# Topic 2: Basic theoretical tools used in international trade

# Basic trade equilibrium

International trade is inherently a general-equilibrium concept (minimum 2 goods, 2 factors, 2 countries). This calls for developing some extended microeconomic theory.

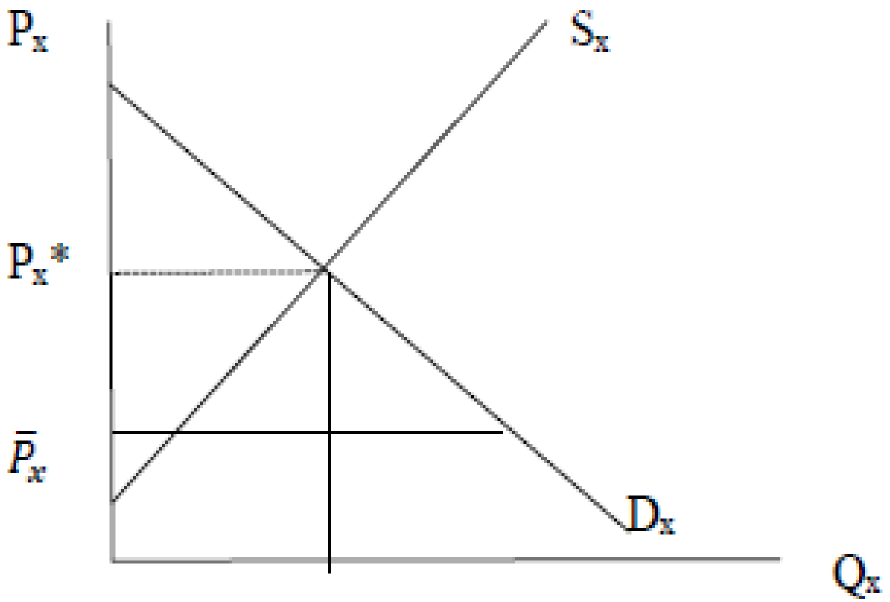
But we will often use basic partial-equilibrium tools (supply and demand for one good or factor) to illustrate ideas. So let's work on these tools.

*Trade equilibrium for one good with 2 countries*

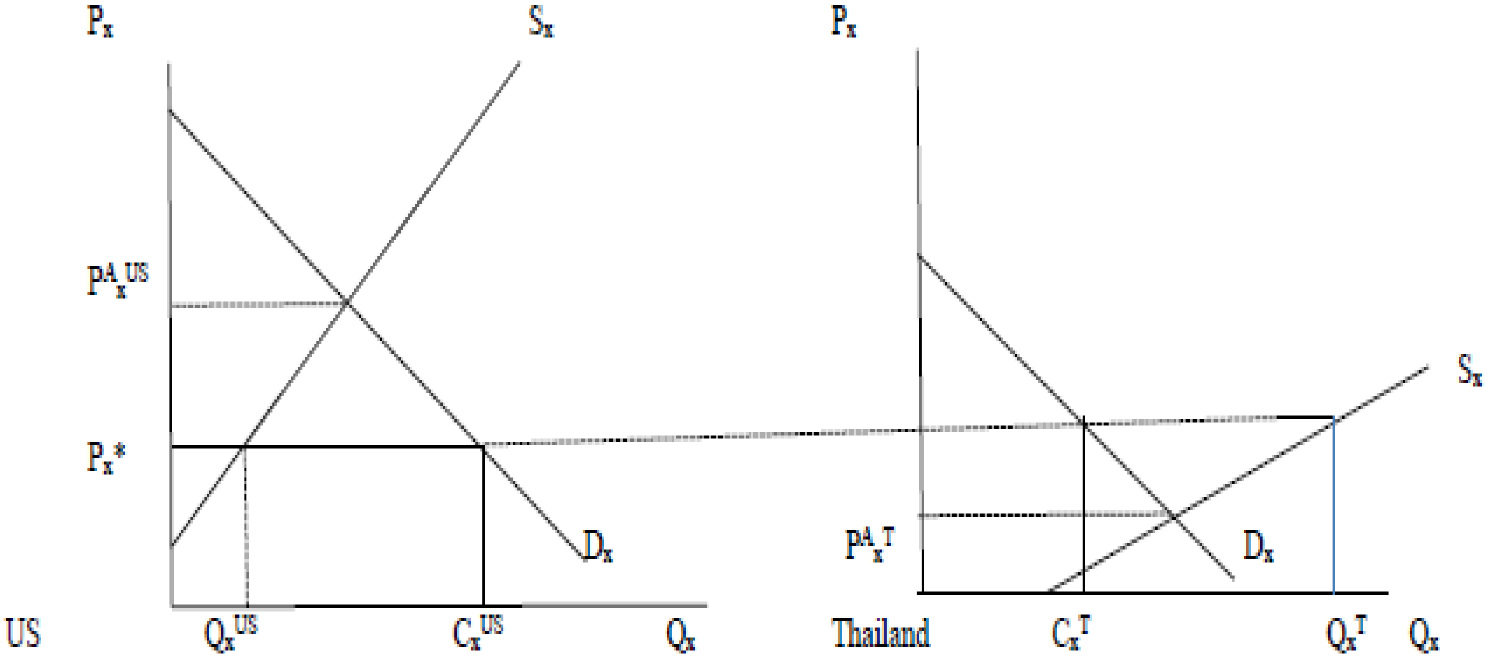
A familiar idea: basic supply and demand (diagram).

No-trade equilibrium quantity and price.

You may have studied the idea of a price ceiling at $\overline{P}_x$ , generating a shortage in this good. But note this shortage could be filled by importing good X.




To analyze a trade equilibrium, consider supply and demand curves for 2 countries. The simple question Is which country has the higher price and which has the lower price for good X?




The “A” superscripts refer to “autarky” prices, or the equilibrium prices if countries cannot trade (autarky means a condition of isolation, so no trade in goods or factors).

# Notes on the trade equilibrium

We can see that Thailand has the lower price and US the higher price of good X. If they now trade with one another Thailand would export X and the US would import X.

If there are no remaining barriers or costs of trade there would be established an equilibrium price in free trade, labeled $P_x$*.

Note that US imports are the difference between consumption and production, while Thai exports are the difference between production and consumption.

Comparing autarky points to free trade, output of X falls in US and rises in Thailand. Consumption of X rises in the US and falls in Thailand.

This is "sort of" a general equilibrium (GE) since it links 2 national markets for X. But there are problems:

- Trade must involve at least 2 goods, X and Y.
- Trade must be balanced (dollar value of X imported equals dollar value of Y exported). (Countries do run trade deficits and surpluses, which we will ignore until we get to international finance.)
- But this means we need to get 2 goods and 2 prices into the model.

# Fundamental concept: relative prices

Let there be 2 goods, Bicycles (B) and Nuts (N). (Text uses Soybeans (S) and Textiles (T)). Usually we think of nominal prices:

$P_B^{US}$=\$500 per bike $P_B^T$=16,000 Baht (B)per bike
$P_N^{US}$=\$100 per ton $P_N^T$=2,000 B per ton

Let's make some important points here.

Economists argue that rational consumers (and producers) don't really care about nominal prices since those don't mean much in the context of the economy generally. That is they don't have *money illusion*, meaning they realize that if their income goes up 10% and both prices go up 10% they are not any better off. Nothing important has changed in the economy in real terms.

Consumers (and producers) do care about relative prices, because that indicates the *opportunity cost* of buying 1 or the other good. So if $P_B$ rises by 10% but $P_N$ by 20% you would buy more B, less N because B have become *relatively* less expensive. But producers would produce more N, less B.

We have given this example with prices in different currencies, so which to use? Or does that matter?

# Relative prices and comparative advantage

We resolve these problems by using relative prices.

$$p_B^{US}/p_N^{US} = 5 \; and \; p_B^{T}/p_N^{T} = 8$$

Bikes are more expensive and nuts cheaper in Thailand in relative terms.

Stated as opportunity costs, in the US 1B is worth 5N. So the OC of buying 1 more B is not being able to buy 5N. The OC of buying 1 more N is 1/5 B. In Thailand the OC of 1 more B is 8 N and the OC of 1 more N is 1/8 B.

These relative prices (opportunity costs) are what matters for CA and trade.

**Concept: Define a country's *comparative advantage* as the product in which it has the lower relative price:**

US has the CA in bikes and T has the CA in nuts.

Our trade models largely explain the sources of these price differences.

# Clicker question

Consider two countries, Japan and France, and two goods, textiles (T) and machines (M). We have these prices:

In Japan: $P_T = 100{,}000\ yen$ and $P_M = 600{,}000\ yen$

In France: $P_T = 150\ euros$ and $P_M = 450\ euros$

Then we can say that:

A. Japan has a higher OC for textiles than France.

B. France has a lower OC for machines than Japan.

C. Japan has a comparative advantage in machines.

D. France has a comparative advantage in textiles.

# Utility maximization

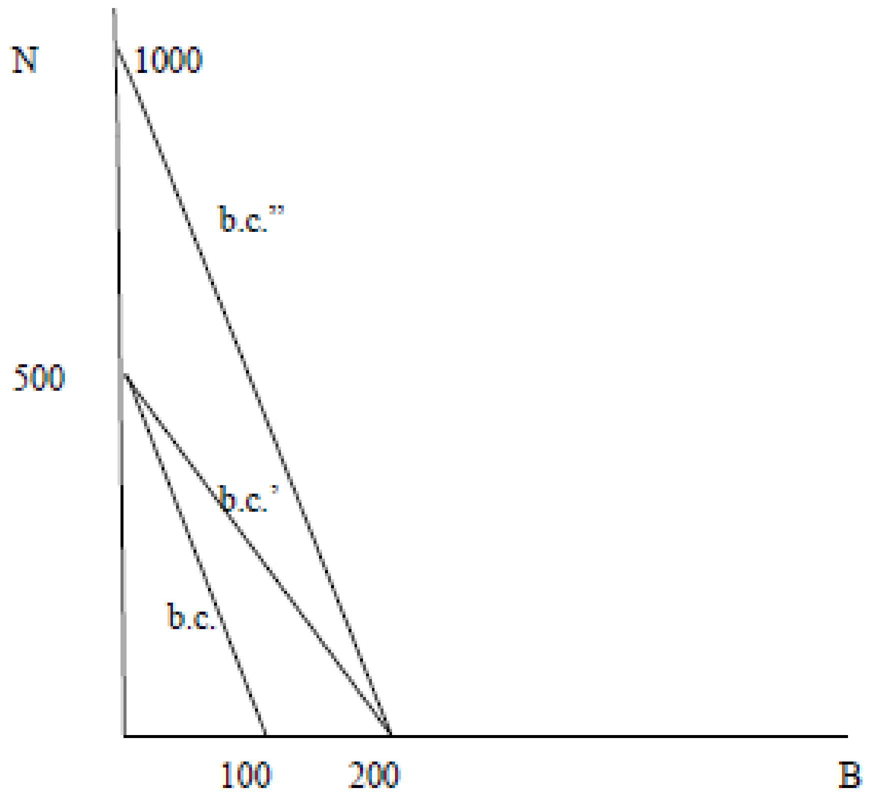
Consider a consumer in the US, with income M. Her budget constraint (b.c.) is

$$M = p_B B + p_N N$$

Rewrite as $N = {}^{M}/_{p_N} - \frac{p_B}{p_N} B$. This is the b.c. expressed as a straight line, with intercept ${}^{M}/_{p_N}$ and slope $-\frac{p_B}{p_N}$. The slope is the negative of the relative price of bikes.

Let's map this line assuming M = $50,000.

Then Max B = 100, Max N = 500 are the endpoints. The b.c. is the straight line between them and shows combinations of N and B that the consumer can buy by spending all of her income.




The slope = -$p_B/p_N$ = -5.  We find it easier to think of the absolute slope: $|slope| = \frac{p_B}{p_N} = 5.$

# Utility maximization

*Important note:* we've shown the slope as rise/run, or 5/1. This means you give up 5N per 1B. But the slope is the relative price of B. That is, since $P_B/P_N = 5$ it's the same thing as 1B = 5N. DON'T GET CONFUSED BY UNITS VERSUS PRICES.

This price ratio is the market rate of exchange at which consumers and producers buy and sell B,N. Some comparative statics (simple changes within the model):

Let $P_B$ fall to \$250, then $P_B/P_N = 2.5$, max B = 200. This means the b.c. gets flatter (lower slope) and consumers have a better opportunity to buy things (see b.c.').

Let M rise to \$100,000. This shifts the b.c. out parallel (same relative price) by a factor of 2. At the same nominal prices consumers can buy more of both goods (see b.c.").

Clearly for consumers lower prices and higher incomes are beneficial in shifting out the b.c. The larger the available (B, N) bundle the better off is an individual consumer.

# Utility maximization

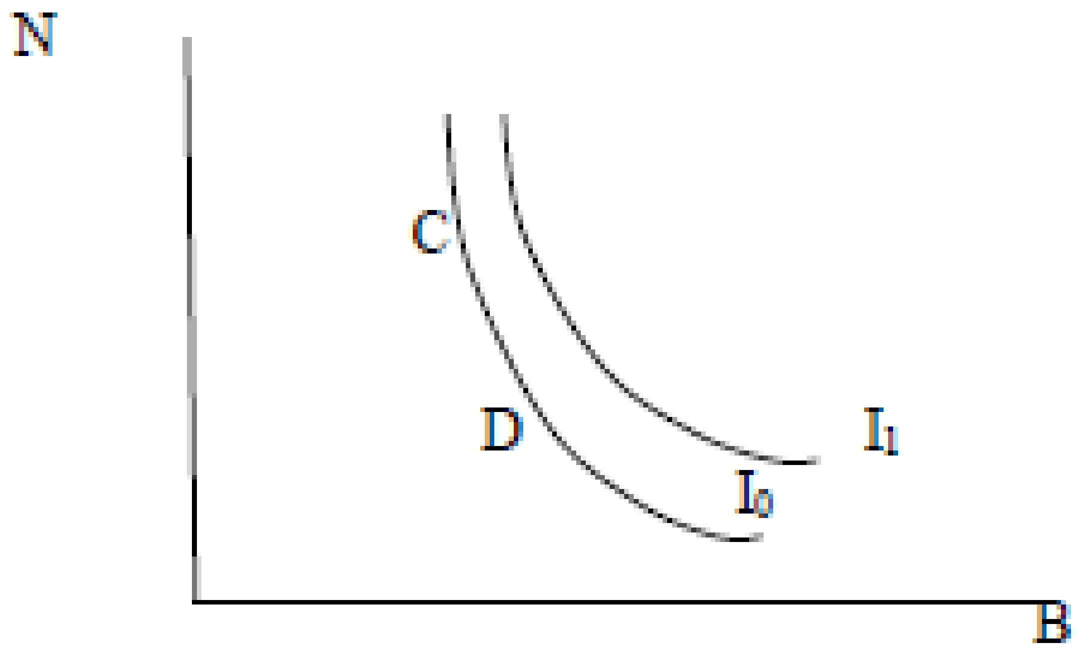
We need to figure out where the consumer chooses to buy B, N, which determines her quantities demanded for the given prices and income.

This is a much deeper issue than it sounds but we will assume (as the text does) that individual consumer preferences are given by *indifference curves*.

**An indifference curve shows the combinations of goods B and N which make the consumer equally well off.** The idea comes from assuming a person has a well-defined utility function: $U = U(C_B, C_N)$.

Indifference curves have these properties:

- IC's are downward-sloping (if consumer has less B she must get more N); note this assumes goods are *substitutes* in demand.
- IC's are *convex* (curved away from origin), which means there is *diminishing marginal utility* for each good.
- Higher IC's indicate higher levels of utility.
- IC's do not intersect.



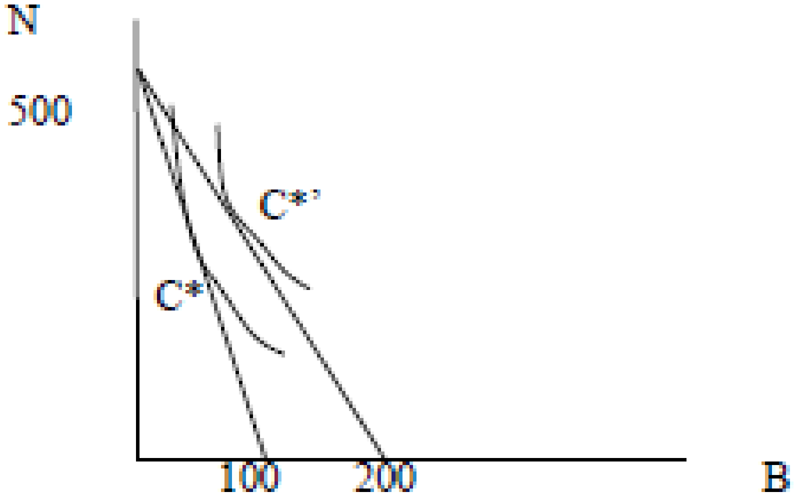

Define the *marginal rate of substitution* (MRS) as the absolute slope of an IC. $MRS = \left|{}^{\Delta N}/_{\Delta \mathrm{B}}\right|$ for a given level of utility.

The diagram shows how this slope diminishes as more B and less N are consumed. So for example at point C the MRS might be 3 (the consumer can give up 3N for 1B and feel equally well off) while at point D the MRS might be 1 (give up 1N for 1B). This idea reflects *diminishing marginal utility*: the more B you have the less you want it at the margin so the fewer units of N you are willing to give up.

# Utility maximization

The consumer maximizes her utility (welfare) by choosing the IC that is the highest available for the given b.c.  In the diagram below this would be at point C* on the original b.c.

Now if the relative price of bikes falls to 2.5 there is a higher b.c. permitting the consumer to move to C*', with higher utility (here she consumes more of both goods, though that isn't necessary depending on her preferences.  But she does get to a higher indifference curve.)



# Utility maximization

Implication: in equilibrium $MRS = {}^{P_B}/_{P_N}$. **The MRS equals the market price ratio**.

If this were not true the consumer could choose a different bundle. Imagine an indifference curve that cuts the original b.c. rather than is tangent to it. That curve must lie below the one tangent at C*, so it would imply a lower utility level for the given income.

Note next that if price of B falls, the person is better off (true also if price of N falls). And if real income rises the person is better off.

# Individual demand curves

It is also important that we can define *demand curves* for this individual. Note that consumption of *both* goods changes when price of B falls. What really matters is the relative price change. So demand curves are defined by

$$D_B = D_B\left(\frac{p_B}{p_N}, M\right) \, and \; D_N = D_N\left(\frac{p_B}{p_N}, M\right)$$

In general, if M rises we expect both $D_B$ and $D_N$ to rise (positive impacts).

If the price ratio rises (higher relative price of bikes) we expect lower quantity demanded for B (negative impact) and higher quantity demanded for N (positive impact).

This is all just like regular demand theory except that we have relative prices in these demand curves, not just the individual good price.

# Demand in the national economy

Can we do the same thing for the total economy?

First, let's think about the national budget constraint.  To do this, a brief aside on GNP (or Gross National Income) versus GDP.

Gross National Income (used to be called GNP) is the total income earned by factors (labor, capital, land) of one country, no matter where they produce or sell things (at home or abroad).

Gross Domestic Product is the total final output produced in a country, no matter whether the factors of production are domestic or foreign-owned.

In a world where factors do not move across borders, GNI and GDP are the same.  This is what we will assume until later in the course.  But they can be different.

Countries that have a lot of workers abroad who send remittances home generally have GNI > GDP.

Countries that invest a lot abroad and own intellectual property abroad also have GNI > GDP.

Just the opposite cases for GDP < GNI.

# Demand in the national economy

Here are some countries with large inward personal remittances (as % of GDP) in 2016:

- Nepal 31.3%; Kyrgyz Republic 30.4%; Haiti 29.4%; Liberia 26.1%; Honduras 18.0%; El Salvador 17.1%; Philippines 10.2%.

What about Mexico? It's at 2.7% of GDP, but that's a large number: $35.1 billion at the 2016 exchange rate.

For now we assume no international factor movements, so GNP (or GNI) = GDP.

*National budget constraint*

Here, GNI (GNP) will indicate the national budget constraint but we can substitute GDP.  In our simple 2-good case

$$GDP = P_n N + P_B B. \text{ Then } N = \frac{GDP}{P_n} - \left(\frac{P_B}{P_N}\right) B$$

Or $$\frac{GDP}{P_N} = N + \left(\frac{P_B}{P_N}\right) B$$

This says that the ratio $\frac{GDP}{P_N}$ is ***real GDP*** measured in units of nuts.  It is the maximum number of N that could be consumed if all the country's GDP were spent only on N (that is, if B = 0).

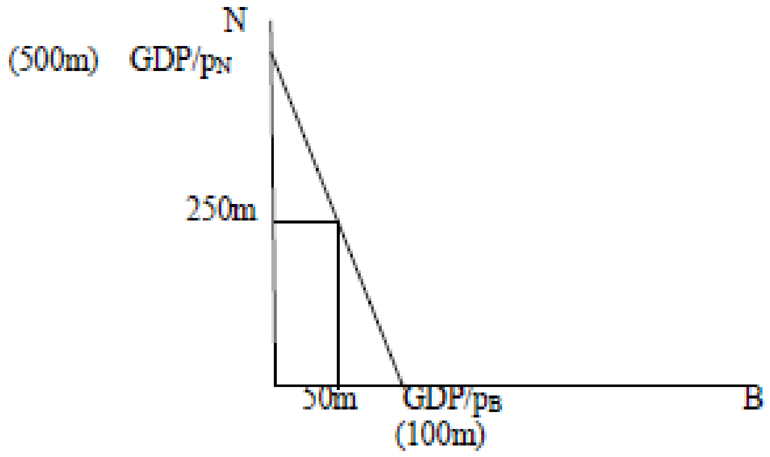
And $\frac{GDP}{P_B}$ would be real GDP measured in bicycles.

# Demand in the national economy

Example: suppose there are 1 million identical people in the US, each with an income of $50,000. (GDP per capita is $50,000.) Then

- Nominal GDP = 1m * 50,000 = $50 billion.
- Real GDP in N = ($50 billion/100) = 500 million N; Real GDP in B = ($50 billion/500) = 100 million B.

Stated in a diagram:




Thus, real GDP is given by the national budget constraint.

At the midpoint, $\frac{GDP}{P_N} = N + \left(\frac{P_B}{P_N}\right) B$ = 250m + 5(50m) = 500m nuts. So real GDP is the same anywhere along the national budget constraint.

# Demand in the national economy

Now we just need to figure out what the national economy would choose to consume given these prices and GDP.

Can we add up preferences (utility functions) to get a set of community indifference curve (CICs)? And would that define aggregate demand curves?

Yes in the very special case that at all times and in all situations every person has the same income (perfectly equal income distribution) and same preferences for B and N. Then CICs would just be "blown up" versions of any person's ICs and total demand curves would be the number of people times each person's demand curves.

But in any case more general than this it becomes virtually impossible to define clean community utility functions or CICs. That's because (1) income distributions can be different as the economy changes and (2) individual taste patterns are different. So when prices change or aggregate income goes up, how much demand for the goods changes depends on the new income distribution and the structure of individual preferences.

This is a real problem (and it is true for any branch of economics where you care about welfare; also political science, sociology, philosophy, etc.). We aren't in a position in this class to solve it. So what do we do?

# Demand in the national economy

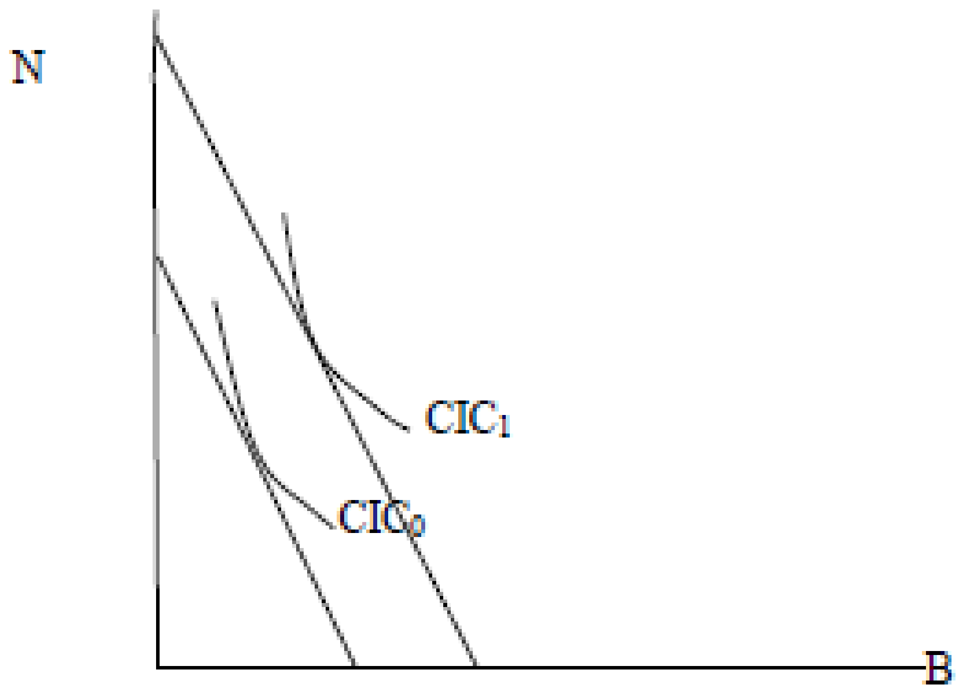
We assume we can characterize national utility function by a set of "community indifference curves" (CICs), which have the same characteristics as individual CICs.  Then we have these implications:

Aggregate demands are defined by points where CICs are tangent to GDP lines (next diagram). So as before we can write national demand curves as

$$D_B = D_B\left(\frac{p_B}{p_N}, GDP\right) \text{ and } D_N = D_N\left(\frac{p_B}{p_N}, GDP\right)$$

We would ordinarily expect the same effects: higher GDP raises demand for both N and B but a rise in relative price would reduce quantity demanded of B but raise quantity demanded of N.

Since a higher real GDP (higher b.c.) generates consumption on a higher CIC we are willing to say that going from a lower to a higher CIC raises national welfare (see diagram below where GDP rises for the same relative price).


N
CIC1
CIC0
B

# Demand in the national economy

But keep the following issues well in mind:

In general a higher GDP does not mean that all people are better off. It depends on how income is distributed in the new cases versus the original case. So that makes it hard really to argue that the economy in total is better off.

But what we can say is that the higher GDP makes it possible to tax the gainers and compensate the losers so that nobody is worse off and some are better off.

So our welfare criterion comes down to this ***compensation principle***: ***If a change in the economy (policy, technology, factor supplies, etc.) generates a higher real GDP so that the gainers could in principle compensate the losers, society is better off.***

Actual compensation policies are not common. There is one in the trade area for the US: the Trade Adjustment Assistance (TAA) program offers additional monetary benefits to people who are laid off due to import competition. In general, progressive income taxes and other policies to redistribute income might be thought of in this way.

# Supply side: the PPF

What are the constraints on the supply side of an economy?

Supplies ("endowments") of labor and capital;

The technologies to produce goods (production functions);

If these 2 items are held fixed producing more B requires producing less N. But if either factor supplies expand or technology improves the PPF expands.

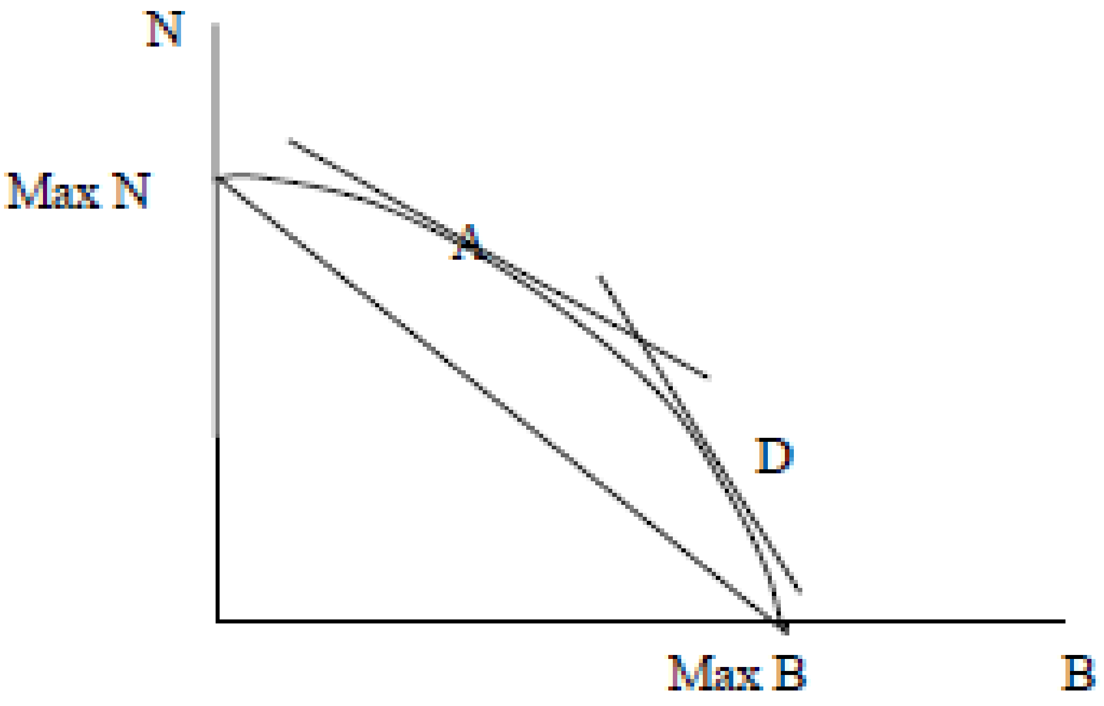
So we can define the production possibility frontier: The PPF shows the maximum amount of N that can be produced for every level of B, with given factor endowments and technologies.

Characteristics of PPF:

- Downward sloping;
- Endpoints (max N or B that can be produced) depend on endowments and technologies;
- Slope of the PPF represents the opportunity cost of converting N into B.

Define the ***marginal rate of transformation (MRT) as the absolute value of slope of PPF***. MRT= $|\Delta N/\Delta B|$ for a given set of factor endowments and technologies for producing N and B.

The PPF we're familiar with is concave, showing increasing opportunity costs at the margin.




Why this concave shape? It depends on features of the production functions for B and N. The 2 primary ones:
*Returns to scale*. We will generally assume constant returns to scale (CRS), which means if you double both inputs you double the output of goods B and N. But we will spend time later thinking about IRS in at least one good.
*Factor intensities*. Let's let B be capital-intensive and N be labor-intensive. That means production of B uses a higher capital-labor ratio than N (and N has a higher labor-capital ratio).

# PPF

A hand-waving description of the shape (concavity) of the PPF (but the math works):

Consider the diagram above and suppose nuts are labor-intensive and bikes are capital-intensive. This means B uses a higher ratio of capital to labor in production than N does. Starting at max N, the N sector releases relatively much K and not much L in order to remain efficient, so it doesn't lose much output. But this high K/L ratio generates a large expansion in B output. This means that at a point like A the MRT is small, say ½ (economy gives up 1/2N for 1B in production).

But the further you go the smaller the amount of K per L the N sector can release so at the margin the amount of additional B produced goes down. This means a reduced marginal product (lower gain in output) for a given fall in N output. Or put differently, for every 1 unit of higher B the amount of N that must be given up gets higher. At point D this could be an MRT of 2, for example (give up 2N for 1B).

This reflects *rising marginal costs* (or *rising opportunity costsl)* of producing B as shown by the higher MRT as the economy moves along the PPF toward more B and less N. This is an *increasing costs* PPF. (And this works in both directions; there are increasing opportunity costs of producing N as you move upward on the PPF.)

**Key concept: a concave PPF demonstrates increasing opportunity costs in production (even though each good is produced with constant returns to scale).**

# PPF

We can actually explain this a little better by imagining that in fact N and B have the same factor intensity (they both use the same capital to labor ratio). In effect, they are the same product as far as production technologies and costs go.

Suppose the (absolute) slope of the line between max N and max B is 1. Then starting at max N the economy would lose 1N to produce the first B by releasing K and L in exactly the ratio needed by B. So this just linearly reduces N to raise B output. If these intensities never change this linear tradeoff would exist all the way to the max B point.

But if intensities are different then we can do better than this tradeoff because the different intensities permit a more efficient reallocation of K and L from N to B, along the concave PPF.

Summary:

With identical factor intensities (and CRS) the PPF is a straight line with a constant MRT (constant opportunity costs in production).

With different factor intensities (and CRS) the PPF is concave ("bowed out") and has a rising MRT as more B is produced (increasing opportunity costs).

Note that the economy wants to produce somewhere along the PPF, which is necessary for full employment.

# Clicker question

Which of the following statements about the PPF is false?

A. Endowments of production factors and the state of technologies determine how far the PPF is from the origin.

B. When production functions have constant returns to scale the PPF is a straight line.

C. When production functions have different factor intensities the PPF is concave (“bowed out” from the origin).

D. When the country produces on the PPF it displays full employment of factors.

E. The concave curvature of the PPF reflects increasing opportunity costs.

# Supply and demand: General Equilibrium

Assume perfect competition (no distortions, taxes, monopolies, labor unions, etc.). This means that prices equal marginal costs (MC):

$p_N = MC_N$ and $p_B = MC_B$ Then $p_B/p_N = MC_B/MC_N$.

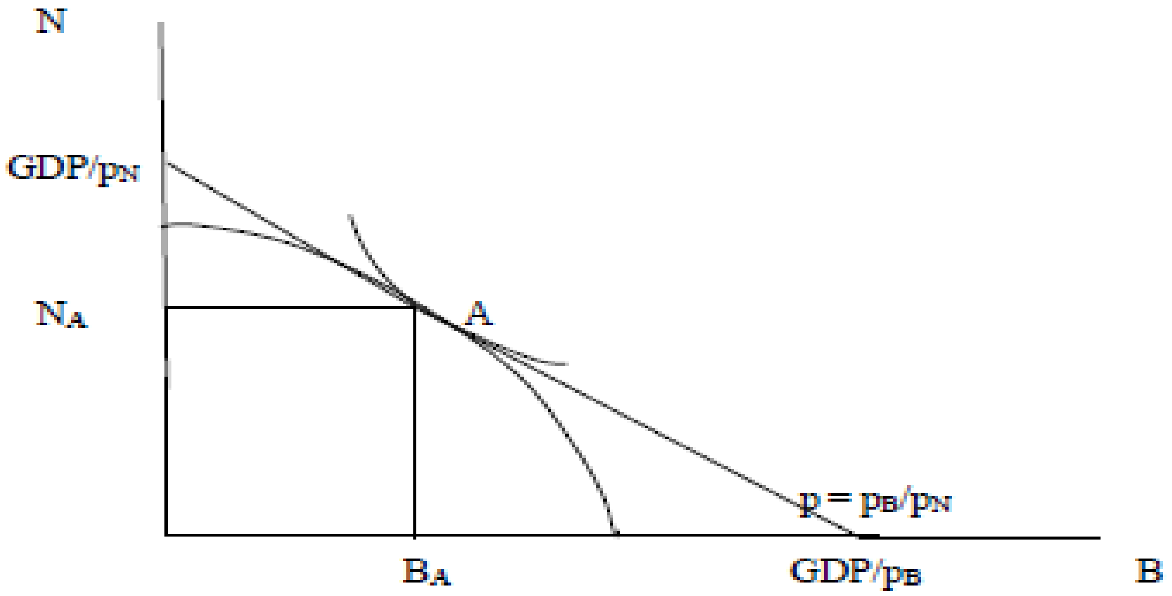
Note also that along the PPF it must be that the value of resources released from N must equal the value of resources gained in B (simply reflects full employment):

$MC_B * \Delta B = - MC_N * \Delta N$

Then $MC_B/MC_N = -(\Delta N/\Delta B) = MRT$.

***So in an efficient economy with perfect competition we have MRT = $p_B/p_N$, or the slope of the PPF equals the market price ratio.***

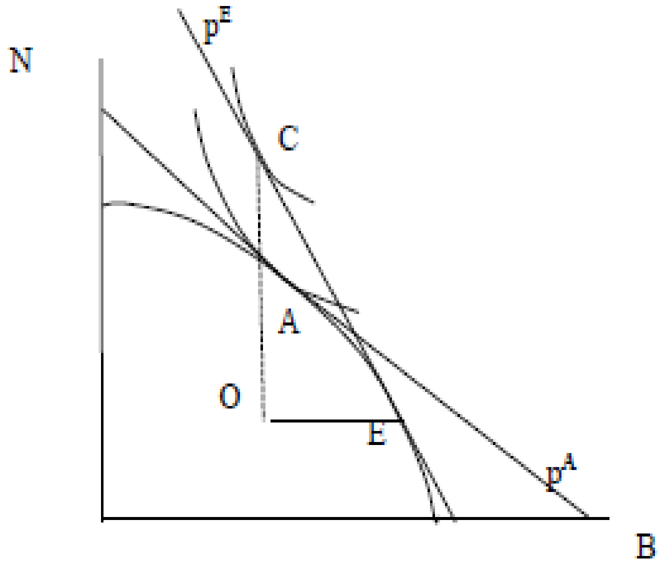
This is the meaning of GE in a closed economy (autarky).




Relative price: $p = p_B/p_N$ = MRT = MRS at A.
Each market is in equilibrium (output in B equals consumption in B, same for N).
This equilibrium maximizes real GDP (and GNP) for the given PPF and preferences. Note that the line with absolute slope p (the relative price in autarky) shows real GDP and is also the economy’s budget constraint in autarky.

# Aggregate demand, PPF, and international trade

Consider what happens to output and consumption decisions as the relative price of B rises from the autarky level.  From now on we will use p to mean relative price in general equilibrium diagrams.

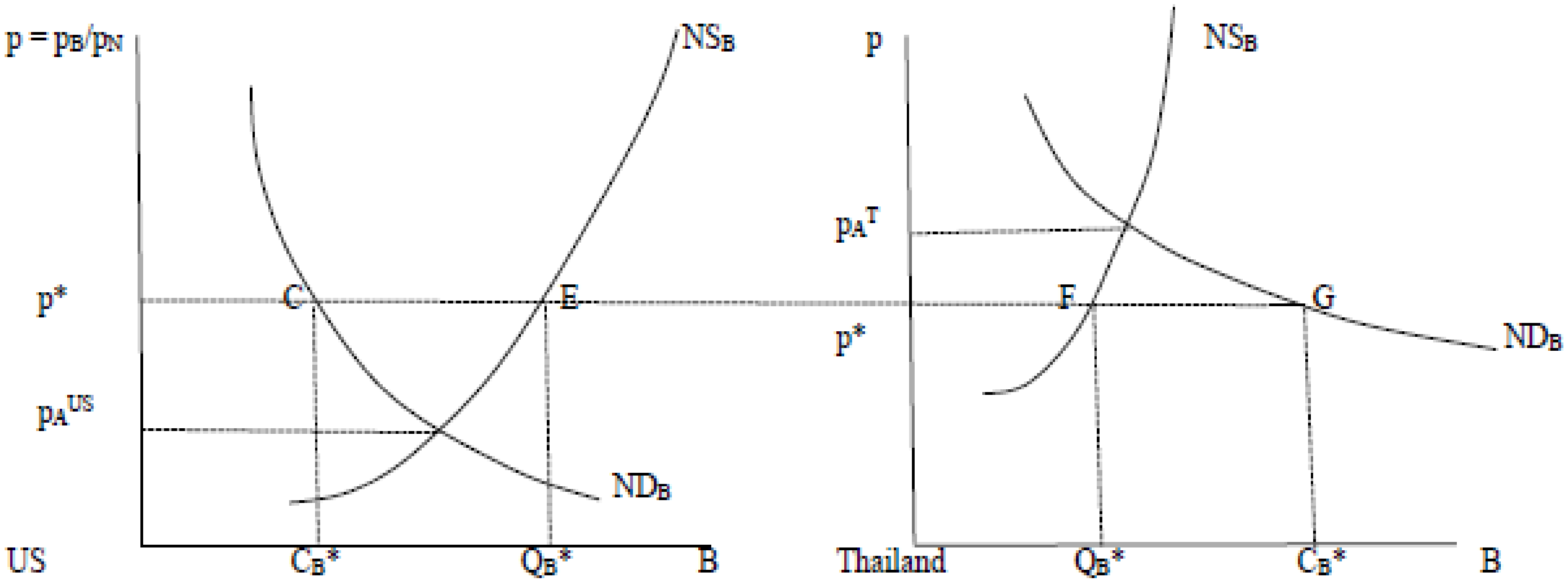



Let $p^A$ rise to $p^E$.  Again, this is an increase in the relative price of B.  We get:

1. Output of B rises (compare A to E along the PPF), so the national supply quantity of B rises.  (And the national supply quantity of N falls.)
2. If the economy can consume along the new price line tangent to production at E, the consumption mix would shift to point C on the higher CIC.  So consumption of B (probably) falls compared to aurarky.  Thus, the national demand quantity of B falls.  (And consumption quantity of N rises.)
3. At $p^E$ the economy consumes outside its PPF, so there is international trade between points E and C (export EO of B, import OC of N).  There would be higher national welfare (higher CIC).

# International trade GE

We want to bring in another country.  But these diagrams are hard to draw so we turn this thinking into aggregate S and D with general-equilibrium (GE) diagrams.



# International trade GE

In the PPF diagram, let price in US rise from autarky $p_A to\ p_E$ .

As we saw, this raises output of B, so there is an upward-sloping national supply (NS) curve.

But it also reduces consumption of B, so there is a downward-sloping national demand (ND) curve.

There is a similar analysis for Thailand for good B.  These supply and demand curves for good B (bicycles) determine the autarky prices $p_A^{US}\ and\ p_A^T$ in this new diagram.

Let p* be the equilibrium price in trade.  As shown here US has a CA in B because its autarky price is below that price.  Thailand has a comparative disadvantage in B.  Consumption and production points are shown as $C_B$* and $Q_B$* on the B axis.  Similarly for Thailand.  Trade quantities are shown in units of B.  Note that US exports of B (= CE) equal Thailand imports of B (=FG).

Question: how do we know the US and Thailand are better off in free trade than in autarky?

# International trade GE

But at the same time Thailand has the comparative advantage in nuts and will export N. Can we figure out how to depict the quantity of N traded? Yes because in general equilibrium there must be balanced trade in value terms. For the US:

$$EXP_B p_B^* = IMP_N p_N^* \text{ which can be rewritten as } IMP_N = \frac{p_B^*}{p_N^*} EXP_B$$

So the box coming down from points C and E in fact is the quantity of US imports (and Thai exports) of N.

We've come full circle: the diagram above is the general equilibrium version of the initial supply-and-demand depiction of international trade (for one good) at the beginning.