroeconomic data as increases in productivity. We could compute GDP like this: Sum production of apples and bananas, values at a consistent set of prices. In this case we'll use the free trade prices, which is similar to "PPP-adjustment" (apply the same prices in every country). GDPs at world prices are

	Free Trade	No Trade
US	100.0	91.7
Mexico	33.3	27.1

  And once trade shows up in GDP, it shows up in aggregate productivity. We don't have capital in this model, so the production function is Y = AL. Since L is unchanged across trade regimes, the change in Y reflects an increase in "total factor productivity" A.

- No jobs were created or lost. In our example, every unit of labor was used whether trade was possible or not. This is only a little extreme: no trade models suggest that trade will have much impact on employment. Any effect there might be comes from the impact on labor supply of an increase in the standard of living. So when you read the newspaper, especially in an election year, remember: trade has nothing to do with the total number of jobs, only with which jobs are created and which are destroyed.

Winners and losers

From what we've seen, free trade is a wonderful thing. Who could be against it? In fact, lots of people seem to have a passionately held view that free trade and globalization are a plague on the world. What could they be thinking. What follows is a list of arguments one might use.

Monopolies. The invisible hand of Adam Smith doesn't work if either some producers are monopolies (non-competitive, we'd say). For a monopoly, think of this: would Mexico be better off if a large US monopoly took over an industry? It depends. If the monopoly sells at a lower price than domestic producers, then they're better off. And if it doesn't, it's hard to see how it would maintain a monopoly position in Mexico. But in principle the argument for free trade depends on competition.

Externalities. This is another classic "failure" of markets, the (unpriced) impact of one person's decision on another's utility. For example, a polluting producer may inflict bad air on you and reduce your welfare. In trade, people often talk about external effects on

productivity. Are there advantages to having a local industry beyond the profit and loss? Could it help you learn how do produce efficiently, which you'd use later on? This is a legitimate argument, but probably not a good one in most cases. Moreover, it's typically used by firms and industries looking for special deals from their governments.

Differences among residents of a country. We rushed over it, but built into our theory of trade was that there was a representative consumer in each country – someone whose welfare represents the country as a whole. In practice, trade will affect each person differently. One example: in the example summarized in Exhibit 2, the representative Mexican consumer is better off. But suppose Mexicans differ in how much they spend on apples and bananas. The average Mexican spends 75% of her income on apples, but some spend 50% and some spend 100%. In this case, the one who spends less on apples and more on bananas may be worse off, since the relative price of bananas has gone up with free trade. In short, there can be losers. What the theory says, however, is that the winners win a lot more than the losers – Mexicans gain on average. In principle, you might want to take some of the winners' gains and give them to the losers, but in practice this isn't that easy to do. Another example shows up regularly in the press: people who lose their jobs when production adjusts to trade. In this case, suppose you worked for an apple producer and lost your job. The long-term answer is: get a job working for a banana producer, since their productivity is higher. But in the short run, there's no question you suffer a loss from losing your job. Again, the winners should be able to compensate the losers and still be better off, but in practice it rarely happens. More than that: people lose jobs all the time for lots of reasons, and trade is unlikely to be a major factor in most cases.

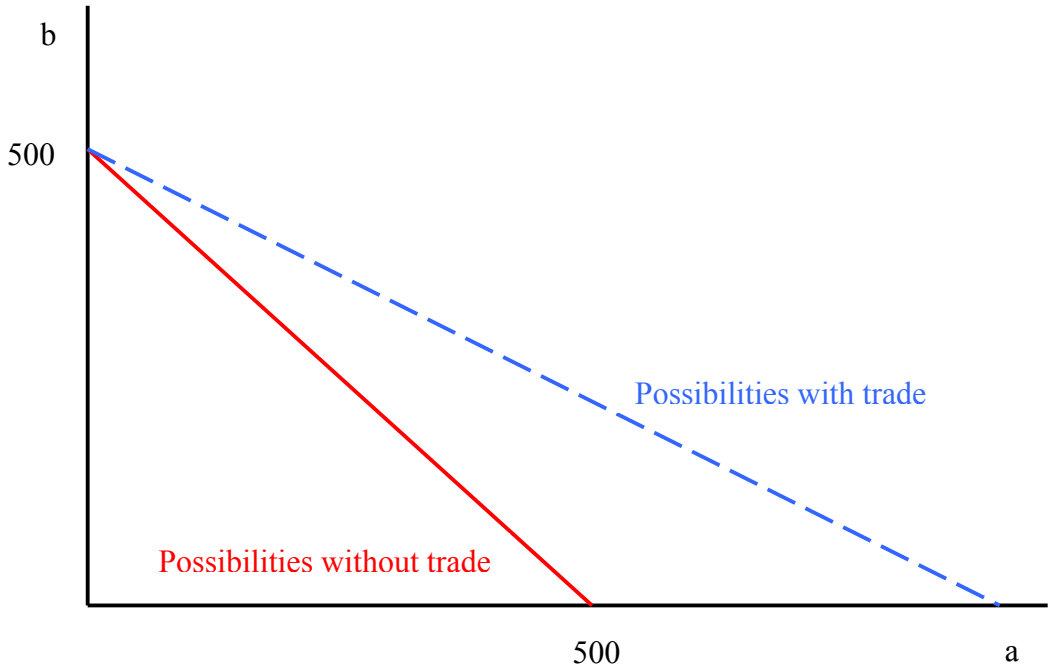
Information Sources

The personal information about Ricardo comes from a web site,

http://cepa.newschool.edu/het/profiles/ricardo.htm

The same site includes profiles of other leading economists, too.

Exhibit 1
Gains from Trade in Mexico



Notes. The figure illustrates the possible combinations of apples (a) and bananas (b) that Mexico can consume. The red (solid) line shows the possibilities if Mexico produces both goods itself. The blue (dashed) line shows the possibilities if Mexico trades in world markets at a relative price q>1 of bananas to apples (you trade q apples for one banana). Clearly trade expands the set of opportunities.

Exhibit 2
Prices and Quantities with and without Trade

	Free Trade	No Trade
	US	
Price of apples p_a	0.05	0.05
Price of bananas p_b	0.0667	0.10
Wage w	1	1 (dollar)
Consumption of apples a	1500	1500
Consumption of bananas b	375	250
Aggregate consumption c	1061	958
	Mexico	
Price of apples p_a	0.05	0.2
Price of bananas p_b	0.0667	0.2
Wage w	0.3333	1 (peso)
Consumption of apples a	500	375
Consumption of bananas b	125	125
Aggregate consumption c	354	285

Notes: Numbers pertain to a numerical example outlined in the text. They describe the equilibrium prices and quantities for two situations: one in which the US and Mexico trade freely, the other in which they do not.