

## MEASURING THE ECONOMY

### TOTAL OUTPUT

**Total Output (Y)** = total output is basically all the goods produced and sold in a country, i.e. aggregate supply of goods (AS). It is simultaneously a measure of all income received and all spending in an economy. It is normally measured by GDP.

**GDP** = Gross domestic product = the money value of all final goods and services produced and sold within a country in a given period of time (usually one year). It is a measure of total output (= total income = total expenditures).

**Bureau of Economic Analysis: (BEA)** (a division of the Dept. of Commerce) collects the official GDP data. ([www.bea.gov](http://www.bea.gov))

### PRICE LEVEL

**Price level (P)** = the price level is an overall indicator of prices for goods and services in a domestic economy. It is normally measured by CPI.

**CPI (Consumer Price Index)** = The Consumer Price Index is a measure of the cost of a representative bundle of goods bought by a typical urban household in an economy relative to its cost in some base period. It is a common measure of the "**price level**"

**Bureau of Labor Statistics (BLS)** (a division of the Dept. of Labor) collects the official CPI data. ([www.bls.gov](http://www.bls.gov))

## GDP Basics

Total output = Total Spending = Total income.

*Why?* Because a good sold means a good sold to *someone*, and every dollar spent by someone is a dollar earned by someone. So there are many ways to measure GDP.

### (1) Expenditure aggregation

So we can reduce total output to expenditure categories. Who spends? Who buys the total output of the economy?

- Individual consumers - **consumption** spending (C).
- Individual firms - **investment** spending (I) (i.e. new factories, equipment, etc.)
- The government - **government spending** (G) (note: this means government procurement, e.g. of battleships, stationery, etc., it does *not* include transfers of income across people via social programs.)
- Foreigners - **net exports** (NX) (minus what we buy from them; exports minus imports; net exports is identical to the trade balance).

So,  $GDP = C + I + G + NX$ .

### (2) Income aggregation

So we can reduce total output to income categories. How much income is received from the output of the economy?

- Workers receive **wages**
- Landlords receive **rents**
- Capitalists receive **profits & interest**

So adding up all incomes:

$GDP = \text{Wages} + \text{Rents} + \text{Profits} + \text{Interest}$

### (3) Disposal aggregation

We can reduce total output to how the income is disposed of, i.e. what happens to peoples' incomes. They are:

- spent = **consumption** (C)
- saved = **savings** (S)
- taxed = **taxes** (T)

So adding up:

$GDP = C + S + T$ .

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The most important data is the expenditure categories. According to the BEA's latest figures: ([http://www.bea.gov/newsreleases/national/gdp/2011/pdf/gdp1q11\\_adv.pdf](http://www.bea.gov/newsreleases/national/gdp/2011/pdf/gdp1q11_adv.pdf))

**2010 data:**

			<b>Amount</b>	<b>% of GDP</b>
Consumers	Consumption Spending	C	\$10,349 bn	71%
Firms	Investment spending	I	\$1,828 bn	12.5%
Government	Government Spending	G	\$3,000 bn	20%
Foreigners	Exports		\$1,838 bn	
	Imports		\$2,354 bn	
	Net Exports	NX	-\$516 bn	-3.5%
	Total Output	GDP	\$14,600 billion	100%

$$\text{GDP} = C + I + G + \text{NX}$$

$$\$14,660\text{bn} = \$10,349 \text{ bn} + \$1,828 \text{ bn} + \$3,000 \text{ bn} + (-\$516 \text{ bn})$$

## The Macro Constraint

**Note:** We can combine two categories and mess around with them. e.g.  $GDP = C + I + G + NX$ . We also know  $GDP = C + S + T$ . Since  $GDP = GDP$  by definition, then:

$$C + I + G + NX = C + S + T$$

Notice that the  $C$  cancels out on both sides. So, rearranging, gives us:

$$(I - S) + (G - T) + (NX) = 0$$

This is known as the "macroeconomic constraint". It must be true at all times. Notice we can identify three balances:

The private sector balance  $(I - S)$  = investment spending minus savings

The government sector balance  $(G - T)$  = government spending minus taxation

The trade balance  $(NX)$  = export minus imports.

Trade balance is  $-\$516$  bn these days. (trade deficit)

Government balance is about  $\$1,560$ bn. (government deficit)

Meaning the private balance must be somewhere around  $\$1$  trillion for this to be true, i.e. a *lot* more investment than savings is going on in the private sector.

## MACROECONOMIC DYNAMICS

### Inventories

Total expenditures = aggregate demand (AD) =  $C + I + G + NX$ .

Total Output = aggregate supply (AS) =  $Y$ .

Is it *always* the case that total expenditures = total output? By definition, yes.

But there is a glitch that can cause a mismatch. The glitch is **inventories** (i.e. goods companies have produced but have not sold yet).

If  $AD < AS$ , then more is produced by firms than is sold to people. What will firms do with the excess of goods they have? They will add it to their inventory stock.

If  $AD > AS$ , then *more* is spent by people than is produced by firms. How can firms sell more than they produce? They sell from their inventory stock.

Let us say  $\Delta$  (delta) = additions to inventory stock = basically, the firms' *own* demand for their *own* goods. Then *necessarily* we have it that:

$$AD + \Delta = Y$$

This true *at all times*. (**Note:** additions to inventory are typically included in GDP data).

### Macro Dynamics

The mechanics of the Keynesian multiplier depend on this process.

When AD exceeds Y, then firms inventories are depleting. Normally, a firm reacts to depleting inventories by ordering more production, i.e. expanding output.

Similarly, when AD falls below Y, firms inventories are building up. Normally a firm reacts to accumulating inventories by canceling production orders or cutting back output (firing workers, etc.)

In sum, the **macroeconomic dynamics** (the adjustment of total output in the economy as a whole) follows this rule:

If  $AD > Y \Rightarrow$  inventories deplete  $\Rightarrow$  production orders increase  $\Rightarrow$  output rises

If  $AD < Y \Rightarrow$  inventories accumulate  $\Rightarrow$  production orders decrease  $\Rightarrow$  output falls

*So supply reacts to demand*; firms take inventories as their indicators of when to increase/decrease supply. The exact level of total output in the economy depends on aggregate demand.

## Nominal vs. Real GDP

**Nominal GDP** = the value of GDP in regular dollar terms.

This causes problems when trying to compare GDP across time.

2010 production = 5 apples & 2 oranges

2010 prices = 0.25 per apple, 0.50 per orange

so:  $GDP_{2010} = 0.25 \times 5 + 0.50 \times 2 = \$1.25 + \$1.00 = \underline{\$2.25}$

2011 production = 6 apples & 3 oranges

2011 prices = 0.30 per apple, 0.75 per orange

so  $GDP_{2011} = 0.30 \times 6 + 0.75 \times 3 = \$1.80 + \$2.25 = \$4.05$

Growth rate =  $(GDP_{2011} - GDP_{2010})/GDP_{2010} = \$1.8/\$2.25 = 0.8$  or 80% growth of GDP

Unrealistic since it doesn't distinguish rise in value of GDP because of real production increase (1 more apple + 1 more orange) and rise in value of GDP because of rising prices.

We need to filter the price increases out.

Easiest solution: calculate  $GDP_{2011}$  at 2010 prices to get **real GDP**.

So  $real\ GDP_{2011}$  (i.e. at 2010 prices) =  $0.25 \times 6 + 0.50 \times 3 = \$1.50 + \$1.50 = \underline{\$3.00}$

and  $real\ growth\ rate = \$0.75/\$2.25 = 30\%$  (or 6% per year)

**Real GDP** = Real GDP is GDP assessed at "constant prices". This is calculated by deflating GDP by a price index (such as the CPI) so that GDP becomes expressed in **base year** dollars.

## The Consumer Price Index (CPI)

**CPI** (Consumer Price Index) = The Consumer Price Index is a measure of the cost of a representative bundle of goods bought by a typical urban household in an economy relative to its cost in some base period. It is a common measure of the "**price level**"

(Note: this is not the *only* measure of the price level. There are other measures which you can look up at the BLS website).

Take 2010 as our "base year". Start with a basket of goods "typically" consumed. Then calculate:

$$\text{CPI}_{2011} = (\text{Price of Basket in 2011} / \text{Price of basket in 2010}) \times 100$$

Say, typical household consumes 2 apples & 1 orange (= our basket)

Prices in 2010 = \$0.25 for apples, 0.50 for oranges

Cost of basket in 2010 = \$0.50 + \$0.50 = \$1

Prices in 2011 = \$0.30 for apples, \$0.75 for oranges,

Cost of *same* basket in 2011 = \$0.60 + \$0.75 = 1.35

So (base year)  $\text{CPI}_{2010} = (\$1 / \$1) \times 100 = 100$

So,  $\text{CPI}_{2011} = (\$1.35 / \$1) \times 100 = 135$

or 35% more than 2000 (i.e. **inflation** rate of 35%)

Remember our **nominal** GDP for 2011 was \$4.05. Now, let's **deflate** that GDP by the CPI index to get the **real** GDP for 2011.

$$\text{GDP}_{2011} / \text{CPI}_{2011} \times 100 = \text{real GDP}_{2011}$$

$$\$4.05 / 135 \times 100 = \$3.00 \text{ -- which is } \textit{exactly} \text{ what we had before.}$$

**Example:** Currently, BEA uses 2005 as base year. Using the latest BEA numbers, the nominal  $\text{GDP}_{2010} = \$14,660.4$  and  $\text{CPI}_{2010} = 110.65$ . So,

$$\text{real GDP}_{2010} = \$14,660.4 / 110.65 \times 100 = \$13,248.2 \text{ (in 2005 dollars)}$$

## Determining GDP - Some Unpleasant Arithmetic

In our discussion of inventories, we noted that output (GDP) is *determined by* aggregate demand. So the question of finding the GDP seems like a simple matter of finding the values of the components of AD.

The problem is that the components of AD may themselves be dependent on GDP, making it seem like the argument is circular.

Specifically, the amount of consumption spending people undertake depends to a large extent on the amount of income people have. The greater the income, the more is spent.

But total income, as we noted earlier, is identical, by definition, to total output. So consumption is itself dependent on GDP.

The circularity of argument seems disturbing: aggregate demand determines output (GDP) by the inventory process, but at least one of the components of aggregate demand (consumption) is itself dependent on GDP. So what determines what then? What is the direction of causation exactly?

### **(1) The Multiplier Process, Once Again**

Answer: Aggregate demand determines output, yes, but there is a feedback loop via the consumption factor: if AD rises, GDP rises to follow it, which in it generates more demand, which generates more output, which generates more demand, etc.

It seems like an never-ending process. But remember people *don't* consume all their income. They save some of it. Suppose people save 20%, then the process is as follows, going in steps:

1. An initial \$100 rise in AD will, by the inventory process, prompt firms to produce more, thereby raising GDP by \$100,
2. but the \$100 rise in GDP (the extra output) necessarily translates into someone's income. And \$100 in extra income raises consumption by \$80 only, since \$20 is saved.
3. the \$80 in increased consumption constitutes an increase in AD by \$80 by the very definition of AD ( $= C + I + G + NX$ )...
4. But if AD rises by \$80, then by the inventory process, GDP must rise to meet it. So GDP increases by \$80.
5. but the extra \$80 rise in GDP (= income) raises consumption further by \$64 (since \$16 = 20% of \$80, is saved),
6. that extra \$64 in consumption constitutes an increase in AD by \$64;
7. by the inventory process, the \$64 rise in AD prompts output to be increased by \$64.
8. the extra \$64 in output induces a further \$51.2 in extra consumption spending (\$12.8 = 20% of \$64 is saved);
9. rise in consumption spending by \$51.2 by definition constitutes a rise in AD by \$51.2.
10. That \$51.2 rise in AD will prompt firms to increase production by \$51.20

and so on.

This should look very familiar. It is nothing other than the good old **multiplier process**.

Step 1, the **initial injection** of \$100 in spending, will generate wave after wave of extra income and extra spending (what is commonly called "**induced consumption**"). But because some of that extra income is saved, the amount of induced consumption at every wave becomes smaller and smaller - \$80, \$64, \$51.2, and so on. So the induced waves of extra income and spending don't go on forever, but gradually wind down and peter out.

We've gone through this before (see Economic Growth section). And we know that there is a simple formula to calculate the total amount of output generated:

$$\text{total extra output} = \text{multiplier} \times \text{initial injection}$$

where multiplier =  $1/(1-c)$  where  $c$  = marginal propensity to consume.

So if  $c = 0.8$  (i.e. we spend 80% of every extra dollar), then the multiplier is 5. So, applying the formula, an initial injection of \$100 will generate \$500 output.

All this should be old hat. But the main point to note that recognizing the multiplier will help us out of the circular reasoning.

## (2) The Consumption Function

So back to the original question. If  $AD = C + I + G + NX$ , and we know that GDP will follow AD, then determining GDP should be a simple matter of knowing the components of AD. But we need to pay some recognition to the feedback loop. So let's go carefully.

**Consumption** spending can be divided into two components:

- **autonomous** consumption, that is the amount of consumption spending that's going to happen *anyway*, regardless of income level. We normally denote this  $C_0$ . This is the part that is influenced by everything except income (e.g. it is the part of consumption influenced by consumer confidence, accumulated real wealth, etc.)

- **induced** consumption, that is the amount of consumption spending that depends on income. To calculate induced consumption we must know two things: (1) the amount of income in the economy (GDP, economists like to denote this by "Y", I don't know why.), (2) the marginal propensity to consume (i.e. percentage of extra dollar of income that will be spent on consumption, normally denoted by little  $c$ ).

So total consumption can be written as:

$$C = C_0 + cY$$

$\downarrow$                        $\downarrow$   
 (autonomous) (induced)

So, suppose that

$C_0 = \$50$  (spent no matter what).

$c = 0.8$  (i.e. 80% of every dollar earned is spent).

$Y = \$100$  (i.e. GDP is \$100, just assume that for now).

Then total consumption spending is:

$$\begin{aligned}
 C &= C_0 + cY \\
 &= \$50 + (0.8)(\$100) \\
 &= \$50 + \$80 \\
 &= \$130
 \end{aligned}$$

Total consumption spending is \$130, of which \$50 was autonomous and \$80 was induced by \$100 of income.

Make sense? So far so good

### **(3) Calculating Output**

Remember our aggregate demand formula:

$$AD = C + I + G + NX$$

just plug in the consumption formula in place of C:

$$AD = (C_0 + cY) + I + G + NX$$

OK. Next comes the magic.

Because of the inventory story, we know output will adjust to the amount of spending in an economy. That is, when all is said and done and production has adjusted, we should have it that:

$$Y = AD$$

So what is total output, i.e. what is the value of Y? Just plug in what we had before for AD:

$$Y = (C_0 + cY) + I + G + NX$$

Notice that output (Y) now appears both on the *left* side and the *right* side of the equation. This is no surprise. It is the feedback loop. So to find output, we do as good mathematicians do: we solve for Y. This is just basic algebra: first bring cY to the left side:

$$Y - cY = C_0 + I + G + NX$$

Now factor the left:

$$(1-c)Y = C_0 + I + G + NX$$

and divide by (1-c):

$$Y = [C_0 + I + G + NX]/(1-c)$$

and presto, we're done. Notice that this can also be written as:

$$Y = \frac{1}{(1-c)} \times [C_0 + I + G + NX]$$

Hey! Notice that  $1/(1-c)$  is nothing but our old friend the multiplier. So, in words, this says:

$$\text{total output} = \text{multiplier} \times [\text{autonomous spending terms}]$$

very similar to the formula we had before. Except before we were only finding out the *extra* output from an *extra* injection of spending. Now we're finding out the *total* output from on the basis of bunch of autonomous spending terms  $[C_0 + I + G + NX]$ .

So, suppose we have the following **initial data**:

marginal propensity to consume (c) = 0.8

autonomous consumption spending ( $C_0$ ) = \$50

Investment spending (I) = \$60

Government spending (G) = \$80

Exports (EX) = \$40

Imports (IM) = \$30

That's all the data we need to find the output.

$$\text{output} = Y = \frac{1}{(1-c)} \times [C_0 + I + G + NX]$$

Then just plug the data in the formula:

$$\text{output} = Y = \frac{1}{(1-0.8)} \times [\$50 + \$60 + \$80 + \$10]$$

(remember that Net Exports (NX) = Exports - Imports = 40 - 30 = 10). So, noticing  $1/(1-0.8) = 5$ , then:

$$\text{output} = Y = 5 \times [\$200]$$

$$\text{output} = Y = \$1,000$$

And there you have it. Given the data above, we *know* GDP is going to be \$2,000.

#### (4) Measuring Policy impact

We can use this formula to calculate the impact of policy.

**Example #1** - Suppose, starting from the earlier data, the Federal Reserve lowers interest rates and prompts investment spending to increase from \$60 to \$75. Everything else remains the same. Then:

$$\text{output} = Y = \frac{1}{(1-0.8)} \times [\$50 + \$75 + \$80 + \$10]$$

$$\text{output} = Y = 5 \times [\$215]$$

then:

$$\text{output} = Y = \$1,075$$

Thus an increase in investment spending from \$60 to \$75 has increased output from \$1,000 to \$1,075.

[Notice we could have simply used our earlier formula too; after the Fed manipulated interest rates, it induced an injection of \$15 in investment spending, so total extra output =  $5 \times \$15 = \$75$ . Which is exactly what total output increased by. So we can see the correspondence between the two formulas.]

**Example #2** - The great thing about using the total formula is we can do multiple policies at once. Suppose, starting from initial data, the Congress and Treasury coordinate policy

so that government spending (G) is cut from \$80 to \$70 and simultaneously exchange rates are lowered that net exports (NX) rise from \$10 to \$25. What is the net impact? Well, just plug in the numbers:

$$\text{output} = Y = \frac{1}{(1-0.8)} \times [\$50 + \$60 + \$70 + \$25]$$

$$\text{output} = Y = 5 \times [\$205]$$

or:

$$\text{output} = Y = \$1,025$$

so, after both policies are implemented, output increases by \$25.

**Example #3** - We can make it even more complicated. Suppose, starting from initial data, consumers suddenly start saving more, cutting back their propensity to consume from 80% to 75%. Suppose that in response to slackening demand, government undertakes public works projects raising government spending from \$80 to \$90. The net result is:

$$\text{output} = Y = \frac{1}{(1-0.75)} \times [\$50 + \$60 + \$90 + \$10]$$

$$\text{output} = Y = 4 \times [\$210]$$

where, notice, the multiplier has now fallen from 5 to 4 because of declining propensity to consume ( $1/(1-0.75) = 1/0.25 = 4$ ). The net result is:

$$\text{output} = Y = \$840$$

So, on net, output has fallen by a whopping \$260. The government's attempt to counter-balance the decline in propensity to consume with public works projects hasn't worked as well as hoped.

## Complete Government Policy

We have seen how we can calculate the impact of shocks and government policies on output. But that was a very simplified menu. We should write it a more complete manner with added complications.

We have been assuming, thus far, that consumption is the only component that has a feedback loop, that is that only consumption depends on income. But this is not exactly true. Several other things depend on income - most notably, taxes and imports. So we should complete the story with a more expanded menu.

### (1) Complex Consumption Function

First, let us revisit the consumption function. We wrote that total consumption was:

$$C = C_0 + cY$$

where  $C_0$  was autonomous consumption and  $cY$  was induced consumption. This is a little oversimplified. For starters, people don't consume out of gross income. They consume out of their **personal disposable income**, that is the income that is left after deducting taxes and adding or subtracting any transfers from forced programs (unemployment benefits, social security, etc.). So we should really write:

$$C = C_0 + cY^p$$

where  $Y^p$  is personal disposable income, which is defined as:

$$Y^p = Y - TX + TR$$

where  $Y$  = gross income (or output),  $TX$  = taxes,  $TR$  = net transfers.

Taxes are of two types:

- **autonomous taxes** (taxes you have to pay regardless of your income, e.g. poll taxes, property taxes, etc. Let us call this  $TX_0$ )
- **income taxes** (taxes you pay as a percentage of your income. We denote this as  $tY$ , where  $t$  = marginal tax rate, e.g.  $t = 0.15$  means that for every dollar of income earned, 15 cents are paid in taxes).

So total taxes can be written as:

$$TX = TX_0 + tY$$

↓            ↓  
(autonomous) (income taxes)

That should be reasonably clear. The more you earn ( $Y$ ), the more you pay in income taxes ( $tY$ ) and thus the more total taxes ( $TX$ ).

[Notice the general implication that when income rises, tax revenues rise. When income falls, tax revenues fall. Let the government **budget balance** be defined as [Revenues - Expenditure] =  $[TX - G]$ .  $G$  doesn't change unless Congress votes for it; but  $TX$  changes automatically with income. So there is an automatic tendency for **budget surplus** ( $TX > G$ ) in a boom, when incomes rise (since  $TX$  rises), and a automatic tendency for **budget deficit** ( $TX < G$ ) in a recession, when incomes fall (since  $TX$  falls).]

What about **net transfers** ( $TR$ )? This depends on social demographics and benefit arrangements. In, say, a Social Security program, we have a fund: income is taken away from the young (via FICA) and paid to the old (SS benefits). If there are a lot of young people in society and few old people, then a lot of people are paying in, and few people taking out of the Social Security fund. That means that in total, net transfers are *negative* (in total, adding young and old together, transfer programs are taking income *away* from consumers as a whole). To use specific numbers, if the Social Security program *takes away* \$60 from the young and *adds* \$50 to the old, then net transfers =  $-\$10$ , a negative number.

If the structure is different and there are a few young people and a lot of old people, then net transfers are *positive*. Few people get FICA deducted, lots of people receive SS benefits. So, in total, adding young and old, transfers are adding more income to consumers as a whole). To use specific numbers, if the Social Security program *takes away* \$60 from the young and *adds* \$75 to the old, then net transfers =  $\$15$ , a positive number.

So, we have a much more complication consumption function now. Previously we assumed that  $C = C_0 + cY$ . Now we have:

$$C = C_0 + cY^p$$

where personal disposable income is  $Y^p = Y - TX + TR$ , so:

$$C = C_0 + c(Y - TX + TR)$$

and since  $TX = TX_0 + tY$ , then:

$$C = C_0 + c(Y - (TX_0 + tY) + TR)$$

or:

$$C = C_0 + c(Y - TX_0 - tY + TR)$$

It's beginning to look ugly. Now, if we open the brackets, we distribute  $c$  among the various terms:

$$C = C_0 + cY - cTX_0 - ctY + cTR$$

or collecting the income (Y) terms:

$$C = C_0 + (c - ct)Y - cTX_0 + cTR$$

Which is a much more complicated consumption function that we had before.

## (2) Complex Net Exports

Let us keep going and complicate **imports**. The amount people import at least partly depends on the amount of income they have (the richer you are, the more you buy of everything - domestic and foreign - so your imports should rise with income.). As you can expect, we can divide imports into two types:

- **autonomous imports** (the imports you'd buy regardless of your income; Let us call this  $IM_0$ ; this is the part that is dependent on exchange rates, tariffs, quotas, etc.).
- **induced imports** (the imports you buy only when income increases. We denote this as  $mY$ , where  $m$  = marginal propensity to import, e.g.  $m = 0.10$  means that for every extra dollar of income you earn, you buy 10 cents more of imports).

So total imports can be written as:

$$\begin{array}{ccc}
 IM & = & IM_0 + mY \\
 & & \downarrow \quad \downarrow \\
 & & (\text{autonomous}) \quad (\text{induced})
 \end{array}$$

That should be reasonably clear. The more you earn (Y), the more induced imports (mY) and thus the more total imports (IM).

Note: exports (sale of domestic goods to foreigners) are obviously not affected by domestic income; it is *foreign* income that determines demand for *domestic* exports. Exports (EX) is, however, affected by exchange rates.

Since Net Exports = Exports - Imports, or using abbreviations,  $NX = EX - IM$ , where EX is total exports and IM is total imports, then:

$$NX = EX - IM$$

plugging in for IM:

$$NX = EX - (IM_0 + mY)$$

$$NX = EX - IM_0 - mY$$

So now our net exports equation is no longer as simple as before.

OK. That's about as complicated as we want to get right now. So let's plug everything in.

### (3) Calculating Output (Complete)

We know that output catches up to aggregate demand by the inventory adjustment process:

$$Y = AD$$

Now, by definition we know that  $AD = C + I + G + NX$ , so it must be that in equilibrium:

$$Y = C + I + G + NX$$

We know now we have our complicated consumption function  $C = C_0 + (c - ct)Y - cTX_0 + cTR$  and a complicated net export equation.  $EX - IM_0 - mY$ , so plugging them in:

$$Y = [C_0 + (c - ct)Y - cTX_0 + cTR] + I + G + [EX - IM_0 - mY]$$

Quite ugly it is!

Now to figure out what the output level will be, we have to solve it for output (Y). Notice we have one Y on the left side and two Ys on the right side, so we need to collect them all on the left (notice how the signs change):

$$Y - (c - ct)Y + mY = C_0 - cTX_0 + cTR + I + G + EX - IM_0$$

And, as before, we want to factor out Y:

$$(1 - c + ct + m)Y = C_0 - cTX_0 + cTR + I + G + EX - IM_0$$

and now divide by  $(1 - c + ct + m)$ :

$$Y = [C_0 - cTX_0 + cTR + I + G + EX - IM_0] / (1 - c + ct + m)$$

Or if you prefer:

$$Y = \frac{1}{(1 - c + ct + m)} \times [C_0 - cTX_0 + cTR + I + G + EX - IM_0]$$

or, in English:

$$\text{output} = \text{complicated multiplier} \times [\text{autonomous spending terms}]$$

Evidently our multiplier is no longer as simple as it was before. It includes not only the marginal propensity to consume (c) but also the marginal propensity to import (m) and the income tax rate (t). Ugly it is indeed. But at least now it is more complete and we have a richer menu of policy options.

To calculate the exact number, suppose the following is our **initial data**:

marginal propensity to consume (c) = 0.8

marginal tax rate (t) = 0.15

marginal propensity to import (m) = 0.10

autonomous consumption spending ( $C_0$ ) = \$50

autonomous taxes ( $TX_0$ ) = \$40

net transfers (TR) = \$10

Investment spending (I) = \$60

Government spending (G) = \$80

Exports (EX) = \$40

autonomous imports ( $IM_0$ ) = \$30

Just plug in the numbers!

$$\begin{aligned} Y &= \frac{1}{(1 - c + ct + m)} \times [C_0 - cTX_0 + cTR + I + G + EX - IM_0] \\ &= \frac{1}{(1 - (0.8) + (0.8)(0.15) + (0.10))} \times [\$50 - (0.8)(\$40) + (0.8)(\$10) + \$60 + \$80 + \$40 - \$30] \end{aligned}$$

Yuck. But pressing on:

$$Y = 2.38 \times [\$176]$$

where 2.38 is our complicated multiplier and \$240 is the sum of all those autonomous terms. So finally:

$$Y = \$418.88$$

And there we have it.

It is useful to note the modifications we have done: the multiplier (2.38) is much smaller than before (5). This gives us the insight that income taxes and imports represent a kind of **leakage** from the system. Remember in the our exercise of circulating a dollar around, we deducted 20 cents for savings before we passed it on for further consumption? Those savings were a leakage out of the circulation system. So, now, in our more complicated story, savings, taxes and imports are all leakages, they are all deducted from

the dollar before we pass it on to our fellow-countrymen in spending. Overall, these leakages diminish the bang-for-buck impact of our spending on the economy.

The only other thing worth noticing is that the marginal propensity to consume (c) also shows up in our autonomous terms, attached to  $TX_0$  and TR. That reflects the fact that taxes and transfers only have an impact on the economy *indirectly* through consumption spending, whereas the other terms ( $C_0$ , G, I, EXP,  $IM_0$ ) impact spending and thus the economy *directly*. This will be important for us later.

#### **(4) Calculating Policy Impact (Complete)**

In the more complex arrangement, the policy tools available are:

**Fiscal Policy** (Congress): any adjustments in government spending (G), autonomous taxes ( $TX_0$ ), income taxes (t) and transfer programs (TR). Some fiscal measures have direct impact (e.g. G), others affect indirectly by influencing personal disposable income of consumers (e.g. taxes & transfers).

**Monetary Policy** (Federal Reserve): adjustment in interest rates to affect investment spending (I). Adjustment in Fed policies on reserve requirements, discount rates, etc. also affect lending rates and thus investment spending.

**External Policy** (Treasury): adjustments in exchange rates to affect exports and imports. Adjustments in tariffs/quotas are usually done by Congress, and also impact exports & imports.

**Example 1 (Monetary policy)**: Federal Reserve reduces interest rates thereby raising investment spending from \$60 to \$90 (i.e. I rises by \$30)

Calculating the long way:

$$\text{output} = Y = \frac{1}{(1 - (0.8) + (0.8)(0.15) + (0.10))} \times [\$50 - (0.8)(\$40) + (0.8)(\$10) + \mathbf{\$90} + \$80 + \$40 - \$30]$$

$$\text{output} = Y = 2.38 \times [\$206]$$

$$\text{output} = Y = \$490.28 \quad (\text{output increased by } \$71.4 \text{ from } 418.88)$$

Happily, to avoid having to calculate everything from scratch, there is a short-cut. Instead of making the change and adding it all up, we can measure the impact of the change alone. Remember the simple old multiplier formula:

$$\text{extra total output} = \text{multiplier} \times \text{initial injection}$$

we can adapt it more generally as follows:

$$\text{change in output} = \text{multiplier} \times [\text{change in autonomous terms}]$$

Since the only autonomous term that changed in this case was investment spending (it increased by \$30). As nothing else changed, you can ignore all the other terms. So:

$$\begin{aligned} \text{change in output} &= 2.38 \times [\$30] \\ &= \$71.4. \end{aligned}$$

which exactly corresponds to the result we discovered the long-winded way! So, in most (but not all) cases, you can get to the result quicker by the short-cut way.

**Example 2 (Fiscal Policy - tax rebate):** Government gives out stimulus tax rebate checks worth \$15. (So subtract \$15 from  $TX_0$ , which falls from \$40 to \$25):

Calculating the long way:

$$\text{output} = Y = \frac{1}{(1 - (0.8) + (0.8)(0.15) + (0.10))} \times [\$50 - (0.8)(\$25) + (0.8)(\$10) + \$60 + \$80 + \$40 - \$30]$$

$$\text{output} = Y = 2.38 \times [\$188]$$

$$\text{output} = Y = \$447.44 \quad (\text{output increased by } \$28.56 \text{ from } 418.88)$$

Calculating the short way:

$$\text{change in output} = \text{multiplier} \times [\text{change in autonomous terms}]$$

$$\text{change in output} = 2.38 \times [-(0.8)(-\$15)]$$

Note! Autonomous taxes  $TX_0$  falling by \$15 means autonomous spending terms *increase* by  $-(0.8)(-\$15) = \$12$ . There is a double negative there and you need to take marginal propensity to consume (c) into account since it is attached to  $TX_0$  term in the equation.

$$\begin{aligned} \text{change in output} &= 2.38 \times [ \$12] \\ &= \$28.56 \end{aligned}$$

which matches the result obtained the long-run way.

**Example 3 (Fiscal Policy - income taxes):** Government increases the marginal tax rate from 15% to 20%. You now need to adjust  $t$  in the multiplier from 0.15 to 0.20:

Calculating the long way:

$$\text{output} = Y = \frac{1}{(1 - (0.8) + (0.8)(0.20) + (0.10))} \times [\$50 - (0.8)(\$40) + (0.8)(\$10) + \$60 + \$80 + \$40 - \$30]$$

$$\text{output} = Y = 2.17 \times [\$176]$$

Note that now the multiplier changed! It was 2.38 before, now it is only 2.17. That's how changes in income tax rates affect the economy - they change the multiplier, not the autonomous terms. So now:

$$\text{output} = Y = \$381.92 \quad (\text{output decreased by } \$36.96 \text{ from } 418.88)$$

Unfortunately, there is no short-cut way for this particular example (actually there is, but you have to use calculus, which gets ugly rather quick.)

**Example 4: (Combination of policies):** Federal Reserve raises interest rates to reduce investment spending from \$60 to \$40 (reduction of I by \$20), while Congress introduces quotas to reduce imports from \$30 to \$22 (reduction of  $IM_0$  by \$8). What is net effect?

Calculating the long way:

$$\text{output} = Y = \frac{1}{(1 - (0.8) + (0.8)(0.15) + (0.10))} \times [\$50 - (0.8)(\$40) + (0.8)(\$10) + \mathbf{\$40} + \$80 + \$40 - \mathbf{\$22}]$$

$$\text{output} = Y = 2.38 \times [\$164]$$

$$\text{output} = Y = \$390.32 \quad (\text{output decreased by } \$28.56 \text{ from } 418.88)$$

Calculating the short way:

$$\text{change in output} = \text{multiplier} \times [\text{change in autonomous terms}]$$

As we have *two* policy changes, we must include *both* in the changes in autonomous terms:

$$\text{change in output} = 2.38 \times [-\$20 - (-\$8)]$$

being careful with double negatives, notice that  $-\$20 - (-\$8) = -\$12$ , that is, on net, a *reduction* by \$12. So:

$$\text{change in output} = = 2.38 \times [-\$12]$$

$$= -\$28.56.$$

which is exactly what we found by the long-winded way.

**Example 5 ("Balanced Budget" Fiscal Policy):** Many politicians think it desirable for governments to maintain a "balanced budget" and often require that any increase in spending be exactly offset by increased taxes. What is the impact of such a requirement on the economy? Intuitively, you'd expect it to be zero - what the government gives with one hand, it takes away with the other. But that isn't the case.

To see why, suppose government increases spending by \$30 (G rises from \$80 to \$110) but politicians anxious to keep balanced budget also vote to raise autonomous taxes by exactly the same amount (TX<sub>0</sub> rises by \$30, from \$40 to \$70). The budget is balanced perfectly - more spending by \$30 matched by more taxes of \$30. Let's now assess the impact:

Calculating the long way:

$$\text{output} = Y = \frac{1}{(1 - (0.8) + (0.8)(0.15) + (0.10))} \times [\$50 - (0.8)(\$70) + (0.8)(\$10) + \$60 + \$110 + \$40 - \$30]$$

$$\text{output} = Y = 2.38 \times [\$182]$$

$$\text{output} = Y = \$433.16 \quad (\text{output increased by } \$14.28 \text{ from } 418.88)$$

Calculating the short way:

$$\text{change in output} = \text{multiplier} \times [\text{change in autonomous terms}]$$

$$\text{change in output} = 2.38 \times [-(0.8)(\$30) + \$30]$$

Again, notice we must include both changes in autonomous terms. But, here's the piece of magic: notice that the reduction in TX<sub>0</sub> has the marginal propensity to consume (c) term attached to it. That is because c is attached to TX<sub>0</sub> in the original collection of autonomous terms. So we must include it here. Again, this reflects that TX<sub>0</sub> has only an indirect effect on spending (i.e. it influences personal disposable income of consumers), whereas government spending (G) has a *direct* effect (and thus no c attached).

$$\text{change in output} = 2.38 \times [-\$24 + 30]$$

$$= 2.38 \times [\$6] \quad \leftarrow \text{note: net increase by } \$6!$$

$$= \$14.28.$$

So even though we raise taxes to exactly counterbalance spending in the budget, the *net impact* on the economy is actually positive! Again, that is because one component (TX<sub>0</sub>) works only indirectly, whereas the other (G) works directly.

So our initial intuition was wrong: even if the government matches tax-and-spending, it doesn't cancel out the impact to zero. There *is* a net impact on the economy.

And there you have it. These examples show how you can calculate the impact of a variety of different policies on the economy's GDP.

**Example 6 (Impact of Inflation):** You can use this tool to also measure the impact not only of policy, but also of different sudden shocks to the system that may be brought about for other reasons.

For instance, suppose there is suddenly a bout of **inflation** for some extraneous reason. There are several channels by which inflation affects expenditure:

(1) **Wealth Effect** it reduces the real purchasing power of money-denominated wealth of consumers. Note: *not* their income. Consumer income comes from wages, profits, etc. and those things adjust concurrently with inflation, so the purchasing power of income remains the same. It is their accumulated *wealth* - that is, their holdings of bank accounts, bonds, etc. - that is affected, since they don't adjust with inflation. Consumers thus react to decline in real value of wealth by cutting back autonomous spending;

(2) **External Effect** by raising the prices of domestic goods, inflation makes imports more attractive to domestic consumers and exports less attractive to foreign consumers.

There are other channels & effects, but let's just assume these two for now.

So suppose there is a bout of inflation and, by the first channel, consumer cut back  $C_0$  from \$50 to \$40 (thus a reduction by \$10), while by the second channel exports (EX) decline from \$40 to \$35 and imports ( $IM_0$ ) increase from \$30 to \$38. So, calculating the impact the long way:

$$\text{output} = Y = \frac{1}{(1 - (0.8) + (0.8)(0.15) + (0.10))} \times [\$40 - (0.8)(\$40) + (0.8)(\$10) + \$60 + \$80 + \$35 - \$38]$$

$$\text{output} = Y = 2.38 \times [\$153]$$

$$\text{output} = Y = \$364.14 \quad (\text{output decreased by } \$54.74 \text{ from } 418.88)$$

Calculating the short way:

$$\text{change in output} = \text{multiplier} \times [\text{change in autonomous terms}]$$

$$\text{change in output} = 2.38 \times [(-\$10) + (-\$5) - (+\$8)]$$

notice we have *three* changes - the decline by \$10 in autonomous consumer spending, the decline by \$5 in exports and the rise by \$8 in imports (be careful with the negative signs!). So:

$$\begin{aligned}\text{change in output} &= 2.38 \times [-\$23] \\ &= -\$54.74.\end{aligned}$$

Exactly as we calculated via the long-winded way. So the impact of inflation will be to reduce output by \$54.74.

### **Conclusion**

In sum, we have seen how economists calculate the impact of policy (and natural shocks, like inflation) on the real economy. This is precisely the kind of calculation that is routinely done by government institutions, like the Federal Reserve, the US Treasury, Congressional Budget Office (CBO), the Bureau of Economic Analysis (BEA), the President's Council of Economic Advisors (CEA) etc. whenever they are contemplating the introduction of a new policy measure. Of course, the models they use are a bit more complex, but not that much more complex than what we've done here. They sit around estimating multipliers and inputting data, and assessing the impact exactly like we did here.

## CAPACITY CONSTRAINTS

You might be a little confused for a moment. In our Economic Growth section we said GDP is determined by the volume of land, labor, capital and technology. Now we're saying GDP is determined by Aggregate Demand. They're not the same thing. So which is it?

In nutshell: Economic Growth determines how much we *can* produce. Aggregate Demand determines how much we *will* produce.

Let us see why. We have seen *how* the exact level of GDP (output or Y) depends on the amount of aggregate demand. Whether in the simplified form:

$$Y = \frac{1}{(1-c)} \times [C_0 + I + G + NX]$$

or with all the nitty gritty details:

$$Y = \frac{1}{(1-c+ct+m)} \times [C_0 - cTX_0 + cTR + I + G + EX - IM_0]$$

Once we're given the levels of the autonomous expenditure terms and propensities (& tax rates) etc., we can easily determine what the output level is.

We've also seen the dynamic at work: if we change any of the expenditure terms, then output adjusts accordingly. This gives the numerical filler to what we said before in our macro dynamics: the level of total output in the economy *follows* whatever the aggregate demand level is. As we explained in our macro dynamics story:

If  $AD > Y \Rightarrow$  inventories deplete  $\Rightarrow$  production orders increase  $\Rightarrow$  output rises

If  $AD < Y \Rightarrow$  inventories accumulate  $\Rightarrow$  production orders decrease  $\Rightarrow$  output falls

But there is a big assumption we're making here. We're assuming that firms *can* adjust their output to meet whatever the level of aggregate demand is. What if they can't? What if they hit a capacity constraint?

Suppose aggregate demand rises for some reason (consumer confidence, lower interest rates, tax rebates or something). Firms will want to expand output to meet it. Take an oven factory. It has an increased orders of oven production. So they have to go out and hire *more* workers and buy *more* steel, *more* energy, rent out more factory space, etc. to increase production and fill their orders.

But that *assumes* there's a bunch of idle workers out there ready to be hired, a pile of unused steel it can buy, and that its own factory has the current size capacity to ramp up production of ovens easily.

But what if there are no workers out there? What if there is a sharp shortage of steel. Or the factory isn't large enough? In other words, what if our economy is operating at full **resource capacity**, i.e. no underutilized resources out here? Then our firm has to *poach* - i.e. lure workers from other factories, outbid other firms for steel, and rent out factory space by offering landlords high rents to evict their current tenants. Notice that means two things:

- (1) that it is increasing its production at the expense of *someone else's* production (taking away their resources);
- (2) that it has to offer higher wages, higher prices for inputs and higher rents, which squeezes their profits.

(1) means that the oven firm is *not* actually contributing to an increase in total output. Its output rises, but the output of someone else has to fall (because they have lost resources). So total GDP is *not* increasing.

(2) means that the firms now face increasing costs for inputs, profit margins are squeezed. To restore those profit margins, it *has to* pass those higher costs onto consumers in the form of higher prices.

This changes our story a bit. Previously we said output follows aggregate demand. And that is true *so long* as there are enough underutilized resources in the economy that the firm can pick up quickly. But if the economy is operating at full resource capacity, than attempts to increase output to meet aggregate demand will not happen. Or rather, firms will *try* to increase output, but they'll just be poaching resources from each other and raising prices. Total output will *not* rise. But *prices* will rise, i.e. **inflation**.

In sum: GDP *will* rise and follow aggregate demand *up to* the resource capacity constraint of the economy. In this process there is no inflation. But if aggregate demand *continues* to rise, real GDP cannot follow, it will stop rising, and we will only get inflation.

When we hit the capacity constraint of the economy, rising GDP suddenly stops and inflation begins.

(Of course, it is never such a quick sharp turn. We can have periods of both rising GDP *and* inflation. Rather starting low, GDP will rise without inflation until we begin *approaching* the constraint, then inflation begins rising slowly as GDP starts slowing down, until we push beyond the constraint and GDP slows down to a near halt and inflation accelerates. )

## Aggregate Demand vs. Economic Growth

What determines the resource constraint? Well, the amount of resources out there - labor, land, capital and technology. In our "Economic Growth" section, we discussed how the total supply of these things in an economy change slowly over time - people are born, ovens are built, new technologies invented, etc.

This is how we reconcile our Aggregate Demand theory with our Economic Growth discussion.

Economic growth determines the capacity constraint, the GDP how much the economy *can* produce, the *potential* GDP. But the *actual* GDP, how much the economy actually *does* produce, depends on Aggregate Demand.

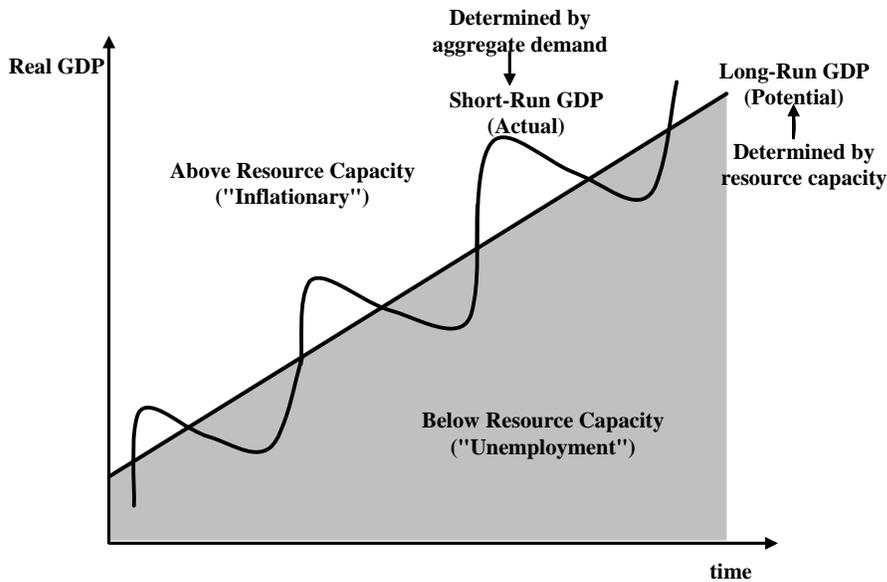
At any point in time, actual GDP may be above or below the capacity constraint, the potential GDP. If it is below the capacity constraint, we have **unemployment**. That is, resources (labor, land, etc.) are available, but firms are not using them - aggregate demand isn't there. But if aggregate demand pushes (or tries to push) actual GDP above the capacity constraint, then we have **inflation**.

## Business Cycle

The capacity constraint itself changes, of course. Through growth of resources, technological change, productivity improvements etc. But it changes only slowly (and rather steadily) over time. By contrast, aggregate demand is a flightier animal and changes relatively quickly.

So the actual GDP in the economy - or what we can call the *short-run* GDP, the GDP determined by the aggregate demand - tends to fluctuate around the resource capacity constraint (what we can call the *long-run* GDP). Sometimes actual GDP is above capacity - and we have inflationary situation. Sometimes it is below capacity - and we have an unemployment situation.

The relationship between short-run and long-run GDP over time can be illustrated in the following diagram:



Notice that potential (long run) GDP (resource capacity constraint) increases slowly & steadily over time, while actual (short-run) GDP moves around a lot. At times it is above it (inflationary) at times it below it (unemployment).

We already know what determines Long-Run GDP - population growth, capital-labor ratios, technological change, productivity, etc.

We also know what determines Short-Run GDP - aggregate demand (consumer confidence, taxes, monetary policy, etc.)

Notice that the long-run GDP forms a kind of "center" or "trend" around which the short-run GDP fluctuates. The fluctuations of the short-run GDP around this trend is known as the **business cycle**. We'll turn to that next.