Ricardian Trade Model: Chapter 7

Consider the following claims, both heard often in the debate over NAFTA:

The US should not trade freely with Mexico because the lower wages there would mean their workers would produce most or all products more cheaply than US workers and we would lose jobs in the US.

Mexico should not trade freely with the US because US workers have much higher productivity and would produce goods more cheaply, causing job losses in Mexico.

Both can't be true and our earlier analysis suggests both countries would gain from trade. Note these ideas view trade essentially as a zero-sum game rather than a positive-sum game in which trade itself is a technological improvement over no trade.

Wages compared to productivity matter within a country for trade shifts jobs between sectors; it does not destroy them overall.

This is one of the insights of thinking about *comparative advantage* or *comparative costs*.

The Classical Trade Theory, or Ricardian Model, or simply the technology-differences model, focus on CA to demonstrate GFT.

Assumptions:

1. 2 countries, 2 goods, 1 factor (labor).
2. No distortions and there is perfect competition (price = MC for all goods).
3. L is homogeneous and mobile between industries. It is immobile across countries.

4. Production functions are CRS with fixed output/labor ratios. But these coefficients vary across countries and industries.

Home: $X^h = \alpha^h L_x^h; \quad Y^h = \beta^h L_y^h; \qquad \bar{L}^h = L_x^h + L_y^h$

Foreign: $X^f = \alpha^f L_x^f; \quad Y^f = \beta^f L_y^f; \qquad \bar{L}^f = L_x^f + L_y^f$

Note these α and β coefficients are fixed by assumption and give both the *average products* and *marginal products* of labor.

We can define *absolute advantage* as a comparison of productivity: if $\beta^h > \beta^f$ then h is absolutely more productive than f in good Y. Similar rankings can be defined for good X. It is possible for one country to have an absolute advantage in both goods.

We can use these relationships to get a relationship between goods prices and wage. Consider this for home.

$L_x^h = \left(\frac{1}{\alpha^h}\right) X^h; \quad L_y^h = \left(\frac{1}{\beta^h}\right) Y^h;$ With CRS the level of output does not matter for these so let X = Y = 1.

Each good is produced with constant average (and marginal) costs = wage times unit labor input. But perfect competition implies each good has average (and marginal) costs = commodity price. So we can write

$$p_x^h = w^h L_x^h \; for \; X^h = 1 \; or \; p_x^h = \left(\frac{1}{\alpha^h}\right) w^h \;\; and \; similarly \; p_h^h = \left(\frac{1}{\beta^h}\right) w^h$$

This means that relative price depends only on labor productivities:

$$p^h = \frac{p_x^h}{p_y^h} = \left(\frac{\frac{1}{\alpha^h}}{\frac{1}{\beta^h}}\right) = \frac{\beta^h}{\alpha^h}$$

Similarly, $p^f = \frac{\beta^f}{\alpha^f}$

Comparative advantage is measured by the ratio of relative prices in autarky. So we have

$If\ \frac{\beta^h}{\alpha^h} > \frac{\beta^f}{\alpha^f}$ h has a CA in good Y because good Y is comparatively cheap and good X is comparatively expensive in autarky in h compared to f . (The same result is that $p^h > p^f$.) The reason is the relatively high (low) productivity of labor in Y (X) in h compared to f.

Stated this way CA is a ranking within each country of labor productivity across industries. It's equivalent to a ranking across countries:

$If\ \frac{\beta^h}{\beta^f} > \frac{\alpha^h}{\alpha^f}$ then h has a CA in Y and f has a CA in X.

Note one implication: demand patterns do not matter in autarky for determining relative prices and CA. Strictly a supply-side theory.

Consider a numerical example (coefficients are output per unit of labor).

	X	Y
h	4	8
f	4	3

Here h has an absolute advantage in Y but same productivity level in X. But we can immediately see that:

$p^h = 8/4 = 2$ and $p^f = 3/4$. So h has CA in Y and f has CA in X.

Also can see this by noting that h is equally productive in X but 8/3 times as productive in Y so its labor is particularly suited to Y. But that means labor in f is particularly suited to producing X in a CA sense.

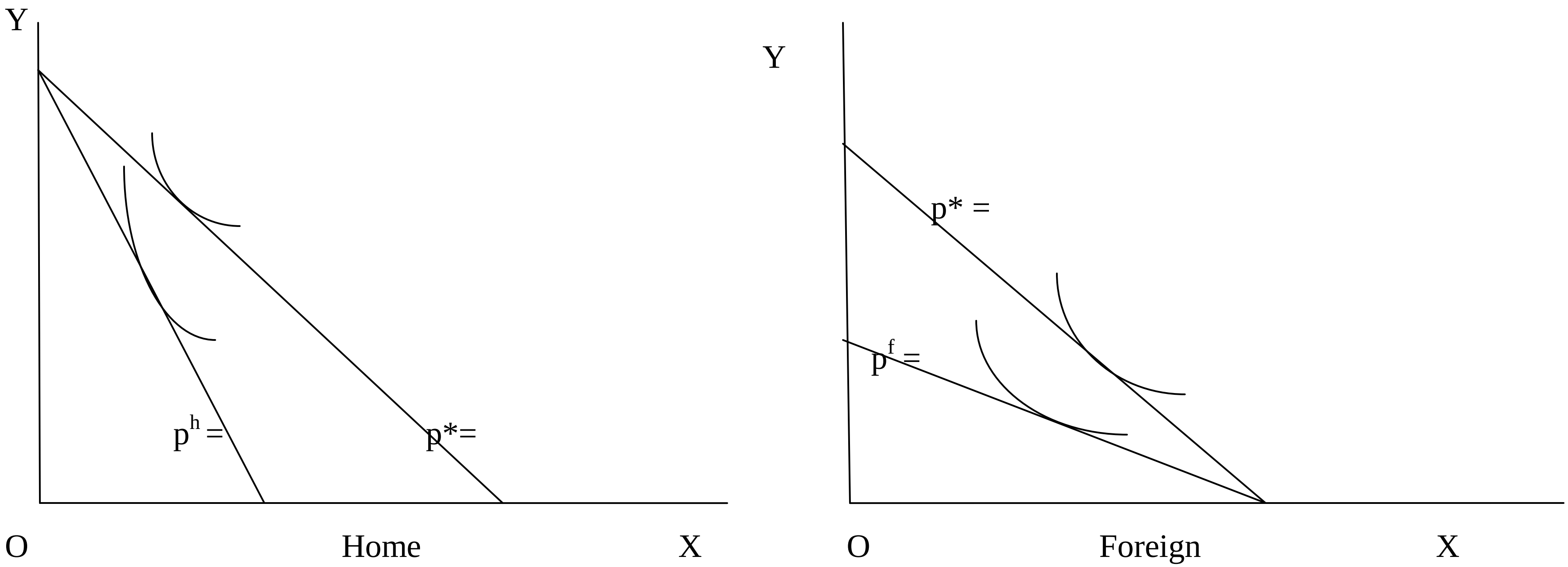
Let's also restate this in terms of *opportunity costs* of production. Suppose we take one unit of L from X in h and give it to Y. We lose 4 X, gain 8Y. If you shift one L from Y in f and give it to X you gain 4X and lose 3Y. World output of X remains the same but global output of Y rises by 5 units. So reallocation of labor is globally efficient.

In h: 1X = 2Y (or 1Y = (1/2)X) in autarky.
In f: 1X = (3/4)Y (or 1Y = (4/3)X) in autarky.

But these tradeoffs just reflect relative prices: $p^h = 2$; $p^f = 3/4$.

It is clear these countries could gain by trading with each other at some intermediate price ratio p*. If $p^* < 2$, h would specialize all its L in Y and export Y for X. If $p^* > 3/4$ f would specialize in X and export X for Y. Both would gain from trade.

Questions: what happens if $p^* > 2$ or $p^* < 3/4$? Can those be equilibrium trade prices?
And what happens if $p^* = 2$ or $p^* = 3/4$?
Let's put in some PPFs. Let $\bar{L}^h = 120$ *and* $\bar{L}^f = 160$.



We’ll fill in the relevant numerical quantities in class.

Endpoints of PPFs: for home
For foreign

Slopes of PPFs (MRTS) : for home
For foreign

Assume demand in autarky splits labor forces in half in both h and f. What are autarky consumption and production levels?
Now suppose p* = 1 and h exports 300Y and imports 300X. Show that both countries completely specialize, trade is balanced, and both gain from trade.

But here we can calculate the GFT explicitly:

	Autarky Consumption		Free Trade Consumption		GFT	
	X	Y	X	Y	X	Y
h						
f						
World						

This increase in world production and consumption is possible due to efficient specialization in trade. Trade according to CA is an *improvement in technology* over the autarky situation.

This same analysis can be translated into excess-demand curves as in Figure 7.4 and 7.5 Let h have a high relative autarky price for good X. In the Home PPF above, suppose free trade happens but hold p fixed at autarky level. Then consumption would remain at the autarky point but h could produce more Y and less X along PPF, permitting exports of Y and imports of X. This is a linear trade reaction at given price until we reach complete specialization, explaining the flat portion of the excess demand curve in Figure 7.4. Beyond complete specialization the world price falls and imports and welfare rise for h. (And note it is possible to move in the other direction if h had a CA in good X; there would be a flat part up to complete specialization then exports at higher p*.)

Similar analysis generates f's export-supply curve in Figure 7.5. Equilibrium is shown with price p*

Notes

1. Trade is balanced physically (what h exports is same as what f imports and vice-versa)
2. Trade is balanced in value terms for both countries:

$$p^* E_y^h = M_x^x \text{ and } p^* M_y^f = E_x^f$$

Again, this condition means that for each country the value of production = value of consumption.

3. Trade is globally Pareto-Optimal ($MRS^h = MRS^f = p^*$)
4. p* becomes the price ratio in both countries.
5. What determines the share of GFT between h and f?
   Has larger gains here than f. Why?

   In h price moved from 2 to 1 (a -50% change, which is really a gain in terms of trade).
   In f price moved from ¾ to 1 (a +33% change, also a gain in terms of trade).

   In general, the larger is the relative change in price the greater is the share of GFT.

   An interesting example for you to work out: Suppose f is small with a labor endowment of just 16 workers, while h remains large at 120 workers. Now figure out their PPFs and convince yourself that even if f fully specializes in X it cannot satisfy demand for X in both h and f. The result must be p* = 2 and only f gains from trade. Does h lose in this case?

   So we have these concepts introduced before:

   A *small country* is a price taker; its decisions to export or import have no effect on world prices.
   A *large country* is a price maker; its decisions do matter for world prices.

   Figure 7.8 in the text shows this situation where h is small and f is large.

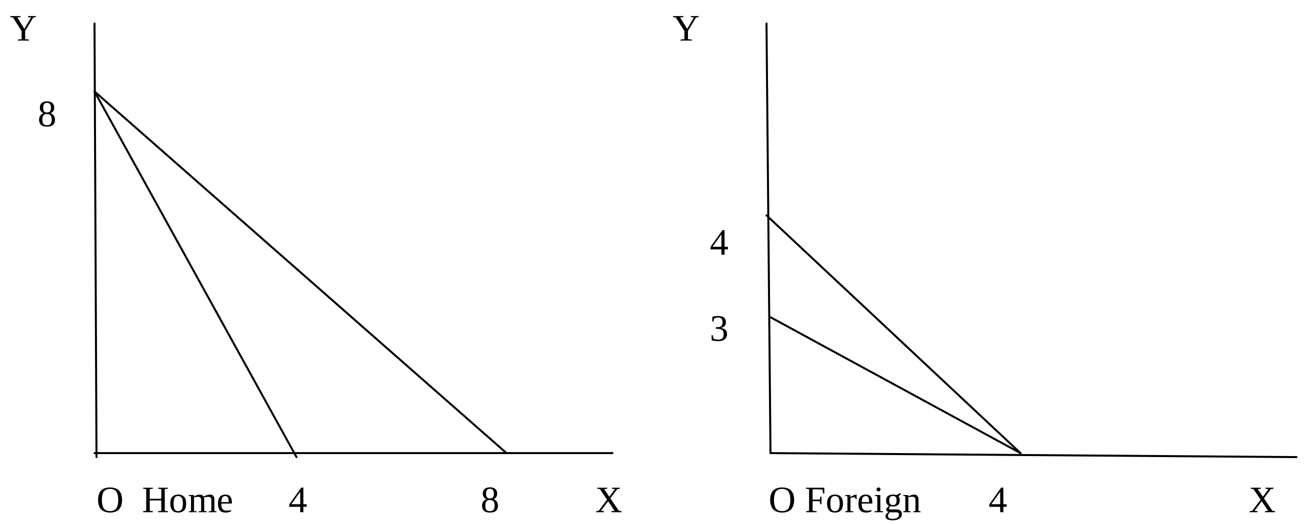
   Our analysis so far says that small countries can trade at given world prices and achieve substantial GFT from improved prices and specialization. It seems odd then that small countries often restrict trade. We'll have to try to figure that out later.

Note an interesting implication: CA and the GFT depend only on relative labor productivities and the change in the terms of trade. Nowhere did we discuss the idea that nominal wages matter for anything. We'll look at that later with an example.

Another question: in the case where both h and f gain overall, does everyone inside those countries gain individually? Yes because all workers are identical in tastes and preferences. Can see this with individual budget constraints.
What are real wages in autarky?

For home we have $\frac{w_h}{p_x^h} = \alpha^h; \quad \frac{w_h}{p_y^h} = \beta^h$

and similarly for foreign.
This means that real wages (wage divided by price of each good) are just equal to marginal products of labor in autarky. But each worker has one unit of labor so these coefficients determine her real wages and endpoints of budget constraint:



What about real wages in free trade? Since f has CA in X and h in Y, we find that only f produces X and only h produces Y (unless one country is so large it has to produce both).

Then $p_y^* = w^{h*}\left(\frac{1}{\beta_h}\right)$ *and* $p_x^* = w^{f*}\left(\frac{1}{\alpha_f}\right)$ here these w's indicate nominal wages in free trade, which should be different than in autarky.

Compute real wages compared to these prices:

Home: $$\frac{w^{h*}}{p_y^*} = \beta^h \ and\ \frac{w^{h*}}{p_x^*} = \beta^h\left(\frac{p_y^*}{p_x^*}\right) = \frac{\beta^h}{p^*} > \alpha^h.$$

This says there is no change in h's real wage in good Y (which it produces in free trade) but h workers have a higher real wage in good X (which h imports in free trade).

The last inequality above holds because $p^* < \frac{\beta^h}{\alpha^h}$ due to comparative advantage.

Now consider foreign. You should go through similar analysis to show that:

Foreign: $$\frac{w^{f*}}{p_x^*} = \alpha^f \ and\ \frac{w^{f*}}{p_y^*} = \alpha^f\left(\frac{p_y^*}{p_x^*}\right) = \alpha^f p^* > \beta^f.$$

(Why does this last inequality hold? Because $p* > \frac{\beta^f}{\alpha^f}$)
So there is no change in real wage in X but a higher real wage in Y.

These real wages in free trade determine the new endpoints of the budget constraints above. With p* = 1 we see that workers in h in principle could specialize in Y and trade for as much as 8 X; workers in f could specialize in X and trade for as much as 4 Y. Each person gains from trade.

Let's see if we can do this analysis using examples of nominal prices and wages.

Suppose 2 countries are US and Mexico, while the goods are Chemicals (C) and Radios (R). Let's take the same productivity numbers as before:

	R	C
US	4	8
M	4	3

US is more productive in C and same productivity in R. Mexico is less productive in C. This should affect real wages in the 2 countries and the ratio of their wages.

Assert that in free trade: min $w^M/w^{US} = 3/8$ max $w^M/w^{US} = 1$.

First consider prices and costs in autarky. Let w^M = \$1 and w^{US} = \$10. (Comment: in general we would also have to think about the exchange rate to convert peso wage into dollars but let's ignore this. The exchange rate in this analysis is another nominal price that will adjust to reflect comparative advantage.)

Now price = unit cost in each country, each good. Unit cost is wage divided by labor productivity.

	R	C
US	10/4 = \$2.50	10/8 = \$1.25
M	¼ = \$0.25	1/3 = \$0.33

note that $\frac{p_R^{US}}{p_C^{US}} = 2\ and\ \frac{p_R^{M}}{p_C^{M}} = 3/4$, which is consistent with relative costs based on productivity.

Real wages in autarky are nominal wage divided by prices:

	R	C
US	10/2.50 = 4	10/1.25 = 8
M	1/0.25 = 4	1/0.33 = 3

can see that real wages equal marginal products.

Suppose these countries decide to trade with each other. Both prices are lower in Mexico so in a transition US might buy both there and none in the US but this would drive up M wage and drive down US wage. Sounds good for M and bad for US but that's not the case. Let the new wages be w^{US} = \$9 and w^{M} = \$5. Now what are production costs in US and M?

US: $p_R^{US} = \frac{\$9}{4} = \$2.25;\quad p_C^{US} = \frac{\$9}{8} = \$1.13$

Mexico: $p_R^{M} = \frac{\$5}{4} = \$1.25;\quad p_C^{M} = \frac{\$5}{3} = \$1.67$

We see that C is cheap in US and R is cheap in Mexico (consistent with CA) and the countries can trade advantageously. Here is the answer to earlier question: nominal wages (and exchange rates) "don't matter" because they must adjust to reflect underlying comparative advantage. Question: if this were an analysis of the exchange rate, which currency would get more expensive?

Now let's look at real wages in free trade and see if workers gain in M and US. Note that US specializes in C and M in R so the prices in free trade depend where they are produced, even though they are consumed at the same free-trade prices:

$$p_R^* = \$1.25 \quad p_C^* = \$1.13$$

Real wages are nominal wages divided by prices:

US: $\frac{w^{US*}}{p_R^*} = \frac{\$9}{\$1.25} = 7.2$ in terms of radios (each worker can buy 7.2 radios per hour of work.)

$\frac{w^{US*}}{p_C^*} = \frac{\$9}{\$1.13} = 8$ in terms of chemicals.

Show that real wages in Mexico are 4 radios, 4.4 chemicals.

Note two important things:

1. Real wages stay the same in terms of the export good because marginal products do not change and that good is produced where it is exported from.
2. Real wages are higher in terms of the import good because its price falls relative to the wage (radios for US) or fell while the wage rose (chemicals for M).

So all workers are better off. You should show this in terms of their individual budget constraints, which are higher in free trade for the import good.

And some more important points regarding wages in free trade:

1. The US has higher real wages than Mexico in both goods because US labor is more productive than M labor. In the Ricardian model labor cannot move between countries, but if we allowed labor migration, all of Mexico would move to the US.
2. We can calculate limits to relative international wages from underlying productivity ratios. Define $w^* = w^{M*}/w^{US*}$ (sometimes called the "labor terms of trade" or "factoral terms of trade".) In the example above we had w* = 0.1 in autarky and w* = 5/9 = 0.56 in free trade. But we can see that

   Min w* = 3/8 = 0.375 (given by C where M is least productive compared to US).
   Max w* = 4/4 = 1.0 (given by R where M is most productive compared to US).

   If the ratio is below the minimum M would produce both goods cheaper than US, which cannot be an equilibrium. If the ratio is above the maximum US would produce both cheaper.

   Clearly as p* rises, so does w* (recall p* is relative price of R in trade, the good Mexico exports.) So an increase in p* implies a rise (fall) in M real wages (US real wages). In example above, p* = $1.25/$1.13 = 1.106 (M's terms of trade). Now let the price of radios rise to get p* = $1.50/$1.13 = 1.327. We can now calculate new real wages, noting nominal wages must change also.

   New nominal wages: w^{M*} = 4x$1.50 = $6.00
   w^{US*} = 8x$1.13 = $9.00 (no change)

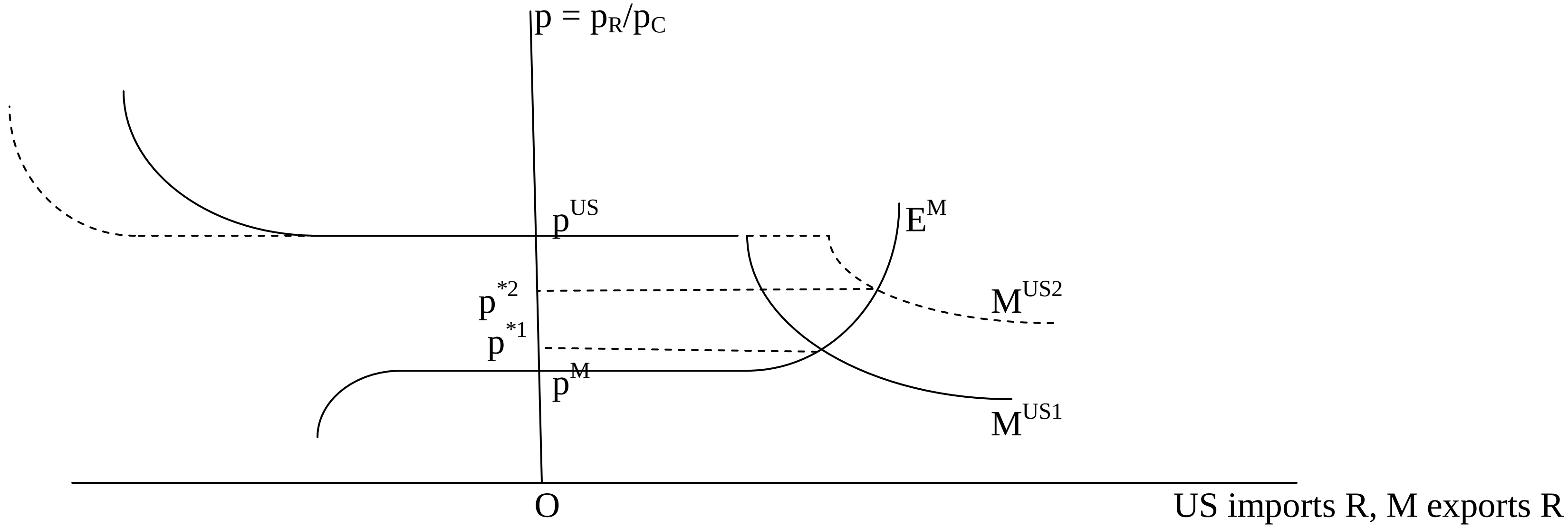
   Note that w* = 6/9 = 0.67 is higher.

   New real wages: Mexico in good R = $6/$1.50 = 4 (no change)
   Mexico in good C = $6/$1.13 = 5.31 (higher than 4.44)

   US in good R = $9/$1.50 = 6 (less than 7.2)
   US in good C = $9/$1.13 = 8 (no change)

So a rise in p* is good for M (bad for US) because it also alters real wages. But that's not surprising; if you raise p* in the individual budget constraints you'll find M workers have a better ability to consume and US workers have a diminished ability to consume.

One practical example: suppose US gets larger in the sense of a higher labor force without a change in productivity. Then its excess-demand curve expands at the autarky price ratio as follows:



In this case after the US growth we find that Mexico's terms of trade are better and US terms of trade are worse. This growth causes US to export more C and import more R, raising the relative price of R. Because workers in US are not more productive but they face a worse terms of trade, US is worse off compared to the initial free trade case. Mexico is better off. Note here is a case where having a higher trade volume does not imply higher welfare. This case is called "immiserizing growth" for the US.

SUMMARY

1. Real wages rise in free trade compared to autarky due to lower import prices.
2. There are limits to both p* and w*, determined by productivity ratios.
3. As terms of trade change, so does the wage ratio.
4. Nominal wages adjust to lie within the limits to w* in free trade, reflecting CA.
5. If one country is absolutely more productive in both goods (or at least one and equally productive in the other) it will have higher real wages than the other country in free trade. But both gain from trade; there are higher real wages in both compared to autarky. In this case in free trade there would be an incentive for labor to migrate from the low-productivity location to the high-productivity location.

An important practical point: real wages ultimately reflect marginal labor productivity. In industries where nominal wages become quite high in relation to labor productivity, imports are likely to increase and reduce domestic output. In extreme case the industry may shut down altogether. (Think of US steel in 1970s-80s; textils and apparel, 1960s-now; airlines 1990s-now. Can you think of other examples?)

Some actual data on wages and productivity are in new section 7.6.