Ricardian Model:

Dornbusch, Fischer, and Samuelson model.

1. Introduction

There are several models that explain the reasons why two countries trade. In Ricardian models countries try to exploit technological differences. In Heckscher-Ohlin models (and essentially specific-factors models too) countries try to exploit their endowment differences, and in increasing-returns models countries try to exploit increasing returns at the industry level.

From the empirical point of view, as it should be expected, there is no single explanation that describes the world as a whole. However, trade among developed countries (North-North) is usually better explained by HO and increasing return models. The technological differences across these countries are small and they tend to trade goods that are relatively close substitutes. On the other hand, trade between developing economies (South-South) or between developed and developing economies (North-South) is quite well explained by Ricardian models.

In these notes I will only concentrate on Ricardian models because I think are the most important and interesting reason explaining what is behind trade in developing countries.

First, I start with some numerical examples that I hope will change the way we look at common-conversation reasons for trade. You have seen this before, but I want to make a very strong point here. Second, I will present the Dornbusch-Fischer-Samuelson (DFS) model.

2. Numerical examples

To keep things as simple as possible let's assume that there are only two countries in the world, that there are only two goods (apples and bananas), and that each country has the same labor supply: 100 hours.

Assume that consumer preferences are as follows: agents consume apples and bananas in equal proportions, regardless of their price. This simplifies a lot of the issues as the next section shows, however, most of the intuitions can be developed in this framework. This assumption implies that production will be organized in the world to have equal proportion of apples and bananas; otherwise, goods are wasted. The second implication is that prices do not affect demand.

Before even reading the next cases, there are a couple of questions we should think: should countries produce those goods which they manufacture more efficiently? Or, is the most competitive sector the one in which the country should specialize? In which sectors a developing economy should concentrate its R&D efforts? In those that have a higher value added, like communications, financial services, consulting, internet? Will a country that is bad producing everything, end up producing nothing, like most courses in MBA's globalization classes would predict?

Try to develop your intuitions about these questions before starting. I hope in the end I will be able to convince you that most of the common wisdom in this area is wrong.

We will see three cases:

2.1. Case 1

Assume that the unit labor requirements are as follows:

	Country A	Country B
Apples	2	1
Bananas	1	2

This means that in country A two hours of labor produce one unit of apple, and one hour of labor produces one banana. The converse for country B. Note that country A is good at producing bananas, while country B is good at apples. We could think of this as competitive advantages.

2.1.1. Autarky

Let's see the allocation of production if countries are closed. Country A has to solve the following system of equations:

$$Ha + Hb = 100$$

$$Ha/2=Hb/1$$

In other words, the first equation states that the total amount of hours that can be worked is at most 100, while the second one indicates that the production of apples (Ha/2) has to be equal to the production of bananas (Hb/1). Which implies that the number of hours dedicated to the production of apples is 200/3 and 100/3 in bananas. This allocation produces 33.33 units of apples and 33.33 units of bananas.

Similarly, Country B has to solve:

$$Ha + Hb = 100$$

$$Ha/1=Hb/2$$

Where the only change is in the second equation. The solution is summarized in the following table, where the first two rows indicate the number of hours dedicated to the production of each of the goods, while the next two rows indicate the actual production of apples and bananas in each country. The total world production is added in the end.

	Country A	Country B	Total
Apples	66.67	33.33	
Bananas	33.33	66.67	
Apples	33.33	33.33	66.67
Bananas	33.33	33.33	66.67

2.1.2. Specialization

Now, assume that the borders are open and goods can freely move across countries. We will concentrate only in country A specializing on a particular good. In the spreadsheet you guys have access, however, all four forms of specialization are analyzed.

In this section, the idea is to maximize world production of goods. In other words, if we can change the allocation of production to increase the world production of goods from autarky, then we can give each country the production of autarky and something else is left. We then split the surplus in any form, and both countries are going to be better off.

2.1.2.1.Country A specializes in Apples

Assuming that this country specializes in apples is making the assumption that the total hours are spent in the production of apples. In other words, Ha=100, and Hb=0. This means that country A produces 50 apples and no bananas.

Country B has to solve the following problem: it has to allocate production between apples and bananas in such a way that the world production of apples and bananas is equal. Thus, they solve

$$Ha + Hb = 100$$

$$Ha/1+\mathbf{50}=Hb/2$$

Where as you can see the second equation takes into consideration the production in country A. The solution of this system of equations generates the following production:

	Country A	Country B	Total
Apples	100.00	0.00	
Bananas	0.00	100.00	
Apples	50.00	0.00	50.00
Bananas	0.00	50.00	50.00

As it can be seen, this allocation of labor generates a world production of 50 apples and 50 bananas. Which is smaller than the production that can be achieved in autarky. This is not an efficient allocation then.

2.1.2.2.Country A specializes in Bananas

Now, for country A, Ha=0, and Hb=100. Thus, country A produces no apples and 100 bananas. Country B then solves:

$$Ha + Hb = 100$$

$$Ha/1=Hb/2+\mathbf{100}$$

The solution is as follows:

	Country A	Country B	Total

Apples	0.00	100.00	
Bananas	100.00	0.00	
Apples	0.00	100.00	100.00
Bananas	100.00	0.00	100.00

Thus, the world production is 100 apples and 100 bananas; 50 percent more than in autarky. In this case, we can allocate 33 units of each good for each country. Thus, the production before opening is the same, and the extra 33 units can be allocated in any form and both countries are going to be better off (or indifferent at most).

Note that the pattern of production that maximizes the world production indeed implies that each country produces what they do better. Country B produce apples in which they are the world leader in productivity, and country A produces bananas in which it is the world leader. This example could lead us to think that countries produce where they have competitive advantages, and that sort of stuff. Let's start changing some of these paradigms.

2.2. Case 2

Now assume that the unit labor requirements are as follows:

	Country A	Country B
Apples	4	1
Bananas	3	2

This means that in country A four hours of labor produce one unit of apple, and three hours of labor produce one banana. Country B remains as before.

Notice that here country A is worse producing both goods. One question is if country B is better of if country A does not exists, the second question is if country A will be able to survive at all, and the third one is if country A will produce bananas, which is where it is more efficient.

2.2.1. Autarky

Here we solve a similar system of equations as before. The solution is:

	Country A	Country B	Total
Apples	57.14	33.33	
Bananas	42.86	66.67	
Apples	14.29	33.33	47.62
Bananas	14.29	33.33	47.62

Country B's solution is the same as before, while Country A produces substantially less amount of goods. The world production is less than 48 units of each good.

2.2.2. Specialization

2.2.2.1. Country A specializes in Apples

Country A produces 100/4=25 apples and no bananas. Country B solves

$$Ha + Hb = 100$$

$$Ha/1+\mathbf{25}=Hb/2$$

The solution is:

	Country A	Country B	Total
Apples	100.00	16.67	
Bananas	0.00	83.33	
Apples	25.00	16.67	41.67
Bananas	0.00	41.67	41.67

Note that country B allocates some production to apples and some to bananas in such a way that world production of both goods is the same. Note that if country A specializes in apples, it implies that world production is smaller than in autarky: 42 instead of 48.

2.2.2.2. Country A specializes in Bananas

Now, for country A, Ha=0, and Hb=100. Thus, country A produces no apples and 100/3=33.33 bananas. Country B then solves:

$$Ha + Hb = 100$$

$$Ha/1=Hb/2+\mathbf{33.33}$$

The solution is as follows:

	Country A	Country B	Total
Apples	0.00	55.56	
Bananas	100.00	44.44	
Apples	0.00	55.56	55.56
Bananas	33.33	22.22	55.56

Thus, the world production is 56 apples and 56 bananas. Again, with this allocation of production both countries can improve.

Note that the pattern of production that maximizes the world production indeed implies that each country produces what they do better. Country A produces bananas.

Second, note that even though country B is better in the production of both goods, it can benefit from the existence and the production of country A. Therefore, country A will not “disappear” even though they are worse in producing every good. Compare this with what a CEO will tell you if he losses competitiveness!

2.3. Case 3

This is by far the most counter intuitive result. So, read it twice. Assume that the unit labor requirements are as follows:

	Country A	Country B
Apples	2	1
Bananas	3	2

This means that in country A two hours of labor produce one unit of apple, and three hours of labor produces one banana. Country B remains as in case 1.

Notice that here country A is worse producing both goods. But in this case it is better producing apples than bananas. Let's ask the same questions as before; in particular, will country A produce apples, which is where it is more efficient?

2.3.1. Autarky

Here we solve a similar system of equations as before. The solution is:

	Country A	Country B	Total
Apples	40.00	33.33	
Bananas	60.00	66.67	
Apples	20.00	33.33	53.33
Bananas	20.00	33.33	53.33

Country B's solution is the same as before, while Country A produces substantially less goods because it is less productive than in case 1. The world production is little bit more than 53 units of each good.

2.3.2. Specialization

2.3.2.1. Country A specializes in Apples

Country A produces 100/2=50 apples and no bananas. Country B solves

$$Ha + Hb = 100$$

$$Ha/1+\mathbf{50}=Hb/2$$

The solution is:

	Country A	Country B	Total
Apples	100.00	0.00	
Bananas	0.00	100.00	
Apples	50.00	0.00	50.00
Bananas	0.00	50.00	50.00

Note that if country A specializes in apples it implies that in the end world production is smaller than in autarky: 50 instead of 53.

2.3.2.2. Country A specializes in Bananas

Now, for country A, Ha=0, and Hb=100. Thus, country A produces no apples and 100/3=33.33 bananas. Country B then solves:

$$Ha + Hb = 100$$

$$Ha/1=Hb/2+\mathbf{33.33}$$

The solution is as follows:

	Country A	Country B	Total
Apples	0.00	55.56	
Bananas	100.00	44.44	
Apples	0.00	55.56	55.56
Bananas	33.33	22.22	55.56

Thus, the world production is 56 apples and 56 bananas. Again, with this allocation of production both countries can improve from autarky. Each country can get what they obtain during autarky and the surplus can be shared in any way.

Note that the pattern of production that maximizes the world production implies that country A produces BANANAS!!!!! In other words, it produces bananas where labor is LESS productive.

2.4. Why?

Well, here is the intuition. Really, it does not matter in which sector you are more productive, what it really matter is your productivity relative to the rest of the world. In case 1, it is clear that country A has advantages in the production of bananas and, therefore it specializes in bananas. In case 3, however, if we look at country A, we will be tempted to say that it should produce apples instead of bananas. This should be obvious. Why on earth country A will decide to produce bananas, a sector in which it sucks, instead of producing apples, in which it is at least better?

Well, the problem is that this is the wrong intuition. In case three, country A sucks in both sectors, but it sucks more on apples than in bananas when it is compared to the world. In bananas they are just 50 percent worse, while in apples they are 100 percent worse. Is this relative productivities what determines the pattern of production and not the individual productivities.

This is exactly what we call comparative advantages. Country A has no competitive advantages, still it produces something, so it does not disappear. In country A, apples have competitive advantages over bananas, still apples are not produced. Country A produces according to comparative advantages, allocating production to a sector that has competitive DIS-advantages in every respect.

	Country A	Country B	Relative Productivity
Apples	2	1	100%
Bananas	3	2	50%

As Krugman points out in one of his papers, competitive advantages are not the determinant for trade; comparative advantages are.

3. DFS

Let's now move to a model that relaxes a lot of the assumptions made in the previous section. This is a general equilibrium model (thus, wages and prices are determined within the model).

Assume there are **N** goods, indexed by **z**. Assume (as before) that there are only two countries (Home and foreign) and that the labor unit requirements at home are **a(z)** for good **z**, and **a*(z)** in the foreign country. We assume that there is only one factor of production (labor) and perfect competition. Therefore, prices are given by:

Price at home: $P(z) = a(z)\, w$

Price at foreign: $P^*(z) = a^*(z)\, w^*$

Where **w** and **w*** represent the wages in each of the countries measured in the same currency (dollars for simplification). Now, if it is assumed that goods can freely travel across countries, then a good is produced at home only if

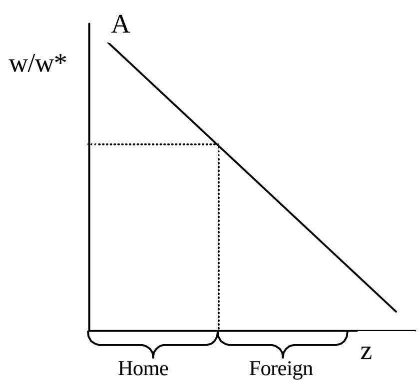
$$P(z) \leq P^*(z).$$

Which implies that a good is produced at home if the relative wages satisfy the following inequality.

$$a(z)w \leq a^*(z)\, w^*$$

$$\mathbf{w/w^* \leq a^*(z)/a(z)}$$

This is the fundamental equation of comparative advantages. As we saw in the previous section, the only thing that matters for determining the allocation of production is the relative productivities and not the absolute ones. Now, assume we index the goods (choosing the **z**'s) such that the higher the **z** the lower the ratio **a*(z)/a(z)**.



For a given relative wage, then, those goods in which **a*(z)/a(z)** is larger than **w/w*** will be produced at home. Now we turn our attention to the determination of wages. Here we compute the relative wages that, given some allocation of production, are consistent with equilibrium in the balance of payments. To do this we first have to have a theory of how goods are consumed. In this respect, we will adopt a very simple theory: consumers spend **1/N**th of their income in each good.[1] Finally, assume there are **L** workers at home and **L*** workers at the foreign country. Assume some allocation of production where $\underline{\mathbf{z}}$ is the cut off good:

Home produces goods between: 0 and $\underline{z}$

[1] If the utility function is a Cobb-Douglas with coefficient 1/N this is the result we would obtain from utility maximization.

Foreign produces the goods between: $\underline{z}$ and N

Given these assumptions let's compute total imports and exports by the home country

Wealth of home country: wL

Home imports goods produced abroad: $\underline{z}$ to N

Total imports: $wL\ 1/N\ (N-\underline{z})$

This is saying that total imports are equal to the total wealth per each good times the number of goods imported. Similarly the exports of home goods are the imports by foreigners.

Wealth of foreign country: w*L*

Home exports goods produced inside: 0 to $\underline{z}$

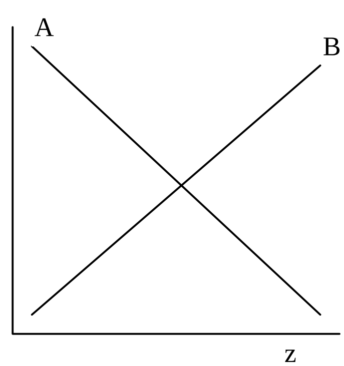
Total exports: $w^*L^*\ 1/N\ \underline{z}$

Because we want equilibrium in the balance of payments, total exports have to be equal to total imports.

$$wL\ 1/N\ (N-\underline{z}) = w^*L^*\ 1/N\ \underline{z}$$

$$\mathbf{w/w^* = L^*/L\ \underline{z}/(N-\underline{z})}$$

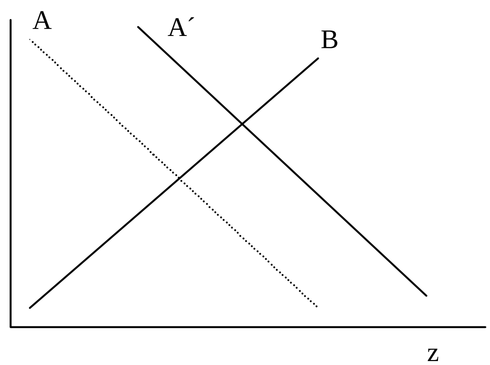
This is the equation that indicates, given some allocation of goods, what is the relative wage consistent with equilibrium in the balance of payments. The intuition behind this equation is the following: If there is an increase in **z** maintaining the same relative wages, the share of world production of home increases. Because income remains the same (relative wages are the same) then the home country imports less goods and exports more. Thus there is an improvement in the balance of payments. In order to return to equilibrium we have to increase the demand in the home country (that in the end will bring imports up). This is achieved by increasing the relative wages. Thus the **B** schedule is increasing.



This defines an equilibrium in which the relative wages across countries and the allocation of production are determined. The original paper looks at changes in technology as well as changes in preferences. Here I only concentrate on the questions regarding technological improvements.

3.1. Technological improvement

What happens if in the home country there is an improvement in productivity across the board? This is like implying that there is a reduction of the unit labor requirements for all goods. Note that if **a(z)** goes down for all gods, then the schedule **A** shifts up. Therefore, the relative wage goes up, and the number of goods produced increases.



This is the general message, but there are several interesting questions that we can raise:

1. This model implies that an increase in technology abroad will reduce the relative wage at home. Is this good for the home country?
2. Imagine that there is only technological improvement in the goods produced at home. What is the impact on the relative wages? If there is no impact, is this good for the home country?
3. What happens when there is technology transfers? Is this good or bad?

In order to answer these questions we have to look at the welfare implications of each of these technological changes. In order to simplify the analysis, I will just concentrate on the total amount of goods consumed. Thus, if the technical change increases or keeps the consumption of all goods constant, then we can say that the change has a positive effect.

3.1.1. Technical improvement abroad

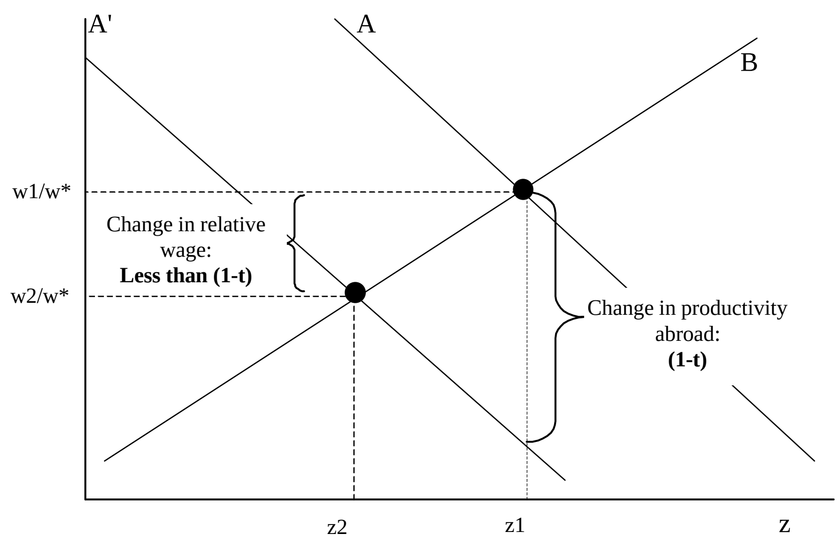
This model implies that if foreigners increase their technology then home's relative wage goes down, and the production of goods also goes down. This sounds quite bad! Let's see if this is indeed as bad as it sounds. Assume foreigners have an improvement in all goods of **t** percent. In other words, there is a decrease in **a*(z)** to **a*(z)(1-t)** for all **z's**.

This means that the schedule **A** moves down exactly by **t**. This is because the change in the relative unit labor requirements is exactly matched by the change in relative wage in the schedule **A**. Formally,

$$\mathbf{w/w^* = a^*(z)/a(z)}$$

$$\mathbf{w/w^* = a^*(z)/a(z)\ (1-t)}$$

Thus, the schedule moves exactly in that proportion. Note that because the **B** schedule is upward, the drop in relative wages in equilibrium is smaller than **t**. In other words, if the schedule **B** is vertical, then the drop in the equilibrium relative wage is exactly **t**. Otherwise, there is some adjustment in the production mix that requires a fall in wages smaller than **t**. Also note that before, the home country was producing goods from 0 to **z1**, now it is from 0 to **z2**. Let's see the welfare implications.



In order to understand the welfare implications, let's compute the quantity of goods that home consumers were consuming for each good. I will divide the space of goods in three: **0-z2-z1-N**.

For simplicity assume that the foreign wage remains constant and only the domestic wages moves (this is completely innocuous because only relative movements matter. However this simplifies the explanation). We denote the original wage as **w1**, while the second wage as **w2**.

Let's compute the consumption of goods before the equilibrium changes.

Goods	Consumption in each of the good types per consumer (for each **z**)	Who produces the good?	Price of good **z**	Total units consumed: expenditure per good divided by its price	
0-Z2	w1 / N	Home	P(z) = w1 a(z)	w1 / N / (w1 a(z))	= 1/ (N a(z))
Z2-Z1	w1 / N	Home	P(z) = w1 a(z)	w1 / N / (w1 a(z))	= 1/ (N a(z))
Z1-N	w1 / N	Foreign	P*(z) = w* a*(z)	w1 / N / (w* a*(z))	= w1/w* / (N a*(z))

Now let's see what happens when **a*** falls by **(1-t)**.

Goods	Consumption in each of the good types per consumer (for each **z**)	Who produces the good?	Price of good **z**	Total units consumed: expenditure per good divided by its price	
0-Z2	w2 / N	Home	P(z) = w2 a(z)	w2 / N / (w2 a(z))	= 1/ (N a(z))
Z2-Z1	w2 / N	**Foreign**	P*=w*a*(z)(1-t)	w2 / N / (w*a*(z)(1-t))	= w2/w* / (1-t) / (N a*(z))
Z1-N	w2 / N	Foreign	P*=w*a*(z)(1-t)	w2 / N / (w* a*(z))	= w2/w* / (1-t) / (N a*(z))

Now we have to compare the total consumption for each type of good. Therefore, the idea is that if, for each type of good, consumers can buy more goods afterwards, then the country has to be better off.

Goods	Consumption before	Consumption after	**Comparison**	Improvement?
0-Z2	1/ (N a(z))	1/ (N a(z))	1/ (N a(z))< 1/ (N a(z))	Same
Z2-Z1	1/ (N a(z))	w2/w* / (1-t) / (N a*(z))	a*(z)(1-t)/a(z)< w2/w*	Yes
Z1-N	w1/w* / (N a*(z))	w2/w* / (1-t) / (N a*(z))	w1/w2 < 1/(1-t)	Yes

The comparison column is computed by asking if the quantity of goods consumed after the change is larger than before. After some algebra you get those inequalities. If the inequalities are satisfied, then it implies that the consumption increases afterwards.

For the goods between 0-z2, the total consumption for each good is the same. Thus, for this group of goods there is no change in welfare.

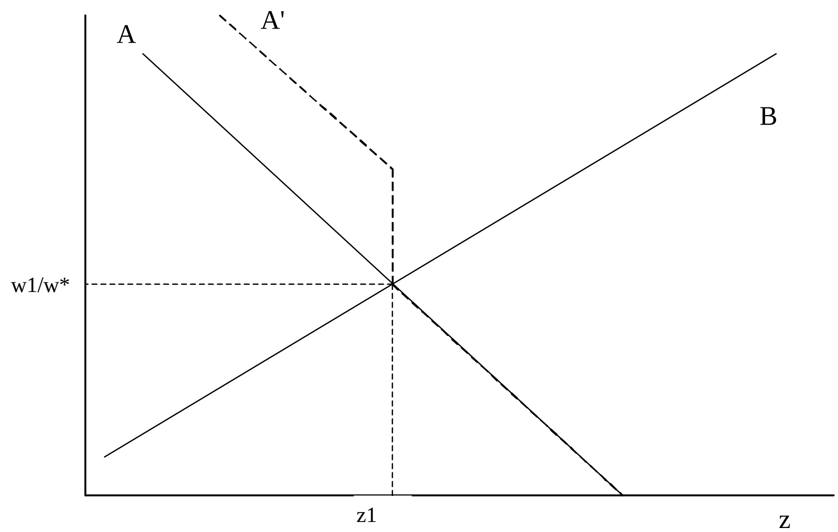
For the goods between z2-z1, the total consumption increases if a*(z)(1-t)/a(z)< w2/w*. Note that the left-hand side is the **A'** schedule and the right hand side is the equilibrium wage after the improvement. Notice that in the previous figure, indeed, the relative wage is equal to the **A'** schedule only for **z2**. For all the **z's** greater than this, the wage is higher than the relative productivity. Therefore, the inequality is satisfied and this implies that the agents are consuming more goods.

For the goods between z1-N, the total consumption increases if w1/w2 < 1/(1-t). Note that this is satisfied if the fall in wages is smaller than the increase in productivity. As it was argued before, this is indeed the case.

In conclusion, productivity increases abroad decrease the relative wages and reduce the mix of goods produced at home, however, the fall in international prices more than compensates these drawbacks and total consumption goes up unambiguously.

3.1.2. Technical improvement only in the goods produced at home.

Now assume that there is a decrease in **a(z)** to **a(z)(1-t)** for only for the goods produced at home. Note that in this case the **A** schedule breaks and only the left hand section shifts upward. Note that in this case there is no shift in the production, nor in the wages. Let's see the welfare implications.



Let's repeat the same procedure as before.

Goods	Consumption in each of the good types per consumer (for each **z**)	Who produces the good?	Price of good **z**	Total units consumed: expenditure per good divided by its price	
0-Z1	w1 / N	Home	P(z) = w1 a(z)	w1 / N / (w1 a(z))	= 1/ (N a(z))
Z1-N	w1 / N	Foreign	P*(z) = w* a*(z)	w1 / N / (w* a*(z))	= w1/w* / (N a*(z))

Now let's see what happens when **a** falls by **(1-t)**.

Goods	Consumption in each of the good types per consumer (for each **z**)	Who produces the good?	Price of good **z**	Total units consumed: expenditure per good divided by its price	
0-Z1	w1 / N	Home	P(z) = w1 a(z)(1-t)	w1 / N / (w1 a(z) (1-t)))	= 1/ (N a(z) (1-t))
Z1-N	w1 / N	Foreign	P*=w*a*(z)	w1 / N / (w* a*(z))	= w1/w* / (N a*(z))

Now we have to compare the total consumption for each type of goods. Therefore, the idea is that, if for each type of good, consumers can buy more goods afterwards, then the country has to be better off.

Goods	Consumption before	Consumption after	**Comparison**	Improvement?
0-Z1	1/ (N a(z))	1/ (N a(z) (1-t))	1/ (N a(z))< 1/ (N a(z) (1-t))	Yes
Z1-N	w1/w* / (N a*(z))	w1/w* / (N a*(z))	w1/w* / (N a*(z))< w1/w* / (N a*(z))	Same

For the goods between 0-z1, the total consumption for each good increases by 1/1-t. Thus for this group there is a welfare increase.

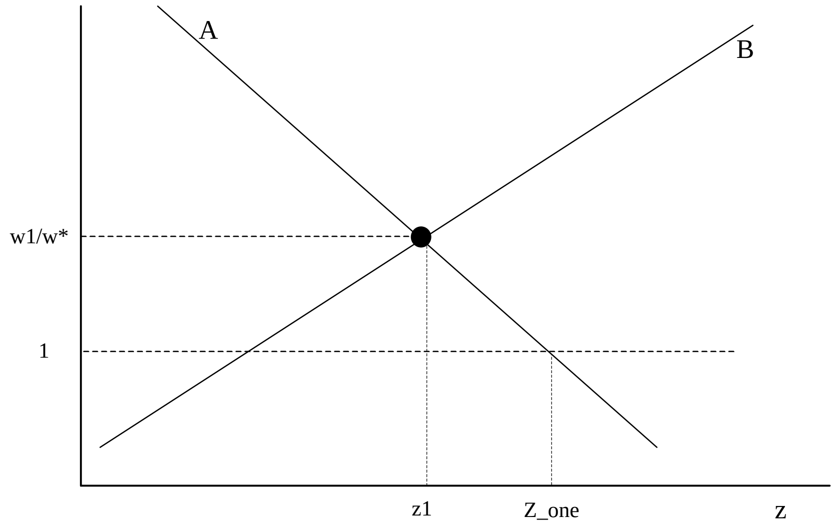
For the goods between z1-N, the total consumption remains the same.

In conclusion, the productivity increases only in the goods home produces, even though they have no implications on the real wage, nor in the pattern of production, are welfare improving.

3.1.3. Technological transfers

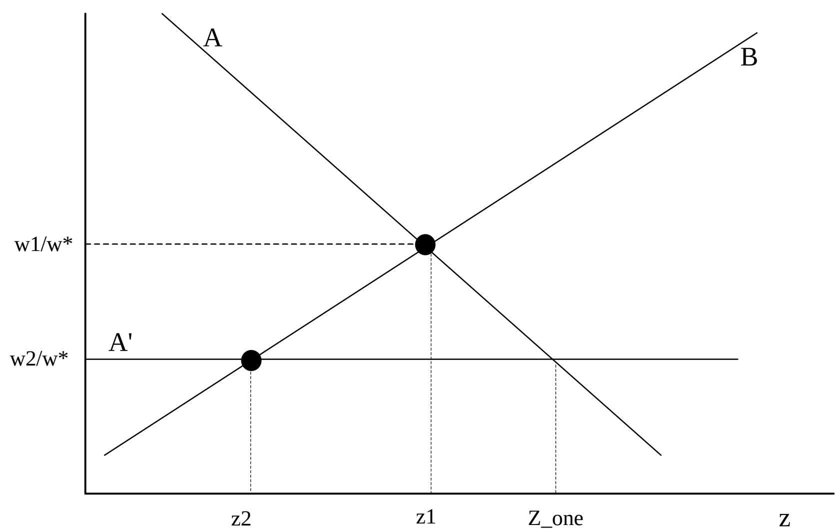
This is a very interesting and difficult case. The answer is *it depends*. So, I will study a case in which the transfer deteriorates the welfare of the home country. Other cases can be built in which the outcome is the opposite. This is quite interesting because the conditions in which this is bad for welfare have interesting policy implications.

A technological transfer across the world means that all countries will adopt the technology of the most efficient one.



In the previous figure I have depicted the usual situation but I have also indicated the place in which the two countries have the same productivities (the 1 schedule). The technological transfer implies that foreigners will adopt home technologies for those goods that are manufactured more productively at home. In fact, these are all the goods between 0 and Z-one. On the other hand, home will adopt the technology from foreign firms for all those goods that are between Z-one and N.

In the end, the **A** schedule collapses to a horizontal line across one. And the process of improvement implies that **a*** falls to **a** for all those goods between 0 and Z-one, and **a** falls to **a*** for all those goods above Z-one. Let's see the welfare implications. Now we have four regions:



Let's compute the consumption of goods before the equilibrium changes.

Goods	Consumption in each of the good types per consumer (for each **z**)	Who produces the good?	Price of good **z**	Total units consumed: expenditure per good divided by its price	
0-Z2	w1 / N	Home	P(z) = w1 a(z)	w1 / N / (w1 a(z))	= 1/ (N a(z))
Z2-Z1	w1 / N	Home	P(z) = w1 a(z)	w1 / N / (w1 a(z))	= 1/ (N a(z))
Z1-Z_one	w1 / N	Foreign	P*(z) = w* a*(z)	w1 / N / (w* a*(z))	= w1/w* / (N a*(z))
Z_one-N	w1 / N	Foreign	P*(z) = w* a*(z)	w1 / N / (w* a*(z))	= w1/w* / (N a*(z))

Now let's see what happens when the technological harmonization occurs. Remember for all the goods between 0 and Z_one the **a(z)** remains the same and all the new **a*(z)** fall to **a(z)**. And from Z_one to N, it is the **a(z)** that falls to **a*(z)**.

Goods	Consumption in each of the good types per consumer (for each **z**)	Who produces the good?	Price of good **z**	Total units consumed: expenditure per good divided by its price	
0-Z2	w2 / N	Home	P(z) = w2 a(z)	w2 / N / (w2 a(z))	= 1/ (N a(z))
Z2-Z1	w2 / N	**Foreign**	P*=w***a(z)**	w2 / N / (w***a(z)**)	= w2/w* / (N **a(z)**)
Z1-Z_one	w2 / N	Foreign	P*=w***a(z)**	w2 / N / (w* **a(z)**)	= w2/w* / (N **a(z)**)
Z_one-N	w2 / N	Foreign	P*=w*a*(z)	w2 / N / (w* a*(z))	= w2/w* / (N a*(z))

Now we have to compare the total consumption for each type of goods. It is quite important to note that all the benefits in productivity that takes place in the goods between 0-z2 and z_one-N have no effect on the price level. These improvements are occurring in sectors that will never change production, or that are not producing in the countries receiving the technological improvement.

On particular, from 0-z2 the transfer of technology goes from home to foreign, but these goods are produced at home. From z_one-N the technological improvement goes from foreign to home, but at home these goods are not produced. In other words, these technological transfers are not changing the prices, nor the costs of goods produced in the world. Thus, they do not affect welfare.

Also, note that because we are assuming that it is the wage in the home country the one that adjusts, then w2=w*.

Goods	Consumption before	Consumption after	**Comparison**	Improvement?
0-Z2	1/ (N a(z))	1/ (N a(z))	1/ (N a(z))< 1/ (N a(z))	Same
Z2-Z1	1/ (N a(z))	w2/w* / (N **a(z)**)	1< w2/w*	Same
Z1-Z_one	w1/w* / (N a*(z))	w2/w* / (N **a(z)**)	w1/w2 < a*(z)/a(z)	**NO**
Z_one-N	w1/w* / (N a*(z))	w2/w* / (N a*(z))	w1<w2	**NO**

For the goods between 0-z_2, the total consumption for each good is the same. Thus, for this group of goods there is no change in welfare.

For the goods between z_2-z_1, the total consumption is also the same. Remember that w_2 is equal to w^* given that the schedule **A** becomes the horizontal line through 1.

For the goods between z_1-Z_one, the total consumption decreases. Remember that w_2 is equal to w^* and the inequality will be true if $w_1/w^*<a^*/a$. In other words, the inequality is true if the relative wages in the original equilibrium are smaller than the relative productivities in the original **A** schedule. However, the case is exactly the opposite (except for the good z_1 where it is equal). Therefore, the consumption of goods falls and welfare goes down.

For the goods between Z_one-N, the total consumption goes down. In this case, there is no productivity improvement abroad. Therefore the price of the goods remain the same, but the wage goes down. Therefore, consumption falls.

In conclusion, it is possible to construct an example in which the transfer of technology is detrimental to the country. It is important to highlight that if Z_one does not exist (e.g. one of the countries is always better than the other in all goods), the transfer of technology always improves the situation of both countries. The intuition why this transfer of technology is bad is the following: first, the gains from trade (the fact that the countries are different) have been eliminated. Second, countries receive some technological improvements that cannot be exploited because they occur in goods in which production does not take place in the countries receiving the technological improvement. This is the example of the first and fourth regions.

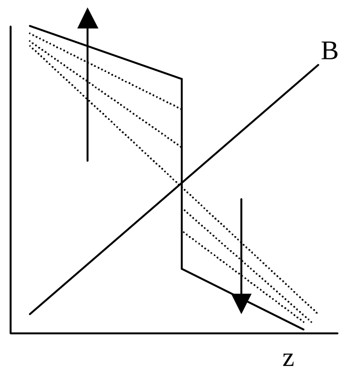
Homework: It is easy to check that in this example foreigners are better off with the transfer. The intuition is that the home country is the one that suffers the fall in wages because it is the one that is receiving fewer technical improvements. In other words, transfers from US to LA could deteriorate welfare in US but not in LA.

3.2. Protectionism

With very few modifications, this model is able to explain in which conditions protectionism could successfully change the pattern of production. In other words, we can look at import substitution policies and their impact on the pattern of production.

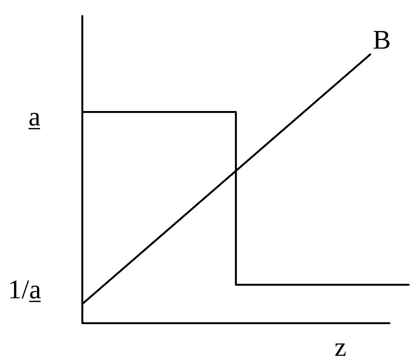
Let's assume that in this model the technological improvements can occur through two processes: learning by doing and imitation. Let's assume that the learning by doing is more powerful but that imitation limits the technical differences. Let's do this more formally.

Assume that technical improvement occurs mostly in those goods that the country produces. This is the case for both countries. Through time the **A** schedule evolves as follows:

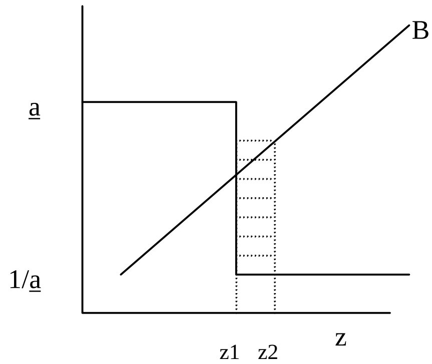


The goods produced at home have technological improvements, therefore **a** is falling and the **A** schedule moves upward. On the other hand, there are technical improvements in the foreign country in foreign goods thus **a*** is fallings and **A** is shifting downwards.

The assumption on imitation limits the extent to which learning by doing can differentiate the two countries. For simplicity we assume that the maximum technical differences is **<u>a</u>**. This implies that the model will collapse to the following:

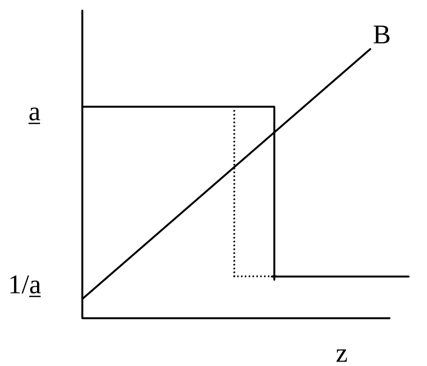


Assume that the home country bans imports of all goods between z1 and z2 cannot be imported.



What is happening through time is that for those goods, the home country has technological improvements that it did not have before. Assume that the improvements at home are larger than abroad. For example, this is the case if the home country is larger than the foreign country, or if production is subsidized to the extent in which it can sell abroad. In the former case, we call the policy import substitution, in the later, export promotion.

In the long run, the home country is gaining productivity to a point in which the protection can be lifted and the home country will still produce the goods.



Note that in the end the home country has a higher wage and a more diversified economy.

From the welfare point of view it is not clear if this is a good transaction because the economy has to pay at the beginning and enjoy the benefits later. The net present value might be negative. This obviously depends on how long the period of protection is there.

Finally, what are the conditions for countries to use these policies successfully?

1. First, the country has to be big enough to take advantage of the learning by doing, or the export subsidy has to be large enough such that it can export to the rest of the world.

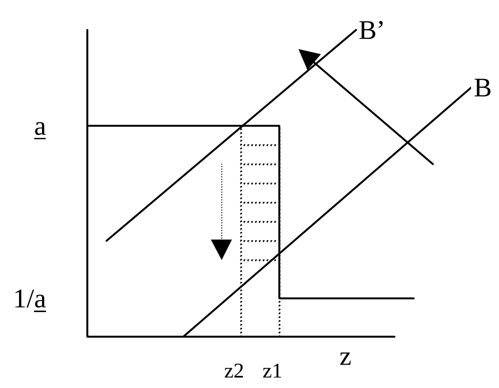
2. Second, there has to be no retaliation from abroad.

3. Third, it has to have a relatively small wage to start with. Otherwise the required subsidy is so large that it is probably inefficient to implement the policy.

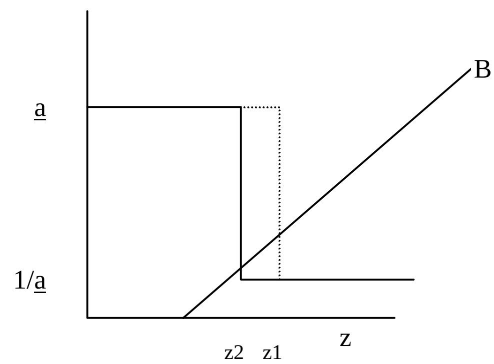
3.3. Real Exchange Rate Appreciation: the Dutch Disease

In the same model we have developed here, let's study what happens when countries receive transitory positive transfers. Here we want to study, for example, what is the effect of a transitory increase in the price of commodities for a commodity exporter country, or the discovery of natural resources, or a transfer from abroad, etc. (In fact, this is called Dutch disease because of the discovery of vast natural gas fields in Holland and the effects it had on the tradable sector there).

All the previous examples have the implication of improving the balance of payments in the short run. For example, assume that the home country is an oil exporter and there is an increase in the price of oil. There is an immediate improvement in the balance of payments and consumers enjoy a higher income. Consumers obviously spend some of the windfall on more imports, but it should be expected that the initial improvement dominates. This means that the B schedule will shift to the left. In other words, at the initial point with the same relative wages and the same pattern of production there is a surplus of the balance of payments. To return to the equilibrium, then, there has to be an increase in domestic income to increase demand of imports. This is done by increasing the relative wage for the same **z**.



The shift of the B schedule upward implies that home country does not produce the goods above z2. Thus, the foreign country starts to experience technological improvements in those goods. If the windfall is long enough then when the B schedule returns to the original position, the country has lost its comparative advantages on those goods permanently.



Note that the home country will end with a lower wage and a more concentrated mixture of production, which has happened in almost all African and OPEC countries since the 70's.

3.4. Transport Costs

Finally, let's look at the problem of introducing tariffs or transport costs in this model. Assume the transport costs adopt the Samuelson's Iceberg form: A domestic good in the foreign country has a price equal to **P(z)(1+g)** and the foreign good at home has a price equal to **P*(z)(1+g)**.

Imports to home are for those goods in which:

$$P(z)=w\ a(z) > P^*(z)(1+g)=w^*\ a^*(z)\ (1+g)$$

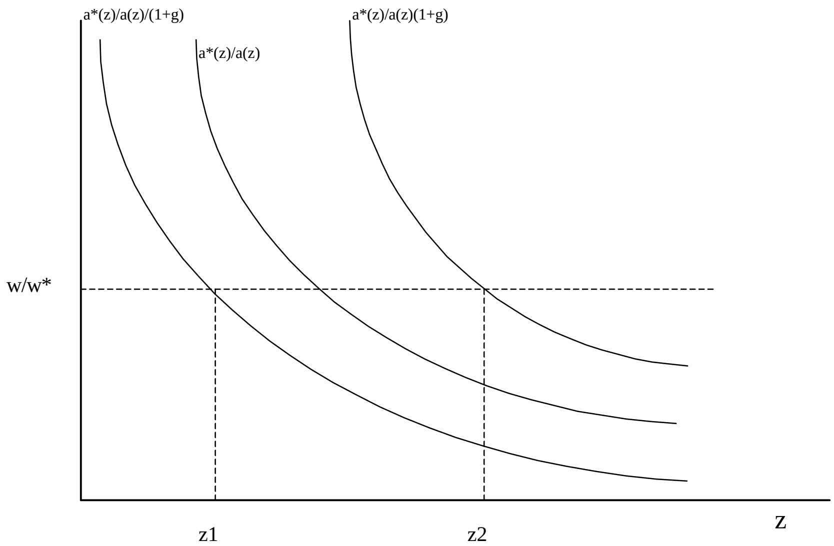
$$w/w^* > a^*/a\ (1+g)$$

Similarly, exports to foreign are

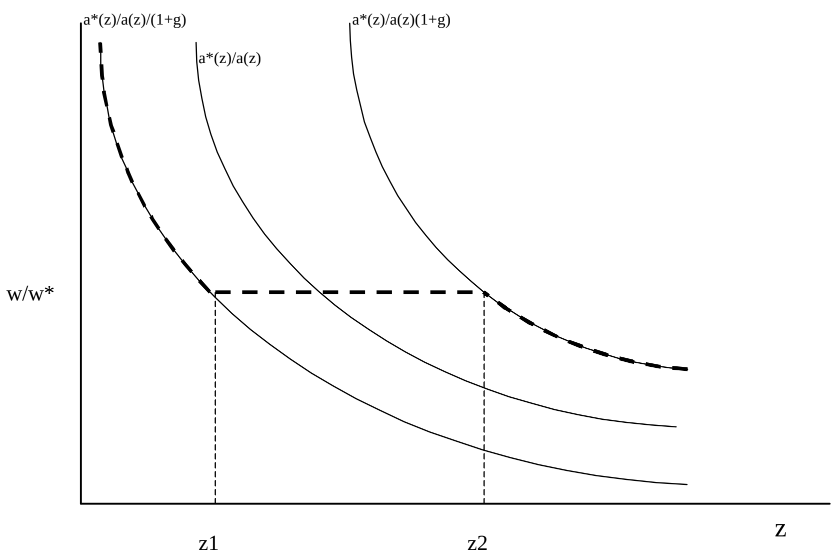
$$P(z)(1+g)=w\ a(z)\ (1+g) < P^*(z)=w^*\ a^*(z)$$

$$w/w^* < a^*/a\ 1/(1+g)$$

Let's see the three schedules given a relative wage and what is the new **A** schedule.



In the next figure, the darker dashed line represents the relevant **A** schedule,



The goods between z1 and z2 are non-tradable, while the goods from 0-z1 are produced at home and exported, and the goods above z2 are produced abroad and imported.[2]

[2] I was asked if the equilibrium wage when g>0 is the same as when g=0. This is generally not the case and it depends on the slope and concavity of the **A** schedule. The wage will remain the same if and only if the **A** schedule is linear.