Chapter 2

Basis of Exchange

In the modern world, almost everyone of us specializes in the production of some goods and services and then use what we produce to exchange for something that we do not produce. YAO Ming specializes as basketball player; Thomas FRIEDMAN specializes as a prominent writer; Bill Gates specializes in the development of Windows operating system; Ms. WU Yi specialized as a vice-premier of the State Council of the People's Republic of China from 2003 to 2008.

Take Ms. WU Yi, as an example. One would expect that Ms. WU Yi, like any Chinese women of her cohort, was capable of doing household chores. Then, would we expect Ms. WU Yi to be doing her household chores during the years when she was a vice-premier? Should she? Most of us would say no because she had much more important things to attend than household chores. The statement that she has much more important things to attend than household chores is another way of saying her opportunity cost of doing household chores is too high (higher than the benefit of doing household chores). Someone would have attended the household chore for her. Yes, this is a specialization. To allow for such specialization, exchange is inevitable.

Why do we specialize and exchange, to begin with? If all decisions are voluntary, it must be the case that such arrangement of specialization and exchange improves the well-being of all parties concerned.

2.1 Absolute advantage and comparative advantage

Consider Robinson Crusoe and Friday who live on an island. There are only two production activities available: Coconut gathering and fishing. Suppose the time required by each to gather a coconut or to catch a fish is summarized below.

	Coconut	**Fish**
Crusoe	3 hours	4 hours
Friday	2 hours	1 hour

We can easily see that Friday takes less time to gather a coconut than Crusoe. In economics jargon, we say Friday has an absolute advantage over Crusoe at the production (or gathering) of coconut. Similarly, we can easily check that Friday also has an absolute advantage over Crusoe at the production of fish.

Definition. *Person A is said to have an **absolute advantage** over person B at the production of a good if it takes A less resources (say, time) to produce a given amount of the good than B or if A can produce more of the good than B given a fixed amount of resources.*

Suppose each of them has to gather one coconut and catch one fish for food. Crusoe might ask this question, "So, Friday, you have absolute advantage over me in the production of both goods. Can you help me gather a coconut and catch a fish?" If you were Friday, what would you say?

Consider the following response from Friday:

> *"I would like to help you. However, there is an opportunity cost of me helping you. I have to use 1 hour to catch a fish. If I help you catch a fish, I have give up 1-hour worth of production – a fish or 1/2 coconuts. It takes me 2 hours to gather a coconut. If I help you gather a coconut, I have to give up 2-hour worth of production – 2 fish or 1 coconut. Thus, I am willing to help anyone catch a fish only if I am compensated at least 1/2 coconuts; I am willing to help anyone gather a coconut only if I am compensated at least 2 fish."*

Of course, it is only fair for Friday to refuse to help Crusoe for free!

How much is Crusoe willing to compensate Friday?

> *"I have to use 4 hours to catch a fish. Using this same amount of time, I could have gathered 4/3 coconuts. Thus, if Friday is willing to help me catch a fish, I am willing to give him at most 4/3 coconuts. It takes me 3 hour to gather a coconut. Using this same amount of time, I could have caught 3/4 fish. Thus, if Friday is willing to help me gather a coconut, I am willing to give him at most 3/4 fish."*

Will there be a deal? Which of the following two deals will make both of them happy?

1. Friday helps Crusoe catch fish and Crusoe helps Friday gather coconuts.
2. Friday helps Crusoe gather coconuts and Crusoe helps Friday catch fish.

To help answer this question, it is useful to table the opportunity cost discussed earlier.

	Friday helps Crusoe catch fish	**Friday helps Crusoe gather coconuts**
The minimum compensation required by Friday	1/2 coconuts	2 fish
The maximum compensation Crusoe is willing to pay	4/3 coconuts	3/4 fish

From the table (and the discussion), we can easily see that Friday has a lower opportunity cost of catching fish than Crusoe; Crusoe has a lower opportunity cost of gathering coconuts than Friday. In economics jargon, Friday is said to have a comparative advantage (or be relatively more efficient) over Crusoe in the production of fish; Crusoe is said to have a comparative advantage (or be relatively more efficient) over Friday in the production of coconuts.

Definition. *Person A has a* ***comparative advantage*** *over person B at a task if and only if A has a lower opportunity cost of performing it than B.*

By comparing the minimum compensation required by Friday and the maximum compensation Crusoe is willing to pay, we can see that only one type of agreement can be reached. Friday helps Crusoe to catch fish and Crusoe helps Friday to gather coconuts. The compensation has to lie between 1/2 and 4/3 coconuts per fish. For instance, the term of trade "1 coconut per fish" is admissible.

Definition. *The* ***term of trade*** *between two goods A and B is how many units of good A can be exchanged into a unit of good B.*

Suppose the term of trade is 1 coconut per fish. Will the exchange (and hence the specialization) benefit both? Without the exchange, Crusoe will need to spend 7 hours to catch a fish and gather a coconut; Friday will need to spend 3 hours. With the exchange, Crusoe only needs to spend 6 hours to gather two coconuts and exchange 1 coconut for 1 fish; Friday needs only 2 hours to catch 2 fish and exchange 1 fish for 1 coconut.

Time needed to obtain 1 fish and 1 coconut

	Without exchange	**With exchange**
Crusoe	7 hours	6 hours
Friday	3 hours	2 hours
Total	10 hours	8 hours

This example illustrates that by focusing on the production at which each of them has comparative advantage and then engaging in exchange, both will benefit. One must note that the term of trade of 1 fish to 1 coconut is one of the many admissible term of trade. Given the specific numbers of this example, any term of trade of 1 fish to x coconuts with x between 1/2 and 4/3 are considered admissible and thus will ensure savings for both parties.

The table below summarizes the intended direction of trade under different terms of trade (1 fish to x coconuts). We know that as it costs 4/3 coconuts for Crusoe to produce one fish, Crusoe will be interested in offering coconuts for fish when $x < 4/3$. Similarly, as it costs 1/2 coconuts for Friday to produce one fish, Friday will be interested in offering coconuts for fish when $x < 1/2$. Thus, for $x < 1/2$, both will be interested in offering coconuts for fish. Therefore, there will not be any trade.

Term of trade (1 fish to x coconuts)	**Crusoe**	**Friday**
$x < 1/2$	offer coconut, want fish	offer coconut, want fish
$x = 1/2$	offer coconut, want fish	Indifferent
$1/2 < x < 4/3$	offer coconut, want fish	offer fish, want coconut
$x = 4/3$	Indifferent	offer fish, want coconut
$x > 4/3$	offer fish, want coconut	offer fish, want coconut

A remark. Some students will find it difficult to understand the sentence like "as it costs 4/3 coconuts for Crusoe to produce one fish, Crusoe will be interested in offering coconuts for fish when $x < 4/3$." Sometimes, we use "x" to make a general case. There is a cost, however. The cost of generalization is the difficulty in understanding it. Again, when we have difficulty understanding something, try to rewrite the context to a situation that is so much easier to understand and then gradually change it back to the original situation. It should be easy to see the parallel of the following descriptions.

1. Suppose it costs Tom 2 dollars to produce one fish. When the price of fish is 1.5 dollars per fish (note, $1.5 < 2$), Tom would be interested in buying the fish from the market instead of producing it himself. That is, Tom is offering money to exchange for fish.

2. Suppose it costs 2 dollars for Tom to produce one fish. When the price of fish is x dollar per fish and $x < 2$, Tom would be interested in buying the fish from the market instead of producing it himself. That is, Tom is offering money to exchange for fish.

3. As it costs 4/3 coconuts for Crusoe to produce one fish, when the term of trade is x coconuts per fish and $x < 4/3$, Crusoe will be interested in offering coconuts to exchange for fish.

2.1.1 Computing opportunity cost

Productivity information are sometimes given as the amount of resources required to produce one unit of the goods, sometimes as the amount of output produced with a fixed amount of resources. To some students, while the concept of opportunity cost is intuitive, the computation of opportunity cost can be a challenging exercise. Below, we illustrate the steps when different types of productivity information are provided.

Amount of output produced with a given amount of resources

Suppose with a fixed amount of resources (a day), Crusoe can gather the following amount of coconuts and fish.

Coconut per day	**Fish per day**
a	b

How to compute Crusoe's OC of gathering 1 coconut? Essentially, we need to "normalize" the above information in the table so that the entry for coconut is 1. The way to do this is to consider a different amount of resources. Instead of a day, let consider the resources of "$1/a$" days and ask the amount of the goods Crusoe can produce in "$1/a$" days. Crusoe can gather "a" coconuts in a day implies he can gather 1 coconuts in "$1/a$" days. And, of course, in "$1/a$" days, Crusoe can gather $(1/a) \times b$ fish. Thus, Crusoe's OC of gathering 1 coconut is "b/a" fish.

Coconut per day	**Fish per day**
a	b

$\longrightarrow$

Coconut per "$1/a$" day	**Fish per "$1/a$" day**
$a/a = 1$	b/a

Similarly, to compute Crusoe's OC of gathering 1 fish, we will "normalize" the fish entry to 1, by considering what they can do in "$1/b$" days. After such normalization, we find that Crusoe's OC of gathering 1 fish is "a/b" coconuts.

Coconut per day	**Fish per day**
a	b

$\longrightarrow$

Coconut per "$1/b$" day	**Fish per "$1/b$" day**
a/b	$b/b = 1$

The amount of resources required to produce one unit of the goods

Suppose for Crusoe, the time required to gather a coconut or to catch a fish is summarized below.

Hours required per coconut	**Hours required per fish**
a	b

How to compute Crusoe's OC of gathering 1 coconut? It will be convenient to imagine the availability of "a" hours for the production and ask how many units of each good he can produce in "a" hours. Obviously, in "a" hours, Crusoe can produce 1 coconuts and "a/b" units of fish. Thus, Crusoe's OC of gathering 1 coconut is "a/b" fish.

Hours required per coconut	**Hours required per fish**		**Coconut per "a" hours**	**Fish per "a" hours**
a	b	$\longrightarrow$	$a/a = 1$	a/b

Similarly, to compute Crusoe's OC of gathering 1 fish, we can imagine the availability of "b" hours for the production. Thus, Crusoe's OC of gathering 1 fish is "b/a" coconut.

Hours required per coconut	**Hours required per fish**		**Coconut per "b" hours**	**Fish per "b" hours**
a	b	$\longrightarrow$	b/a	$b/b = 1$

2.2 Sources of comparative advantage

What determines our comparative advantage in performing different tasks? At the individual level, comparative advantage is determined by our inborn talent and temper (genes?), education, training and experience. Inborn talent and temper cannot be changed. However, education, training and experience can be adjusted to change our comparative advantage. For instance, an exchange experience at a German university might improve our comparative advantage in the trading business between Hong Kong and Germany. A bachelor degree in Economics will give us a comparative advantage in working in banks.

At the national level, a country's endowment of natural resources, climate, its culture and institutions determine the country's comparative advantage. Saudi Arabia has a comparative advantage in the production of oil because its oil reserve is much more abundant and its cost of extraction is much lower than other countries. Hong Kong has its comparative advantage as a financial centre over Shanghai because Hong Kong inherited legal institutions and English as an official language from the British, and it has a convertible currency and a relatively simple taxation system.[1]

Even for a country, comparative advantage can change. Consider a brief economic history of Hong Kong. Manufacturing industry was Hong Kong's pillar in the sixties and seventies. The manufacturing industry was relatively land and labor intensive. In 1978, mainland China adopted an open-door policy. Land and labor were much cheaper across the border and became accessible to Hong Kong entrepreneurs. The effect was that Hong Kong gradually lost its comparative advantage in manufacturing. Factories gradually moved across the border. As China and the region grew, Hong Kong gradually became a financial centre, a realization of its comparative advantage due to its legal framework, the convertibility of its currency, its proximity to mainland China and a more educated population. In fact, the adoption of compulsory education and the development of higher education contributed to Hong Kong's comparative advantage of becoming a financial center.

[1] On the simple taxation system, see *Taxation without representation: the history of Hong Kong's troublingly successful tax system* By Michael Littlewood, HKU Press.

Some countries may take more drastic steps to change its comparative advantage. In 2010, Georgia has changed its second official language from Russian to English. In 2008, the Rwandan government decided to replace French with English as the language of business, diplomacy and scholarship. For years, Japan and South Korea have proposed to adopt English as a second official language.[2] The hope is that the adoption of English as an official language will improve its comparative advantage in doing business with the English-speaking world.[3]

2.3 Production possibility curves

Definition. *A **production possibility curve** is a graph that describes the maximum amount of one good that can be produced for every possible level of production of the other good.*

2.3.1 One-person economy

Suppose Tarzan can produce 6 squared metres of shelter per week or 12 kilograms of food per week. If Tarzan is the only person in the economy, what is the economy's production possibilities. From the information, we gather that

1. if Tarzan uses all his time on the production of shelter, he can produce 6 squared metres of shelter per week and zero kilograms of food per week;
2. if Tarzan uses all his time on the production of food, he can produce zero squared metre of shelter per week and 12 kilograms of food per week;
3. if Tarzan divides his time equally on the production of shelter and food, he can produce 3 squared metre of shelter per week and 6 kilograms of food per week;
4. or more generally, if Tarzan spend w proportion of his time on the production of shelter and $(1 - w)$ on the production of food, he can produce $6w$ square metre of shelter per week and $12 \times (1 - w)$ kilograms of food per week.

So, if we let w be the proportion of Tarzan's time on the production of shelter, we have the PPC summarized as

$$(\text{Shelter}, \text{Food}) = (6w, 12 - 12w)$$

Alternatively, if we let z be the amount of shelter Tarzan produces, we have the PPC summarized as

$$(\text{Shelter}, \text{Food}) = (z, 12 - 2z)$$

These possibilities are often summarized in a graph, called a production possibilities curve (i.e., PPC).

[2] See http://www.yomiuri.co.jp/adv/wol/dy/opinion/culture_100823.htm for the Japanese proposal. See http://www.koreatimes.co.kr/www/news/biz/2008/11/123_34000.html for the Korean proposal.

[3] For a discussion of how trade is associated with language, see Melitz, Jacques (2008), "Language and foreign trade," *European Economic Review* 52 (2008) 667–699.

Table 2.1: Tarzan's PPC

The PPC is informative.

1. Any combinations of food and shelter production within the triangle (0,0), (12,0) and (0,6) are attainable. Examples include (4,2), (0,0), (12,0), etc.

2. Any combinations of food and shelter production outside the triangle (0,0), (12,0) and (0,6) are not attainable. Examples include (8,4), (4,6), (12,2), etc.

3. Any combinations on the straight line connecting (12,0) and (0,6) are attainable and efficient. Examples include (12,0), (8,2), (4,4), (0,6), etc.

4. Any combinations **strictly inside** the triangle (0,0), (12,0) and (0,6) are attainable but inefficient. Examples include (0,0), (4,2), etc. For instance, (4,2) is inefficient because given 4 kg of food per week, we can produce more than 2 sq metres of shelter. Producing at the point of (4,2) would be like throwing away some resources or some output.

The most important information we can derive from a PPC is the opportunity cost of production. On a PPC, producing one more kg of food, Tarzan has to sacrifice 0.5 sq metre of shelter. In other words, the opportunity cost of one kg of food is the 0.5 sq metre of shelter. Since the PPC is a straight line, we can easily compute the opportunity cost of one kg of food as the slope of the PPC

$$\frac{\Delta y}{\Delta x} = \frac{(6-0)}{(0-12)} = -0.5$$

where the *negative* sign shows the *sacrifice* of good y in order to obtain an additional unit of good x.

Given the information, we can also identify the equation describing the PPC.

$$y = 6 - 0.5x$$

2.3.2 Two-person economy

Suppose Tarzan is now joined by Jane, who can produce 4 sq metres/wk of shelter or 4 kgs/wk of food. What would be the economy's production possibilities curve?

First, from the information provided, we know Jane's own production possibilities curve looks like

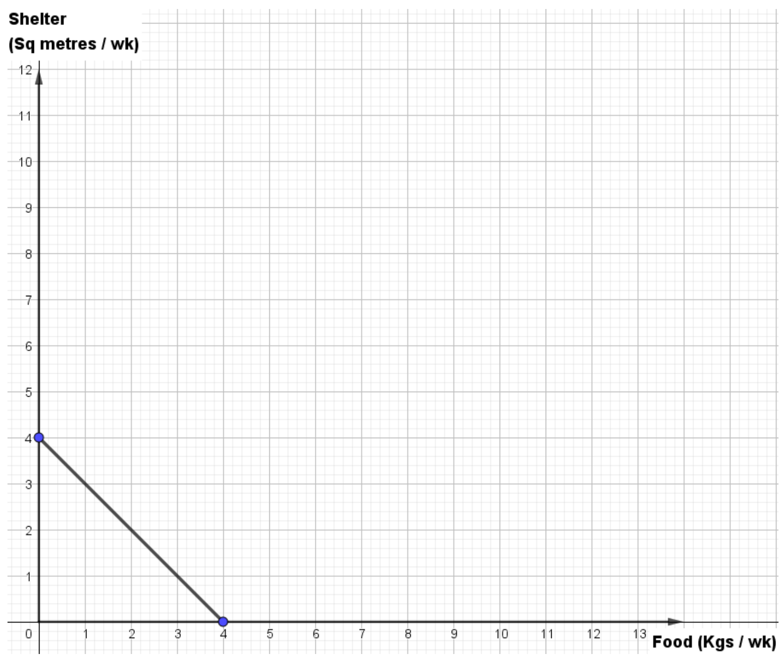


Figure 2.1: Jane's PPC

Her opportunity cost of producing 1 kg of food per week is 1 sq metre of shelter per week.

By comparing the productivity of Tarzan and Jane, we conclude that

1. Tarzan has absolute advantage over Jane in the production of food, as well as in the production of shelter.

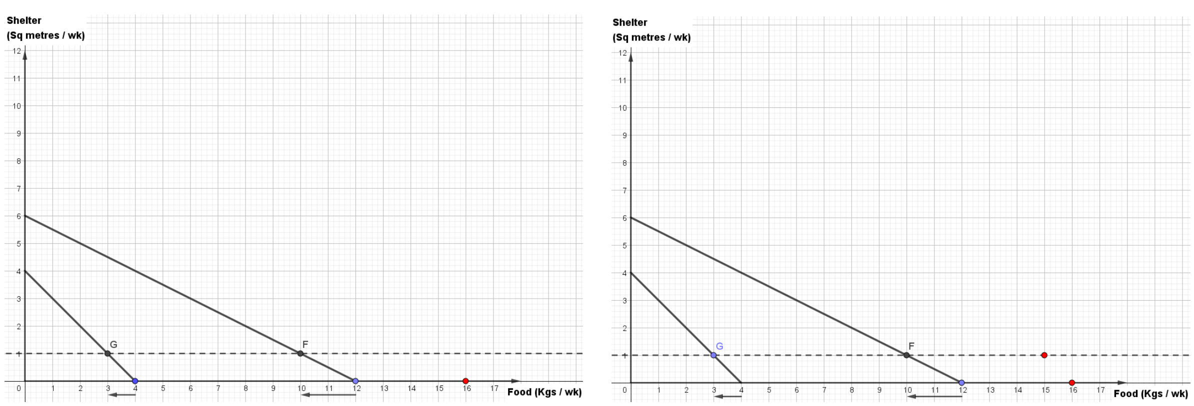
2. Tarzan has comparative advantage over Jane in the production of food. Correspondingly Jane has comparative advantage over Tarzan in the production of shelter.

To find the production possibilities of the two-person economy, we will start from the situation when all resources of the economy are used to produce food and ask how much food the economy has to sacrifice in order to produce a little bit more shelter.

1. If Tarzan and Jane spend all their resources on the production of food, they will obtain 16 kgs of food and 0 sq metre of shelter per week, i.e., (16, 0).

Figure 2.2: Both Tarzan and Jane completely specialize in Food production

2. If Tarzan and Jane would like to produce one square metre of shelter, they would have to negotiate who to produce the one sq metre of shelter. We know from the previous discussion that Jane has comparative advantage over Tarzan in the production of shelter, they will benefit by letting Jane produce the two square metres of shelter. Indeed, we can see that if they let Jane produce the one square metre of shelter, they will have to give up 1 kgs of food whereas if they let Tarzan do it, they will have to give up 2 kgs of food.



(a) Jane has a lower opportunity cost

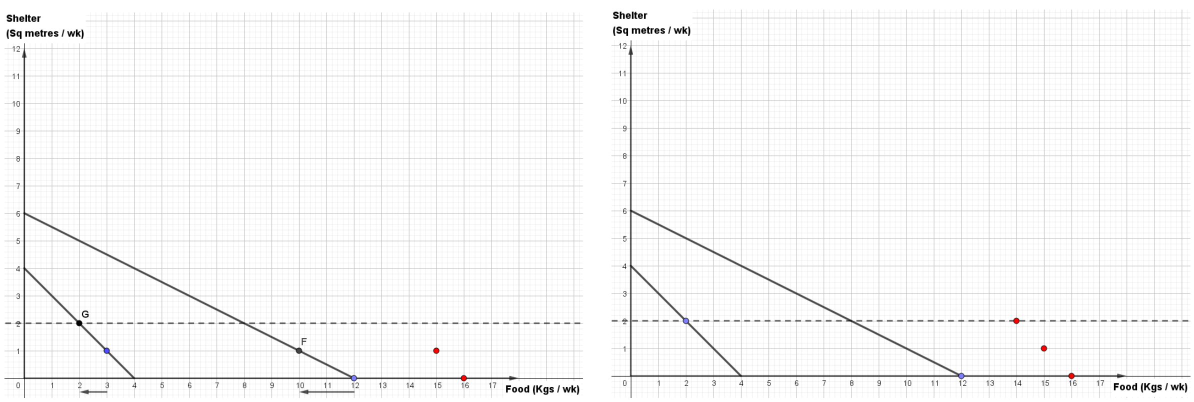
(b) The concluded production point (Shelter=1)

Figure 2.3: Who to produce the first unit of shelter

From the economy's perspective, letting Jane produce the one sq metre of shelter will incur a smaller cost or a smaller reduction in food production. That is, the production mix of 15 kgs of food and 1 sq metre of shelter per week, i.e., (15,1), is a point on the PPC.

3. If Tarzan and Jane would like to produce an additional one sq metre of shelter, again they would have to negotiate who to produce the additional one sq metres of shelter. The analysis will be

similar to the one above. We know from the previous discussion that Jane has a comparative advantage over Tarzan in the production of shelter, they will benefit by letting Jane produce the one sq metre of shelter. Indeed, we can see that if they let Jane produce the one sq metre of shelter, they will have to give up 1 kgs of food whereas if they let Tarzan do it, they will have to give up 2 kgs of food.



(a) Jane has a lower opportunity cost (b) The concluded production point (Shelter=2)

Figure 2.4: Who to produce the second unit of shelter

From the economy's perspective, letting Jane produce the two sq metres of shelter will incur a smaller cost or a smaller reduction in food production. That is, the production mix of 14 kgs of food and 2 sq metres of shelter per week, i.e., (14,2), is a point on the PPC.

4. We can repeat the above steps to increase the amount of shelter one sq metre at a time till four sq metres.

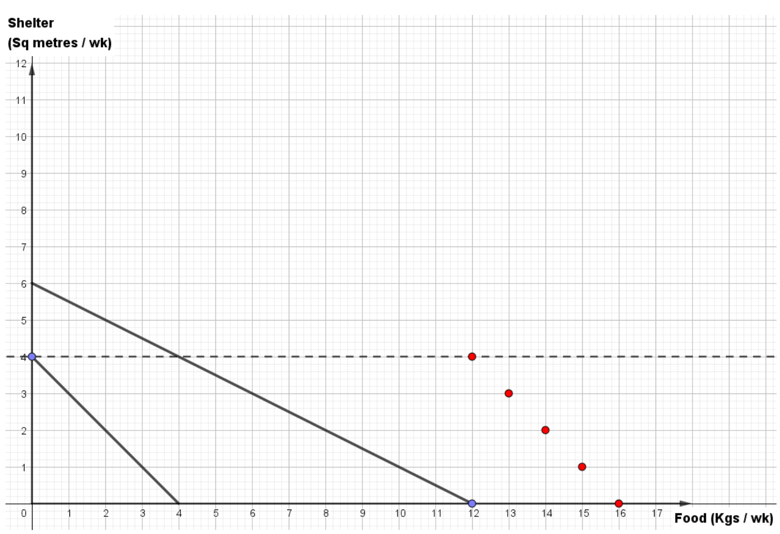
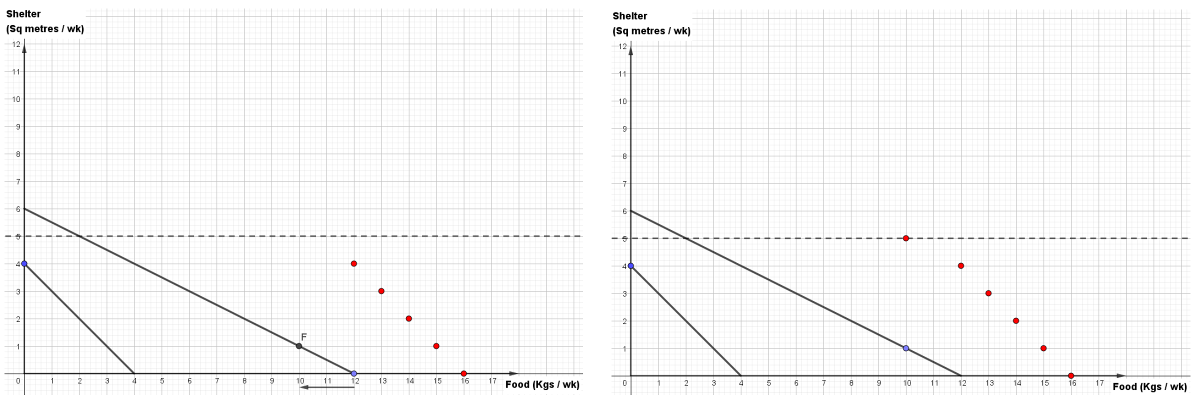


Figure 2.5: Who to produce the first four units of shelter

5. Now if Tarzan and Jane would like to produce an additional one sq metres of shelter, there is no need to negotiate who to produce the additional one sq metre of shelter because Jane is already completely specialized in the production of shelter and she cannot contribute anymore to the additional production of shelter. That is, to produce the additional one sq metre of shelter, Tarzan has to switch his time from production of food to the production of shelter, resulting in a reduction of 2 kgs of food.

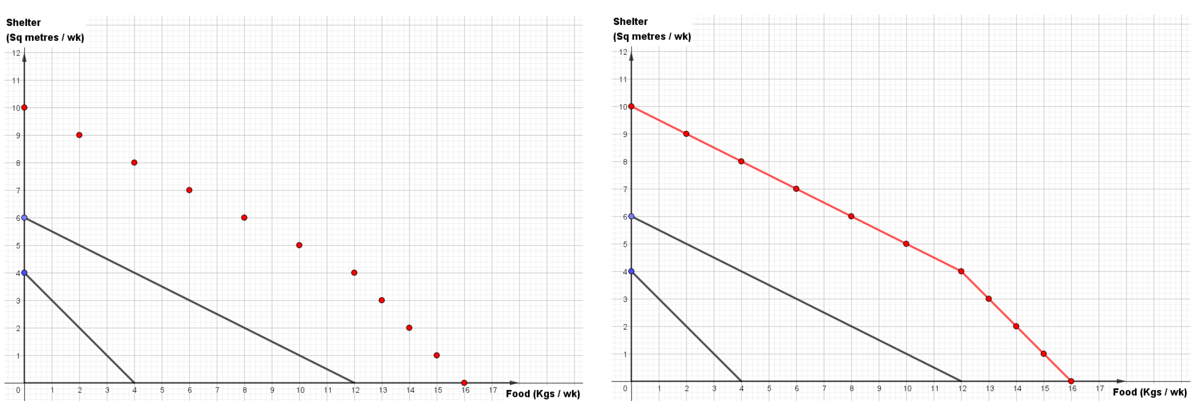


(a) Only Tarzan available (b) The concluded production point (Shelter=5)

Figure 2.6: Who to produce the fifth unit of shelter

That is, the production mix of 10 kgs of food and 5 sq metres of shelter per week, i.e., (10,5), is a point on the PPC.

6. We can repeat the above steps to increase the amount of shelter one sq metre at a time till ten sq metres, when both Tarzan and Jane are completely specialized in the production of shelter.



(a) Obtaining the production points one by one (b) Lines connecting the production points

Figure 2.7: Obtaining the final PPC

Connecting the dots, we have the PPC of this two-person economy.

Note that there is a kink at the point where Tarzan and Jane completely specialize in the tasks that they have comparative advantage in.

The above derivation of the PPC uses the concept of comparative advantage. In expanding the production of shelter, we first employ those resources with the lowest opportunity cost of producing shelter (i.e., Jane), and only afterward turn to resources with higher opportunity costs (Tarzan). This principle is sometimes called **The Principle of Increasing Opportunity Cost** or **The Low-Hanging-Fruit Principle**.

> **The Principle of Increasing Opportunity Cost** or **The Low-Hanging-Fruit Principle**
>
> When we pick fruits from a fruit tree, we always start picking those hanging low because it costs less to do so. When the fruits hanging low are exhausted, we will start picking those higher up, incurring a slightly higher cost.

As an additional illustration, consider that both Tarzan and Jane initially specialize in the production of shelter (i.e., the production mix of (0,10)). If they want to increase the food production a little bit, who should they employ to produce this additional food production? It must be Tarzan, who has a lower opportunity cost of producing food. We continue to use Tarzan to produce additional amount of food until all Tarzan's time is used up for food production. This means moving along the line segment connecting (0,10) and (12,4). As the increase of food production is all due to Tarzan, the decrease in shelter is all due to Tarzan. Hence, this segment of the two-person PPC has the same slope as the one-person PPC of Tarzan. As Tarzan's time is used up for food production and if we still want to produce more food, we will turn to Jane, until Jane's time is all used up. This means moving along the line segment connecting (12,4) and (16,0). As the increase of food production is all due to Jane, the decrease in shelter is all due to Jane. Hence, this segment of the two-person PPC has the same slope as the one-person PPC of Jane.

How to describe the two segments of the joint PPC in equations? Using the information from the graph and the discussion we have done, we can write

Segment 1, linking (0,10) and (12,4):	$y = 10 - 0.5x$	for $0 \leq x \leq 12$
Segment 2, linking (12,4) and (16,0):	$y = 16 - x$	for $12 \leq x \leq 16$

Verify, again, that the slopes are just the OCs of the corresponding individual PPCs.

2.3.3 Three-person economy

Suppose Tarzan and Jane are now joined by Michael, who can produce 2 sq metres/wk of shelter or 1 kg/wk of food. What is the production-possibilities curve for the new economy consisting of Tarzan, Jane, and Michael?

First, from the information provided, we know Michael's own production possibilities curve looks like

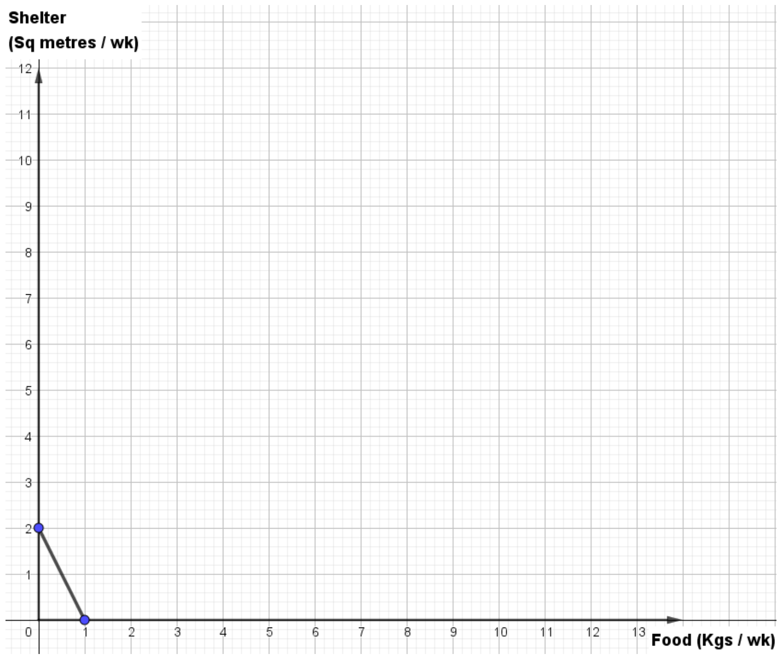


Figure 2.8: Michael's PPC

By comparing the productivity of Jane and Michael, we conclude that

1. Jane has absolute advantage over Michael in the production of food, as well as in the production of shelter. (Recall Tarzan has absolute advantage over Jane in the production of food, as well as in the production of shelter.)

2. Jane has comparative advantage over Michael in the production of food. Correspondingly Michael has comparative advantage over Jane in the production of shelter. (Recall Tarzan has comparative advantage over Jane in the production of food.)

To find the production possibilities of the three-person economy, we will start from the situation when all resources of the economy are used to produce food and ask how much food the economy has to sacrifice in order to produce a little bit shelter. According to the low-hanging-fruit principle, to produce a little bit more shelter, we should use the person with the lowest opportunity cost first (i.e., Michael), then turn to the person with slightly higher opportunity cost (i.e., Jane), and finally the person with the highest opportunity cost (i.e., Tarzan).

The resulted PPC is shown below.

Figure 2.9: PPC of the three-person economy

Note that there are two kinks on the PPC,

1. one kink at the point where Michael completely specializes on the production of shelter and Tarzan and Jane completely specializes in the production of food.

2. one kink at the point where Michael and Jane completely specialize on the production of shelter and Tarzan completely specializes in the production of food.

Again, we can describe the three segments of the joint PPC in equations.

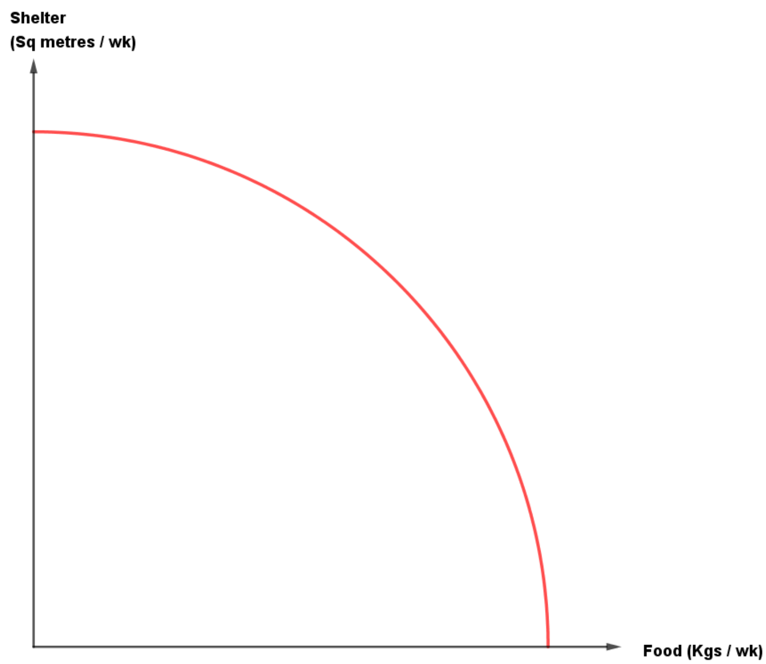
Segment 1, linking (0,12) and (12,6):	$y = 12 - 0.5x$	for $0 \leq x \leq 12$
Segment 2, linking (12,6) and (16,2):	$y = 18 - x$	for $12 \leq x \leq 16$
Segment 3, linking (16,2) and (17,0):	$y = 34 - 2x$	for $16 \leq x \leq 17$

If the three persons would like to jointly produce 4 units of shelter, how would they spend their time on each of the two tasks?

	Proportion of time			Output	
	Food	Shelter		Food	Shelter
Tarzan	100%	0%	$\longrightarrow$	12 kgs	0 m^2
Jane	50%	50%		2 kgs	2 m^2
Michael	0%	100%		0 kgs	2 m^2

2.3.4 Many-person economy

An extension to the case with many persons of different opportunity costs is straight-forward. One would expect that the PPC will look like the following.



While the curve looks smooth, one can imagine that when one looks at a specific section of the curve with a magnifier, we will see kinks that correspond to a group of individuals specializing in the production of food and the remaining specializing in the production of shelter. The curve looks smooth because we have many individuals of slightly different opportunity costs. Of course, the bowing out shape of the PPC of many persons is due to the increasing opportunity cost principle or the low hanging fruit principle.

Most textbooks will assume the PPC of each person to have this bowing out shape. Our discussion shows that **bowing out shape of the PPC will result even when we assume linear individual PPC**s. Our derivation of the bowing out PPC from linear individual PPCs illustrates the importance of the principle of increasing opportunity cost.

2.3.5 Many-good economy

When there are more than two goods, it would be difficult to draw the PPC as we did. In fact, for two goods (x_1 and x_2), we will draw a PPC of two dimensions as we have ($x_1 = a+bx_2$, or $a_1x_1+a_2x_2 = k$). For three goods (x_1, x_2 and x_3), we will draw a PPC of three dimensions (we can still draw it if we try hard). Mathematically, it will be like $a_1x_1 + a_2x_2 + a_3x_3 = k$. For four goods ($x_1$, x_2, x_3 and x_4) we will end up drawing a PPC of four dimensions. I have not seen any four dimensional graphs. In this case, we have to represent the production possibilities using mathematics. Mathematically, it will be like $a_1x_1 + a_2x_2 + a_3x_3 + a_4x_4 = k$.

The discussion of a many-good economy is rather involved mathematically. Such discussion is better left to more advanced courses.

Often, students of Economics do not understand why we need to use mathematics in Economics, the discussion here illustrates such necessity. There is a trade-off. If we want to limit our use of mathematics, we will have to stick to the simplified two-good economy. If we want to analyze the more realistic many-good economy, the use of mathematics appears necessary.

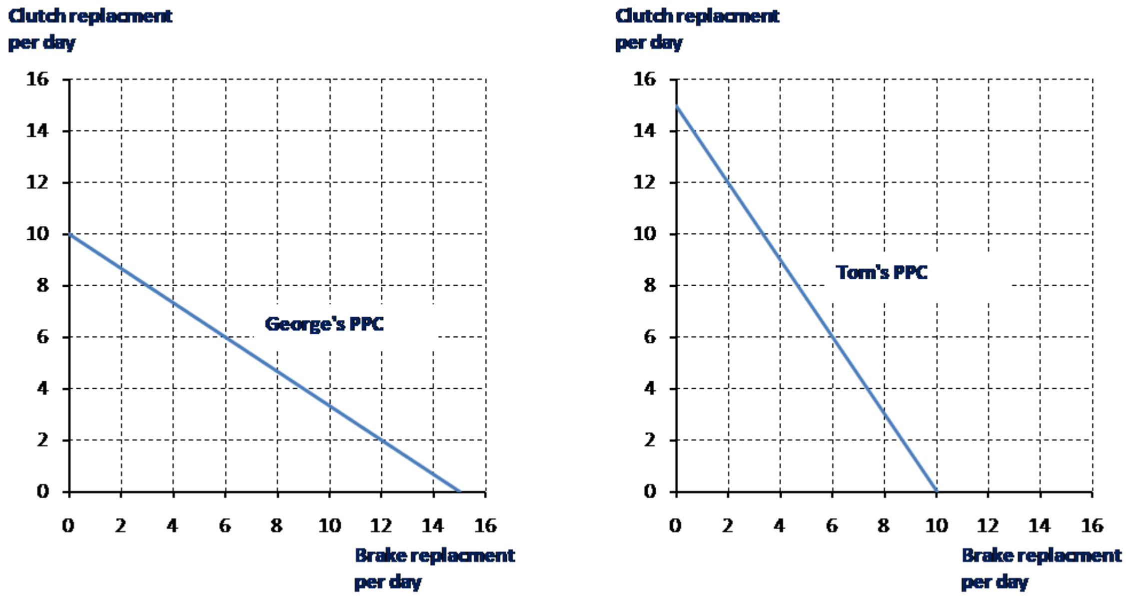
2.4 The possible gains due to specialization

The principle of comparative advantage and exchange can lead to more output given the same amount of resources. Tentatively, we can use comparative advantage to explain the difference in output across economies. How about the vast difference in the production possibilities between developing and developed countries?

2.4.1 Small difference in comparative advantages

Consider the following scenario. George and Tom are mechanics. Tom can replace 15 clutches per day or 10 sets of brakes, i.e., the opportunity cost of replacing a pair of brakes is 1.5 clutches; George can replace 10 clutches per day or 15 sets of brakes, i.e., the opportunity cost of replacing a pair of brakes is $2/3$ clutches. At their garage, a service job consists of a brake replacement and a clutch replacement, i.e., the number of brake replacements performed each day has to be the same as the number of clutch replacements. How many more service jobs can they accomplish if they specialize than if each do the jobs separately?

First , we have to figure out the number of jobs each of them can accomplish when they perform the jobs independently. From the information provided, we can draw the two PPCs by George and Tom as below.



(a) George's PPC (b) Tom's PPC

Figure 2.1: The PPCs of George and Tom

It is easy to figure out the equations that describe the two PPCs.

$$\begin{aligned} \text{George: } C &= 10 - \left(\frac{2}{3}\right) B \\ \text{Tom: } C &= 15 - \left(\frac{3}{2}\right) B \end{aligned}$$

Equal number of clutch and brake replacement means $C = B$. Using this condition, it is easy to solve $B = C = 6$ for both of them.[4] Thus, if they do the jobs independently, they would have accomplished a total of 12 jobs.

Second, it is easy to figure out that George has comparative advantage over Tom on brake replacement and Tom has comparative advantage over George on clutch replacement. Thus, if they specialize, George will tend to specialize on brake replacement, and Tom on clutch replacement. Since the numbers in the example are symmetric across individuals, we expect together, they can accomplish 15 jobs.

[4]For example, consider George. Setting $C = B$, we have

$$\begin{aligned} B &= 10 - (\frac{2}{3})B \\ (\frac{5}{3})B &= 10 \\ B &= 6 \end{aligned}$$

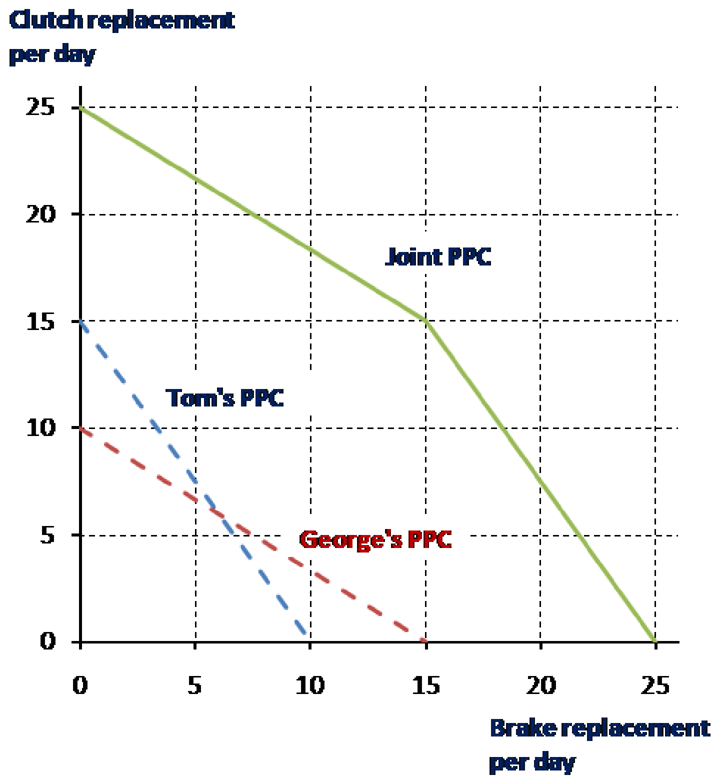


Figure 2.2: Joint PPC of the two-worker garage

Therefore, the gain from specialization is

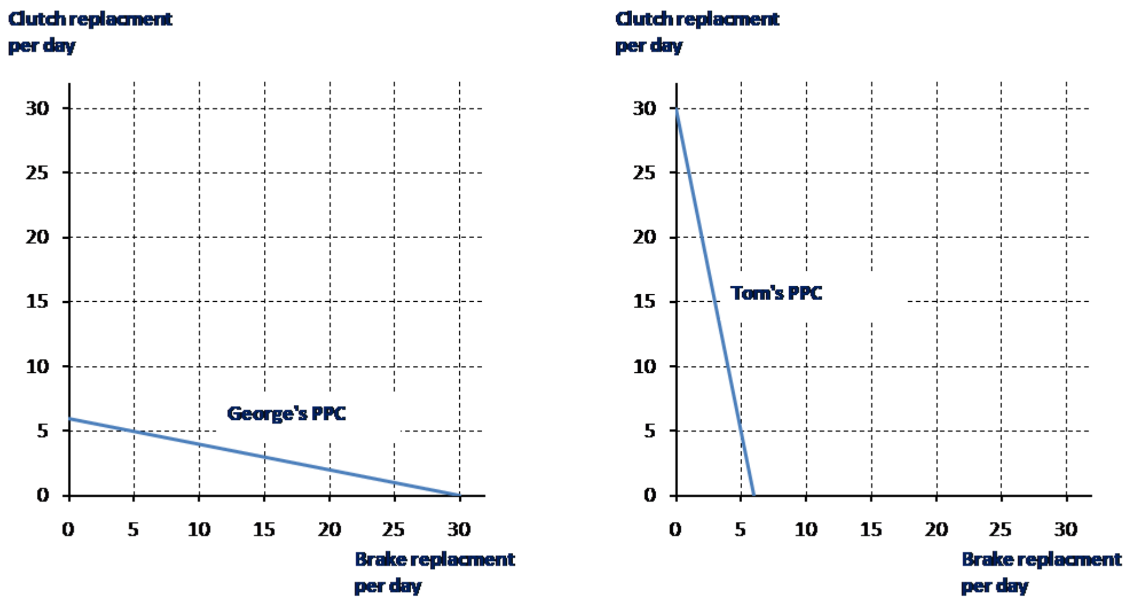
$$\frac{15-12}{12} \times 100\% = 25\%$$

Producing, and thus consuming, 25% more simply due to specialization is good. However, this gain is not big enough to explain the vast difference between the developed and developing countries.

2.4.2 Large difference in comparative advantages

Let's modify the previous scenario slightly. George and Tom are mechanics. Tom can replace 30 clutches per day or 6 sets of brakes, i.e., the opportunity cost of replacing a pair of brakes is 5 clutches; George can replace 6 clutches per day or 30 sets of brakes, i.e., the opportunity cost of replacing a pair of brakes is 0.2 clutches. How many more job can they accomplish if they specialize than if each do the jobs separately?

Again, we have to first figure out the number of jobs each of them can accomplish when they perform the jobs independently. From the information provided, we can draw the two PPC by George and Tom as below.



(a) George's PPC (b) Tom's PPC

Figure 2.3: The PPCs of George and Tom (bigger difference in OC)

It is easy to figure out the equations that describe the two PPCs.

$$\begin{aligned} \text{George: } C &= 6 - \left(\frac{1}{5}\right) B \\ \text{Tom: } C &= 30 - 5B \end{aligned}$$

Equal number of clutch and brake replacement means $C = B$. Using this condition, it is easy to solve $B = C = 5$ for both of them.[5] Thus, if they do the jobs independently, they would have accomplished a total of 10 jobs.

Again, it is easy to figure out that George has comparative advantage over Tom on brake replacement and Tom has comparative advantage over George on clutch replacement. Thus, if they specialize, George will tend to specialize on brake replacement, and Tom on clutch replacement. Since the numbers in the example are symmetric across individuals and equal number of brake and clutch replacements, we expect together, they can accomplish 30 jobs.

[5]For example, consider George. Setting $C = B$, we have

$$\begin{aligned} B &= 6 - \left(\frac{1}{5}\right) B \\ \left(\frac{6}{5}\right) B &= 6 \\ B &= 5 \end{aligned}$$

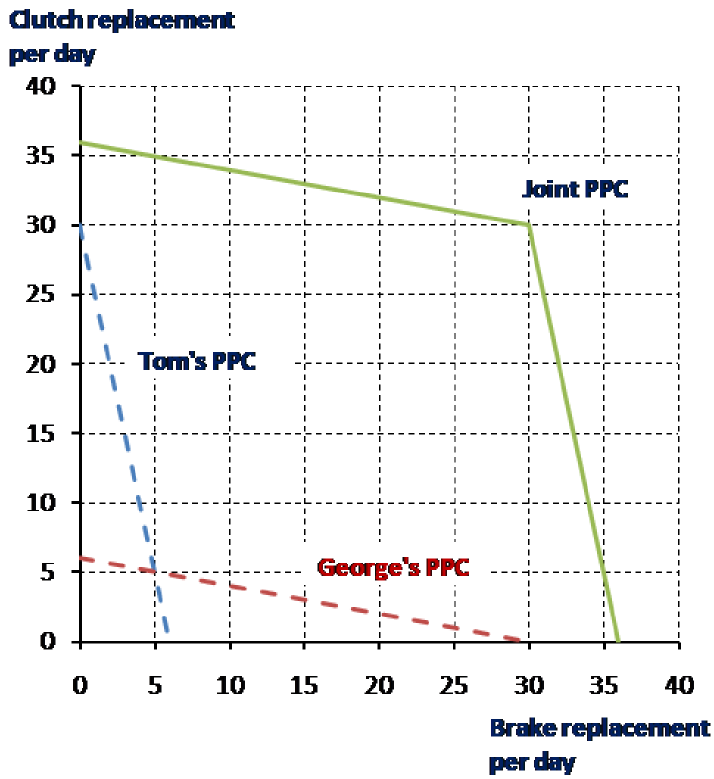


Figure 2.4: Joint PPC of the two-worker garage (bigger difference in OC)

Therefore, the gain from specialization is

$$\frac{30 - 10}{10} \times 100\% = 200\%$$

The gain from specialization of 200% is much more than the scenario we considered earlier. The reason for this much bigger gain from specialization is due to the bigger difference in opportunity cost, i.e., comparative advantage.

In the real world, do we see more specialization in developed countries than developing countries? Yes, we do!

In order to use the principle of comparative advantage and specialization to explain the vast difference in output between the developed and developing countries, developed countries must have a bigger difference in opportunity costs than the developing countries.

How come the developed countries have a much bigger difference in opportunity costs than the developing countries? In developed countries, to take advantage of the gain from specialization, a production process is sub-divided into many sub-processes. Workers are divided to handle different sub-processes according to talent and temperament. Specialized capital equipment, i.e., technological progress, may be developed to improve the productivity of the sub-process. Each worker is often trained to use very specialized set of tools to handle one of the sub-processes. Once they starts to specialize in the jobs, they get even better in the respective jobs – so called learning by doing. Such much bigger difference in opportunity costs in the developed countries cause the gains from specialization to look far more spectacular.

Indeed, Adam Smith argues that[6]

> *The greatest improvement in the productive powers of labor, and the greater part of the skill, dexterity, and judgment with which it is anywhere directed, or applied, seem to have been the effects of the division of labor.*
>
> *.... To take an example, therefore, from a very trifling manufacture; but one in which the division of labour has been very often taken notice of, the trade of the pin-maker; a workman not educated to this business (which the division of labour has rendered a distinct trade), nor acquainted with the use of the machinery employed in it (to the invention of which the same division of labour has probably given occasion), could scarce, perhaps, with his utmost industry, make one pin in a day, and certainly could not make twenty. But in the way in which this business is now carried on, not only the whole work is a peculiar trade, but it is divided into a number of branches, of which the greater part are likewise peculiar trades. One man draws out the wire, another straights it, a third cuts it, a fourth points it, a fifth grinds it at the top for receiving the head; to make the head requires two or three distinct operations; to put it on, is a peculiar business, to whiten the pins is another; it is even a trade by itself to put them into the paper; and the important business of making a pin is, in this manner, divided into about eighteen distinct operations, which, in some manufactories, are all performed by distinct hands, though in others the same man will sometimes perform two or three of them. I have seen a small manufactory of this kind where ten men only were employed, and where some of them consequently performed two or three distinct operations. But though they were very poor, and therefore but indifferently accommodated with the necessary machinery, they could, when they exerted themselves, make among them about twelve pounds of pins in a day. There are in a pound upwards of four thousand pins of a middling size. Those ten persons, therefore, could make among them upwards of forty-eight thousand pins in a day. Each person, therefore, making a tenth part of forty-eight thousand pins, might be considered as making four thousand eight hundred pins in a day. But if they had all wrought separately and independently, and without any of them having been educated to this peculiar business, they certainly could not each of them have made twenty, perhaps not one pin in a day; that is, certainly, not the two hundred and fortieth, perhaps not the four thousand eight hundredth part of what they are at present capable of performing, in consequence of a proper division and combination of their different operations.*

[6] Wealth of Nations. Book I, Chapter 1 "Of the Division of Labour". Available at http://www.econlib.org/library/Smith/smWN.html.

2.5 International Trade

The same logic that leads the individuals in an economy to specialize and exchange goods with one another also leads nations to specialize and trade among themselves. As with individuals, each trading partner can benefit from exchange, even though one may be more productive than the other in absolute terms.

Imagine Ken and Liz are the only two persons who live in a small nation. Their production possibilities are shown below.

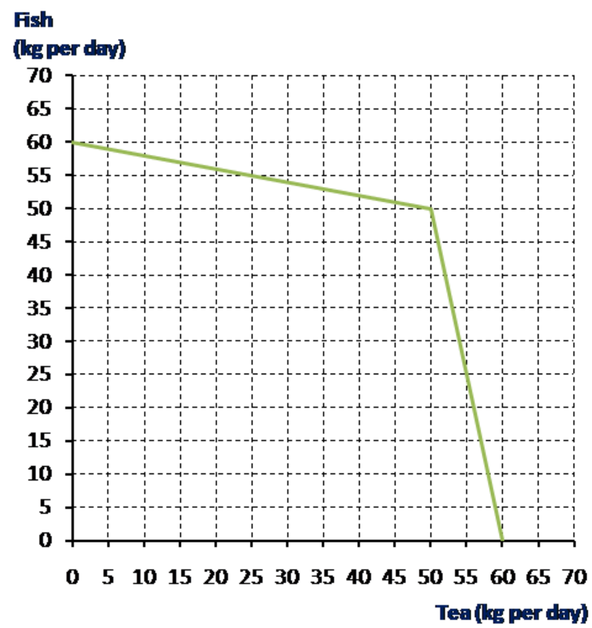


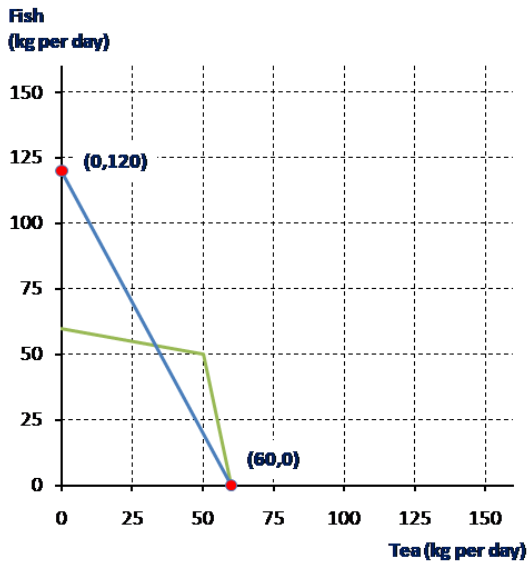
Figure 2.1: PPC of a two-person economy

When there is no trade with the rest of the world, it should be obvious that their consumption possibilities are constrained by their production possibilities. For instance, if they would like to consume 55 kgs of tea and 25 kgs of fish, they will have to produce 55 kgs of tea and 25 kgs of fish.

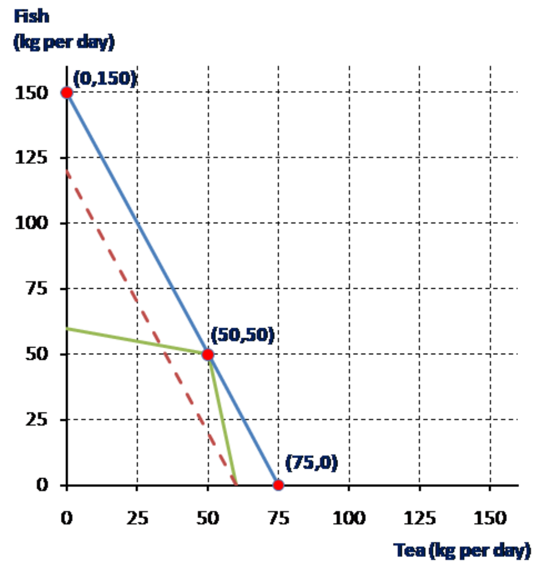
Now, suppose trade is possible. As a small nation, the country takes the world prices as given. Tea can be purchased or sold at a price of \$2 per kg and fish can be bought or sold at a price of \$1 per kg. How would international trade affect the consumption possibilities?

Suppose they choose to produce 60 kgs of tea and 0 kgs of fish, i.e., (60,0). What would be their consumption possibilities? Imagine that they sell everything at the world prices, they will get an income of \$120 ($= 1 \times 0 + 2 \times 60$). Then, the income can be used to purchase various combinations of tea and fish, characterized by the following equation:

$$1 \times Fish + 2 \times Tea = 120$$



(a) Consumption possibilities if produce at (60,0)



(b) Consumption possibilities if produce at (50,50)

Figure 2.2: Consumption possibilities of a small open economy

It is obvious that given this budget, they can purchase the combination of (60,0) that we produce.

Of course, there is no reason that they have to choose to produce at (60,0). They can choose to produce at (50,50), say. Then, the consumption possibilities will be characterized by the equation:

$$1 \times Fish + 2 \times Tea = 1 \times 50 + 2 \times 50 = 150$$

By comparing the consumption possibilities when different production combinations are chosen, we can easily conclude that the production combination of (50,50) yields the biggest consumption possibilities. Note that the set of consumption possibilities includes the set of the production possibilities and some combinations that are outside the production possibilities. That is, with international trade, we will be able to consume combinations that were not feasible in a closed economy.

What if the prices are \$20 per kg of tea and \$10 per kg of fish. What would be the consumption possibilities with international trade? By going through a similar analysis as we did above, we would be able to conclude that the production mix of (50,50) produces the biggest consumption possibilities characterized by the equation:

$$10 \times Fish + 20 \times Tea = 10 \times 50 + 20 \times 50 = 1500$$

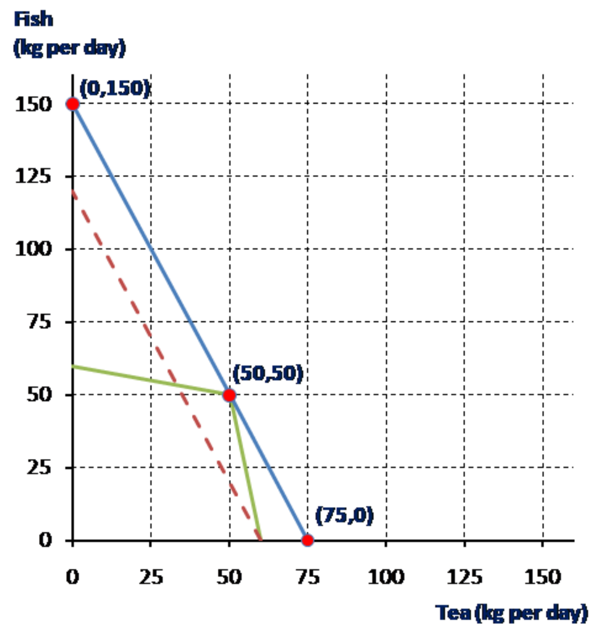


Figure 2.3: Consumption possibilities when prices are scaled proportionally

The consumption possibilities when the prices are \$20 per kg of tea and \$10 per kg of fish are the same as the consumption possibilities when the prices are \$2 per kg of tea and \$1 per kg of fish. In fact, any proportional increase in the prices of the two goods will yield the same consumption possibilities.

$$10 \times Fish + 20 \times Tea \quad = \quad 10 \times 50 + 20 \times 50$$

can be reduced to

$$1 \times Fish + 2 \times Tea = 1 \times 50 + 2 \times 50$$

and is the same as

$$z \times Fish + 2z \times Tea \quad = \quad z \times 50 + 2z \times 50$$

The key is that the relative prices (price of fish to price of tea) remain the same no matter what positive real value z takes.

$$\frac{z}{2z} = \frac{1}{2}$$

Thus, only relative price matters.

One can easily show that when the change in prices is not proportional, the consumption possibilities will be different. In fact, at some relative prices, the small nation may even choose to produce at the corners of the production possibilities, i.e., (60,0) and (0,60).

Let me repeat our claims for a small economy/nation:

1. In a closed economy, the consumption possibilities are the same as the production possibilities.

2. In an open economy, the consumption possibilities are at least as large as the production possibilities.

Some students are confused about the second claim. My advice is to really try to follow the steps below to derive the consumption possibilities of Islandia (a small economy) when trade is allowed.

1. Pick a production mix of banana and tea.

2. Sell the mix in the world market according to the world prices.

3. Take the income from (2) above and then try to figure out the consumption possibilities (all possible consumption mix of banana and tea).

4. Repeat with a different production mix of banana and tea.

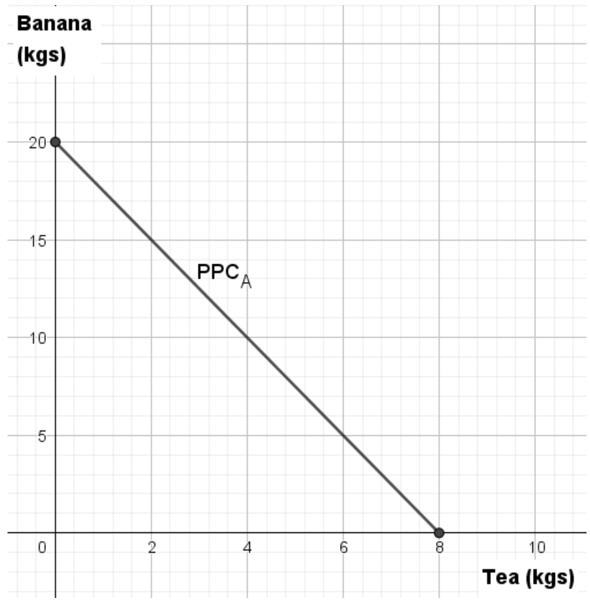
We can then see the largest consumption possibilities among all given production mixes in such open economy is larger than that of the closed economy.

2.6 Which mix to produce and consume

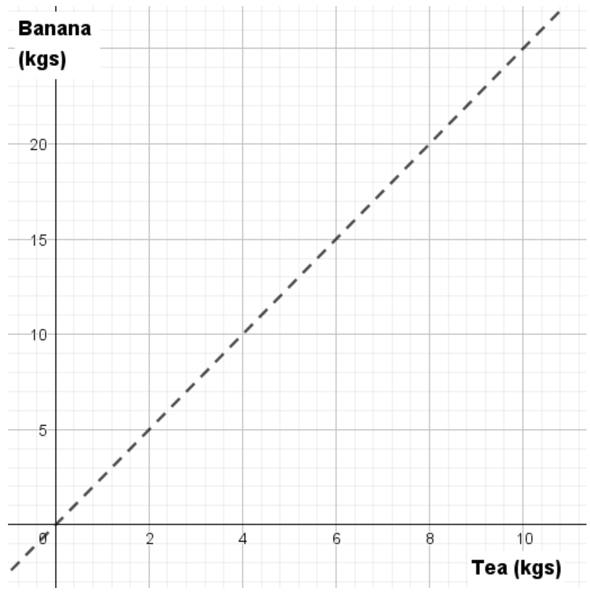
The production possibilities curve shows the possible production mix of goods. It does not tell us which mix we should produce and which mix we should consume. To determine the mix, we will need to know the preference of the individuals or the small economy. Preference often leads to a specific consumption mix – a pre-specified ratio of consumption mix or a minimum of consumption of a specific good.

2.6.1 One-person economy without international trade

Consider Albert with the following production possibilities shown in Figure 2.1a. Without trade, the consumption possibilities are the same as the production possibilities. Suppose Albert has a preference to consume a banana to tea ratio of 2.5. Such preference really means he wants to consume on any point along the straight line shown in Figure 2.1b.



(a) Production possibilities



(b) Consumption preference

Figure 2.1: Albert's production possibilities and consumption preference

Given this preference and the production possibilities (hence consumption possibilities), we know that Albert will choose to produce and consume at point C in Figure 2.2, i.e., 4 kgs of tea and 10 kgs of banana.

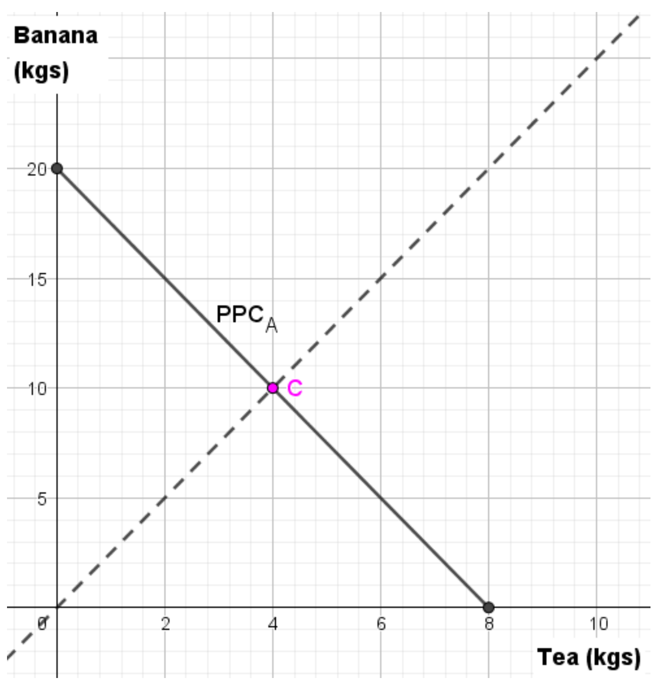


Figure 2.2: Optimal production and consumption mix without trade (one-person economy)

But, how to find point C? There are several approaches.

Approach 1: Solve the intersection point of the equation representing the consumption preference and the PPC.

$$\begin{aligned} \text{Consumption preference:} \quad & B = 2.5T \\ \text{PPC:} \quad & B = 20 - 2.5T \end{aligned}$$

We can easily find

$$\begin{aligned} 2.5T &= 20 - 2.5T \\ 5T &= 20 \\ T &= 4 \end{aligned}$$

Hence, $B = 2.5 \times 5 = 10$.

Approach 2: Solve the point using an equation representing the trade-off.

Start from a point on the PPC, say, $(T, B) = (0, 20)$. Based on the PPC, we know if we want to have an additional 1 unit of tea, we will need to give up 2.5 unit of banana. Or, if we want to have an additional x units of tea, we will need to give up $2.5x$ unit of banana. Thus, we must have $(T, B) = (x, 20-2.5x)$. We need to choose x to achieve the desired ratio. That is,

$$\begin{aligned} \frac{20 - 2.5x}{x} &= 2.5 \\ 20 - 2.5x &= 2.5x \\ 5x &= 20 \\ x &= 4 \end{aligned}$$

Thus, the optimal production and consumption mix is $(T, B) = (4, 10)$.

Approach 3: Trial and error with an educated guess of the adjustment

Start from a point on the PPC, say, $(T, B) = (0, 20)$. Obvious, the B/T ratio is far from the desired one. Based on the PPC, we know if we want to have an additional 1 unit of tea, we will need to give up 2.5 unit of banana. We will then consider an increase in T, usually based on an educated guess. Say, an increase of T by 2. Because we have to give up 5 ($= 2 \times 2.5$) units of B, we will end up with $(T, B) = (0 + 2, 20 - 5) = (2, 15)$. We are close to the desired ratio, but not quite there yet. So, we can experiment an increase of T by 1 unit. We will end up with $(T, B) = (2 + 1, 15 - 2.5) = (2, 12.5)$. We are closer to the desired ratio, but not quite there yet. So, we can experiment an increase of T by 1 more unit. We will end up with $(T, B) = (3 + 1, 12.5 - 2.5) = (4, 10)$. Now, we have reached the desired ratio.

(T, B)	Ratio B/T
$(0, 20)$	undefined, or ∞
$(2, 15)$	7.5
$(3, 12.5)$	4.16
$(4, 10)$	2.5

The three approaches have their own merits. Depending on the situation and our proficiency in mathematics, one approach may be preferred to the others.

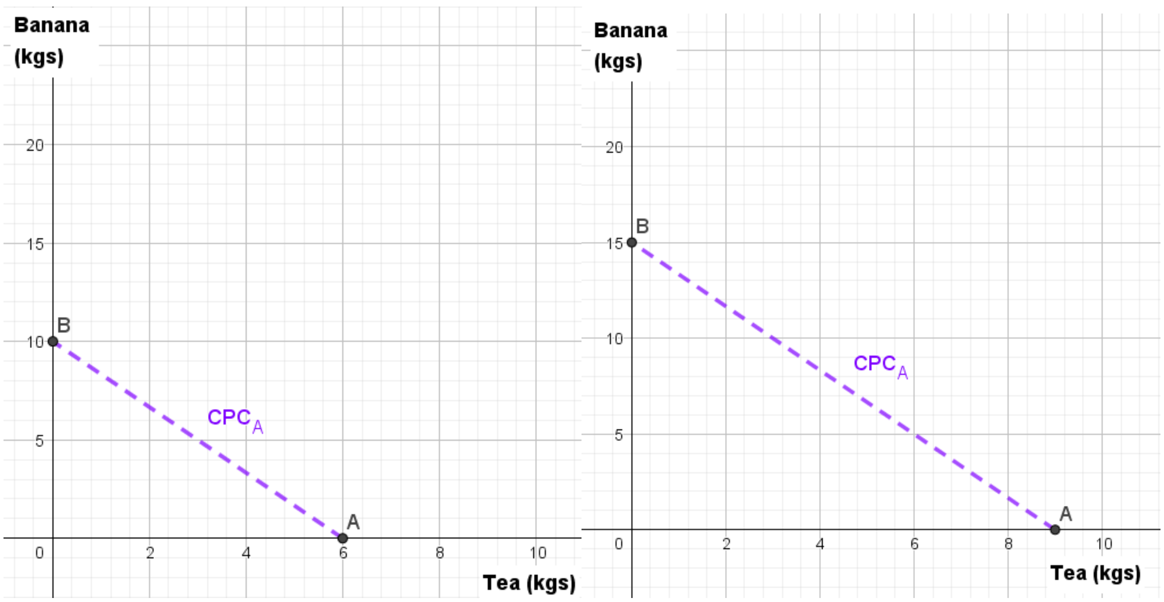
2.6.2 One-person open economy with international trade

Consider Albert again with the same production possibilities and preference shown earlier (i.e., 2.1a and 2.1b). Now, as a small one-person economy, he can trade with the rest of world at the price of \$0.6 per kg of banana and \$1 per kg of tea.

What is the meaning of the world prices? If we have a production of (Tea, Banana)=$(0, 10)$, i.e., point B in Figure 2.3a, we can sell all 10 kgs of banana in the world market, obtain \$6 of revenue and use the revenue to buy 6 kgs of tea. That is, we will end up with point A in Figure 2.3a. We can also sell z kgs of banana in the world market, obtain \$$0.6z$ of revenue and use the revenue to buy $0.6z$ kgs of tea. Thus, we will end up with (Tea, Banana)=$(0.6z, 10 - z)$. By changing z, we will see that the consumption possibilities will be the whole segment of AB in Figure 2.3a. We can also describe the consumption possibilities as

$$y = 10 - (5/3)x$$

$$\frac{\text{Production mix}}{\text{(Tea, Banana)}=(0,10)} \longrightarrow \frac{\text{Revenue}}{\$6} \longrightarrow \frac{\text{CPC}}{y = 10 - (5/3)x}$$



(a) Hypothetical production point (0,10) (b) Hypothetical production point (0,15)

Figure 2.3: Meaning of world price

We can verify easily that the slope in this CPC equation is the same as a price ratio of the two goods.

$$\text{slope} = -\frac{P_x}{P_y} = -\frac{1}{0.6} = -\frac{5}{3}$$

The intercept is

$$\frac{\text{Revenue}}{P_y} = \frac{6}{0.6} = 10$$

If, instead, we have a production of (Tea, Banana)$=(0, 15)$, i.e., point B in Figure 2.3b, we can sell all 15 kgs of banana in the world market, obtain \$9 of revenue and use the revenue to buy 9 kgs of tea. That is, we will end up with point A in Figure 2.3b. We can also sell z kgs of banana in the world market, obtain \$$0.6z$ of revenue and use the revenue to buy $0.6z$ kgs of tea. Thus, we will end up with (Tea, Banana)$=(0.6z, 15-z)$. By changing z, we will see that the consumption possibilities will be the whole segment of AB in Figure 2.3b. We can also describe the consumption possibilities as

$$y = 15 - (5/3)x$$

$$\frac{\text{Production mix}}{\text{(Tea, Banana)}=(0,15)} \longrightarrow \frac{\text{Revenue}}{\$9} \longrightarrow \frac{\text{CPC}}{y = 15-(5/3)x}$$

Again, we can verify easily that the slope in this CPC equation is the same as a price ratio of the two goods. That is, regardless of the choice of production point, the slope of CPC equation remains the same price ratio of the two good.

$$\text{slope} = -\frac{P_x}{P_y} = -\frac{1}{0.6} = -\frac{5}{3}$$

The intercept is

$$\frac{\text{Revenue}}{P_y} = \frac{9}{0.6} = 15$$

When both production points $(0, 10)$ and $(0, 15)$ are feasible, which point should Albert choose? Obviously, it should be $(0, 15)$. The reason is that given the same zero amount of tea, a larger quantity of banana is preferred. Since the two CPCs have identical slope, we can easily verify that, for any given quantity of tea, the production mix $(0, 15)$ allows us to consume a larger quantity of banana than the production mix of $(0, 10)$.

How about the choice between other feasible production points? Consider the two production points $(0, 10)$ and $(9, 0)$. Suppose they are both feasible, which point should Albert choose? It is not as obvious as the comparison of $(0, 10)$ and $(0, 15)$, but Albert should choose (9,0). The reason is that the production mix of (9,0) can be converted into $(0, 15)$ through the world market.

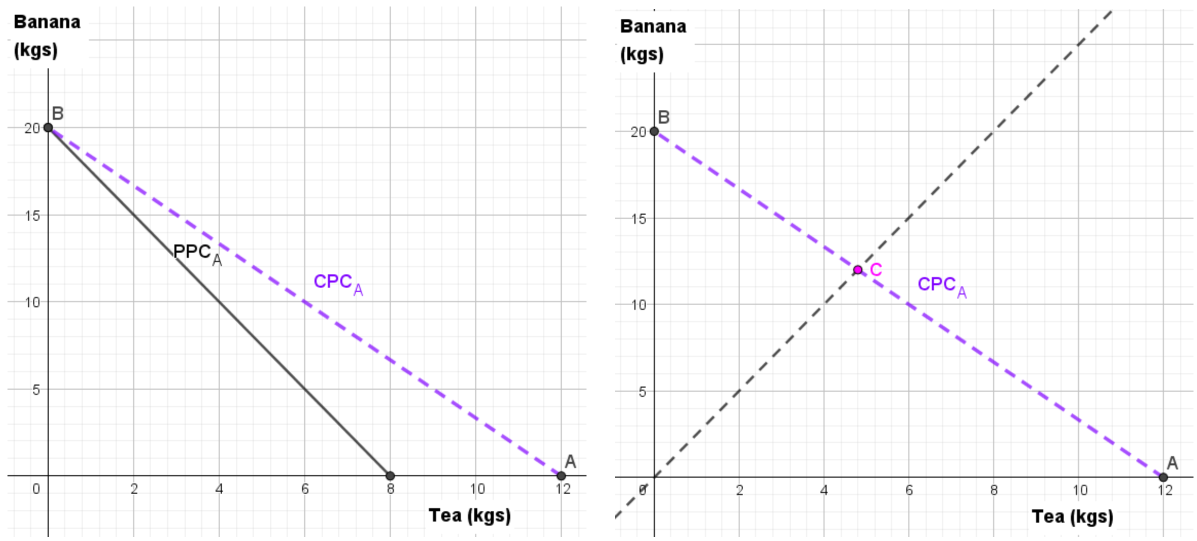
Another way to look at it is the revenue generated from these two production mixes. The production mix $(0, 10)$ generates a revenue of \$6 $(= 0 \times 1 + 10 \times 0.6)$ while the production mix $(9, 0)$ generates a revenue of \$9 $(= 9 \times 1 + 0 \times 0.6)$.

Production mix	$\longrightarrow$	Revenue	$\longrightarrow$	CPC
(Tea, Banana)=$(0, 15)$		\$9		$y = 15 - (5/3)x$
(Tea, Banana)=$(9, 0)$		\$9		$y = 15 - (5/3)x$

For any two production points A and B that generate the same revenue from their sale in the world market, we would expect them to result in the same CPC. The one that generates a higher revenue will has a bigger consumption possibilities.

$$\begin{aligned}
\text{Revenue}(A) > \text{Revenue}(B) &\iff CPC(A) > CPC(B) \\
\text{Revenue}(A) = \text{Revenue}(B) &\iff CPC(A) = CPC(B) \\
\text{Revenue}(A) < \text{Revenue}(B) &\iff CPC(A) < CPC(B)
\end{aligned}$$

Thus, we should always choose the production mix that will yield a higher income/revenue. That would be point B in Figure 2.4a.



(a) Optimal production mix (b) Optimal consumption mix

Figure 2.4: Optimal production and consumption mix with trade (one-person economy)

Given this consumption possibilities and the preference to consume a banana to tea ratio of 2.5, we can find out the optimal consumption mix is (Tea, Banana)=$(4.8, 12)$.

To summarize, in the presence of international trade with the price of \$0.6 per kg of banana and \$1 per kg of tea, Albert would produce (Tea, Banana)=$(0, 20)$ and consume (Tea, Banana)=$(4.8, 12)$.

But, how to find point C? There are several approaches.

Approach 1: Solve the intersection point of the equation representing the consumption preference and the CPC.

$$\begin{aligned} \text{Consumption preference:} \quad & B = 2.5T \\ \text{CPC:} \quad & B = 20 - \tfrac{5}{3}T \end{aligned}$$

We can easily find

$$\begin{aligned} 2.5T &= 20 - \frac{5}{3}T \\ (2.5 + \frac{5}{3})T &= 20 \\ T &= 4.8 \end{aligned}$$

Hence, $B = 2.5 \times 4.8 = 12$.

Approach 2: Solve the point using an equation representing the trade-off.

Start from a point on the PPC, say, $(T, B) = (0, 20)$. Based on the CPC, we know if we want to have an additional 1 unit of tea, we will need to give up $5/3$ (=20/12) unit of banana. Or, if we want to have an additional x units of tea, we will need to give up $(5/3)x$ unit of banana. Thus, we must have $(T, B) = (x, 20 - (5/3)x)$. We need to choose x to achieve the desired ratio. That is,

$$\begin{aligned} \frac{20 - (5/3)x}{x} &= 2.5 \\ 20 - (5/3)x &= 2.5x \\ (2.5 + \frac{5}{3})x &= 20 \\ x &= 4.8 \end{aligned}$$

Thus, the optimal production and consumption mix is $(T, B) = (4.8, 12)$.

Approach 3: Trial and error with an educated guess of the adjustment

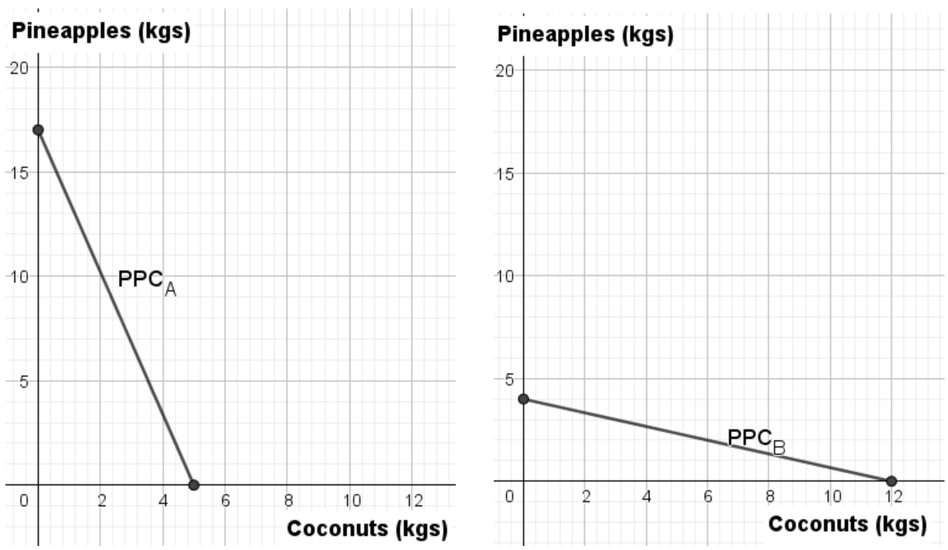
Start from a point on the PPC, say, $(T, B) = (0, 20)$. Obvious, the B/T ratio is far from the desired one. Based on the PPC, we know if we want to have an additional 1 unit of tea, we will need to give up (5/3) unit of banana. We will then consider an increase in T, usually based on an educated guess. Say, an increase of T by 3. Because we have to give up 5 ($= 3 \times 5/3$) units of B, we will end up with $(T, B) = (0+3, 20-5) = (3, 15)$. We are close to the desired ratio, but not quite there yet. So, we can experiment an increase of T by 1 more unit. We will end up with $(T, B) = (3+1, 15-5/3) = (4, 13.33)$. We are closer to the desired ratio, but not quite there yet. So, we can experiment an increase of T by 1 more unit. We will end up with $(T, B) = (4 + 1, 13.33 - 5/3) = (5, 11.67)$. Now the ratio is 2.33. So, we have an over-adjustment. Since the ratio 2.33 is very close to 2.5, we will reduce T by 0.1 unit. We will end up with $(T, B) = (5 - 0.1, 11.67 + 0.1 \times 5/3) = (4.9, 11.83)$. Closer to the desired ratio, but we are not quite there yet. We will reduce T by another 0.1 unit. We will end up with $(T, B) = (4.9 - 0.1, 11.83 + 0.1 \times 5/3) = (4.8, 12)$. Now, we have reached the desired ratio.

(T, B)	Ratio B/T
$(0, 20)$	undefined, or ∞
$(3, 15)$	5
$(4, 13.33)$	3.33
$(5, 11.67)$	2.33
$(4.9, 11.83)$	2.41
$(4.8, 12)$	2.5

Again, these three approaches have their own merits. Depending on the situation and our proficiency in mathematics, one approach may be preferred to the others.

2.6.3 Two-person economy without international trade

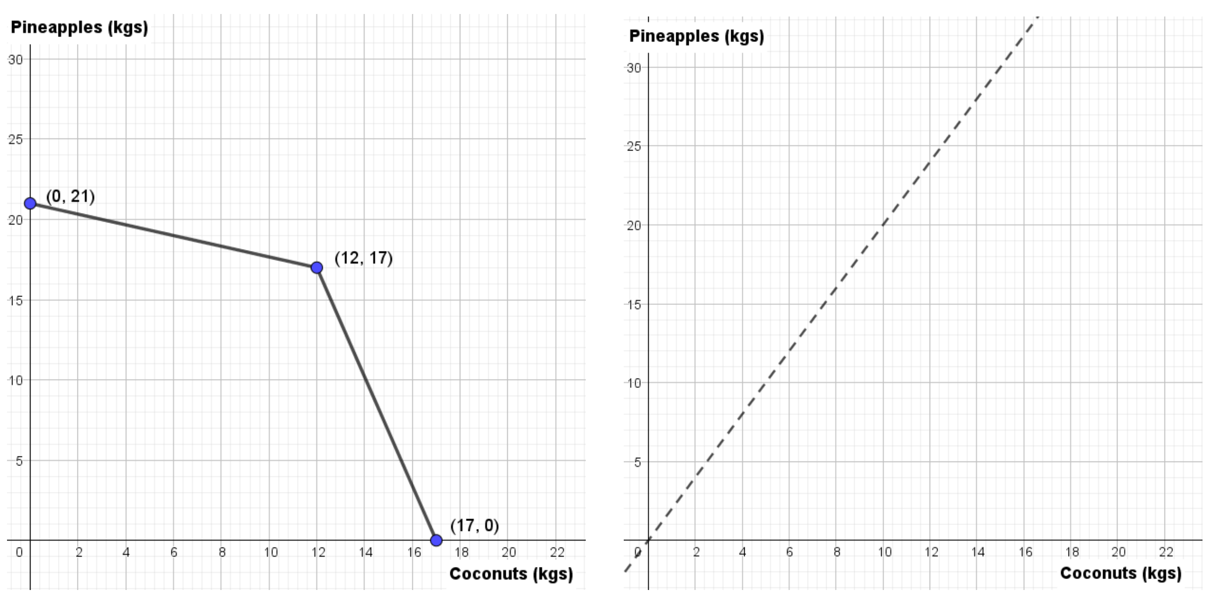
Consider Utopia consisting of two persons (Amy and Ben), with the individual production possibilities as displayed in Figure 2.5.



(a) Amy's production possibilities (b) Ben's Production possibilities

Figure 2.5: Individual production possibilities in Utopia

From the individual production possibilities, we can derive the joint production possibilities as displayed in Figure 2.6a. Suppose the consumption preference of Utopia is a pineapples to coconuts ratio of 2, as displayed in Figure 2.6b.



(a) Production Possibilities (b) Consumption Preference

Figure 2.6: Utopia's production possibilities and consumption preference

It should be easy to find the optimal production (and hence consumption) to be 9 kgs of coconuts and 18 kgs of Pineapples, i.e., point C as shown in Figure 2.7.

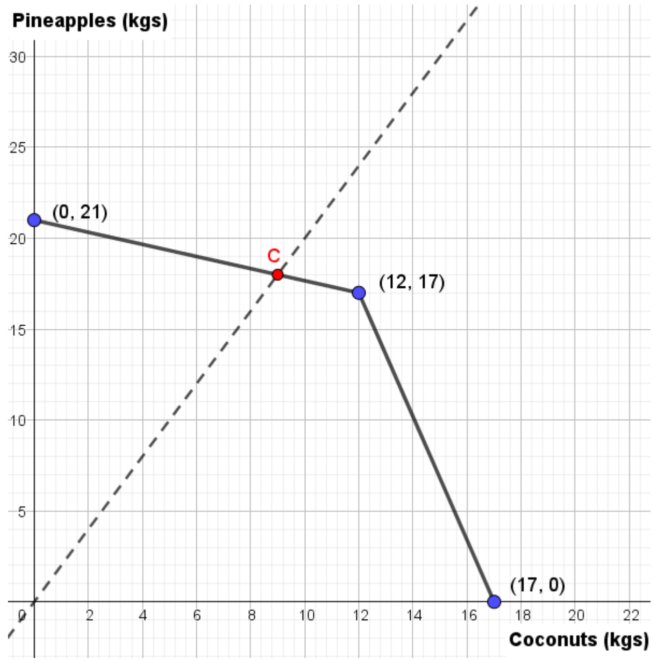


Figure 2.7: Utopia's optimal production and consumption mix without trade

2.6.4 Two-person economy with international trade

Suppose Utopia can now trade in the world market with the prices \$0.9 per kg of pineapples and \$1.2 per kg of coconuts. Which production mix should Utopia choose? We would need to evaluate the revenue we would get from different production combinations. Table 2.2 shows the revenue of these production combinations. We conclude that Utopia should choose the production point (12,17).

Production point	Revenue	
(0, 21)	18.9	$(= 0 \times 1.2 + 21 \times 0.9)$
(12, 17)	29.7	$(= 12 \times 1.2 + 17 \times 0.9)$
(17, 0)	20.4	$(= 17 \times 1.2 + 0 \times 0.9)$

Table 2.2: Utopia's revenue at different production points

Given this choice of production point, we can derive the consumption possibilities curve as displayed in Figure 2.8. In particular, if Utopia consumes only pineapples, it can consume 33 kgs of pineapples ($29.7 \div 0.9 = 33$), i.e., point B (0,33) in the figure; if Utopia consumes only coconuts, it can consume 24.75 kgs of coconuts ($29.7 \div 1.2 = 24.75$), i.e., point A (24.75,0) in the figure.

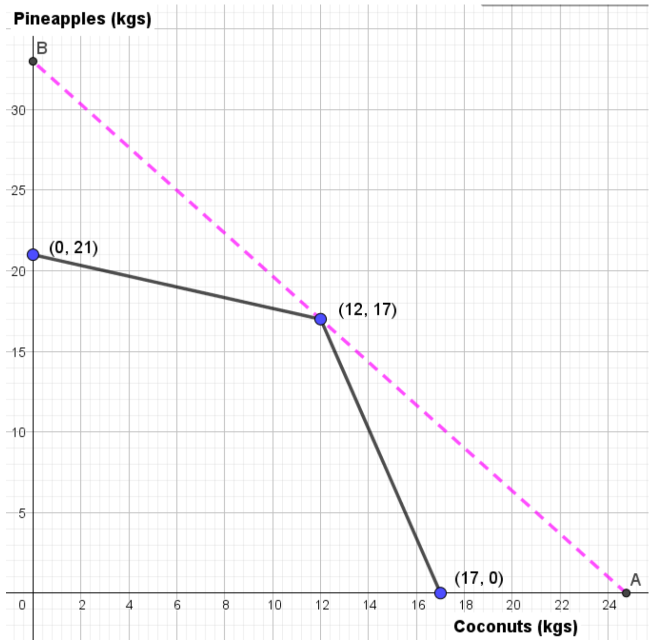


Figure 2.8: Utopia's consumption possibilities at chosen production point

Given the production possibilities curve and the consumption preference, we can find that the optimal consumption is (coconuts, Pineapples) = (9.9, 19.8), i.e., point H in Figure 2.9.

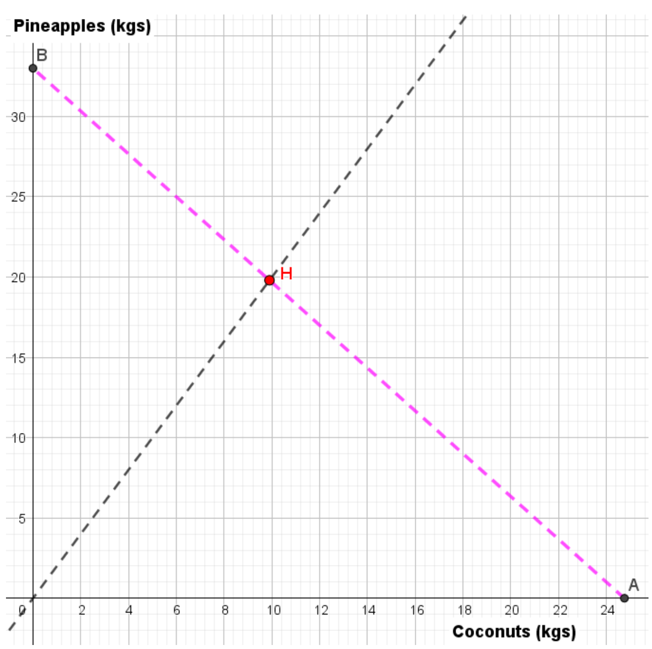


Figure 2.9: Utopia's optimal consumption mix

2.7 Why are developing countries so much poorer than the developed countries?

The extent of specialization is limited by the cost and benefit of specialization. Exchange must come with specialization. The extent of exchange is limited by the cost of exchange. When the cost of exchange is bigger than the potential gains from specialization, we would not want to engage in exchange. Several factors determine the cost of exchange.

1. Population density. If people live far apart (low population density), we would have to walk a very long distance to exchange with each other. Thus, the cost of exchange is positively related to the distance. To facilitate exchange, and hence specialization, we need people to live close to each other, i.e., a higher population density. In other words, the gains from specialization can be a cause of city formation.

2. Legal system and law enforcement. Exchanges often involve non-synchronization of delivery, say due to seasonality patterns of production. For instance, I give you coconuts today, you give me fish tomorrow. How can I be certain that you will give me fish tomorrow? Without a good legal system and law enforcement to protect us, I would give you my coconuts only if you give me fish today. Thus, a good legal system facilitates exchanges and hence encourages specialization. A good legal system and law enforcement also ensure that the exchange is honestly done. If you gave me chickens and intended to get a horse from me but I took your chickens and gave you a mule, you should be able to file a law suit against me. Without such protection, you may not be willing to engage in exchange.

As we illustrated earlier, the benefit of specialization depends on how different opportunity costs of production are.

1. Population size. The more people we have in a country, the more likely we will have extreme opportunity costs of production.

2. Openness to foreign trade. The more countries we can trade with, the more likely we will have extreme opportunity costs of production.

Can you use the costs and benefits from specialization to explain why developing countries are so much poorer than the developed countries?

2.8 How should we divide our labor on different tasks?

There are potential gains from specialization according to the principle of comparative advantage. The pre-condition is that we know the comparative advantage. In a small economy of two persons, we may acquire the productivity information of each other through a conversation. Within a company, the management would have to understand the comparative advantage of its workers and allocate the tasks to its workers accordingly. In a big economy of numerous persons, if a central planner were to allocate the workers to different jobs according to their comparative advantage, he/she would have to collect a lot of information about the worker's productivity. Unfortunately, this process of acquiring the productivity information can be very costly.

Fortunately, some kind of institutions – *markets* – may help to reduce the cost greatly. Individuals watch the market price of different goods (and hence, the term of trade) and make decisions on which production processes to specialize in. Each of them will choose the job that will result in the biggest economic surplus, using simple cost-benefit analysis.