Lecture 2 - Recommended Exercises Solutions

☆☆☆ Problem 5, Chapter 3

In this chapter, we have assumed that the fiscal policy variables G and T are independent of the level of income. In the real world, however, that is not the case. Taxes typically depend on the level of income and so tend to be higher when income is higher. In this problem, we examine how this automatic response of taxes can help reduce the impact of changes in autonomous spending on output.

Consider the following behavioral equations:

$$\begin{aligned} C &= c_0 + c_1 Y_D \\ T &= t_0 + t_1 Y \\ Y_D &= Y - T \end{aligned}$$

G and I are both constant. Assume that t_1 is between 0 and 1.

a. **Solve for the equilibrium output.**
We have:

$$\begin{aligned} C &= c_0 + c_1 Y_D \\ &= c_0 + c_1 (Y - t_0 - t_1 Y) \\ C &= c_0 + c_1 (1 - t_1) Y - c_1 t_0. \end{aligned}$$

The term in front of Y is slightly different than the model shown in the textbook – it now is $c_1(1-t_1)Y$ instead of just $c_1 Y$. However, the next algebra steps are the same as what we did in the original model:

$$\begin{aligned} Y = Z &= C + I + G \\ Y &= c_0 + c_1 (1 - t_1) Y - c_1 t_0 + \bar{I} + G \\ [1 - c_1 (1 - t_1)] Y &= c_0 - c_1 t_0 + \bar{I} + G \end{aligned}$$

Finally:

$$\boxed{Y_{equil} = \underbrace{\left(\frac{1}{1 - c_1 (1 - t_1)} \right)}_{\text{Multiplier}} \times \underbrace{\left(c_0 - c_1 t_0 + \bar{I} + G \right)}_{\text{Autonomous Spending}}}$$

b. **What is the multiplier? Does the economy respond more to changes in autonomous spending when t_1 is 0 or when t_1 is positive? Explain.**
The new multiplier is $\frac{1}{1-c_1(1-t_1)}$. We have two cases:

- When $t_1 = 0$, the multiplier is given by $\frac{1}{1-c_1}$.
- In contrast, when $t_1 = 1$, the multiplier is equal to 1.

This observation is more general. We have that:

$$t_1' > t_1 \quad \Rightarrow \quad \frac{1}{1-c_1(1-t_1')} < \frac{1}{1-c_1(1-t_1)}.$$

In other words, a higher value for t_1 corresponds to a lower multiplier.

The intuition for this result is straightforward. If taxes increase when GDP increases, they go towards reducing aggregate demand at each new round of spending. Therefore, the multiplier is necessarily lower than when $t_1 = 0$. It is minimum, that is equal to 1, when $t_1 = 1$.

c. **Why is fiscal policy in this case called an automatic stabilizer?**
Fiscal policy is then called an automatic stabilizer because it is:

- a stabilizer... : it tends to stabilize GDP. When there are changes in autonomous spending, the multiplier effect is lower and so GDP is "smoother".
- ... that is automatic: the government need not pass new legislation in order to get this stabilizing effect of taxes on GDP. In particular, during a recession, taxes automatically go down, which acts to limit the fall in aggregate demand.

☆☆☆ Problem 6, Chapter 3

It is often argued that a balanced budget amendment would actually be destabilizing. To understand this argument, consider the economy in Q3-5.

a. **Solve for equilibrium output.**
Equilibrium output is the same as what we found in the previous problem 5, chapter 3:

$$Y_{equil} = \left(\frac{1}{1-c_1\left(1-t_1\right)}\right) \times \left(c_0 - c_1 t_0 + \bar{I} + G\right)$$

b. **Solve for taxes in equilibrium.**
Plugging in equilibrium output into the equation for taxes, we have:

$$\begin{aligned} T_{equil} &= t_0 + t_1 Y_{equil} \\ &= t_0 + \left(\frac{t_1}{1-c_1\left(1-t_1\right)}\right)\left(c_0 - c_1 t_0 + \bar{I} + G\right) \\ &= \frac{1-c_1}{1-c_1\left(1-t_1\right)} t_0 + \left(\frac{t_1}{1-c_1\left(1-t_1\right)}\right)\left(c_0 + \bar{I} + G\right) \end{aligned}$$

Suppose that the government starts with a balanced budget and that there is a drop in c_0.

c. **What happens to Y? What happens to taxes?**
Based on the equilibrium equations we derived above, we can see that both Y and T will fall when c_0 declines. To be precise, for a \$1 decline in c_0 output will decline by $\frac{1}{1-c_1(1-t_1)}$ and taxes will decline by $\frac{t_1}{1-c_1(1-t_1)}$.

d. **Suppose that the government cuts spending in order to keep the budget balanced. What will be the effect on Y? Does the cut in spending required to balance the budget counteract or reinforce the effect of the drop in c_0 on output? (Don't do the algebra. Use your intuition and give the answer in words.)**
In part (c), we saw the effect of c_0 on output after allowing for the "normal" multiplier effect along with the dampening effect from the automatic stabilizers in the tax and transfer system. Since we already saw that taxes fell, we know that in order for the budget to remain balanced we need G to fall (recall that maintaining the budget balance means $\Delta G = \Delta T$). The decline in G will further reduce the level of output (and taxes), leaving the economy in an even lower equilibrium than it would have been without the balanced budget rule.

☆☆☆ Problem 7, Chapter 3

Recall that we define taxes, T, as net of transfers. In other words,

$$T = \textbf{Taxes} - \textbf{Transfer Payments}$$

a. **Suppose that the government increases transfer payments to private households, but these transfer payments are not financed by tax increases. Instead, the government borrows to pay for the transfer payments. Show in a diagram (similar to Figure 3-2) how this policy affects equilibrium output. Explain.**
In the standard goods-market diagram, this would be depicted as an upward shift of the aggregate demand line. This upward shift in the aggregate demand line corresponds to a movement up and to the right along the 45 degree line ($Z = Y$), with the new equilibrium level of output higher than it was previously.

b. **Suppose instead that the government pays for the increase in transfer payments with an equivalent increase in taxes. How does the increase in transfer payments affect equilibrium output in this case?**
Since T = Taxes − Transfer Payments, if the change in transfer payments equals the change in taxes then there is no change in T. Since there is no change in T, our basic model suggests that there is no effect on aggregate consumption or aggregate output. All we've done is change how much individual people are consuming, but the total amounts are unaffected.

c. **Now suppose that the population includes two kinds of people: those with high propensity to consume and those with low propensity to consume. Suppose the transfer policy increases taxes on those with low propensity to consume to pay for transfer to people with high propensity to consume. How**

does this policy affect equilibrium output?
When we transfer \$1 of spending from a low MPC person (with c_1^L) to a high MPC person (with $c_1^H > c_1^H$), the immediate effect is that we increase consumption by $c_1^H - c_1^L > 0$. In addition, this initial increase in output is then magnified by the typical multiplier effect. In equilibrium, output increases under this transfer policy.

d. **How do you think the propensity to consume might vary across individuals according to income? In other words, how do you think the propensity to consume compares for people with high income and people with low income? Explain. Given your answer, do you think tax cuts will be more effective at stimulating output when they are directed toward high-income or toward low-income taxpayers?**
The baseline expectation would be that low income households are more likely to spend a large fraction of any new income on additional consumption. High income households would tend to spend some of their additional income, but would save a large fraction. Thus, we would expect that a change in tax and transfer policy that favored high income households would have a smaller effect on aggregate output.

☆☆ Problem 4, Chapter 3

The balanced budget multiplier.
For both political and macroeconomic reasons, governments are often reluctant to run budget deficits. Here, we examine whether policy changes in G and T that maintain a balanced budget are macroeconomically neutral. Put another way, we examine whether it is possible to affect output through changes in G and T so that the government budget remains balanced. Start from equation (3.8).

a. **By how much does Y increase when G increase by one unit?**
In the textbook, we found the following equation for equilibrium output:

$$Y_{equil} = \frac{1}{1 - c_1}\left(c_0 - c_1 T + I + G\right)$$

From this equation, it should be clear that if we change G by some amount ΔG then the change in output will be $\Delta Y = \frac{\Delta G}{1-c_1}$. In other words, the output multiplier for \$1 of direct government spending is $\frac{1}{1-c_1}$.

b. **By how much does Y decrease when T increases by one unit?**
Using the same equation above, a decrease in net taxes leads to a change in output of $\Delta Y = \frac{c_1(-\Delta T)}{1-c_1}$. In other words, the output multiplier for \$1 of transfer income (or for a \$1 decrease in taxes) is $\frac{c_1}{1-c_1}$.

c. **Why are your answers to parts a and b different?**
This is because with **direct government spending**, in the "first round" \$1 of spending raises output by \$1, since government spending is a direct component of total demand. With an increase in **transfers** (decrease in taxes) however, in the "first round" only c_1 dollars are spent because households only increase spending by a fraction c_1 of the transfer. This is because transfers are not a direct component of total demand: transfers

enter into demand only through consumption.

Suppose that the economy starts with a balanced budget $G = T$. If the increase in G is equal to the increase in T, then the budget remains in balance. Let us now compute the balanced budget multiplier.

d. **Suppose that G and T increase by one unit each. Using your answers to parts a and b, what is the change in equilibrium GDP? Are balanced budget changes in G and T macroeconomically neutral?**
Assuming that $\Delta T = \Delta G = 1$:

$$\begin{aligned}\Delta Y_{equil} &= \frac{1}{1-c_1}\left(-c_1 \Delta T + \Delta G\right) \\ &= \frac{1}{1-c_1}\left(-c_1 + 1\right) \\ \Delta Y_{equil} &= 1\end{aligned}$$

This tells us that the output multiplier for a balanced-budget increase in spending is 1. A balanced-budget increase in government spending is not macroeconomically neutral.

e. **How does the specific value of the propensity to consume affect your answer to part a? Why?**
The value of c_1 does not affect the balanced-budget multiplier. As we saw above, the c_1 terms cancel out. The intuition for why this is the case is quite straightforward. The reason is that the first round of government spending generates an increase in aggregate demand of exactly one. The second round of government spending generates an increase of demand equal to c_1, while the third round generates an increase of demand equal to c_1^2, etc.
Because of the balanced budget requirement, the first round of tax increases is equal to 1 also and generates a decrease in demand of $-c_1$ (it is mediated by the marginal propensity to consume). The second round has an decrease in demand of $-c_1^2$, etc. Finally, the total effect is:

$$\underbrace{\left(1 + c_1 + c_1^2 + c_1^3 + ...\right)}_{\text{Effects of government spending}} - \underbrace{\left(c_1 + c_1^2 + c_1^3 + ...\right)}_{\text{Effects of taxes}} = 1$$

which does not depend on c_1: the second round of government spending cancels out with the first round of tax increases, the third round of government spending cancels out with the second round of tax increases, etc.

☆☆ Problem 8, Chapter 3

This problem examines the implications of allowing investment to depend on output. Chapter 5 carries this analysis much further and introduces an essential relation—the effect of the interest rate on investment—not examined in this problem.

a. **Suppose the economy is characterized by the following behavioral equations:**

$$C = c_0 + c_1 Y_D$$
$$Y_D = Y - T$$
$$I = b_0 + b_1 Y$$

Government spending and taxes are constant. Note that investment now increases with output. (Chapter 5 discusses the reasons for this relation.) Solve for equilibrium output.

In addition to the behavioral equations listed above, we still have the aggregate demand identity (defining Z) and the market clearing condition ($Z = Y$). Putting these elements together, we have:

$$Y = Z$$
$$Y = C + I + G$$
$$Y = c_0 + c_1 Y - c_1 T + b_0 + b_1 Y + G$$

and solving for the equilibrium level of output, we have:

$$\boxed{Y_{equil} = \underbrace{\left(\frac{1}{1-(c_1+b_1)}\right)}_{\text{Multiplier}} \times \underbrace{(c_0 - c_1 T + b_0 + G)}_{\text{Autonomous Spending}}}$$

b. **What is the value of the multiplier? How does the relation between investment and output affect the value of the multiplier? For the multiplier to be positive, what condition must $(c_1 + b_1)$ satisfy? Explain your answers.**

As we already noted in the equilibrium result above, the multiplier in this modified model will be $\frac{1}{1-(c_1+b_1)}$. This expression is similar to what we had in the model from the textbook, except now we have two behavioral parameters (c_1 and b_1) instead of only one parameter. The value of the multiplier is increased whenever $b_1 > 0$. We need to have $c_1 + b_1 < 1$, or that multiplier would seem to be negative. (but not really, see the next question)

c. **What would happen if $(c_1 + b_1) > 1$? (Trick question! Think about what happens in each round of spending.)**

The fact that $(c_1 + b_1) > 1$ gives the nonsensical result of a negative level of output is tied to the fact that a geometric sum only converges if the base in the sum has an absolute value less than 1. If $(c_1 + b_1) > 1$, then in each round of spending we add even more output than we did in the previous round, and the total additions to output explode to an impossibly high level. Indeed, imagine that we have an increase in autonomous spending of 1 dollar. Then the first round increase in spending would be one dollar, the second round would lead to $c_1 + b_1$ units of output, the third round to $(c_1 + b_1)^2$, with a sum given by:

$$1 + (c_1 + b_1) + (c_1 + b_1)^2 + ... = \frac{1}{1-(c_1+b_1)}$$

only if $c_1 + b_1 < 1$. If instead $c_1 + b_1 > 1$, then the above geometric sum is infinite (note that if you add infinitely many ones, it is already infinite! so a fortiori, it is infinite if you add infinitely a number higher than 1).

d. **Suppose that the parameter b_0, sometimes called *business confidence*, increases. How will equilibrium output be affected? Will investment change by more or less than the change in b_0? Why? What will happen to national saving?**
We already solved for equilibrium output, where it was clear that when b_0 increases by Δb_0 we would see a change in output of $\frac{\Delta b_0}{1-(c_1+b_1)}$. Investment will change by more than the change in b_0, because output will also increase, and thus investment will increase. In addition, we know from our accounting identity that total saving equals total investment, which also means that the change in saving will equal the change in investment. Thus, savings will increase by more than the change in b_0.

☆☆ Problem 9, Chapter 3

You should be able to complete this question without doing any algebra, although you may find making a diagram helpful for part a. For this problem, you do not need to calculate the magnitudes of changes in economic variables—only the direction of change.

a. **Consider the economy described in Problem 8 (Q3-8 above). Suppose that consumers decide to consume less (and therefore to save more) for any given amount of disposable income. Specifically, assume that consumer confidence (c_0) falls. What will happen to output?**
The direct effect of a decline in c_0 is that households reduce their consumption. Given that output equals total demand, this directly leads to a decline in output. In addition, the direct effect is compounded by the fact that when demand falls, households and businesses react by reducing consumption and investment. The total effect is a fall in output that is larger than the initial fall in c_0, as reflected in the multiplier, which compounds both c_1 and b_1.

b. **As a result of the effect on output you determined in part a, what will happen to investment? What will happen to public saving? What will happen to private saving? Explain. (*Hint*: Consider the savings-equals-investment characterization of equilibrium.) What is the effect on consumption?**
Investment will clearly fall. Because public saving is $S_{pub} = T - G$, public saving will be constant. Therefore, and because investment equals public saving plus private saving, then it must be that private saving falls. Consumption also falls, as we said in question a. How can consumption and private savings fall at the same time? Well, that is because output falls.

c. **Suppose that consumers had decided to increase consumption expenditure, so that c_0 had increased. What would have been the effect on output, investment, and private saving in this case? Explain. What would have been the effect on consumption?**
In this case, the mechanism from part (b) operates in reverse. When c_0 increases, this leads to both a direct effect on consumption, and by raising output also has second-round effects further increasing consumption. In addition, since we now allow investment increases when output increases, this adds another channel to further boost output in

response to the improvement in consumer confidence. As before, the change in investment is mirrored by a change in private savings. The overall effect is an increase in output that is larger than the increase in consumption, which squares with the observation that private savings increases as well. Both consumption and private savings increase, because output is higher.

d. **Comment on the following logic: "When output is too low, what is needed is an increase in demand for goods and services. Investment is one component of demand, and saving equals investment. Therefore, if the government could just convince households to attempt to save more, then investment, and output, would increase."**
The problem is that this logic assumes that output is fixed, which is a mistake. When the government convinces households to save more, this may in fact reduce output, which in turn reduces saving. Efforts at saving are then self-defeating. If on top of that, investment depends on output, then investment will in fact fall, and saving overall might decrease. This is the paradox of thrift.
An example might help: suppose that you decide to save more and eat out less. Then you may put your local restaurant in trouble, who will need to fire workers, who will therefore save less. Overall, saving may decrease – it is the same for investment, if restaurants' investment in a new kitchen depends on rising customer demand.
If you are still confused, know that uncovering the fallacy about the above logic is what made John Maynard Keynes famous in the 1930s. But the facts proved him right, and showed that the above logic was wrong indeed.

☆ Problem 10, Chapter 3

Using fiscal policy in this first (and simplest) model to avoid the recession of 2009: GDP in 2009 was roughly $15,000 billion. You learned in Chapter 1 that GDP fell by approximately 3 percentage points in 2009.

a. **How any billion dollars is 3 percentage points of $15,000 billion?**
This is quite straightforward:

$$0.03 * 15000 = 3 * 150 = 450$$

Thus, 3% of $15,000 billion is $450 billion.

b. **If the propensity to consume was 0.5, by how much would government spending have to have increased to prevent a decrease in output?**
With a marginal propensity to consume of 0.5, the government spending multiplier is:

$$m_G = \frac{1}{1 - c_1} = \frac{1}{1 - 0.5} = \frac{1}{0.5} = 2$$

Thus, to generate $450 billion of additional output, we would need to increase government spending by $225 billion.

c. **If the propensity to consume were 0.5, by how much would taxes have to have been cut to prevent any decrease in output?**

Recall that we showed in Q3-4 (b) that the multiplier for a reduction in taxes is smaller than the multiplier for an increase in direct government spending. Specifically, The multiplier for a reduction in taxes is $c_1/(1 - c_1) = 1$. With a multiplier of 1, we would need \$450 billion in tax cuts to generate \$450 billion in additional output.

d. **Suppose that congress had chosen to both increase government spending and raise taxes by the same amount in 2009. What increase in government spending and taxes would have been required to prevent the decline in output in 2009?**
If there is both an increase in government spending and a raise in taxes by the same amount, then the above effect need to be substracted. Each additional dollar of government spending generates two dollars in output, and each additional dollar of taxes substracts one dollar to output, so the overall effect for each additional dollar of government spending and tax increases is one dollar. Therefore, we would have needed an increase in government spending of \$450 billion as well as an increase in taxes of \$450 billion to prevent the decline in output.