Ricardian Model
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Some terms used:
No (international) trade: autarky or closed economy
(International) trade: open economy.
Basic premise: trade fosters specialization and specialization is at the root of the gains from trade.
Example:
In England, a specific amount of resources can produce
  Either 1,000,000 m of cloth
  Or 1,000 hl of wine
The opportunity cost of 1,000 hl of W is 1,000,000 m of C

In Portugal, a specific amount of resources can produce
  Either 100,000 m of cloth
  Or 1,000 hl of wine
The opportunity cost of 1,000 hl of W is 100,000 m of C
• The opportunity cost of producing wine is clearly lower in Portugal: Portugal has a *comparative advantage* in the production of wine.

• What happens if the 2 countries alter their production in preparation for exchanging 1,000 hl of wine?

• Before trade actually takes place, the following table illustrates the potential gains from specialization.
Hypothetical change in production

<table>
<thead>
<tr>
<th></th>
<th>Wine (hl)</th>
<th>Cloth (1,000 m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>England</td>
<td>-1,000</td>
<td>+1,000</td>
</tr>
<tr>
<td>Portugal</td>
<td>+1,000</td>
<td>-100</td>
</tr>
<tr>
<td>Change in world production</td>
<td>0</td>
<td>+900</td>
</tr>
</tbody>
</table>

Next question: will trade be mutually beneficial? Let’s now set up a formal model.
Formal model

2 countries: France and Germany
2 goods: Bread and Machines
1 factor: Labor

Perfect competition and constant costs

Definition: $a_{Li}$ labor input requirement is the # of labor hours needed to produce one unit of output $i$.

Notation: $a_{LB}$ and $a_{LM}$ are # of labor hours to produce respectively a unit of bread or of machine in France. An asterisk is added for Germany ($a^{*}_{LB}$ and $a^{*}_{LM}$)

Definition: $1/a$ corresponds to the units of output produced by one unit of input (productivity of labor)

$L$ and $L^{*}$ are the total amount of labor hours available in each country.
France has 900 L and needs:
2 labor/ h to produce 1 unit of B  so \( a_{LB} = 2 \)
6 labor/ h to produce 1 unit of M  so \( a_{LM} = 6 \)

Production possibilities:

i. All the resources are used to produce B, France can produce 450B (C)

ii. All the resources are used to produce M, France can produce 150M (A)

iii. Some resources can be allocated to each production (e.g. 600L in B and 300L in M) then France can produce 300B and 50M (B)
Construction of the production possibility frontier for France

The absolute value of the slope is the opportunity cost of bread in terms of machines.
• Limits to production:
  labor in B + labor in M ≤ L

• With full employment of resources, the production possibility frontier (PPF) is
  \[ a_{LB}B + a_{LM}M = L \]
  i.e. \[ + = \]
  equation of line \[ M = f(B) \]

• The opportunity cost of one extra unit of bread in terms of machines forgone is \[ \text{and it is constant.} \]
All the possible mix of production are exhibited on the PPF. How will the supply decisions be made? To figure it out, we need to make two assumptions.

i. Perfect competition \(\rightarrow\) Profit = value of production = total = total costs since with one input there is only one kind of cost

So value of production in 1 hour =

ii. Workers are maximizers and choose to work where wages are
Notation: $P_B$ is the price of bread and $P_M$ is the price of machines.

As $1/a$ is the output of 1 labor/hour

$$1/a_{LB} \times P_B \quad \text{or} \quad P_B/a_{LB}$$

is the cost of 1 labor/hour in the bread industry or the producer price of this output i.e. the hourly wage in the bread industry

Equivalently

$$P_M/a_{LM}$$

is the hourly wage in the machine industry
Supply possibilities

If \( \frac{P_B}{a_{LB}} > \frac{P_M}{a_{LM}} \) OR \( \frac{P_B}{P_M} > \frac{a_{LB}}{a_{LM}} \)
only is produced

If \( \frac{P_B}{a_{LB}} < \frac{P_M}{a_{LM}} \) OR \( \frac{P_B}{P_M} < \frac{a_{LB}}{a_{LM}} \)
only are produced

If \( \frac{P_B}{a_{LB}} = \frac{P_M}{a_{LM}} \) OR \( \frac{P_B}{P_M} = \frac{a_{LB}}{a_{LM}} \)
are produced

In sum, when the relative price of a good is smaller than its opportunity cost, the good is produced.

In autarky, relative prices are equal to opportunity cost, so goods are produced.
Same analysis for Germany

\[ L^* = 800 \quad a_{LB}^* = 5 \quad \text{and} \quad a_{LM}^* = 2 \]

<table>
<thead>
<tr>
<th></th>
<th>Bread</th>
<th>Machines</th>
</tr>
</thead>
<tbody>
<tr>
<td>A*</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>B*</td>
<td>100 (w/500L)</td>
<td>(w/  )</td>
</tr>
<tr>
<td>C*</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Absolute value of slope is opportunity cost of B in terms of M i.e. to produce one extra unit of B one must take labor hours from the machine production and give up producing machines.
In France \( \frac{a_{LB}}{a_{LM}} = \frac{1}{3} \)

In Germany \( \frac{a^{*}_{LB}}{a^{*}_{LM}} = 2.5 \)

So \( \frac{a_{LB}}{a_{LM}} > \frac{a^{*}_{LB}}{a^{*}_{LM}} \)

France has a comparative advantage (CA) in because the opportunity cost of producing is lower in France than in Germany.

Germany has a comparative advantage in

*In autarky,* the opportunity cost in each country is _____ to the relative prices i.e. \( \frac{a_{LB}}{a_{LM}} \frac{P_{B}}{P_{M}} \)

and each country produces both bread and machine.
Gain from trade

1st approach: *indirect method of production*

France can either produce M

or produce B and trade it for M

If France uses 1 labor/h to produce M:

it gets \(\frac{1}{a_{LM}}\) = (French productivity in M)

If France uses 1 labor/h to produce B:

it produces \(\frac{1}{a_{LB}}\) =

that France can trade at some world price (assume \(\frac{P_B}{P_M} = 1\)) for

(or \(\frac{1}{a_{LB}} \times \frac{P_B}{P_M}\) )
If \( \frac{1}{\alpha_{LB}} \cdot \frac{P_B}{P_M} > \frac{1}{\alpha_{LM}} \) or \( \frac{P_B}{P_M} > \frac{1}{\alpha_{LB}} \)
France gains from trading

And at this relative world price (equal to 1)
\[ \frac{P_B}{\alpha_{LB}} > \frac{P_M}{\alpha_{LM}} \]

the French wage in the bread industry is ______ that in the machine industry, so all the workers move into ______ making and France only produces (specializes into) ______.
2nd approach: *based on consumption possibilities (CPF) with and without trade.*

- Without trade, consumption and production possibilities coincide: a country cannot consume beyond its PPF
- With trade, the CPF lies ______ the PPF as a country can specialize in its CA good and trade it at a higher relative price (for more of the other good than in autarky)
With world price  \( \frac{P_B}{P_M} = 1 \)
Small country case

England (60M inhabitants) and New Zealand (4M)

Trucks and wool

We have $a_{LT}/a_{LW}$ $P_T/P_W$ $a^{*}_{LT}/a^{*}_{LW}$

where the a’s are for England and the a*’s for NZ

In this case England produces ____ trucks and wool

while NZ now specializes in wool.

Rationale: Although NZ has a CA in wool and fully specializes in its production, the resulting level of production is too small to meet the demand of both NZ and England, so England must continue to produce wool.
In this case, NZ trades at the English relative price.
# Trade and relative wages

Australia and the UK - Flour and cars

## Labor input requirement

<table>
<thead>
<tr>
<th>To produce 1 unit of</th>
<th>Australia</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>flour</td>
<td>a(_{LF}) = 1</td>
<td>a(_{LF}^*) = 6</td>
</tr>
<tr>
<td>cars</td>
<td>a(_{LC}) = 2</td>
<td>a(_{LC}^*) = 3</td>
</tr>
<tr>
<td>a(<em>{LF}/a</em>{LC})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Productivity

Units of output produced by 1 labor/hour

<table>
<thead>
<tr>
<th></th>
<th>Australia</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units of flour</td>
<td>$1/a_{LF} =$</td>
<td>$1/a^*_{LF} =$</td>
</tr>
<tr>
<td>Units of cars</td>
<td>$1/a_{LC} =$</td>
<td>$1/a^*_{LC} =$</td>
</tr>
</tbody>
</table>
i. If $P_F = $15 and $P_C = $15

With perfect competition, wages

$w^A = \frac{P_F}{P_C} = \frac{15}{15} = 1$ in Australia

$w^{UK} = \frac{P_F}{P_C} = \frac{15}{15} = 1$ in the UK

So $w^A/w^{UK} = 1/1 = 1$

ii. If $P_W = $20 and $P_C = $15

$P_F/P_C = \frac{20}{15} = \frac{4}{3}$

$w^A = \frac{P_F}{P_C} = \frac{20}{15} = \frac{4}{3}$

$w^{UK} = \frac{P_F}{P_C} = \frac{20}{15} = \frac{4}{3}$

So $w^A/w^{UK} = \frac{4}{3}/\frac{4}{3} = 1$

[we can transform relative price into relative wage because of perfect competition assumption]
Trade takes place because $\frac{a_{LF}}{a_{LC}} < \frac{P_F}{P_C} < \frac{a^*_{LF}}{a^*_{LC}}$ (1)

As countries specialize in their CA good

$$w^A = \frac{\text{(CA)}}{} \text{ and } w^{UK} = \frac{\text{(CA)}}{}$$

so $\frac{w^A}{w^{UK}} =$

Multiply every term in (1) by $\frac{a^*_{LC}}{a_{LF}}$

we get $\frac{a^*_{LC}}{a_{LC}} < \frac{w^A}{w^{UK}} < \frac{a^*_{LF}}{a_{LF}}$

In the example (slide 23), trade takes place when

Either $0.5 < \frac{P_F}{P_C} < 2$ Or $1.5 < \frac{w^A}{w^{UK}} < 6$
The data of case i. and case ii. yield a relative wage within the bonds for trade to take place. This is not always the case:

If \( w_A = $20 \) and \( w_{UK} = $2 \), \( w_A/w_{UK} = $10 > $6 \)

The wage in Australia is too ____ and the Australian productivity advantage cannot compensate for such a high wage.

If \( w_A = $20 \) and \( w_{UK} = $20 \), \( w_A/w_{UK} = $1 < $1.5 \)

The wage in the UK is too _____ and the UK needs a ______ wage to account for its low productivity.
Comparative advantage with many goods

In this case, we can’t use relative prices to determine CA (there is one between any 2 goods). Instead we will use the concept of relative wage for the 2 countries. Then we can focus on the relative productivity for each good (instead of the relative input requirements).
The cost of producing 1 unit of good i is equal to the wage $w$ multiplied by the number of hours required $a_{Li}$

At home the cost is  and abroad it is

If \( wa_{Li} < w^*a^*_{Li} \) or \( a^*_{Li}/a_{Li} > w/w^* \), good i should be produced in the _______ country

If \( wa_{Li} > w^*a^*_{Li} \) or \( a^*_{Li}/a_{Li} < w/w^* \), good i should be produced in the _______ country

Rationale: \( a^*_{Li}/a_{Li} = \frac{1/a_{Li}}{1/a^*_{Li}} \)

is the relative _______ which is compared to the relative _______ (i.e. cost) $w/w^*$. 
Example:
France and Germany
Calculators, bread, cheese, wine and apples
we only need to know the relative wage to
figure out which good each country will
export.
Assume that $\frac{w}{w^*} = 2.5$
<table>
<thead>
<tr>
<th>Good</th>
<th>$a_{Li}$ (Fr)</th>
<th>$a^*_{Li}$ (G)</th>
<th>$a^*<em>Li/a</em>{Li}$</th>
<th>w/w*</th>
<th>CA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculator</td>
<td>50</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bread</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td>2.5</td>
</tr>
<tr>
<td>Cheese</td>
<td>3</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wine</td>
<td>5</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apples</td>
<td>3</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For calculators, the relative productivity in France ( ) is _____ than the relative wage (2.5), so France is ___ competitive and ____________ has the comparative advantage.
Similarly for bread, France has relative wages that are ______ than its relative productivity (2.5 2) so France has a comparative ___________ in both computers and bread.

However in the case of cheese, wine and apple, France’s relative productivity is _______ than the relative wage so France has the comparative _______ in these 3 goods and will _______ them to Germany while Germany will ______ computers and bread to France.
Comparative advantage with many goods - with transportation cost.

Let’s assume that the cost of the good doubles when shipped abroad - all the a’s double for each country’s export good.

In the previous analysis we have determined that calculators and bread are Germany’s export goods while cheese, wine, and apples are France’s export goods when shipping costs are negligible.
The relative productivity for apple from France is still greater than the relative wage for France ($5 > 2.5$) so France still has a CA in apple and export them.
The relative productivity for computer from Germany is also greater than the relative wage for Germany (1/1 > 1/2.5 or 1 > .4) so Germany still has a CA in computers and export them.

When we consider the other three goods that were previously traded (bread, cheese and wine), we find the following:

the relative productivity has become smaller than the relative wage due to the inclusion of the shipping costs.

It is now prohibitive to export these goods.

These are categorized as *non-tradables*. 
# Multi country case

<table>
<thead>
<tr>
<th>Good Country</th>
<th>Fish: $a_{LF}$</th>
<th>Chicken: $a_{LC}$</th>
<th>$a_{LF}/a_{LC}$</th>
<th>$P_F/P_c$</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>4</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>5</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
<td>5</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CA</td>
<td></td>
<td></td>
<td></td>
<td>.3</td>
</tr>
</tbody>
</table>
In the case of Sweden and of France, the answer is straightforward: they have a comparative advantage over the other 2 countries in fish and chicken respectively.

Unless we know the relative world price, the answer for Germany is unclear.

If \( \frac{a_{GF}}{a_{GL}} \cdot \frac{P_F}{P_C} \) Germany has a CA in fish over France only (but not over Sweden).

If \( \frac{a_{GF}}{a_{GL}} \cdot \frac{P_F}{P_C} \) Germany has a CA in chicken over Sweden only (but not over France): this is the case if the relative price is 0.3