Problem Set 9 - Solutions

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9 Problem Set 9 - Solution

9.1 A Budget Surplus and a Trade Deficit

1. Aggregate consumption is given as shown in lecture **??** by:

$$C = C_0 - \left(\underline{c}_1 \underline{T}_0 + \bar{c}_1 \bar{T}_0\right) + c_1(1-t_1)Y,$$

where we have defined the average MPC c_1 as a function of $\underline{c}_1$ and $\bar{c}_1$ by:

$$c_1 \equiv \frac{\lambda \underline{c}_1 + (1-\lambda)\gamma \bar{c}_1}{\lambda + (1-\lambda)\gamma}.$$

Using that Z is $C+I+G+X-M$, we get:

$$\begin{aligned} Z &= C + I + G + X - M \\ &= C_0 - \left(\underline{c}_1 \underline{T}_0 + \bar{c}_1 \bar{T}_0\right) + c_1(1-t_1)Y + b_0 + b_1 Y + G + x_1 Y^* - m_1 Y \\ Z &= \left[C_0 - \left(\underline{c}_1 \underline{T}_0 + \bar{c}_1 \bar{T}_0\right) + b_0 + G + x_1 Y^*\right] + \left(c_1(1-t_1) + b_1 - m_1\right) Y \end{aligned}$$

Equating output to demand $Z = Y$ gives the value for output:

$$Y = \frac{1}{1-(1-t_1)\,c_1 - b_1 + m_1}\left[C_0 - \underline{c}_1 \underline{T}_0 - \bar{c}_1 \bar{T}_0 + b_0 + G + x_1 Y^*\right].$$

A reduction in taxes on the poor $\Delta \underline{T}_0 < 0$, with an offsetting increase in taxes on high income earners $\Delta \bar{T}_0 = -\Delta \underline{T}_0$ such that aggregate taxes are zero ($\Delta T_0 = \Delta \underline{T}_0 + \Delta \bar{T}_0 = 0$) therefore leads to a change in output given by:

$$\boxed{\Delta Y = \frac{\underline{c}_1 - \bar{c}_1}{1-(1-t_1)\,c_1 - b_1 + m_1}\Delta \bar{T}_0}.$$

2. Using the value for aggregate taxes $\Delta \underline{T}_0 + \Delta \bar{T}_0 = 0$, we now get that aggregate taxes are higher because of automatic stabilizers, just as in lecture **??**:

$$\begin{aligned} \Delta T &= \Delta \underline{T}_0 + \Delta \bar{T}_0 + t_1 \Delta Y \\ &= t_1 \Delta Y \\ \Delta T &= \frac{t_1\left(\underline{c}_1 - \bar{c}_1\right)}{1-(1-t_1)\,c_1 - b_1 + m_1}\Delta \bar{T}_0 > 0. \end{aligned}$$

This unambiguously leads to a reduction in the public deficit, or an increase in public saving, as in lecture **??**, because of automatic stabilizers, since $\Delta\left(T-G\right) = \Delta T$:

$$\boxed{\Delta\left(T-G\right) = \frac{t_1\left(\underline{c}_1 - \bar{c}_1\right)}{1-(1-t_1)\,c_1 - b_1 + m_1}\Delta \bar{T}_0}.$$

3. An increase in output leads to a trade deficit because some of the additional demand of the low income falls on imported goods so that $\Delta NX = -m_1 \Delta Y$ which implies:

$$\boxed{\Delta NX = -\frac{m_1 \left(\underline{c}_1 - \bar{c}_1\right)}{1-(1-t_1)\,c_1 - b_1 + m_1}\Delta \bar{T}_0}.$$

Therefore, since $\Delta \bar{T}_0 > 0$, we have both a trade deficit and a budget surplus:

$$\boxed{\Delta NX < 0, \qquad \Delta(T-G) > 0}.$$

4. Again, the change in net exports NX are equal to the change in total saving minus the change in investment:

$$\Delta NX = \Delta S + \Delta(T-G) - \Delta I.$$

Therefore, the fact that an increase in the government surplus comes together with a trade deficit is somewhat of a puzzle: everything else being equal, an increase in government surplus should lead to a trade surplus, because it increases total saving. (everything else equal $\Delta NX = \Delta(T-G)$) In order to understand this "puzzle", we first compute the change in investment, which depends on output through $I = b_0 + b_1 Y$ so that $\Delta I = b_1 \Delta Y$, implying:

$$\boxed{\Delta I = \frac{b_1 \left(\underline{c}_1 - \bar{c}_1\right)}{1-(1-t_1)\,c_1 - b_1 + m_1}\Delta \bar{T}_0 > 0}.$$

The increase in investment consecutive to redistributive policies does contribute to explaining the puzzle. Indeed, there was an investment boom at the end of Bill Clinton's presidency. For example, you can read this Paul Krugman op-ed, where he gives this argument:

At the time, Martin Feldstein famously linked the two, calling them "twin deficits." While this oversimplified matters – in the late 1990s we ran both budget surpluses and trade deficits, thanks to booming investment – the logic made sense.

5. Private saving S is:

$$\begin{aligned}
S &= Y - T - C \\
&= Y - \left(\left(\underline{T}_0 + \bar{T}_0\right) + t_1 Y\right) - \left(C_0 - \left(\underline{c}_1 \underline{T}_0 + \bar{c}_1 \bar{T}_0\right) + c_1(1-t_1)Y\right) \\
&= Y - t_1 Y - c_1(1-t_1)Y - C_0 - \left(\underline{T}_0 + \bar{T}_0\right) + \left(\underline{c}_1 \underline{T}_0 + \bar{c}_1 \bar{T}_0\right) \\
S &= (1-t_1)(1-c_1)Y - C_0 - \left(\underline{T}_0 + \bar{T}_0\right) + \left(\underline{c}_1 \underline{T}_0 + \bar{c}_1 \bar{T}_0\right)
\end{aligned}$$

Therefore, :

$$\begin{aligned}
\Delta S &= (1-t_1)(1-c_1)\Delta Y + \underline{c}_1 \Delta \underline{T}_0 + \bar{c}_1 \Delta \bar{T}_0 \\
&= \frac{(1-t_1)(1-c_1)\left(\underline{c}_1 - \bar{c}_1\right)}{1-(1-t_1)\,c_1 - b_1 + m_1}\Delta \bar{T}_0 - (\underline{c}_1 - \bar{c}_1)\Delta \bar{T}_0 \\
&= \left[\frac{(1-t_1)(1-c_1)}{1-(1-t_1)\,c_1 - b_1 + m_1} - 1\right](\underline{c}_1 - \bar{c}_1)\Delta \bar{T}_0 \\
&= \left[\frac{(1-t_1)(1-c_1) - (1-(1-t_1)\,c_1 - b_1 + m_1)}{1-(1-t_1)\,c_1 - b_1 + m_1}\right](\underline{c}_1 - \bar{c}_1)\Delta \bar{T}_0 \\
&= \left[\frac{-t_1 + b_1 - m_1}{1-(1-t_1)\,c_1 - b_1 + m_1}\right](\underline{c}_1 - \bar{c}_1)\Delta \bar{T}_0 \\
\Delta S &= \frac{(-t_1 + b_1 - m_1)\left(\underline{c}_1 - \bar{c}_1\right)}{1 - c_1(1-t_1) - b_1 + m_1}\Delta \bar{T}_0
\end{aligned}$$

The sign of the change in private saving is ambiguous:

$$\boxed{\Delta S = \frac{(-t_1 + b_1 - m_1)\left(\underline{c}_1 - \bar{c}_1\right)}{1 - c_1(1-t_1) - b_1 + m_1}\Delta \bar{T}_0}.$$

However, if $m_1 = b_1$ as in the numerical application, then private saving decreases, which also contributes to explaining the puzzle: private saving move against public saving, which tends to increase the trade deficit.

6. The net effect on net exports can be given as:

$$\begin{aligned}\Delta NX &= \Delta S + \Delta(T - G) + \Delta I \\ &= \frac{(-t_1 + b_1 - m_1) + t_1 - b_1}{1 - (1 - t_1)\, c_1 - b_1 + m_1} \left(\underline{c}_1 - \bar{c}_1\right) \Delta \bar{T}_0 \\ \Delta NX &= -\frac{m_1}{1 - (1 - t_1)\, c_1 - b_1 + m_1} \left(\underline{c}_1 - \bar{c}_1\right) \Delta \bar{T}_0\end{aligned}$$

We find the same expression as in question 3:

$$\boxed{\Delta NX = -\frac{m_1}{1 - (1 - t_1)\, c_1 - b_1 + m_1} \left(\underline{c}_1 - \bar{c}_1\right) \Delta \bar{T}_0}$$

7. Assuming that $m_1 = 1/6$, $b_1 = 1/6$, $t_1 = 1/4$, $\underline{c}_1 = 1$, $\bar{c}_1 = 1/3$, $\gamma = 9$, $\lambda = 0.9$, the average marginal propensity to consume is:

$$\begin{aligned}c_1 &= \frac{\lambda \underline{c}_1 + (1 - \lambda)\, \gamma \bar{c}_1}{\lambda + (1 - \lambda)\gamma} \\ &= \frac{\lambda}{\lambda + (1 - \lambda)\gamma} \underline{c}_1 + \frac{(1 - \lambda)\, \gamma}{\lambda + (1 - \lambda)\gamma} \bar{c}_1 \\ &= \frac{0.9}{0.9 + 0.1 \cdot 9} \cdot 1 + \frac{0.1 \cdot 9}{0.9 + 0.1 \cdot 9} \cdot \frac{1}{3} \\ &= \frac{1}{2} \cdot 1 + \frac{1}{2} \cdot \frac{1}{3} \\ c_1 &= \frac{2}{3}.\end{aligned}$$

If redistribution is given by $\Delta \bar{T}_0 = 1$, we get an increase in output which is given by:

$$\begin{aligned}\Delta Y &= \frac{\underline{c}_1 - \bar{c}_1}{1 - (1 - t_1)\, c_1 - b_1 + m_1} \Delta \bar{T}_0 \\ &= \frac{1}{1 - (2/3) \cdot (1 - 1/4) - 1/6 + 1/6} \cdot \left(1 - \frac{1}{3}\right) \cdot 1 \\ &= 2 \cdot \frac{2}{3} \cdot 1 \\ \Delta Y &= \frac{4}{3}\end{aligned}$$

The change in the trade balance ΔNX can be decomposed as:

- A change in private saving ΔS:

$$\begin{aligned}\Delta S &= (-t_1 + b_1 - m_1) \cdot \Delta Y \\ &= \left(-\frac{1}{4} + \frac{1}{6} - \frac{1}{6}\right) \cdot \frac{4}{3} \\ \Delta S &= -\frac{1}{3}\end{aligned}$$

- A change in public saving $\Delta(T - G)$:

$$\begin{aligned}\Delta(T - G) &= t_1 \cdot \Delta Y \\ &= \frac{1}{4} \cdot \frac{4}{3} \\ \Delta(T - G) &= \frac{1}{3}\end{aligned}$$

- A change in investment ΔI:

$$\begin{aligned}\Delta I &= b_1 \cdot \Delta Y \\ &= \frac{1}{6} \cdot \frac{4}{3} \\ \Delta I &= \frac{2}{9}.\end{aligned}$$

The sum of all these contributions is:

$$\boxed{\Delta NX = \Delta S + \Delta(T-G) - \Delta I = -\frac{1}{3} + \frac{1}{3} - \frac{2}{9} = -\frac{2}{9}}.$$

Note that this same expression can be obtained using that $\Delta NX = -m_1 \Delta Y$ directly:

$$\begin{aligned}\Delta NX &= -m_1 \Delta Y \\ &= -\frac{1}{6} \cdot \frac{4}{3} \\ \Delta NX &= -\frac{2}{9}.\end{aligned}$$

9.2 Coordination of Economic Policies

1. Given Y^*, aggregate demand is:

$$\begin{aligned}Z &= C + I + G + X - M \\ &= (10 + 0.8 \cdot (Y - T)) + (8 + 0.1Y) + (g_0 + 0.1Y) + 0.1Y^* - 0.1Y \\ &= 10 + 0.8 \cdot (Y - 10 - 0.5Y) + 8 + 0.1Y + g_0 + 0.1Y + 0.1Y^* - 0.1Y \\ Z &= 0.5Y + 10 + g_0 + 0.1Y^*\end{aligned}$$

Setting $Y = Z$ gives:

$$\boxed{Y = 20 + 2 \cdot g_0 + 0.2 \cdot Y^*}.$$

2. Assuming that foreign output is given, the multiplier is 2 since:

$$\boxed{\Delta Y = 2 \cdot \Delta g_0}.$$

Note that foreign output cannot be fixed when government spending changes in the home economy: because of imports, a stimulus in the home economy necessarily increases output in the foreign economy. The rest of this problem shows why.

3. If we were to close the economy, then demand would be:

$$\begin{aligned}Z &= C + I + G \\ &= 10 + 0.8(Y - 10 - 0.5Y) + 8 + 0.1Y + g_0 + 0.1Y \\ Z &= 0.6Y + 10 + g_0\end{aligned}$$

Setting $Y = Z$ gives:

$$\boxed{Y = 25 + 2.5 \cdot g_0}.$$

Therefore, the multiplier is 2.5 since

$$\boxed{\Delta Y = 2.5 \cdot \Delta g_0}.$$

In a closed economy, the multiplier would be higher because all the increase in income would be feeding domestic demand: there would be no "leakage" of aggregate demand.

4. We similarly have: $Y^* = 20 + 2g_0^* + 0.2Y$. Therefore:

$$\begin{aligned} Y &= 20 + 2g_0 + 0.2Y^* \\ &= 20 + 2g_0 + 0.2\left(20 + 2g_0^* + 0.2Y\right) \\ Y &= 24 + 2g_0 + 0.4g_0^* + 0.04Y \end{aligned}$$

   This gives output Y, and symmetrically foreign output Y^*:

$$\begin{aligned} Y &= \frac{24}{0.96} + \frac{2}{0.96}g_0 + \frac{0.4}{0.96}g_0^* \\ Y^* &= \frac{24}{0.96} + \frac{2}{0.96}g_0^* + \frac{0.4}{0.96}g_0. \end{aligned}$$

   Finally:

$$\boxed{Y \approx 25 + 2.08 \cdot g_0 + 0.42 \cdot g_0^*} \qquad \boxed{Y^* \approx 25 + 2.08 \cdot g_0^* + 0.42 \cdot g_0}.$$

5. The multiplier is now given by $2/0.96 \approx 2.08$. Indeed:

$$\boxed{\Delta Y = \frac{2}{0.96}\Delta g_0 \approx 2.08 \cdot \Delta g_0}.$$

   This is higher than 2. The reason is that increasing G in the home economy increases M from the foreign economy and therefore, Y in the foreign economy, which in turn increases demand for X in the home economy.

6. We have the following two equations for Y and Y^*:

$$Y = 20 + 2 \cdot g_0 + 0.2 \cdot Y^*$$

   and:

$$Y^* = 20 + 2 \cdot g_0^* + 0.2 \cdot Y.$$

   The second equation says that whenever output increases by \$1 in the home economy, this leads output to increase by \$0.2 in the foreign economy. In turn, this increase of \$0.2 in the foreign economy leads to an increase of $\$0.2 \cdot 0.2 = 0.04$ in the home economy. Therefore, when output increases by \$1 in the home economy, then through the spillover effects it leads to an increase in \$0.04 in the home economy. In turn, this \$0.04 increase leads to a further $\$0.04 \cdot 0.04 = 0.04^2$ increase, etc. Finally, we get a total spillover effect for 1 dollar given by:

$$\boxed{1 + 0.2 \cdot 0.2 + (0.2 \cdot 0.2)^2 + ... = \frac{1}{1 - 0.04} = \frac{1}{0.96} \approx 1.04}.$$

   This explains why the open economy multiplier is $1/0.96$ times the closed economy multiplier, so that:

$$\boxed{\Delta Y = \frac{2}{0.96} \cdot \Delta g_0 \approx 2.08 \cdot \Delta g_0}.$$

7. U.S.'s government spending increases Germany's exports, and after the multiple rounds:

$$\Delta Y^* = 0.42 \cdot \Delta g.$$

   The impact on Germany's surplus is:

$$\begin{aligned} \Delta(T^* - G^*) &= \Delta T^* - \Delta G^* \\ &= 0.5 \cdot \Delta Y^* - 0.1 \cdot \Delta Y^* \\ &= 0.4 \cdot \Delta Y^* \\ &= 0.4 \cdot 0.42 \cdot \Delta g \\ \Delta(T^* - G^*) &= 0.168 \cdot \Delta g \end{aligned}$$

Therefore, U.S.'s government spending leads to a surplus in Germany's budget, given as a function of U.S.'s increase in government spending by:

$$\boxed{\Delta(T^* - G^*) = 0.168 \cdot \Delta g}.$$

8. The multiplier for a coordinated increase in government spending, such that $\Delta g_0 = \Delta g_0^*$ is given by:

$$\begin{aligned}\Delta Y &= \frac{2}{0.96}\Delta g_0 + \frac{0.4}{0.96}\Delta g_0^* \\ &= \frac{2.4}{0.96}\Delta g_0 \\ \Delta Y &= 2.5 \cdot \Delta g_0\end{aligned}$$

   The multiplier for a coordinated increase in government spending is 2.5. Note that this is equal to the closed economy multiplier, which is intuitive.

9. The multiplier is higher. If government spending is coordinated, then exports in the home economy increase, which contributes to boosting output further. The aggregate demand leakage, increasing imports, is offset by an expansion abroad, increasing exports.

10. There is a free-rider problem because all countries have an incentive to wait other countries to do more Keynesian stimulus. When the U.S. does a Keynesian stimulus, this stimulus benefits Germany in the form of increased GDP in Germany, and their government surplus. Therefore, this non-cooperative game can lead to too little stimulus.

11. Donald Trump believes that Germany is not doing enough to boost aggregate demand, and that this explains the U.S.'s unfavorable trade balance. Again, whether you think that his complaint is legitimate depends on whether you think that global aggregate demand is deficient, or not. Many economists take the view that if Germany is willing to lend to the U.S., and always produce more than it consumes, then Germany is not acting in its best interest, and the U.S. should simply be consuming these "free" goods (same with China). As you know, I am more agnostic. I think that the question is whether supply indeed creates its own demand, and whether people care more about production or about consumption. This controversy dates back to at least Adam Smith against the mercantilists, in the eighteenth century.