PRODUCTION POSSIBILITIES:

Technical Addendum

A **production possibilities curve** (PPC) is a graphical depiction of the maximum combination of outputs that can be produced from a given amount of inputs.

Individual Case

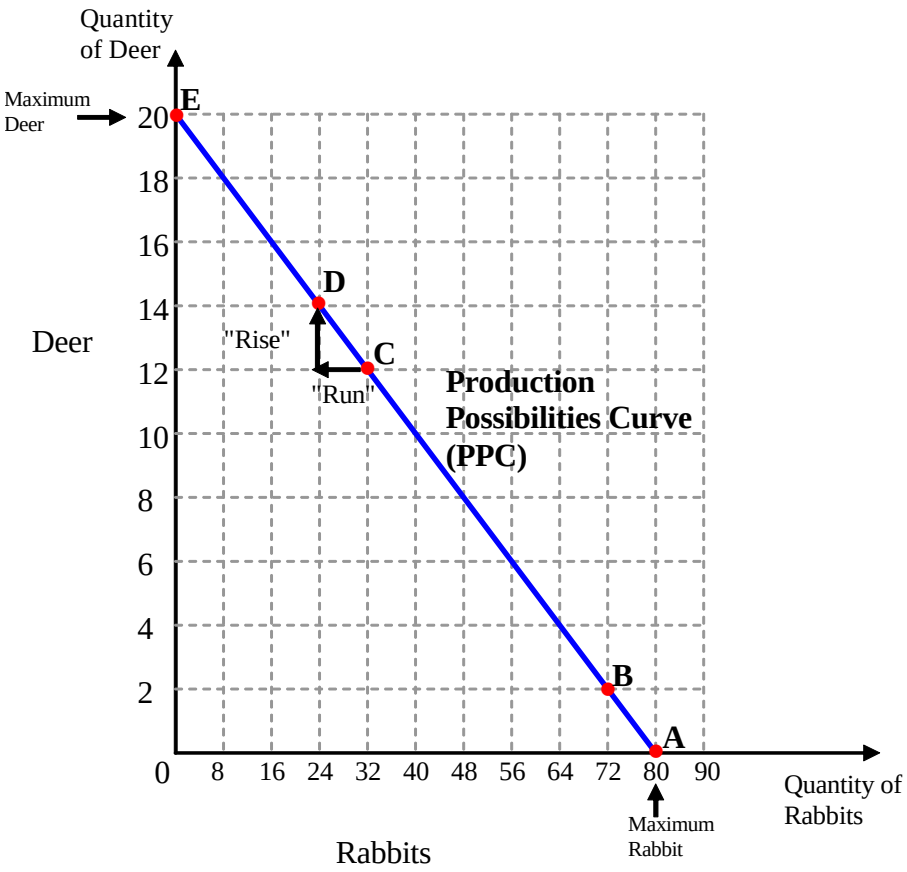
Let us consider the individual first. Consider a hunter who can produce 8 rabbits in an hour or 2 deer in a hour. Suppose he has 10 hours to spend, that is his total resources are 10 hours of work.

If he spends all those 10 hours on rabbits, the maximum he can get is 80 rabbits.
If he spends all those 10 hours hunting deer, the *maximum* he can get is 20 rabbits.

But those are not the only ways he can allocate his ten hours, e.g. he divided up his time differently:

If he spends 10 hours on deer, 0 on rabbits then he gets 20 deer and 0 rabbits.
If he spends 9 hours on deer, 1 on rabbits then he gets 18 deer and 8 rabbits.
If he spends 8 hours on deer, 2 on rabbits then he gets 16 deer and 16 rabbits.
If he spends 7 hours on deer, 3 on rabbits then he gets 14 deer and 24 rabbits.
If he spends 6 hours on deer, 4 on rabbits then he gets 12 deer and 32 rabbits.
If he spends 5 hours on deer, 5 on rabbits then he gets 10 deer and 40 rabbits.
If he spends 4 hours on deer, 6 on rabbits then he gets 8 deer and 48 rabbits.
If he spends 3 hours on deer, 7 on rabbits then he gets 6 deer and 56 rabbits.
If he spends 2 hours on deer, 8 on rabbits then he gets 4 deer and 64 rabbits.
If he spends 1 hour on deer, 9 on rabbits then he gets 2 deer and 72 rabbits
If he spends 0 hour on deer, 10 on rabbits then he gets 0 deer and 80 rabbits

We depict these combinations in the diagram below:



The straight blue line represents the **Production Possibilities Curve** (PPC) for our hunter.

At the extremes are
- point A (all ten hours spent hunting rabbits, none on deer, thus the 80 rabbits and 0 deer),
- point E (all ten hours spent on deer, none on rabbits, thus here we have 0 rabbit, 20 deer.)

Every point along the curve represents another possible combination. e.g. at point B the hunter spends 1 hour on deer, 9 on rabbits, thus yielding 2 deer and 72 rabbits; at point C, the hunter spends 6 hours on deer, 4 on rabbits, so he gets 12 deer & 32 rabbits. And so on.

Opportunity Cost as Slope

You might remember from elementary math that the slope of a line (or a curve) is calculated as "Rise over Run"

Going from point A to point B, the "run" is from 80 rabbits to 72 rabbits, thus -8. The "rise" is from 0 deer to 2 deer, thus +2. So the slope of the curve at that point is: 2 divided by -8 or: slope = -1/4

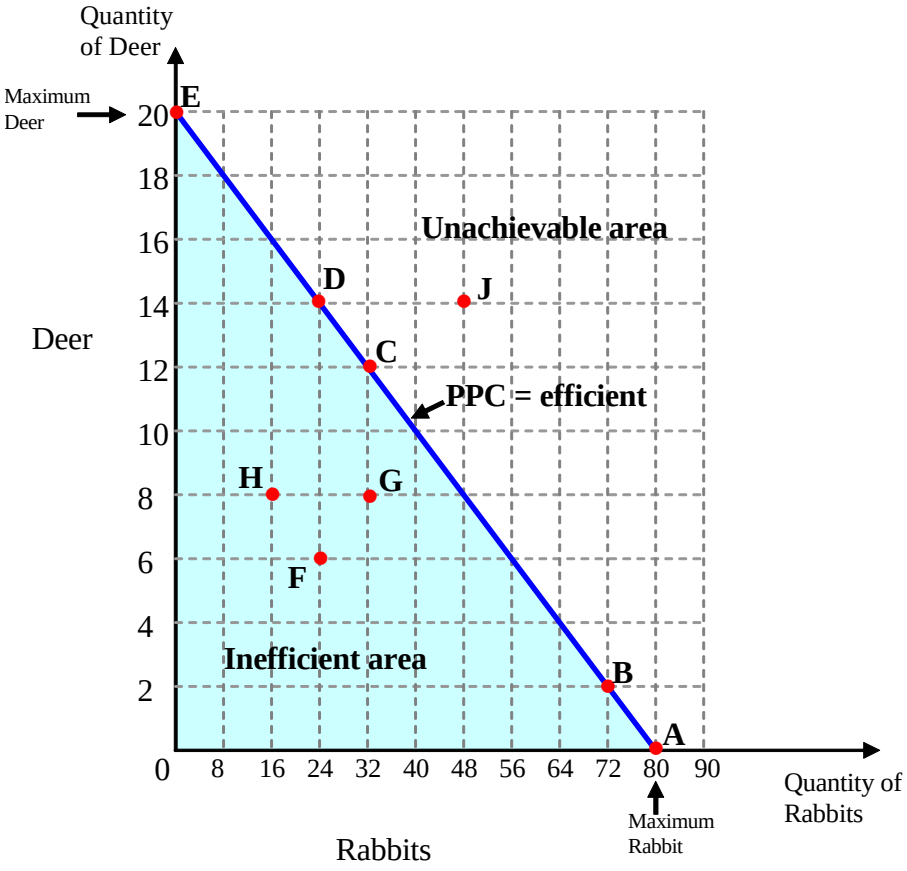
Let's check the slope somewhere else, e.g. from point C to point D, the "run" is 32 rabbits to 24 rabbits, thus -8, the "rise is from 12 to 14 deer thus +2., so again, the slope around there is -1/4.

Notice that on a straight line, the slope is the same *everywhere* along the PPC.

The more interesting point is that slope is nothing other than the ***opportunity cost*** of deer for rabbits. i.e. the opportunity cost of one rabbit = 1/4 of a deer foregone. It is always true for a PPC. The slope of a PPC = opportunity cost.

Efficiency and Inefficiency:

I said the hunter had 10 hours to spend. I outlined the maximum he can produce. But suppose he's decides to spend 3 hours hunting rabbits, 3 hours hunting deer and four hours are wasted contemplating butterflies. The outcome is shown as point F in the diagram below.



Notice that at F = (24 rabbits, 6 deer) is *below* the PPC. This represents an *inefficient* point. That is, our hunter wasted resources - he blew four hours looking at butterflies, which might be personally edifying, but it produced nothing in terms of edible food.

All points below a PPC are *possible* but inefficient. At point G = (32 rabbits, 8 deer), implying he spent 4 hours on deer, 4 hours on rabbits, and wasted two hours looking at his reflection in a creek. G is *more* efficient than F (only two hours wasted, rather than four), but it is still *not efficient* (time was wasted).

By contrast, point H (= 16, 8), is *not* more efficient than F. Notice that it implies he spent 4 hours on deer and 2 on rabbits, that still implies four hours were wasted doing nothing productive.

So *only* the points on the PPC curve represent efficiency. That is, points A, B, C and D are all efficient - all ten hours are spent hunting, no hours wasted. The points in the interior (F, G, H) are all *inefficient*. They imply resources (time) was wasted doing nothing productive.

What about points *above* the PPC? e.g. point J These are impossible to achieve with the given resources. Notice that J represents 48 rabbits and 14 deer. To achieve that amount of output, given the skills of hunter A, that means that he'd have to spend .6 hours hunting rabbit (= 6 x 8 = 48) and 7 hours hunting deer (7 x 2 = 14). That is, he must work 13 hours total. But we stipulated he only had 10 hours available. Thus point J *exceeds* his resources. All points above the PPC are unattainable.

In sum:

- all points *above* the PPC are unachievable.
- all points *below* the PPC are achievable, but inefficient.
- all points *on* the PPC are achievable *and* efficient.

Choice?

We said all the points on the PPC were achievable and efficient. But which is *best*? A, B, C, D or E?

This we cannot say. From an objective, productive point of view, all points on the PPC are "best". From a personal point of view, which one in particular is best depends on the ***tastes*** of our hunter.

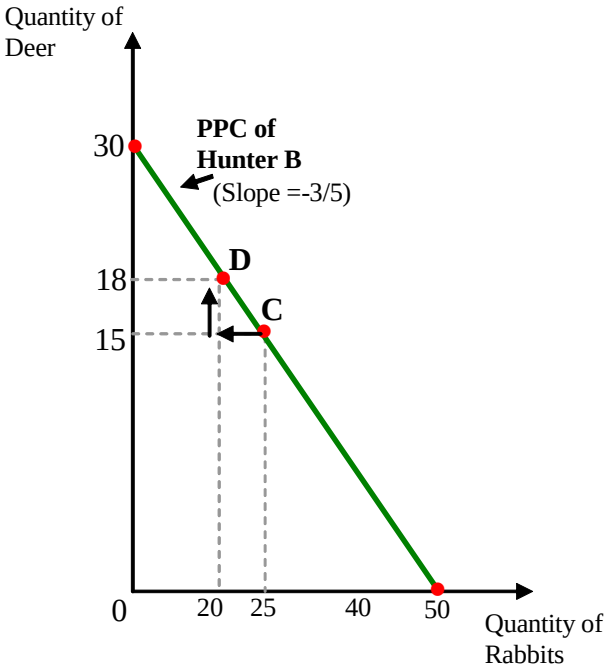
Sometimes it is easy to decipher. Suppose our hunter despises the taste of deer and adores rabbit stew. In this case the "best" choice among the efficient points is obviously point A - spend all the time hunting rabbits and spend no time on deer. Contrarily, if he dislikes rabbit and loves deer meat, then the "best" choice is point E - all time hunting deer, and none rabbits.

Of course, most hunters' tastes are not that extreme. He may like eating deer *and* rabbit. If he likes both, then how should he choose how much to time to dedicate on each? We will turn to this when discussing the household's consumption choice.

GAINS FROM TRADE IN PPCs

Let us introduce a second hunter. Let us suppose Hunter B can produce 3 deer or 5 rabbits in an hour. And that he also has a total of 10 hours to spend.

Hunter B's PPC would look something like the following:



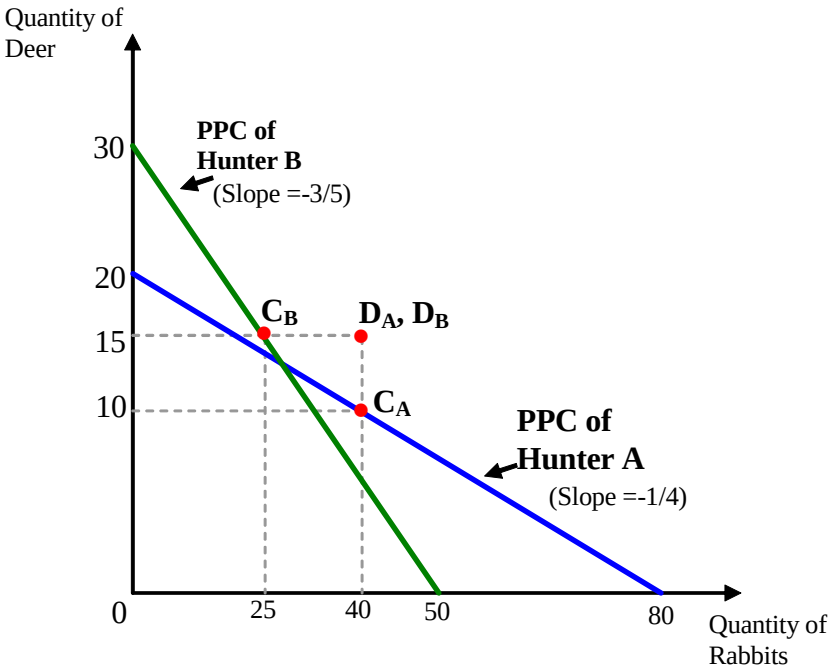
If Hunter B were to spend all his ten hours hunting rabbits, he'd come up with 50 at the end the working day. If he spent all his ten hours hunting deer, he'd come up with 30 at the end of the day. Thus the extreme points of his PPC are 50 and 30 respectively. And the rest of the PPC is just Hunter B reallocating time between deer and rabbit.

e.g.
- spending 5 hours on deer & 5 hours on rabbit, he'd end up with 15 deer and 25 rabbits. (see point C above)
- spending 6 hours on deer & 4 hours on rabbit, he'd up with 18 deer and 20 rabbit. (point D above).

Notice also the slope. The reallocation of an hour from rabbit to deer would reduce rabbit production by 5 ("Run" = 5) and increase deer production by 3 ("Rise" = 3). so the slope of the curve is -3/5. For Hunter B, the opportunity cost of 1 rabbit = 3/5 of a deer foregone.

Gains from Trade with PPCs

If we were to plot out Hunter B's production possibilities curve on the same diagram as Hunter A's, it would look something like the following:



Notice the PPC of Hunter A is flatter than the PPC of Hunter B. That is because the opportunity costs and thus the slopes are different (-1/4 for A, -3/4 for B).

Now let us do some magic.

Let us suppose there was no trade. Hunter A can produce *any* combination on his PPC. Let us suppose for the sake of argument he decided to allocate his time equally on deer and rabbit - five hours on each. In that case, at the end of the ten-hour day, Hunter A would end up with 40 rabbits and 10 deer. Hunter A's choice is depicted in the diagram as the point C_A on the PPC of Hunter A. It is efficient. He's doing his best.

Let us suppose Hunter B makes a similar decision, i.e. allocates his time equally, five hours each. He will end up with 15 deer and 25 rabbits. This is depicted in the diagram in the diagram as the point C_B on the PPC of Hunter B. He too is being efficient.

But now let's specialize and trade. We can see immediately that Hunter A is more efficient in rabbit production and Hunter B in deer production, so they specialize at their extremes.

After ten hours, Hunter A comes up with 80 rabbits and Hunter B comes up with 30 deer.

Let us now propose they exchange with each other. To keep things nice and fair (although that is not necessary), let us suppose that Hunter A gives Hunter B 40 rabbits and Hunter B gives Hunter A 15 deer. So they *each* end up with 15 deer and 40 rabbits.

Look at the diagram now. Hunter A has 15 deer and 40 rabbits. That is represented as point D_A on the diagram. Notice that is *above* Hunter A's PPC, in what we said earlier was the "unachievable" area. We have broken the barrier of the PPC!

What about Hunter B? Well, he also has 15 deer and 40 rabbits after trade. So that is point D_B on the diagram (which happens to be the same as D_A in this example). Notice that it *too* lies above the PPC of Hunter B, in *his* unachievable area. Hunter B *also* exceeds his production possibilities.

So specialization and trade allows *both* hunter to produce more than they could exceed their production possibilities, and for *both* to end up consuming more than they could possibly produce by themselves.

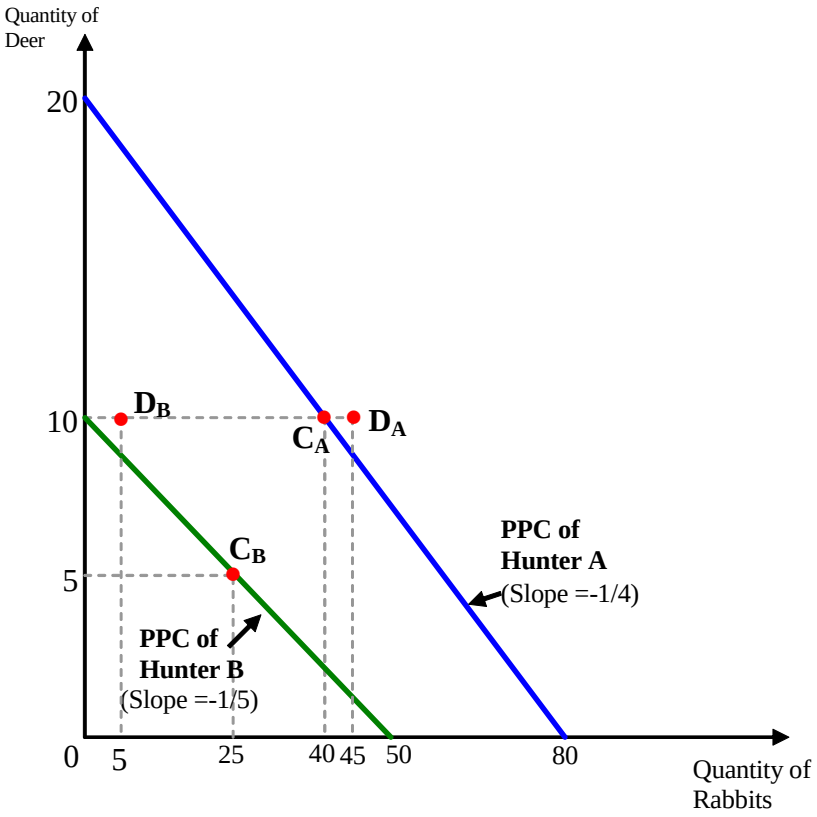
Trade improves well-being from consumption and total production possibilities.

Stunning isn't it?

Another Example, with incompetence

Of course, our task was made easier in that Hunter A had an absolute advantage in rabbit production and Hunter B an absolute advantage in deer production. So we should consider our classic case when Hunter A is more productive in both deer & rabbit, and Hunter B relatively unproductive in both.

Let's keep Hunter A's PPC as is (i.e. 2 deer per hour or 8 rabbits per hour). But now let us have Hunter B's skills be so incompetent he is only able to produce 1 deer per hour or 5 rabbits per hour.



If Hunter B were to spend all his ten hours hunting rabbits, he'd come up with 50 at the end the working day. If he spent all his ten hours hunting deer, he'd come up with 10 at the end of the day. Thus the extreme points of Hunter B's PPC are 10 deer maximum or 50 rabbit maximum. And the rest of the PPC is just his reallocating time between deer and rabbit.

Notice also that Hunter B's opportunity cost for 1 rabbit = 1/5th of a deer. Or the Rise = 1 for a Run of 5, i.e. the slope of Hunter B's PPC is -1/5th. That is, the slope of Hunter B's PPC (=-1/5) is different (slightly flatter) than Hunter A's (= -1/4).

Notice that Hunter B's entire PPC lies completely below Hunter A's PPC. That is, any combination that Hunter B produces would be inefficient in comparison to Hunter A. Hunter B is absolutely less efficient than Hunter A in *both* deer and rabbit. Hunter B has an absolute advantage in nothing, Hunter A an absolute advantage in everything.

But there's still comparative advantage, there's still gains to be made from trade.

Suppose, for the sake of argument that Hunter A chose to produce at point D in the diagram below. If he spends 5 hours on deer, 5 on rabbits then he gets 10 deer and 40 rabbits. Hunter B also divides his time equally, and ends up with 5 deer and 25 rabbits.

Specialization and trade allow them to do better. As Hunter A's opportunity cost for 1 rabbit = 1/4th of a deer and Hunter B's opportunity cost for 1 rabbit = 1/5th of a deer, that means Hunter B has the lower opportunity cost for rabbit, i.e. a comparative advantage in rabbit hunting. B should specialize in rabbit, A should specialize in deer.

If they do so, then at the end of the 10 hour day, Hunter A ends up producing 20 deer, while Hunter B ends up producing 50 rabbit. So now let them trade. Several trades are possibly. Let us consider a trade where Hunter B gives 45 rabbits to A, in exchange for which A gives B 10 deer. The final positions are shown on diagram:

- Hunter A is now at point D_A, with 10 deer and 45 rabbits. That is, *above* his PPC.
- Hunter B is now at point D_A with 10 deer and 5 rabbits. That is, *above* his PPC.

So despite trading with an "inefficient" producer, Hunter A's own consumption bundle has exceeded his own production possibilities. Ditto for Hunter B.