**W2 V4 PPF**

0:12  
In this video, we're going to introduce you to another graphical tool that we work with.

0:16  
Opportunity cost calculations are great, but sometimes it's easier to work with graphs, and this is what we're going to use when we do that.

0:22  
It's called a production possibility frontier.

0:24  
We're going to talk about individual as well as joint PPFS and graphically we're going to again try and convince you that trade makes people better off in our simple world.

0:33  
We're also going to talk about the relationship of the shape of the PPF and opportunity cost.

0:38  
Opportunity cost never far from our thinking, it's integral.

0:41  
So again, we're going to show you where it shows up on the graph.

0:45  
OK.

0:45  
So, so far we've been thinking about production and we've got to think about 3 definitions before we move on.

0:50  
One is given our resources, resources are scarce, right?

0:54  
What is possible to produce and we call that a feasible production, OK.

1:00  
The other thing is what's the best way to produce it?

1:03  
Jargony term we give here is efficient.

1:05  
And all it's saying is that we're producing something to the maximum possible capabilities.

1:10  
There's nothing spare lying around, so there's no way to get more of something without giving up something else, right?

1:18  
That's when we are at efficiency.

1:19  
If it's possible to move stuff around and get extra for free, then we're not efficient.

1:23  
It's not the best allocation, right?

1:25  
Efficient is just saying we have reached a thing where there's no more gains to be had by moving stuff around, OK?

1:33  
And our PPF for production possibility Frontier is finding the border between what's feasible and what's feasible.

1:40  
OK, so let's think about that on a graph.

1:43  
So what we've got is the same data that we've had in the other videos, right?

1:48  
And in build 2 important pieces that we need the resources that each has, which is time, 10 hours each and their production capabilities.

1:56  
Now what I want to know is what's the maximum and or bill can produce.

2:02  
Problem is that they can produce tables, they can produce meals.

2:04  
So I want to find a way of finding everything they can produce on one graph, and the best way to do this is to start with the intercept.

2:13  
If and took all her time and put it into table production, how many tables would she get?

2:19  
The maximum possible right?

2:21  
Well if she has 10 hours and she produces 3 tables in an hour, the maximum possible she can get is 30 tables.

2:28  
Now, if you want her to produce one extra meal, there is no way she can get that for free because she's using all of her resources and she's using them efficiently.

2:41  
So she has got to give up some tables in order to get that extra meal.

2:46  
Well, how many meals tables does she need to give up to get the extra meal?

2:51  
We already know that information from her opportunity cost, right?

2:55  
We already know that Anne's opportunity cost of one extra meal because that's what I want when I'm moving along the X axis.

3:03  
The opportunity cost of one extra meal for Anne is 1 table.

3:07  
She's going to give up one table.

3:10  
So if you want one meal, then she's giving up one table, which means that she's left only with 29 tables, right?

3:18  
And that's going to be one point in here.

3:21  
Keep going.

3:21  
OK.

3:22  
If Anne wants a second table, well, opportunity cost of one extra meal, one table.

3:28  
So she's going to give up here.

3:31  
One table, get one extra meal.

3:35  
We keep going this way.

3:36  
What you're going to get is a line and I'm because my line is not going to match these numbers.

3:43  
I'm going to draw the line and then we'll back out things.

3:48  
Just going to get a line that looks like that where the slope of this line is the opportunity cost, opportunity cost for an for an extra meal.

4:06  
OK Now we're going to talk about how would why is linear in later on, but for now just remember that it's tied to the opportunity cost.

4:14  
What is this intercept?

4:15  
Two ways we can get this intercept, we can keep going in this process or we can double check our calculations by saying if she put all her time into meal production, what's the maximum amount of meal she could produce?

4:27  
Well, with three meals an hour, she's going to get a maximum of 30 meals.

4:36  
This is Anne's PPF.

4:38  
It's the maximum she can produce with the resources that she has.

4:41  
The PPF gives me all the efficient points.

4:48  
Anything outside the PPF, all of this stuff here is not possible.

4:53  
She doesn't have enough time to be able to make that right, so this is not feasible.

5:00  
OK, anything inside here, She's not using all her resources efficiently, right?

5:06  
This stuff here is feasible, but it's not efficient.

5:11  
There's time that she's not using efficiently by moving stuff around.

5:15  
She could get more either tables or chairs without giving up anything else.

5:19  
OK, there's no opportunity cost for her inside the PPF.

5:23  
The opportunity cost is only on the PPF when she's producing efficiently and she has to give up 1 to get more of the other.

5:29  
OK, do the same thing for Bill.

5:31  
I'm leaving it open here for you to make sure that you know how to calculate this by yourself.

5:36  
Now, once we have all of these possibilities, one thing we could ask is, well, what would they produce if they live by themselves?

5:43  
This is what all the possibilities Anne can do.

5:46  
What does she want to produce?

5:48  
Well, we'll leave that up to Anne.

5:49  
We'll make some assumptions like we did in the previous video where we say, oh, she wants equal numbers, but we could also leave that after Anne and just pick a point later and we'll come back to this later, OK?

6:04  
We do what we always do next with a anything we do here, we find something and then we ask what happens when stuff changes.

6:12  
So here, the change we're going to do is we're going to give Anne more resources, resources.

6:16  
This time here, she had 10 hours and that was her PPF.

6:20  
And now what we're doing is we're effectively increasing the amount of resource that she has.

6:24  
So she has 20 hours.

6:26  
What's going to happen in here?

6:27  
We follow exactly the same process that we did before.

6:30  
We ask with all her hours if she's producing efficiently, what's the maximum number of tables she can produce?

6:37  
Before she could produce 30, but now she has extra resources and she can produce 60.

6:44  
But if you want an extra meal here, how many tables does she give up?

6:51  
In this case, her productivity is still the same, which means that her opportunity cost of producing an extra meal is still the same, which is 1 table.

7:03  
So her slope has not changed.

7:05  
She still needs to give up one table to get the extra meal.

7:09  
But what has changed is that her entire PPF has shifted out.

7:13  
Right slope is still the same, but now we've gone from 3030 to 6060.

7:21  
OK, in this case it's a parallel shift.

7:24  
Parallel because the slope remains the same shift out.

7:27  
I have more production than I could before.

7:29  
Notice all of this extra stuff that I can produce that I cannot before because I have more resources.

7:38  
So play around with this, Think about stuff that changes the opportunity cost, stuff that changes the resources, and make sure you understand how the PPF shifts and why.

7:50  
OK.

7:51  
So given that we've drawn the PPFS for each one of these separately, let's think about what happens with trade.

7:56  
We've done this with numbers in the previous video here.

7:59  
We're going to do it on the graph.

8:01  
So remember, is that what happens if they're producing by themselves?

8:05  
Where do we start?

8:05  
So let's start off with a really simple allocation where and produces 1515, Bill produces 5 and 10.

8:20  
OK, so this black dot here and both of these cases is what's happening or where they are with no trade.

8:28  
I'm going to erase this in a second, so make sure you put this in your notes because otherwise my diagram is going to be cluttered.

8:34  
OK, so when I'm looking at the black dot here, this is the no trade.

8:38  
They're on the PPF, they're using their resources efficiently and we are good to go.

8:44  
Now with this starting point, let's think about the same trade that we did before which is Bill gives and three meals in exchange for two tables.

8:54  
So let's start off with Anne.

8:56  
Since we've done and before, if Anne has to produce two more tables, then she was producing 15, she's going to go to 17, right?

9:08  
And she's gonna have to give up some meals for that because otherwise she's not going to be able to give you those two extra meals.

9:15  
So this is where she is producing, and it sounds like it's not a good deal for her because she is getting fewer meals.

9:24  
But remember, she's losing some meals from her production, which is getting extra meals from Bill, right?

9:31  
And what is she getting extra from Bill?

9:33  
She's giving up two.

9:35  
So she's going from 15 to 13 because that's her opportunity cost.

9:41  
But then she's getting 3 from Bill, which means that she's going to move to 16 mills.

9:52  
So what is she consuming?

9:54  
She's producing 17 tables, but she's got a give to to Bill.

9:58  
So she's getting 15 tables of consumption, but more than that she is getting one extra meal than she had before.

10:08  
So this here is her consumption point.

10:12  
Notice relative to what she would do by herself, she is actually able to consume outside her PPF.

10:19  
She's actually able to consume at a point that she could not consume before with trade.

10:25  
And so another way of thinking about trade making people better off is it allows them to consume allocations that would be not possible for them if they did not trade.

10:35  
And we're just producing themselves.

10:37  
Let's do the same for Bill, OK.

10:40  
So now Bill here has to produce three extra meals, right.

10:45  
So this doesn't sound like, let me just put this in here.

10:50  
That's a really small diagram, sorry.

10:52  
So it's coming in here with 13, right?

10:56  
Why 3?

10:57  
Because he's got to give an three extra meals.

11:00  
Now what is Bill's opportunity cost of meal production?

11:04  
So we've got to look for the opportunity cost of Bill for an extra meal.

11:10  
And if you look at the previous videos, we've already decided or we've calculated that that is 0.5 tables.

11:19  
So in this case, if you're going to tell Bill you've got to produce three extra well, from his production, he's going to go down by 1.5, right?

11:28  
So this is 1.5.

11:33  
Just make this this distance here is 1.5.

11:40  
OK, so he's moving down on his PPF and this is his new production point, so efficient production.

11:52  
We're moving down the PPF towards more meals and fewer tables.

11:55  
Now that's going to sound like it's a bad deal for him.

11:57  
Not really, because while he's going down by 1.5, he is going up because Anne is giving him 2 tables, right?

12:08  
So these three extra tables are going to Anne.

12:11  
So he's going to come here, he's giving up 1.5, but then he's getting 2 from Anne, which means that this here is his consumption point.

12:25  
Again, you can kind of see that Bill is able to consume outside his PPF and we can show graphically that trade makes in this simple world with our simple but not simple but many assumptions, trade makes both of them better off, OK.

12:44  
So we've done a lot here, and basically what we've done is try and set up graphically a way to think about production that's possible, that's not possible, and that's efficient in that any extra requires, some sacrifices, requires some trade-offs.

12:58  
We've talked about how we can think about the PPF shifting when those parameters change.

13:03  
But something that comes up a lot, especially from those students who've seen PPF before, is they say this PPF looks weird because what I've seen is APPF that looks like this, right?

13:14  
Or if you've seen anything else from before, you're expecting APPF that looks like this.

13:19  
And so very common question I get during office hours is why is your PPF constant?

13:25  
And I'm going to refer you back to the discussion that we had a few minutes earlier, which is what determines the shape of the PPF.

13:31  
It's the opportunity cost, right?

13:33  
The slope of this PPF here is the opportunity cost because I have meals here, often extra meal.

13:40  
If that's constant, the more meals I produce, it's the same amount of tables I'm giving up.

13:46  
Then my my PPF is going to be linear.

13:49  
If you want a linear PPF that looks like this, what are you saying about the slope?

13:53  
What you are saying about your slope is that initially your slope starts off like that, then your slope gets steeper and steeper and steeper, right?

14:04  
So the more meals you produce, the more steep your PPF gets, the higher the opportunity cost.

14:15  
So again, it's an assumption on the opportunity cost.

14:17  
If you want APPF that looks like this, you're basically saying the more meals I produce, the more expensive meal production gets in terms of the number of tables given up, which may make sense in a lot of examples, for example, meal production.

14:33  
I get worse at meal production the more I produce because I'm tired.

14:38  
It's just I'm not able to use my inputs efficiently.

14:40  
I don't have enough capacity.

14:42  
Or you can think about, well, there's other things to benefit from tables.

14:46  
There's a whole bunch of reasons and we can get into that later with some examples.

14:50  
But the punchline is, please think carefully about the shape of your PPF.

14:55  
Make sure at every point you're coming back to your touchstone, which is opportunity cost.

14:59  
OK, shape is determined by the opportunity cost.

15:02  
If we've got a constant opportunity cost, then I'm going to get a linear PPF.

15:07  
If I've got an opportunity cost that's changing the more I produce because it's more expensive to pull resources out of the other production, right?

15:16  
I guess I get this economies of scale, whatever it is, then I can get potentially an increasing opportunity cost of production either from the individual perspective, from the economy perspective, how we're doing.

15:28  
But please keep track of opportunity cost everywhere.

15:31  
It'll help with understanding the concept.

15:35  
OK.

15:35  
So we've looked at individual PPF.

15:37  
What happens when they change how trade can put us outside the PPF?

15:42  
But sometimes economies, they trade, big economies trade.

15:47  
But sometimes people are different within an economy, right.

15:51  
And so to get at a little bit deeper at this idea of an increasing opportunity cost, one way to get closer to your intuition that you've seen if you've seen economics before is to think about a word where we've got two people and they're different, right.

16:07  
People are different among on many dimensions.

16:09  
We're going to focus on how they're different in terms of opportunity, cost of productions.

16:14  
So these guys are pooling their resources and they're acting as one economy.

16:18  
And our job as The Economist is to think about who's going to produce what.

16:23  
And in this world, now remember at basic, here's what we've got.

16:27  
We've got this gap between what's not possible, what's possible.

16:36  
And the most important thing for us is to find this borderline.

16:39  
Right There's borderline that's efficient.

16:41  
That's the best way to allocate these resources, the maximum possible.

16:44  
OK, so when we're looking for the joint production possibility frontier, this is what we're looking for, the most efficient way.

16:51  
So that means we've got to figure out who's going to be producing which good at each one of these points on the PPF and that can be a little bit complicated.

16:59  
So let's start off with a simple thought experiment where we basically start moving people one unit at a time and then think about what's the most efficient way of doing that.

17:12  
OK.

17:12  
And the way we're going to do that is we are going to start with a completely bank diagram and we're going to start off by saying here's when everybody's doing only table production and in the same way that we did before, start moving resources from table to meal production.

17:31  
OK, Now this is the information I have.

17:34  
Remember I've told you slope is determined by opportunity cost.

17:36  
So that's super important.

17:37  
We want to keep track of that.

17:39  
I've got that information in here.

17:41  
I've also given you information on how many resources we had because that was crucial for us to figure out where we start out at.

17:50  
OK.

17:50  
But one thing I didn't highlight on the previous example is another piece of information that you should always keep track of.

17:56  
So take a second to see if you can find this intercept in here in the same way that we did before.

18:01  
With just this information, When you come back, you're going to see that you're going to need a little bit more information.

18:09  
Specifically, what information do you need?

18:11  
You're going to need to know their raw productivities, OK?

18:15  
Because Ann can have 10 hours and Bill can have 10 hours and their cost of moving from one to the other can be given to me.

18:23  
But I still need to know how much each of them can produce with one hour of their time, otherwise I'm not going to be able to move forward.

18:31  
OK, so I need this production information.

18:34  
Now what do I do with this?

18:35  
I've got 10 hours of Anne.

18:37  
If she's only producing tables, I can get 30 tables from Anne, and then Bill can also produce tables and he's going to give me 10 extra tables.

18:49  
So with both of their time in table production, I'm going to get a maximum of 40 tables.

18:57  
OK, so I've got that starting point in here.

19:00  
Now, if I want an extra meal, who should I put into meal production?

19:06  
I have two potential people.

19:08  
If I put an into meal production, OK, here's what I'm going to lose.

19:13  
I'm going to lose 1 table.

19:15  
So if I pull an out, I'm going to go down to 39 tables for that one extra meal.

19:22  
On the other hand, if I pull Bill out, I'm going to get that same one extra meal, but I'm only going to give up half a table because that's his opportunity cost.

19:33  
So if I ask you, who do you want to do it?

19:34  
Well, least cost producer, right.

19:37  
Comparative advantage again, coming in, put the least cost producer in as long as they have time.

19:42  
So the first person I'm going to move into production is going to be Bill because he has the lower opportunity cost of production.

19:51  
OK.

19:52  
So I'm going to start off with 40 and I'm going to start moving Bill and I'm going to put Bill in red to make things visually easier to see.

20:03  
OK.

20:04  
So Bill is going to be red and let's put an in green.

20:10  
OK.

20:11  
So first I'm going to start pulling Bill into meal production.

20:15  
If I keep pulling Bill into meal production, he'll give me some extra meals, some extra meals.

20:19  
Some point he's going to run out of time.

20:21  
OK, when Bill has put his entire 10 hours into meal production, the maximum number of meals I'm going to get is 20.

20:29  
OK, so that's 20 meals coming in from Bill.

20:33  
It's not free.

20:34  
I've got to give up tables, but Bill only gives up 10 tables, which means I'm still left with 30 tables that Ann is producing, right?

20:43  
So this is going to be the slope of my PPF at that point.

20:48  
And this is going to be the opportunity cost.

20:51  
The slope here, it's going to be the opportunity cost of the person producing the extra meal, which in this case is Bill and he's being moved into meal production.

21:01  
Now at this point, you're going to say Bill give me more meals and Bill is going to say I've got no time.

21:05  
I've used all of my 10 hours in meal production, but if I still want more meals, who am I going to use?

21:11  
Now I've got to pull the second most productive producer in.

21:14  
We only have one more.

21:15  
And that person is going to be Anne, right?

21:18  
Anne is going to come in here and you're going to say, OK, and give me one meal.

21:21  
And it's going to be like, sure, I'll give you the extra meal, but it's going to cost you more because her opportunity cost is 1.

21:27  
So I'm going to jump down at a higher slope, right?

21:31  
Steeper slope, because she's more expensive.

21:33  
Her opportunity cost is higher.

21:35  
So I'm going to keep switching Anne in until Anne as well.

21:39  
It runs out of time and I've got no more extra meals possible.

21:46  
So this here is going to be the slope of the producer and that's going to be an and her opportunity cost of her meal here.

21:53  
This point is a magic point where Bill is producing only meals all of his time, is here, and is producing only tables.

22:05  
Students tend to give this point some magic magic powers in that they really send a focus on full specialization.

22:14  
But there's nothing special about this point when they're fully specialized, going to make the same mistake again.

22:21  
What is important is that when they fully specialize, we know exactly how much of each good we're getting.

22:30  
Okay.

22:31  
These points here on the green segment and the red segment are also possible.

22:35  
And they're also efficient, right?

22:37  
They're just not fully specialized.

22:39  
They're partially specialized.

22:41  
What is true is that we are pulling one person gradually in and that's OK.

22:48  
That's efficient because the best person is being pulled into the production given the situation that we're in.

22:57  
OK, So same thing.

23:04  
We're going to do that again, I'm going to run through that very briefly again.

23:07  
So that's OK if you didn't get it that time.

23:10  
But here's what we're going to do next.

23:12  
We've drawn the drawing PPF again, it's coming up on the next slide.

23:17  
But I also want to show you along the joint PPF how we can see that merging economies or having more people with different opportunity costs in our world, allowing them to specialized, allowing them to partially specialized, not just full specialization allows us to make people better off.

23:36  
We have gains from trade.

23:39  
So the way we're going to do that here is we're going to start off with the same numbers, which is that without trade, before trade, no trade, they were producing something.

23:49  
These are the numbers we said they were splitting their time equally.

23:53  
And so let's stick with these numbers, right?

23:55  
So before trade, this is what each one of them produced.

23:58  
So if we just sum them up right, we would get a total of 20 tables being produced and 25 meals being produced.

24:07  
OK, now what we're going to see is it, is it possible to get more if they work together to start using their comparative advantage.

24:17  
I'm going to show you that on a graph in a second.

24:21  
OK, so here is our joint PPF graph and again, I'm going to walk you through it in case there's still some stuff missing.

24:30  
So we first start off with if everybody put all of their time into table production, that's the maximum amount of tables we could get.

24:38  
When you want to start producing meals, we start pulling the lowest cost producer into meals.

24:44  
So along this segment here we have Bill, he's still producing some tables, right.

24:53  
We're not pulling him fully into meal production just yet, but he's also mixing in a few meals.

25:00  
He's the one giving you the extra meals, which is why the slope of this place is Bill's opportunity cost of meals.

25:11  
At some point, they're going to be fully specialized.

25:13  
At some point, there is no more time that Bill has to put into meal production.

25:19  
Then you're going to have to start pulling an in.

25:22  
Bill is now fully specialized in meal productions.

25:26  
Can't get anything more out of it.

25:28  
What happens to Anne?

25:30  
Well, she's gonna be the one giving you some meals.

25:33  
She's still engaged in some table production, right?

25:36  
We're not pulling her fully out, but she's producing the extra meal.

25:40  
So the slope here is going to be Anne's opportunity cost of an extra meal.

25:49  
OK.

25:51  
Here along this segment and is fully specialized in that she's producing only tables was like you stay there, we're going to get Bill to produce the extra meal.

26:01  
Now that we have this joint PPF, it's tracing out all of the efficient possibilities of which full specialization is 1 not the only.

26:10  
If they were producing by themselves, we've already kind of said on a previous slide that this is where they would be, right?

26:19  
2025, Notice this is inside the joint PPF, which is weird, right?

26:26  
Because if they're inside the joint PPF, then we're saying we're leaving something on the table because it's feasible, sure, but it's not efficient.

26:35  
You're able to get more for free.

26:37  
You don't need to give up anything if you're inside the PPF.

26:40  
So what can make us better off?

26:42  
Well, look, here are all of these possibilities, right?

26:45  
Each one of the points in here is better in terms of total opera meals and tables than where we were without trade.

26:54  
That starting point, that autarky point, right?

26:57  
So all of these are allocations, right, that make both of them better off than no trade.

27:15  
Which one of these?

27:16  
Well, that depends on the details.

27:17  
Will it actually happen or you've got to choose the right exchange rate, which is another thing that we've discussed.

27:23  
But graphically, we can see that there's potential to make people better off.

27:27  
And here's another way of showing you how trade helps make us better off in terms of allowing us to produce more with the same inputs.

27:36  
They both still have 10 hours each, but they're able to produce more because they're using their inputs efficiently by moving from the low cost producer, high cost producer to low cost producers.

27:48  
OK, so when we have a difference in opportunity costs, when there's a difference in comparative advantage, there is potential for gains from trade, right?

27:57  
Whether we achieve this or not depends on finding the exchange rate.

28:00  
But there is potential, OK, if society is producing a good efficiently, if it's on the joint PPF, right?

28:07  
We should find the person with the lowest opportunity cost of production that is available, right?

28:15  
Sometimes the best person is not available.

28:18  
Bill was the best, but he's not available because he's already engaged fully in meal production.

28:23  
Then we've got to switch the lower cost producer in doesn't mean we're not producing efficiently, just means that we're moving people in order.

28:30  
And right now the best producer who's able to switch is the lowest cost producer from the available people, OK.

28:38  
We put them into production and their opportunity cost of production is what society's opportunity cost of production is at that point.