

## 14.02: Solutions Problem Set 2

### 1 Question 1

The answer on this question depends on whether you look at the variables from a mathematical or an economical point of view.

From a mathematical point of view, the economy is represented by a system of five equations with 5 unknowns (Y, C, I, G and T). The 5 unknowns are endogenous variables, as they are mathematically determined by the other variables (which are the exogenous variables).

From an economical point of view, however, only Y, C and T change if the parameters  $c_0$ ,  $c_1$ ,  $t_0$  and  $t_1$  are changed. I and G remain constant in the model (as long as the exogenous variables  $I_0$  and  $G_0$  are not changed). So from an economical point of view, Y, C and T are the endogenous variables.

b. Graphs will be handed out during recitation.

c. If  $t_1$  increases, the demand curve becomes flatter (with the same intercept). The economy moves to the new equilibrium as follows:

When the tax rate increases, consumers spend less out of every dollar of income, because disposable income  $Y-T$  decreases. Therefore sales go down (and inventories increase). Therefore, in the next period, firms will produce less. Therefore, total income will decrease. Consumers, facing a decrease in  $Y$ , will spend less. Therefore, sales go down. And so on, until the economy converges to a new equilibrium.

d. First we substitute equations 2 till 5 in equation 1:

$$Y = c_0 - c_1 t_0 + I_0 + G_0 + c_1(1 - t_1)Y$$

Rearranging gives then the expression for equilibrium Y:

$$Y = \frac{1}{a - c_1(1 - t_1)}(c_0 - c_1 t_0 + I_0 + G_0)$$

Substituting this in equation 5 gives the expression for equilibrium T:

$$T = t_0 + t_1 \frac{1}{1 - c_1(a - t_1)}$$

Using equilibrium Y and T, and substituting in equation 2 gives the expression for equilibrium C:

$$C = c_0 - c_1 t_0 + c_1(1 - t_1) \frac{1}{1 - c_1(1 - t_1)}(c_0 - c_1 t_0 + I_0 + G_0)$$

e. We know from PS1 that  $Y$  is 6374 billion dollar,  $C$  is 4390 billion dollar,  $I$  is 875.2 billion dollar.

We find from the Economic Report that  $T$  is 681.6 billion dollar.

We the find:

$$c_1 = \frac{C - c_0}{Y - T} = 0.33$$
$$t_1 = \frac{T - t_0}{Y} = \frac{T}{Y} = 0.11$$

f. From the expression for equilibrium output which we derived in (d), we find:

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

For  $\Delta G = 1$  billion, and  $c_1 = 0.33$  and  $t_1 = 0.11$ , we find that the increase in GDP,  $\Delta Y$ , is 1.42 billion dollar.

g. If tax  $T$  increases, disposable income  $Y - T$  decreases, and consumers will consume less. So  $C$  decreases. If the government reduces spending,  $G$  decreases. So both measures lead to a reduction in demand, and therefore in equilibrium to a reduction in output. So normally we would have expected a recession. The only reason why we did not experience a recession following the deficit reduction package is that growth of GDP was very strong (due to technological progress for instance, or a more efficient use of the existing capital stock). So even though the deficit reduction package had a negative effect on output, output was growing at such a strong rate anyway, that the negative effect of the deficit reduction package was more than offset by the fact that the economy was growing very strongly for other reasons.

## 2 Question 2

Let us first explain the argument of the Democrats and the argument of the Republicans more carefully.

The Democrats claim that a reduction in  $T$  will increase disposable income  $Y - T$ , and therefore will increase consumption  $C$ . This will increase total demand, which will push up total production. As total production increases, firms will want to invest more, so  $I$  increases. This increases total demand even more, which increases total production even more. So the economy will converge to a higher level of GDP.

The argument of the Republicans is as follows: if  $T$  decreases, the government will run a budget deficit. In this case, the government has to borrow money from the households in order to pay for its expenses. The money which the households lend to the government is part of their savings. So the part of households' savings which is lent to the private sector for investment will decrease. Therefore total demand decreases. Therefore total production decreases. In addition, less investment means that the capital stock will grow more slowly, which means that total production capacity will grow more slowly as well.

The argument of the Democrats is clear, and plausible.

The argument of the Republicans, however, is less clear, because they don't take into account how total savings of the households will change as a result of the increase in the government deficit. We will now explain this. If the government cuts taxes and runs a deficit, they will want to borrow more money from private households. So, for a given amount of investment in the private sector, and therefore for a given amount of money which the private sector wants to lend from the households in order to finance these investments, the total amount of money which the government and the firms together want to borrow from the households will increase. The question is then how the households will react. For the same level of taxation, they will probably react by saving more and consuming less. However, taxes go down, which would increase consumption. So the net effect on consumption is not clear: it can either go up or go down. If it goes up, total production will increase, which will increase investment. We then have the argument of the Democrats. If consumption goes down, however, total production will go down, and firms will want to invest less. This is what the Republicans claim will happen.

The argument of the Democrats is probably right: it is unlikely that the change in households' savings as a result of the decrease in taxes, will be so much that it offsets the positive effect of the tax cut on consumption (because of the increase in disposable income).

### 3 Question 3

a. There is no government and no foreign trade. So total demand is given by:

$$Y = C + I$$

Substituting the expressions for consumption and investment given in the question, and keeping in mind that in equilibrium  $Y_t = Y_{t-1} = Y_{t-2} = Y$ , leads to:

$$Y = c_0 + c_1 Y + d_0$$

Rearranging gives us the equilibrium expression for output:

$$Y = \frac{1}{1 - c_1}(c_0 + d_0)$$

Therefore, initially equilibrium output is  $(1/0.3)(2000 + 1000) = 10000$  billion dollar.

b. Following the wave of optimism,  $c_0$  will be higher with 100 billion dollar. Therefore equilibrium  $Y$  will be higher with  $(1/0.3)100 = 333.33$  billion dollar.

c. The table for output, consumption and investment:

Time	t	t+1	t+2	t+3	t+4	t+5
Output	10100	10190	10251	10288	10309	10320
Consumption	9100	9170	9233	9275	9302	9316
Investment	1000	1020	1018	1012	1007	1004

d. Graphs will be handed out during recitation.

e. Output smoothly converges to its new equilibrium level. The changes in output decrease as time goes on. Consumption lags the response of output by 1 period. Investment first increases (from period  $t$  till period  $t+2$ ), and then decreases and converges to its long-run equilibrium level of 1000 billion dollar. This corresponds closely to what we saw in lecture 4. The exception is the difference in the relative magnitudes of the marginal propensity to consume and invest.

f. The multiplier refers to the accumulated, distributed effects on consumption as a result of the autonomous shift in consumption. The accelerator refers to the more sudden rise in increments of investment, followed by a decrease in investment, which is made to the capital stock as a result of the autonomous shift in consumption.