ECO402: Intermediate Macroeconomics

The Goods Market

Chapter 3

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Questions:

1. When you earn an additional dollar of income in general terms what can you do with it?
2. Suppose you save a little and consume a little, what does the part you spend become?
3. What will the person(s) whose income it becomes do with it?
4. What happens to the size of the increase in income as this repeats?
5. Instead of you spending money, suppose the government does. Does this same process happen?

1 The Composition of GDP

We have spent a lot of time talking about ways to measure GDP and fluctuations in GDP. However we need to define what makes up GDP:

- **Consumption (C):** Represents goods and services purchased by consumers such as calzones, board games, new cars etc. Consumption accounted for about 68.1% of GDP in 2015.
- **Investment (I):** Also referred to as fixed investment (as opposed to inventory investment). This includes the when firms purchase new plants and equipment (nonresidential investment) as well as people's purchases

of new houses or apartments (residential investment). Investment accounted for about 16.9% of GDP in 2015.

- **Government Spending (G):** This includes goods and services purchased by the federal, state, and local governments. Goods can range from airplanes to office equipment, while services are the services provided by government employees. This does not include government transfer programs like Medicare or Social Security, nor payments on government debt. Government spending accounted for about 17.8% of GDP in 2015.

- **Net Exports (NX):** It is the difference between exports, **X**, and imports **IM**. This is also referred to as the trade balance. In 2013 the US trade balance was equal to -2.9% of GDP.

- Also included in GDP is **inventory investment**. If production exceeds sales then firms accumulate inventories and the inventory investment is positive. If sales are higher than production then firms sell off inventories and inventory investment is negative. Intuitively we add it when firms acquire inventory because we want GDP to measure production. We subtract inventory that is sold because they were produced at a different time. In 2015 inventory investment was positive and accounted for .5% of GDP.

2 The Demand For Goods

We will be concerned with the total demand for goods and services which we will refer to as **Z**:

$$Z \equiv C + I + G + X - IM$$

The above equation is an identity, it says that the total demand for goods and services must be equal to what we spend on goods and services. To move forward we need to make some assumptions:

- Assume that there is one homogenous good that firms produce. It can be used by consumers for consumption, by firms for investment, or by the government.

  Discussion: Can you think of any final goods that could fall into consumption, investment, and government spending?

- Assume that firms are willing to supply any amount of the good at a given price level P. This is only a short run assumption.

- We will assume that the residents of this abstract economy prefer to buy local, so the economy is closed, that is shut down imports and exports. This assumption is unrealistic but it makes our analysis easier for now.

2.1 Consumption (C)

Discussion: What factors are important to you when making consumption decisions?

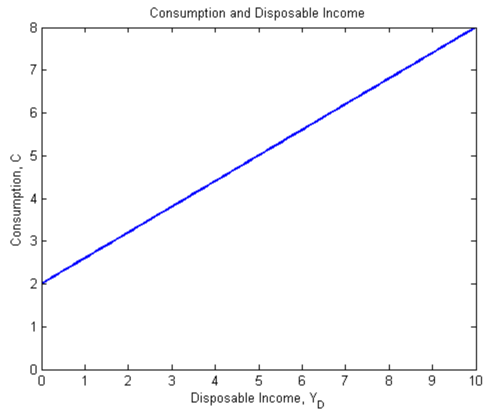
One of the main determinants of consumption is **disposable income** - ie after tax income. We will denote it as $Y_D = Y - T$ where Y and T are income and taxes. Taxes include transfer programs such as social security which are treated as a negative tax. We next will assume that consumption is a **function** of disposable income. Read up in Appendix 2 of the book for more information on functions if you are unfamiliar.

$$C = C(Y_D)$$

$$(+)$$

$$C = c_0 + c_1 Y_D$$

We will assume a simple linear form for the consumption function. The first term c_0 can be interpreted as a subsistence level consumption, or what consumers would consume with no income. The second term c_1 is the **marginal propensity to consume**. It shows how much consumption increases for an increase in disposable income. It is between 0 and 1.



Finally Consumption need not be only a function of Y_D, we could also have consumption be a function of past, current or expected values of the price level, inflation, and or interest rates.

2.2 Investment (I)

For right now we will assume that investment is **exogenous**, that is it does not depend on other variables in the model (unlike consumption, which was **endogenous**). This assumption will be relaxed in the future.

$$I = \bar{I}$$

2.3 Government Spending (G)

We will assume government spending as well as taxes are exogenous. We treat these as exogenous because governments do not behave as predictably as consumers, and additionally one of our main interests is what a change in government policy does to the rest of the economy. In the future we will allow for taxes to depend upon the level of income.

3 The Determination of Equilibrium Output

Equilibrium in the goods market requires that production, **Y**, and demand for goods, **Z**, are equal.

Discussion: Notice that we refer to both production and income as **Y**. Why is that?

Using the equilibrium condition and substituting in for the consumption function we get:

$$Y = c_0 + c_1(Y - T) + \bar{I} + G$$

The text book solves models in three ways:

1. Algebraically, this is to ensure that logically our solutions make sense.
2. Graphically to help build intuition.
3. Explaining the results with words.

3.1 Algebraically

First we will distribute c_1 through the parentheses:

$$Y = c_0 + c_1Y - c_1T + \bar{I} + G$$

Next we will move $c_1 Y$ to the left-hand side and reorganize the right hand side:

$$(1 - c_1)Y = c_0 + \bar{I} + G - c_1 T$$

Finally we divide both sides by $1 - c_1$:

$$Y = \frac{1}{1 - c_1}[c_0 + \bar{I} + G - c_1 T]$$

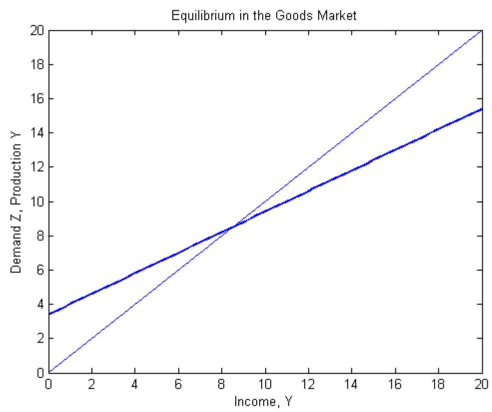
The term $[c_0 + \bar{I} + G - c_1 T]$ is called **autonomous spending**, because it does not depend on output. The term $1/(1 - c_1)$ must be greater than 1 because c_1 is between 0 and 1. This term is often called a multiplier because it amplifies the effects of changes in autonomous spending.

What causes Y to increase more, increasing G by \$1 or decreasing T by \$1?

One way to answer this would be simply assume $G = 1$ and all other autonomous spending were equal to zero. This gives us back the multiplier from above $1/(1 - c_1)$ on the other hand if we set $T = -1$ and all other values equal to zero and in that case $Y = c_1/(1 - c_1)$which is less than GDP with \$1 of government spending.

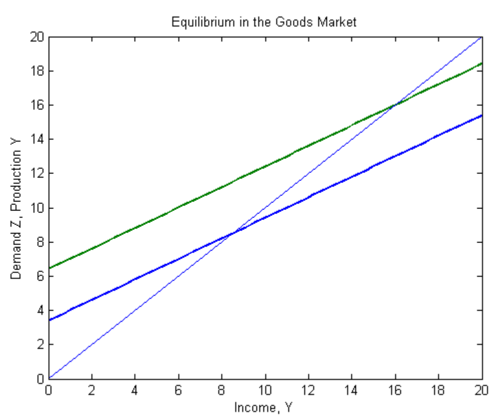
Finally what if we wanted to maintain a balanced budget so we increased G by \$1 and increased T by \$1. In this case we do almost the same as we did above, set $G = 1$ and $T = 1$ now and all other autonomous spending equal to zero. This results in a change in GDP of exactly 1. The balanced budget multiplier is equal to 1.

3.2 Graphically:



In the above figure the 45 degree line represents production i.e. $Y = Y$ and the thicker blue line represents demand. The equilibrium is where both lines intersect. The slope of the demand line is c_1. The intercept of the demand line represents autonomous spending.

Now suppose that c_0 increases by \$3 billion:



When autonomous spending increases production immediately responds. On the graph above this means moving from the initial equilibrium point vertically until it reaches the new green line. Income also equals production so we must move then horizontally to the 45 degree line. But this is an increase in income so production must also increase and so on and so forth.

Initially the increase in demand leads to an equal increase in production of \$3 billion, which then leads to an equal increase in income. But this increase in income leads to a $c_1 \times$\$3 billion increase in demand, which leads to the same increase in production. This repeats infinitely as \$3 billion times:

$$1 + c_1 + c_1^2 + \cdots + c_1^n + \ldots$$
$$\sum_{i=0}^{\infty} c_1^i$$

This sum is called a geometric series and it simplifies to $1/(1 - c_1)$, so in equilibrium a \$3 billion increase in autonomous consumption leads to a \$3 billion times $1/(1 - c_1)$ increase in equilibrium output. This gives us a more intuitive way of thinking about the multiplier.

3.3 Words

Production depends on demand, and demand depends on income, which must be equal to production. An increase in demand leads to an increase in production and correspondingly an increase in income which itself leads to a somewhat smaller increase in demand, which leads to an increase in production and income. This process keeps repeating until the increase in income is indistinguishable from zero. This leads to a cumulative change in output more than the initial change in autonomous spending.

3.4 The Goods Market: The Shock Absorber Version

What if we relaxed the assumptions about investment and taxes being exogenous? It is a sensible assumption that investment depends on the level of output, think back to intermediate micro, for a fixed level of investment the production function has decreasing returns to scale in labor, so to more efficiently keep up with production firms need to invest. As for why taxes depend on the level of output, governments may want to enact what are called automatic stabilizers, which reduce the effects of negative shocks to output (by reducing the tax burden). As a result of these changes the model becomes:

$$
\begin{aligned}
C &= c_0 + c_1(Y - T) \\
T &= t_0 + t_1 Y \\
I &= i_0 + i_1 Y \\
G &= G
\end{aligned}
$$

G remains exogenous, but now I and T are endogenously determined.

There are still fixed levels of taxes and investment, t_0 and i_0, think of these as the level of taxes the government needs to pay for providing the bare minimum level of services and the level of investment needed to keep the economy running respectively. t_1 is the tax rate that is levied upon each dollar of income, and i_1 is the propensity to invest for each additional dollar in output. Recall that in equilibrium the demand for goods equals output $Z = Y$, and we get:

$$Y = c_0 + c_1((1 - t_1)Y - t_0) + i_0 + i_1 Y + G$$

To solve the model collect the constants together and collect the terms that multiply Y together:

$$Y = [c_0 - c_1 t_0 + i_0 + G] + [c_1(1 - t_1) + i_1]Y$$

Then subtract the $[c_1(1 - t_1) + i_1]Y$ to the left hand side of the equation:

$$[1 - c_1(1 - t_1) - i_1]Y = [c_0 - c_1 t_0 + i_0 + G]$$

Finally divide the term multiplying Y on both sides and get:

$$Y = \frac{1}{1 - c_1(1 - t_1) - i_1}[c_0 - c_1 t_0 + i_0 + G]$$

Some things to pay attention to:

- The first term on the right hand side is the multiplier for this expanded model. It is messier than the simple model but it still does the same thing: amplifies changes in autonomous spending. We will assume that $c_1(1 - t_1) + i_1 < 1$ to ensure that the multiplier is positive and defined.

- The second term on the right hand side is still called autonomous spending. It is very similar to the one in our simpler model, but now t_0 takes the place of T and i_0 takes the place of $\bar{I}$.

- Look at the multiplier, what is the effect of increasing i_1 on the denominator? What does that mean for the size of the multiplier?

- If you multiply through the $-c_1$ in the denominator you see that the sign on $c_1 t_1$ becomes positive. The effect of increasing t_1 is that it makes the denominator larger, which decreases the size of the multiplier. That total tax burden T increases when Y increases and falls when Y falls. This gives it the property of being an **automatic stabilizer** because it will fall in recessions and rise in expansions, which will dampen the fluctuations in GDP. When there is a negative shock to autonomous spending it tempers the amplification of that shock.

3.5 Estimating The MPC

You might ask how we would measure the Marginal Propensity to Consume in practice. One way would be to plot changes in consumption versus changes in disposable income. First let us define the variables:

$$\Delta C_t = C_t - C_{t-1}$$

$$\Delta Y_{Dt} = Y_{Dt} - Y_{Dt-1}$$

There is clearly a positive relationship between changes in disposable income and changes in consumption. But with econometrics we can state this relationship more precisely. Using the method of ordinary least squares we can estimate the correlation between consumption and disposable income and use that as a proxy for the marginal propensity to consume.

$$\Delta C_t = \alpha + \beta \Delta Y_{Dt} + \epsilon_t$$

Here β can be interpreted as the MPC.

Discussion: Are there any issues you could see with the above equation? Are there any other specifications that you think might capture the MPC better? Are there any natural experiments that you think we could exploit to possibly get a better measure?

Changes in Consumption vs Changes in Disposable Income (1960-2016)

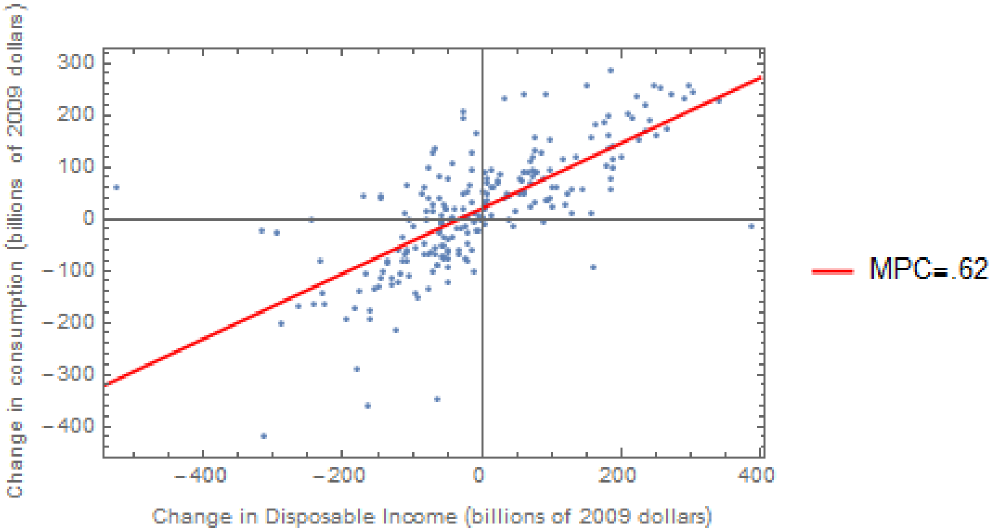


Figure 1: Scatter plot of changes in disposable income on the horizontal axis and changes in consumption on the vertical axis. The red line represents the least squares regression. Source: Federal Reserve Economic Data

4 Dynamics of the Goods Market Equilibrium

Under the assumptions we've made so far output adjusts to equal demand instantly at any point in time. However it may take time to scale up or down production. We must think about what the dynamics of adjustment are:

- Firms make their production decisions quarterly and cannot revise them until the next quarter. During this time if purchases are higher than production firms draw down their inventories to satisfy demand. On the other hand if purchases are lower then firms acquire inventories.
- If consumers decide to spend more demand increases but production is fixed at the beginning of the quarter so it can't change. Therefore income is unchanged.

- Taking the increased demand for their products as a signal firms increase production in the following quarter. The increase in production leads to a corresponding increase in income and a further increase in demand. If purchases still exceed production firms will continue to increase production in the following quarter.

5 Investment Equals Savings

The model we've been studying can also be presented in a different but equivalent way.

Private Savings: Disposable income minus consumption.

Public Savings: Taxes less Government Spending

$$S = Y_D - C$$

$$S = Y - T - C$$

Now if we return to the equilibrium in the goods market equation:

$$Y = C + I + G$$

$$Y - T - C = I + G - T$$

$$S = I + G - T$$

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

Investment equals the sum of public savings and private savings.

We can solve the model in a different path.

$$\begin{aligned} S &= Y - T - C \\ &= Y - T - c_0 - c_1(Y - T) \\ &= -c_0 + (1 - c_1)(Y - T) \end{aligned}$$

Some intuition is built from this. First obviously increases in c_0 lead to decreases in saving. Also as c_1 is the propensity to consume we can say that $(1 - c_1)$ represents the propensity to save. In equilibrium Investment equals savings so:

$$I = -c_0 + (1 - c_1)(Y - T) + (T - G)$$

$$Y = \frac{1}{1 - c_0}[c_0 + I + G - c_1 T]$$

5.1 The Paradox of Savings

Suppose that consumers decide to save more by lowering c_0. What happens? If we look at our equilibrium conditions output unequivocally decreases. But what about savings?

$$S = -c_0 + (1 - c_1)(Y - T)$$

While a decrease in c_0 increases savings for any given value of income, it also leads to a decrease in output so from this equation the result is ambiguous, but if we return to the equilibrium condition we can determine what the net effect is.

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

By assumption $I = \bar{I}$ so savings must be unchanged. As a result an attempt to save more decreases output and leads to savings being unchanged. This is called the paradox of savings(or thrift).

Discussion: This simplified model suggests that the government might want to try to disincentive saving, but why might this not be a good idea?

6 Further Readings (And Listenings)

Blanchard and Johnson Chapter 3 and Appendix 2 & 3

A Goods Market Model Variants

This is a review of what the equilibriums look like for the three types of models we covered in class, as well as how to quickly compute changes in the equilibrium due to shifts in values of autonomous spending.

A.1 The Simple Case: Only Consumption Depends on Income

$$C = c_0 + c_1(Y - T)$$

$$T = \bar{T}$$

$$I = \bar{I}$$

$$G = \bar{G}$$

You will not be expected to memorize these equations. In the equation for consumption c_0 is like the "intercept" and c_1 is like the "slope". For example it might be $C = 200 + .6(Y - T)$. Then $c_0 = 200$ and $c_1 = .6$. The equilibrium in this model is given by:

$$Y = \frac{1}{1 - c_1}(c_0 - c_1 T + \bar{I} + \bar{G})$$

You do not need to memorize the equilibrium, in fact I prefer it if you don't. What I would like you to know is how to solve for it by setting the demand for goods equal to output. If you see a question asking you to calculate new equilibrium values for one of these there are two ways to proceed. The first way is to solve the problem through completely. The other way is to remember that:

$$\Delta Y = \frac{1}{1 - c_1}(\Delta c_0 - c_1 \Delta T + \Delta I + \Delta G)$$

The Δ represents the change in the variable. When something changes in the model calculate the change first. For instance if I said that government spending changed from 200 to 250, $\Delta G = 50$. Now, if only government spending changed, then all the other changes must be equal to zero, so the above equation simplifies to:

$$\Delta Y = \frac{1}{1 - c_1}\Delta G$$

Then to calculate the new equilibrium values you can get $Y_{new} = Y_{old} + \Delta Y$.

A.2 The Somewhat Less Simple Case: Consumption and Investment Depend on Income

$$C = c_0 + c_1(Y - T)$$

$$T = \bar{T}$$

$$I = i_0 + i_1 Y$$

$$G = \bar{G}$$

As above you will not be expected to memorize these. In the equation for investment now i_0 is like the "intercept" and i_1 is like the "slope". For example $I = 150 + .1 * Y$, then $i_0 = 150$ and $i_1 = .1$. Solving for equilibrium, it is similar to before with a few changes:

$$Y = \frac{1}{1 - c_1 - i_1}(c_0 - c_1 T + i_0 + \bar{G})$$

Now let's change things up a bit. Suppose I ask you to solve for the new equilibrium but with a change in taxes. The equation for the change in Y is given now by:

$$\Delta Y = \frac{1}{1 - c_1 - i_1}(\Delta c_0 - c_1 \Delta T + \Delta i_0 + \Delta G)$$

Taxes are the only thing that have changed say from 100 to 90. So all the other changes are zero and taxes have decreased by 10 so $\Delta T = -10$. Notice though that the change in taxes are multiplied in the equation above by $-c_1$, then:

$$\Delta Y = \frac{-c_1}{1 - c_1 - i_1} \Delta T$$

And again calculate the new equilibrium values with $Y_{new} = Y_{old} + \Delta Y$.

A.3 The Least Simple Case: In Which Consumption, Investment, and Taxes all depend on Income

$$C = c_0 + c_1(Y - T)$$
$$T = t_0 + t_1 Y$$
$$I = i_0 + i_1 Y$$
$$G = \bar{G}$$

As above you will not be expected to memorize these. In the equation for taxes now t_0 is like the "intercept" and t_1 is like the "slope". For example $T = 90 + .1 * Y$, then $t_0 = 90$ and $t_1 = .1$. Solving for equilibrium, it is similar to before with a few changes:

$$Y = \frac{1}{1 - c_1(1 - t_1) - i_1}(c_0 - c_1 t_0 + i_0 + \bar{G})$$

Now let's change things up a bit. Suppose I ask you to solve for the new equilibrium but with a change in i_0. The equation for the change in Y is given now by:

$$\Delta Y = \frac{1}{1 - c_1(1 - t_1) - i_1}(\Delta c_0 - c_1 \Delta t_0 + \Delta i_0 + \Delta G)$$

Autonomous Investment is the only thing that has changed say from 150 to 110. So all the other changes are zero and taxes have decreased by 10 so $\Delta i_0 = -40$.

$$\Delta Y = \frac{1}{1 - c_1(1 - t_1) - i_1}\Delta i_0$$

And again calculate the new equilibrium values with $Y_{new} = Y_{old} + \Delta Y$.