MOT 112A – Economic Foundations

R. Stöllinger

Exercises – International Trade (Lecture Week 4)

Exercise 1 – Comparative advantage and absolute advantage

1. Consider the following statement: "*In a model of international trade with 2 countries and 2 goods, each country can have comparative advantage only in one of the two goods*". Would you agree with this statement? If yes, explain why. If not, explain why not.

A: This statement is correct. In the basic 2 country – 2 goods case, each country has comparative advantage in exactly one of the two goods. The reason is that the identification of comparative consists of a comparison of all four production costs involved (a) . More specifically: it compares the relative cost of producing good 1 relative to producing good 2 in country A (a_1^A/a_2^A) with the same ratio in country B (a_1^B/a_2^B). If this ratio is lower in country A, that is, if $a_1^A/a_2^A < a_1^B/a_2^B$, then country A is said to have comparative advantage in good 1. It means that the production of good 1 is feasible at relatively lower cost (in terms of forgone production of good 2 – also referred to as opportunity cost) in country A than in country B. The comparative advantage compares relative costs between the two goods across the two countries. By definition this ratio cannot be lower in one country for both goods because the relative cost of good 2 is simply the inverse of the relative cost of good 1.

2. Consider the following statement: "*In a model of international trade with 2 countries and 2 goods, each country can have absolute advantage only in one of the two goods*". Would you agree with this statement? If yes, explain why. If not, explain why not.

A: This statement is not correct. Absolute advantage is identified with the comparison of the production costs of a good across two countries individually. Country A is said to have absolute advantage in the production of good 1 vis-à-vis country B if $a_1^A < a_1^B$ and analogously for good 2, that is, $a_2^A < a_2^B$. Since these are individual comparisons of cost structures, nothing prevents these costs being lower for both goods in one country compared to the other country.

Exercise 2 – The Ricardian model of trade

Assume a Ricardian trade model. Trade takes place between Brazil and India. The goods traded are sandalwood and coffee. Brazil has 1,000 units of labour available, while India's labour supply equals 4,000 units. The labour input requirements for producing these goods in Brazil (a_S^{BRA},a_C^{BRA}) and India (a_S^{IND},a_C^{IND}) are as follows:

	Sandalwood	Coffee
Brazil	1	2
India	4	4

1. Write down the production possibility constraint for Brazil and India and represent them graphically showing the quantity of coffee on the horizontal axis!

A: The production possibility constraint is given by the full employment condition which is given by the labour endowments *L*.

Brazil: $a_S^{BRA} \cdot Q_S^{BRA} + a_C^{BRA} \cdot Q_C^{BRA} = L^{BRA}$ with L^{BRA} being the labour supply of Brazil.

$a_S^{BRA} \cdot Q_S^{BRA}$ is the amount of labour employed in the production of sandalwood in Brazil.

$a_C^{BRA} \cdot Q_C^{BRA}$ is the amount of labour employed in the production of coffee in Brazil.

Taken together, the goods production in Brazil cannot exceed the total labour supply

With the indicated values we get:

Hence $1 \cdot Q_S^{BRA} + 2 \cdot Q_C^{BRA} = 1000$

India: $a_S^{IND} \cdot Q_S^{IND} + a_C^{IND} \cdot Q_C^{IND} = L^{IND}$ with L^{IND} being the labour supply of India.

(Same line of reasoning as for Brazil).

Hence $4 \cdot Q_S^{BRA} + 4 \cdot Q_C^{BRA} = 4000$

If we depict the production possibilities graphically in which coffee is on the horizontal axis, we can write the production of sandalwood (on the y-axis) as a function of the production of coffee. The amounts of the two goods produced are related because the labour employed in the production of sandalwood is not available for the production of coffee.

Brazil: $Q_S^{BRA} = \frac{L^{BRA}}{a_S^{BRA}} - \frac{a_C^{BRA}}{a_S^{BRA}} \cdot Q_C^{BRA}$ or with the given numbers $Q_S^{BRA} = 1000 - 2 \cdot Q_C^{BRA}$

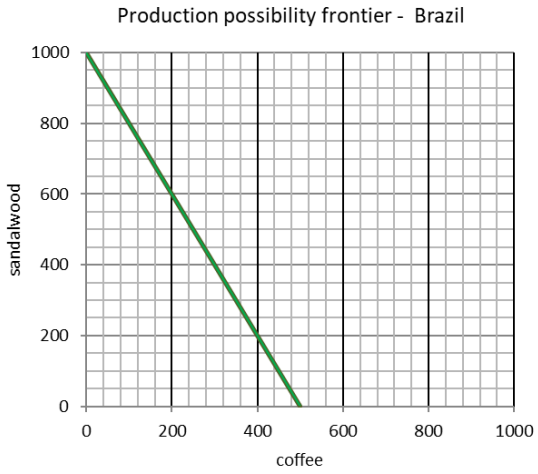
An easy way to draw this linear graph is to search the point where Brazil uses all its labour to produce sandalwood so that Q_C^{BRA} equals zero. So, we have $Q_S^{BRA} = \frac{L^{BRA}}{a_S^{BRA}}$ or $Q_S^{BRA} = 1000$. This is not surprising. If Brazilian production of one unit of sandalwood requires 1 unit of labour and all labour is set to produce sandalwood, the amount of sandalwood produced is 1000.

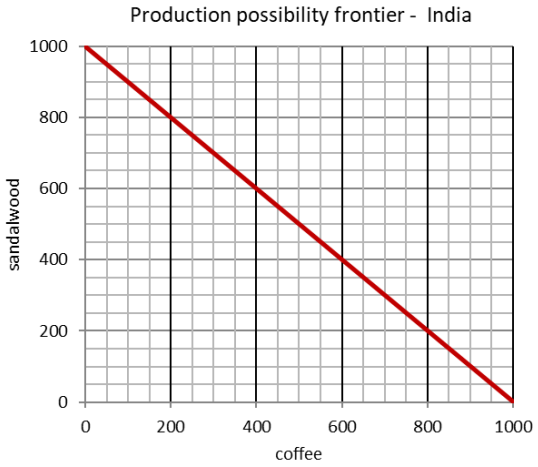
Conversely, if Brazil uses all its labour to produce coffee, we obtain $Q_C^{BRA} = \frac{L^{BRA}}{a_C^{BRA}}$ or $Q_C^{BRA} = \frac{1000}{2}$ or $Q_C^{BRA} = 500$. Again, if it requires two units of labour to produce one unit of coffee, it is rather straightforward that the maximum amount of coffee that can be produced is 500.

Hence, Brazil can either produce 1000 units of sandalwood or 500 units of coffee or any combination within the production possibility frontier given by the above linear function.

The same line of reasoning leads to the production possibility frontier for India.

India: $Q_S^{IND} = \frac{L^{IND}}{a_S^{IND}} - \frac{a_C^{IND}}{a_S^{IND}} \cdot Q_C^{IND}$ or with the given numbers $Q_S^{IND} = 1000 - Q_C^{IND}$





2. What would be the prices of coffee in terms of sandalwood in Brazil and in India in a situation of autarky (assuming that both goods are produced so that wages are identical in the two industries)?

   A: In autarky the prices of the two goods are determined by technology, that is, by the labour input requirements.

   Brazil: The price of coffee in terms of sandalwood is $\frac{P_C^{BRA}}{P_S^{BRA}} = \frac{a_C^{BRA}}{a_S^{BRA}} = \frac{2}{1} = 2.$

   Note that the autarky price of coffee (or more generally the good shown on the x-axis) is equal to the absolute value of the slope of the production possibility frontier.

   By the same token, the price of sandalwood in Brazil is: $\frac{P_S^{BRA}}{P_C^{BRA}} = \frac{a_S^{BRA}}{a_C^{BRA}} = \frac{1}{2} = 0.5$

   India: The price of coffee in terms of sandalwood is $\frac{P_C^{IND}}{P_S^{IND}} = \frac{a_C^{IND}}{a_S^{IND}} = \frac{4}{4} = 1.$

   By the same token, the price of sandalwood in India is: $\frac{P_S^{IND}}{P_C^{IND}} = \frac{a_S^{IND}}{a_C^{IND}} = \frac{4}{4} = 1$

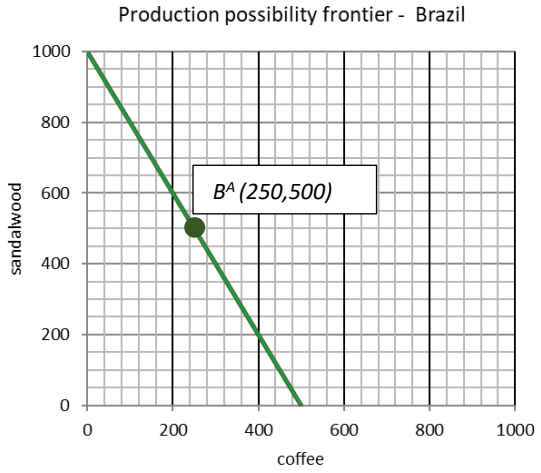
3. Assume that in autarky both countries use half of their labour supply to produce sandalwood and the other half to produce coffee. What would be the amounts produced? Mark these points on the respective production possibility frontier as B^A (for Brazil - autarky) and I^A (for India - autarky).

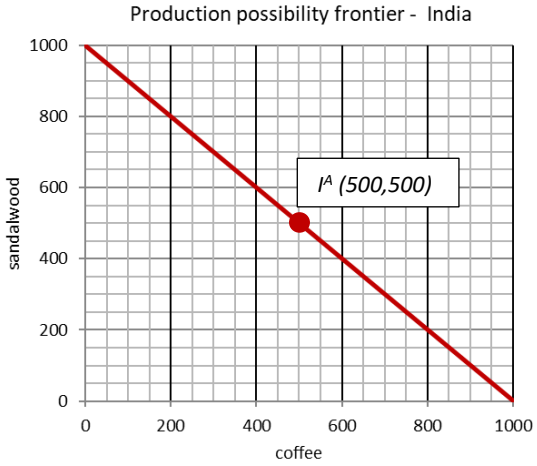
   A: In autarky the prices of the two goods are determined by technology, that is, by the labour input requirements.

   Brazil: $1 \cdot Q_S^{BRA} + 2 \cdot Q_C^{BRA} = 1000$

   Half of L^{BRA} is 500. If 500 units of labour are used to produce sandalwood and the production of sandalwood requires 1 unit of labour, Brazil produces 500 units of sandalwood. If the other 500 units of labour are used to produce coffee and the production of coffee requires 2 units of labour, Brazil can also produce 250 units of coffee. Hence, the production point in autarky in Brazil, B^A, is (250,500)

   India: Same logic as for Brazil. India uses 2000 units of labour for producing sandalwood and 2000 units of labour for producing coffee which yields the production point in autarky, I^A, is (500,500)





4. Imagine now, that Brazil and India engage in international trade. Which country would the Ricardian model predict to export sandalwood and coffee respectively? Use the concept of comparative advantage and the concept of opportunity costs to underpin your answer.

   A: Trade patterns are governed by comparative advantage. Expressing relative costs for coffee we obtain

   $$\frac{a_C^{BRA}}{a_S^{BRA}} > \frac{a_C^{IND}}{a_C^{IND}} \text{ because } \frac{2}{1} > \frac{4}{4} \text{ (or } 2 > 1)$$

   This means that India has comparative advantage in the production of coffee. The reason is the following: the opportunity cost of producing 1 unit of coffee in terms of units of sandalwood is 1. India has to give up 1 unit of sandalwood for each unit of coffee it decides to produce. Compare this with the situation in Brazil. When producing 1 unit of coffee, Brazil requires 2 units of labour which could have produced 2 units of sandalwood. Hence, in Brazil the opportunity cost of one unit of coffee is 2 units of sandalwood.

   Obviously opportunity costs of producing coffee are lower in India ($\frac{a_C^{IND}}{a_C^{IND}} = 1 < 2 = \frac{a_C^{BRA}}{a_S^{BRA}}$).

By definition, the fact that India has comparative advantage in the production of coffee implies that Brazil has comparative advantage in the production of sandalwood.
We can check this by the following relation

$$\frac{a_S^{BRA}}{a_C^{BRA}} < \frac{a_S^{IND}}{a_C^{IND}} \text{ because } \frac{1}{2} < \frac{4}{4} \text{ (or } 0.5 < 1)$$

5. Suppose further that under free trade the relative price of coffee is 1.5 units of sandalwood ($P_C/P_S = 1.5$). Which type of specialisation would result under this world price?
A: The price ratio $P_C/P_S = 1.5$ is above the relative autarky price in India (which is 1) and below the relative autarky price in Brazil (which is 2). This results in full specialisation in both countries.
Why is that so? The reason is that both countries have an incentive to trade so that both countries will be fully specialised in the production of the good in which it has comparative advantage (coffee in the case of India, sandalwood in the case of Brazil).
For India the incentive to fully specialise in the production of coffee stems from the fact that its opportunity cost of one unit of coffee is only 1 unit of sandalwood, while it can trade 1 unit of coffee in exchange for 1.5 units of sandalwood at the prevailing world market price.
The incentive for not producing coffee in Brazil stems from the fact that it would have to give up 2 units of sandalwood when it produced 1 unit of coffee domestically, while it can obtain 1 unit of coffee for only 1.5 units of sandalwood. For this reason, Brazil will set all its labour to produce sandalwood and to buy the desired amounts of coffee from India.

6. Can you infer from your answer in question 5) the quantities of coffee and sandalwood produced in Brazil and India respectively?
A: Both countries are fully specialised. This means that Brazil will use all its labour to produce sandalwood, while India will use all its labour to produce coffee:
Brazil: $\frac{L^{BRA}}{a_S^{BRA}} = \frac{1000}{1} = 1000$. Hence $Q_S^{BRA} = 1000$
India: $\frac{L^{IND}}{a_C^{IND}} = \frac{4000}{4} = 1000$. Hence $Q_C^{IND} = 1000$

7. Assume that under free trade Brazil consumes the same amount of sandalwood as under autarky (see question 3). What is the amount of coffee Brazil can consume under the established world price of $P_C/P_S = 1.5$? Also calculate the corresponding amounts of consumption for India!
Note: For this question it is useful to remember that the quantity exported of any good *i*, by one country is by definition equal to the quantity imported of that good by the other country, so that $X_i^{country\ 1} \equiv IM_i^{country\ 2}$ and $X_i^{country\ 2} \equiv IM_i^{country\ 1}$
A: We start with the production point in Brazil
Brazil: $Q_S^{BRA} = 1000$
In autarky consumption is identical to production, which was 500 units of sandalwood (see question 3). If the consumption of sandalwood $C_S^{BRA} = 500$ is to remain, unchanged this means that Brazil can use the remaining 500 units of sandalwood to export to India:

$$Q_S^{BRA} - C_S^{BRA} = X_S^{BRA} \iff 1000 - 500 = 500$$

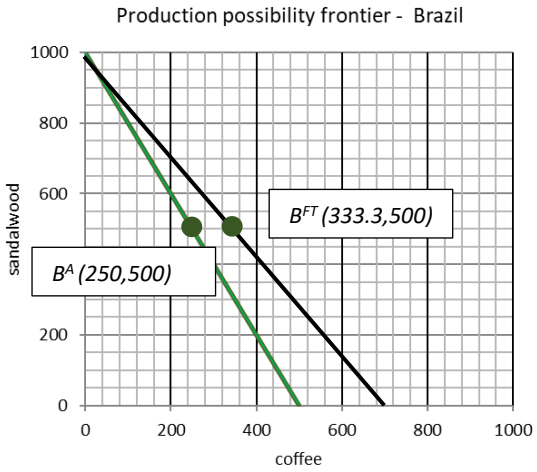
The next question is, how much coffee Brazil can get for the amount of sandalwood that it exports. For this we need to turn to world market prices. The prevailing world market price for coffee of $P_C/P_S = 1.5$ is equivalent to a world market price for sandalwood of $P_S/P_C = \frac{2}{3}$. This is the price (which is indicated in units of coffee!) that Brazil will obtain for each of its units of sandalwood exported. Hence:
$X_S^{BRA} \cdot P_S/P_C = IM_C^{BRA} \Leftrightarrow \ 500 \cdot \frac{2}{3} = 333.\dot{3}.$
Because Brazil does not produce any coffee itself, the amount of coffee imported is equal to the amount of coffee consumed in Brazil. This way, we have arrived at the consumption point of Brazil:
$C_C^{BRA} = 333.3$ and $C_S^{BRA} = 500$

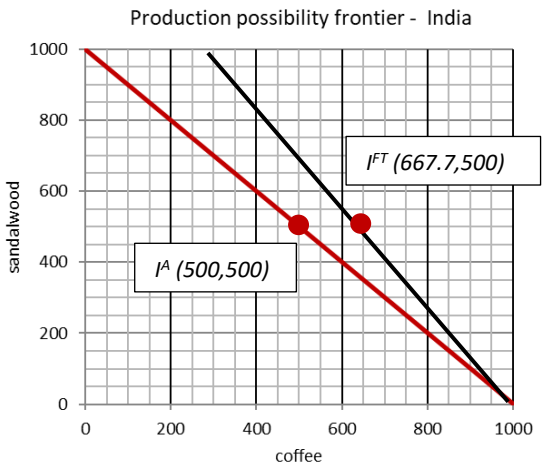
We can use the established trade flows to obtain the consumption points in India:
India: $Q_C^{IND} = 1000$
Since $IM_C^{BRA} \equiv X_C^{IND}$ we know that India exports $333.\dot{3}$ units of coffee to Brazil. This leaves $C_C^{IND} = Q_C^{IND} - X_C^{IND}$ or $667.\dot{6}$ $(= 1000 - 333.\dot{3})$.
We also know that these $333.\dot{3}$ units of coffee are traded for 500 units of sandalwood. Since India does not produce any sandalwood itself, these 500 units are the consumption of sandalwood in India. Hence, we have established consumption in India:
$C_C^{IND} = 667.7$ and $C_S^{IND} = 500.$

8. From your answers obtained so far, can you identify any gains from trade? If so, which country/ies can reap the gains from trade?
   <u>Note:</u> For this question you may want to compare the consumption points of the two countries obtained under autarky and under free trade.
   A: There are gains from trade. These gains from trade take the form of the extra amounts of coffee that is produced under free trade compared to autarky, while the amount of sandalwood produced remained unchanged.

	Autarky (B^A)	**Free trade (B^{FT})**
Brazil:	$C_C^{BRA} = 250$ and $C_S^{BRA} = 500$	$C_C^{BRA} = 333.3$ and $C_S^{BRA} = 500.$
	Autarky (I^A)	**Free trade (I^{FT})**
India:	$C_C^{IND} = 500$ and $C_S^{IND} = 500$	$C_C^{IND} = 667.7$ and $C_S^{IND} = 500.$

   The comparison of these consumption plans illustrate that both Brazil can obtain consumption bundles which are not obtainable under autarky. The free trade consumption bundle of Brazil is outside its production possibility frontier under autarky and the same is true for India.
   The possibility to trade opens up new opportunities for both countries because they can trade at world trade prices for the good in which they have comparative advantage which are favourable for them. Favourable means that the world market price is above their domestic opportunity costs of the 'comparative advantage good'.
   <u>Add on:</u> *While not requested in the question, the gains from trade can also be illustrated by adding the world market price line at which Brazil and India can trade to the production possibility frontier. For ease of comparison, also the free trade points are indicated.*
   At the prevailing world market price, the gains from trade accrue to both Brazil and India.


Production possibility frontier - Brazil
sandalwood
coffee
1000
800
600
400
200
0
0
200
400
600
800
1000
B^{FT} (333.3,500)
B^{A} (250,500)


Production possibility frontier - India
sandalwood
coffee
1000
800
600
400
200
0
0
200
400
600
800
1000
I^{FT} (667.7,500)
I^{A} (500,500)

Exercise 3 – The Ricardian model of trade – once more

Assume a Ricardian trade model. Trade takes place between the US and China. The goods traded are potato chips and computer chips. The US has 800 units of labour available, while the labour supply in China is 8,000 units. The labour input requirements for producing these goods in the US (a_P^{USA},a_C^{USA}) and China (a_P^{CHN},a_C^{CHN}) are as follows:

	Potato chips	Computer chips
USA	1	5
China	10	100

1. Given these labour input requirements, assign absolute advantages and comparative advantages to the US and China!

   A:

   Absolute advantage: $a_P^{USA} < a_P^{CHN}$ because $1 < 10$. The US holds absolute advantage in the production of potato chips.
   $a_C^{USA} < a_C^{CHN}$ because $5 < 100$. The US holds absolute advantage in the production of computer chips.

   We conclude that the US holds comparative advantage in the production of both goods.

   Comparative advantage: $\frac{a_C^{USA}}{a_P^{USA}} < \frac{a_C^{CHN}}{a_P^{CHN}}$ because $\frac{5}{1}(= 5) < \frac{100}{10}$ (=10)

   The US hold comparative advantage in the production of computer chips.

   $\frac{a_P^{CHN}}{a_C^{CHN}} < \frac{a_P^{USA}}{a_C^{USA}}$ because $\frac{10}{100}(= 0.1) < \frac{1}{5}$ (=0.2)

   China holds comparative advantage in the production of potato chips.

2. Which trade patterns will emerge when the two countries decide to engage in international trade? (Note: a qualitative answer indicating which country is expected to export which good is sufficient).

   A: Trade patterns are governed by comparative advantage. Since the US hold comparative advantage in computer chips, the US will export computer chips. Likewise, because China holds comparative advantage in potato chips, it will export potato chips.

3. Now assume that world demand is such that the world market price of computer chips is established at 5 potato chips ($P_C/P_P = 5$). What type of specialisation will emerge in this situation?

   A: With $P_C/P_P = 5$ the world market price is exactly equal to the relative costs in the US. This means that the US is indifferent between producing potato chips or computer chips because it can always obtain both goods at the world market at identical costs. As a consequence, the US will produce computer chips and potato chips and hence remain incompletely specialised. China will fully specialise in the production of potato chips.

4. What will be the amount of computer chips and potato chips produced in China?
   A: China is completely specialised in the production of potato chips. Hence we can consult the production possibility constraint of China to find out the maximum amount of potato chips China can produce given its labour supply:

   China: $a_P^{CHN} \cdot Q_P^{CHN} + a_C^{CHN} \cdot Q_C^{CHN} = L^{CHN}$ with L^{CHN} being the labour supply of China.

   China is fully specialised in the production of potato chips, hence $Q_C^{CHN} = 0$ and therefore:

   $a_P^{CHN} \cdot Q_P^{CHN} = L^{CHN}$ which implies $Q_P^{CHN} = L^{CHN}/a_P^{CHN}$

   At the given labour supply and labour input requirement for producing potato chips in China, the amount of potato chips China can produce is:

$$Q_P^{CHN} = \frac{8000}{10} = 800$$

   At the indicated world market price, China will produce 800 units of potato chips.

5. According to the Ricardian model, which country, if any, would reap gains from trade in this constellation? Explain your answer. (Note: again a qualitative answer supplemented with the accompanying argument is sufficient).
   A: China will gain from trade. The reason is that China can obtain computer chips at lower prices (in terms of potato chips) than its opportunity costs of producing computer chips. This possibility allows China to trade beyond its production possibility frontier.
   This is not the case for the US. The world market price is exactly equal to US opportunity costs of producing computer chips. Therefore no gains from trade accrue to the US.

6. In your view, what could be a potential critique to a Ricardian type of trade analysis in the context of the goods considered in this example, in particular the computer chips? More specifically, would you think that it is reasonable to assume that the labour input requirements for producing computer chips a_C^{USA} and a_C^{CHN} were constant over the past decades. Compare your answer to the assumptions made in the Ricardian model.
   A: Computer chips are a very knowledge intensive product. Innovations in the production of computer chips helped reducing the cost of producing computer chips. This is true for both the US and for China. Lower costs of producing would mean that a_C^{USA} and a_C^{CHN} are not constant. However, constant technology is one of the assumptions of the Ricardian model. In this particular example, the assumption of constant a_C^{USA} and a_C^{CHN} is questionable. *(Additional note: a reduction in a_C^{USA} and a_C^{CHN} would allow the US and China to produce more computer chips with the same amount of labour which would also increase consumption opportunities. From a dynamic perspective, this could be an incentive to specialise in the production of computer chips, also for China, despite the static gains from trade resulting from the specialisation in potato chips).*