Labor Productivity and Comparative Advantage: The Ricardian Model of International Trade

- Model of trade with simple (unrealistic) assumptions. Among them:
  - perfect competition;
  - one representative consumer;
  - no transaction costs, no trade barriers …

- Results: countries trade because they are different from each other:
  - each produces the good or services that it does relatively well;
  - even the least efficient producing country find an advantage to trade.

- Two different families of trade determinants

- Gain from trade
  - based on differences: gains from specialization. A country gains when it specialized in its most productive sector;
  - based on similarities: gains from economies of scales. Each country produces only a limited range of goods, it can produce each of these goods more efficiently than if it tried to produce everything.

- Empirical Results: both types of determinants exist
  - based on differences: more relevant for North-South trade flows;
  - based on similarities: more relevant for North-North trade
  - it is easier to study both type of models within two different models rather than unifying both approach
The concept of comparative advantages

- Comparative advantage exists when a country has an absolute or relative superiority in the production of a good or service i.e. where the opportunity cost of production is lower.
- Opportunity costs describe a trade-off. In order to produce more of one good, a country must retrieve resources from other sectors. The opportunity cost of good 1 in terms of good 2 is the number of good 2 that could have been produced with the resources used to produce a given number of good 1.

Example: absolute comparative advantage

- A country is said to have the absolute advantage in production if it can produce the same amount of output with less input relative to other countries.

<table>
<thead>
<tr>
<th></th>
<th>One unit of wine</th>
<th>One unit of cheese</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switzerland</td>
<td>5 labor hrs</td>
<td>2 labor hrs</td>
</tr>
<tr>
<td>France</td>
<td>3 labor hrs</td>
<td>6 labor hrs</td>
</tr>
</tbody>
</table>

France has an absolute advantage in the …… production and Switzerland has an absolute advantage in the …… production
- France should specialized in ……
- Switzerland should specialized in ……

Why France and Switzerland end up producing the goods in which they have comparative advantages?

Will trade make both country better-off?
- The Ricardian Model
• Hypothesis:
  – one factor of production: Labor (L). Immobile across countries, mobile between sectors
  – only two goods, wine and cheese;
  – perfect competition. Firms do not affect market prices;
  – two identical countries in term of size, home and foreign (*);
  – … BUT different technologies

• Technology
  – summarized by labor productivity in each industry
  – expressed in term of input factor requirement: the number of hour of labor to produce a pound of cheese (\(a_{LC}\)) or a gallon of wine (\(a_{LW}\)).
  – Economy total resources are defined as L: the total labor supply

• Labor Productivity:
  – quantity of output that can be produced with a unit of labor.
  – since \(a_{LC}\) represents hours of labor needed to produce one pound of cheese, its reciprocal, \(1/a_{LC}\), represents the labor productivity of cheese production in a specific country. Similarly, \(1/a_{LW}\), represents the labor productivity of wine production in this country.

• Production Possibilities:
  – limited resources to produce one good. Amount of good depends on L;
  – trade-off: to produce more of one good the economy sacrifices some production of the other goods;
  – Trade-off is represented by a production possibility frontier: maximum amount of a good that can be produced once the decision has been made to produce any given amount of the other goods.
  – \(Q_c\) is the amount of cheese produced, \(Q_w\) is the amount of wine produced
  – \(a_{LC}Q_c\) is the amount of labor used in producing cheese and \(a_{LW}Q_w\) is the amount of labor used in producing cheese, so that the technical constraint is:
    \[ a_{LC}Q_c + a_{LW}Q_w \leq L \]
Relative Prices and Supply

- Assume $P_c$ and $P_w$ be the price of cheese and wine respectively;
- it takes $a_c$ person-hours to produce a pound of cheese and $a_w$ person-hours to produce a pound of wine.
- Assume perfect competition with one factor of production: Labor;
- labor move to the sector that pays the higher wage;
- so that hourly wage in the cheese sector will equal the value of what a worker can produce in an hour. Profit : Revenue - Cost

\[
\Pi = P_c Q_c - w_c a_c Q_c = 0
\]

\[
w_c = \frac{P_c}{a_c}
\]

- Same for the wine sector.
- Wages in the cheese sector will be higher if $P_c > \frac{a_w}{a_c}$
- Wages in the wine sector will be higher if $P_w > \frac{a_w}{a_c}$

In Autarky (absence of trade), the relative prices of goods are equal to their relative unit labor requirement
Country specialization (it devotes all its resources in one sector)

- The economy specialized in the production of cheese if $\frac{P_C}{P_L} > \frac{a_L}{a_C}$
- it specialized in the production of wine if $\frac{P_C}{P_L} < \frac{a_L}{a_C}$
- it specialized in the production of both goods if $\frac{P_C}{P_L} = \frac{a_L}{a_C}$

A country specializes in the production of one particular good if its relative price exceeds its opportunity cost.

Trade

- Two countries: home (France) and foreign (Switzerland) which will always denoted by the superscript *.
- Assume that foreign is more productive in wine than in cheese thus:

  \[
  \frac{a_L}{a_W} < \frac{a_L}{a_C} \quad \text{or} \quad \frac{a_L}{a_C} < \frac{a_L}{a_W}
  \]

- Home has a comparative advantage in cheese and exports its relative cheaper cheese in the foreign country;
- foreign has a comparative advantage in wine and export wine;
- this is the relative advantage and not the absolute advantage that determines trade.

A numerical example

- A country has a relative advantage in the production of a good if it can produce that good at a lower opportunity cost relative to another country
- Suppose one country has an absolute advantage in the production of both goods. Even in this case each country will have a comparative advantage in the production of one of the goods

<table>
<thead>
<tr>
<th></th>
<th>One unit of wine</th>
<th>One unit of cheese</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switzerland</td>
<td>4 labor hrs</td>
<td>2 labor hrs</td>
</tr>
<tr>
<td>France</td>
<td>5 labor hrs</td>
<td>15 labor hrs</td>
</tr>
</tbody>
</table>
• In Switzerland, in order to produce one more unit of wine, resources must be pulled from their next best use: cheese production.

Specifically, 1 unit of wine will require the sacrifice of 2 units of cheese since 1 unit of wine requires 4 hours of labor input that must be drawn from cheese production.

Pulling 4 labor hours away from cheese, means giving up the production of 2 units of cheese (each 'kilo' of cheese requiring 2 labor hours). This sacrifice of cheese represents the opportunity "cost" of producing each additional unit of rice.

• Thus in the case of Switzerland:
  1 unit of wine will "cost" 2.0 units of cheese
  1 unit of cheese will "cost" 0.5 unit of wine

• The case of France:
  1 unit of cheese will "cost" 3.0 units of wine
  1 unit of wine will "cost" 0.333 unit of cheese

Because foreign country’s relative unit labor requirement in cheese is higher than Home’s, its production possibility frontier is steeper.

• Relative prices after trade
  – home exports its relative cheaper cheese in the foreign country and import wine;
  – foreign export its relative cheap wine in the home country and import cheese
  – This is profitable as long as there are relative price differences;
  – Compare autarky and free-trade. In autarky both goods are produced, wages are equalized between sectors

\[
\frac{w_c}{w_w} \Leftrightarrow \frac{w_c}{w_w} = \frac{p_w}{a_{wx}} = \frac{p_w}{a_{cx}} = w_{cw}
\]

\[
\Leftrightarrow \frac{p_w}{P_w} = \frac{a_{cx}}{a_{cy}} \text{ relative price = opportunity cost}
\]
– World Trade Price?

\[ \frac{p_W}{p_C} \quad \text{Free Trade} \quad \frac{p_F}{p_C} \]

– One useful way to keep track of two markets at once is to focus not just on the quantities of cheese and wine supplied and demanded but also on the relative supply and demand

– Relative Demand: \( \frac{dQ_D}{dP} \) decreases with \( \frac{P_C}{P_W} \)

– Relative Supply more difficult. 3 Cases

– Assume that home has a comparative advantage in the cheese production

Case 1

\[ \frac{PC}{PW} = \frac{a_{LC}}{a_{WC}} < \frac{a_{LC}}{a_{WN}} \]

\[ a_{LC}/W = \]

• Home and foreign specialize in wine;
• No world supply of cheese below this threshold

Case 2

\[ \frac{PC}{PW} = \frac{a_{LC}}{a_{WC}} < \frac{a_{LC}}{a_{WN}} \]

\[ a_{LC}/W = \]

• The relative price of cheese is exactly equal to the threshold value.
• Workers at home earn exactly the same wage in both sector. Home supply any relative quantities of the two goods;
• Foreign produce only wine.
• The relative supply curve is flat.
The relative free trade price of cheese is between both autarky prices. Workers at home earn more in the cheese sector. Home specializes in the cheese production. Home production of cheese: $Q_h = \frac{a_{1h}}{a_{c1}}$.

Foreign produce only wine: $Q_f = \frac{1}{a_{1f}}$.

Summary

- Equilibrium price after trade between both autarky price $\Rightarrow$ each country specializes according to its comparative advantage;
- Equilibrium price after trade equal home (foreign) opportunity cost $\Rightarrow$ home (foreign) specializes according to its comparative advantage;
- Equilibrium prices are determined by relative supply and demand;
- Workers move freely between sectors according to their wages.

Gain from trade. Methodology 1: Graphics

- Trade is indirect method of production: home could produce wine directly but trade allows home to produce cheese and exchange it through trade with the foreign country.
- This indirect method of production is efficient because each country specializes in the production of good where it has a comparative advantage.
• Gain from trade. Methodology 2: Compare autarky and free trade

– Autarky: hourly production is \( \frac{1}{a_{LW}} \) unit of wine;
– Alternatively under free trade: home could use this hour to produce \( \frac{1}{a_{LC}} \) unit of cheese, which could be exchanged for wine so that the original hour of labor yields \( \frac{p_C}{p_W} \cdot \frac{1}{a_{LC}} \)
– This will be beneficial as long as

\[
\frac{p_C}{p_W} \cdot \frac{1}{a_{LC}} > \frac{1}{a_{LW}} \quad \text{or} \quad \frac{p_C}{p_W} > \frac{a_{LC}}{a_{LW}}
\]

• Gain from trade. Numerical example.

<table>
<thead>
<tr>
<th></th>
<th>Cheese</th>
<th>Wine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home</td>
<td>( a_{LC} = 1 )</td>
<td>( a_{LW} = 2 )</td>
</tr>
<tr>
<td>Foreign</td>
<td>( a_{LC} = 6 )</td>
<td>( a_{LW} = 3 )</td>
</tr>
</tbody>
</table>

– Autarky:
– home: opportunity cost of cheese is \( \frac{1}{2} \) unit of wine;
– Foreign opportunity cost of cheese is 2 units of wine;

– Trade: assume \( \frac{a_{LC}}{a_{LW}} \cdot \frac{p_C}{p_W} \cdot \frac{a_{LC}}{a_{LW}} \leq \frac{1}{2} \cdot \frac{p_C}{p_W} = 1 < 2 \)
– Home specializes in cheese
– Foreign specializes in wine

• Pattern of specialization produces gain from trade

– *direct production of wine*: 1 hour of Home labor produces only \( \frac{1}{2} \) unit of wine;
– *indirect production of wine*: 1 hour of Home labor produce 1 unit of cheese, which can be traded for 1 unit of wine.
– Similar for Foreign

• Differences between countries’ technologies produce the gain from trade

– if \( \frac{a_{LC}}{a_{LW}} \cdot \frac{p_C}{p_W} = \frac{a_{LC}}{a_{LW}} \): no gain from trade

– only one country gains if the relative prices do not change after trade
### Relative wages.

- Home specializes in cheese. All workers are employed in cheese and earn 1 unit of cheese per hour of labor;
- Foreign workers produce only wine and earn 1/3 unit of wine per hour of labor;
- Assume price of 1 unit of wine=price of one unit of cheese=12€:
  - Home workers earn 12€/h; foreign workers earn 4€/h;
  - relative wage of Home workers = 3 (12/4). Does not depend on the prices of wine and cheese.

- Home workers earn three times more than foreign workers. This ratio lies between both autarky productivities. This is precisely why country ends up with a cost advantage in one good.
- Home is 6 times as productive as Foreign in cheese, but only 1.5 times as productive in wine; Home ends up with a wage rate three times as high as Foreign’s.
- Because of its lower wage rate, Foreign has a cost advantage in wine, even though it has lower productivity.
- Home has a cost advantage in cheese, despite its higher wage rate, because the higher wage is more than offset by its higher productivity.

### Productivity and competitiveness.

- gains from trade depend on comparative rather than absolute advantage in productivity;
- An absolute advantage in producing a good is neither necessary nor a sufficient condition to yield competitive advantage;
- The competitive advantage of an industry depends not only on its productivity relative to the foreign industry, but also on the domestic wage rate relative to the foreign wage rate (see numerical example).
• Productivity and wages.

We assumed that the relative wage of the two countries reflects their relative productivity. What is the evidence?

– If wage were exactly proportional to productivity. All points in the graph would lie along the 45° line.
– … in the real world, national wages rates reflect differences in productivity;

• Differences in productivity reveal poverty and income inequality

Difference in productivity

– Educational policies
– Human capital stock
– Technologies
– Institutions

Could countries specialize in the wrong sector?

– India and UK in the 19th century

• Is a comparative advantage based on low wage unfair? Pauper labor argument.

– “Foreign competition is unfair and hurts other countries when it is based on low wages.” Is it true?
  – Our numerical example: Home is more productive than Foreign in both industries, and Foreign’s lower cost of wine production is entirely due to its much lower wage rate;
  – Foreign’s lower wage rate is irrelevant to the question of whether Home gains from trade (lower cost of wine produced in Foreign is either due to high productivity or low wages, does not matter to Home);
  – All that matters to Home is that it is cheaper in terms of its own labor for Home to produce cheese and trade it for wine than to produce wine for itself.
• Exploitation.
  – Trade makes a country worse off if its workers receive much lower wages than workers in other nations." Is it true?
  – Our numerical example:
    – Foreign workers are paid much less than Home workers.
    – if Foreign refused trade with Home, real wages would be even lower: the purchasing power of a worker’s hourly wage would fall from 1/3 to 1/6 unit of cheese.

• Comparative advantages with many goods.
  – Technology of each country can be described by its unit labor requirement for each good
    \[ a_i \in [1, N] \text{ at Home} \]
    \[ a_i^* \in [1, N] \text{ in foreign country} \]
  – Classify goods according to their relative productivity. Trick: calculate the ratio of Home’s unit labor requirement to Foreign’s.
    \[ \frac{a_{i1}}{a_{i1}^*} < \frac{a_{i2}}{a_{i2}^*} < \cdots < \frac{a_{iN}}{a_{iN}^*} \]

• Relative wages and specialization.
  – Let \( w \) be the wage rate per hour in Home and \( w^* \) be the wage rate in Foreign. The ratio of wage rates is then \( w/w^* \).
  – Goods will always be produced where it is cheapest to make them:
    – at Home for instance if: \( wa_{i1} < w^*a_{i1}^* \Leftrightarrow \frac{a_{i1}}{a_{i1}^*} > \frac{w}{w^*} \)
    – in Foreign if: \( wa_{i1} > w^*a_{i1}^* \Leftrightarrow \frac{a_{i1}}{a_{i1}^*} < \frac{w}{w^*} \)
– wage rates ratio determines countries’ specialization;

– All the goods to the left of the cut end up being produced in Home; all the goods to the right end up being produced in Foreign.

<table>
<thead>
<tr>
<th>Good</th>
<th>Home</th>
<th>Foreign</th>
<th>Relative Home productivity advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple</td>
<td>$a_{A1} = 1$</td>
<td>$a_{A2} = 10$</td>
<td>$a_{A1}/a_{A2} = 10$</td>
</tr>
<tr>
<td>Bananas</td>
<td>$a_{B1} = 5$</td>
<td>$a_{B2} = 40$</td>
<td>$a_{B1}/a_{B2} = 8$</td>
</tr>
<tr>
<td>Caviar</td>
<td>$a_{C1} = 3$</td>
<td>$a_{C2} = 12$</td>
<td>$a_{C1}/a_{C2} = 4$</td>
</tr>
<tr>
<td>Dates</td>
<td>$a_{D1} = 6$</td>
<td>$a_{D2} = 12$</td>
<td>$a_{D1}/a_{D2} = 2$</td>
</tr>
<tr>
<td>Enchiladas</td>
<td>$a_{E1} = 12$</td>
<td>$a_{E2} = 9$</td>
<td>$a_{E1}/a_{E2} = 0.75$</td>
</tr>
</tbody>
</table>

If Home wage rate is five times that of Foreign (a ratio of Home wage to Foreign wage of five to one), apples and bananas will be produced in Home and caviar, dates, and enchiladas in Foreign.

If the Home wage rate is three times that of Foreign, Home produce apples, bananas, and caviar, while Foreign produce dates and enchiladas.

• Relative wages in the multi-goods model

No direct demand on the part of consumers — derived demand. The relative derived demand for Home labor will fall when the ratio of Home to Foreign wages rises, for two reasons:

1. As Home labor becomes more expensive relative to Foreign labor, goods produced in Home also become relatively more expensive, and world demand for these goods falls.

2. As Home wages rise, fewer goods will be produced in Home and more in Foreign, further reducing the demand for Home labor.

→ explain the stepped shape of RD
• **Transport costs and non-traded goods**

World economy described by the Ricardian model is marked by very extreme international specialization.

Countries might also produce the good that they import:
- existence of more than one factor of production reduces the tendency specialization;
- countries sometimes protect industries from foreign competition;
- It is costly to transport goods and services, and in some cases the cost is enough to lead countries into self-sufficiency in certain sectors.

Some goods are non-traded

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• **Transaction costs matter: Anderson and van Wincoop (2004)**

  - Transaction costs are large: Total trade costs in rich countries are large → tax equivalent is about 170%:
    - 55% local distribution costs;
    - 44% border related; about 74% trade costs (1.21 x 1.44 = 1.74)
    - 21% transportation costs.

  - Example: Mattel’s Barbie doll: production costs = 1$; price = 10$ → Differences: transportation costs, distribution costs, marketing costs … In this example: tariffs equivalent = 900%.

  - Transport costs have important implication for developing countries:

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• **Ricardo: Empirical Evidence 1**

  - higher relative productivity in the U.S. industry → U.S. export more in that industry than UK.

  - having high productivity in an industry compared with foreigners is not enough to ensure that a country will export that industry’s products; the relative productivity must be high compared with relative productivity in other sectors;

  - in general, U.S. exports were larger than U.K. exports only in industries where the U.S. productivity advantage was somewhat more than two to one.
• Ricardo: Empirical Evidence II
  – Golub et Hsieh (2000): recent empirical test. Find that a 1% increase in US relative productivity leads to a $\beta$% increase in relative export

\[
\frac{\text{Export US}}{\text{Export Country } i} = \alpha + \beta \ln \left( \frac{\text{Labor Productivity US}}{\text{Labor Productivity Country } i} \right)
\]

<table>
<thead>
<tr>
<th>Country</th>
<th>$\beta$</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>0.33</td>
<td>3</td>
</tr>
<tr>
<td>Germany</td>
<td>0.19</td>
<td>4.3</td>
</tr>
<tr>
<td>UK</td>
<td>0.09</td>
<td>2.8</td>
</tr>
</tbody>
</table>

Low $R^2$: other determinants might be relevant and important