Econ 102 - UCLA - Spring 2018
Instructor: François Geerolf
Final Exam
June 14, 2018
Time Limit: 3 hours

Last Name: _____

First Name: _____

Teaching Assistant: _____

Student ID Number: _____   Signature _____

Test A

This exam contains 21 pages (including this cover page). You can earn 100 points.

Instructions:

1. Print your Last name, First Name, Teaching Assistant Name (as a reminder, teaching assistants are: Maria Alejandra Amado Garfias, Paula Beltran Saavedra, Huifeng Chang, Conor Foley, Benjamin Freyd, Yunfan Gu, Kun Hu, Ivan Lavrov), Student ID Number and Signature at the top of this page.

2. The only items which should be on your desk are pencils and/or pens. NO other items are allowed. Place any other item UNDER your desk. Calculators are NOT allowed.

3. Once the exam begins, you are not allowed to leave the room until you hand in your exam.

Good luck ! Budget your time wisely ! (skip the question or even the exercise if you get stuck)

Do not write below this line (Grader use only)

Question	Points	Score
1	40	
2	10	
3	10	
4	10	
5	10	
6	10	
7	10	
Total:	100	

40 Multiple Choice Questions (40 points)

1. (40 points) Use the Scantron to mark your answers.

   (1) (1 point) Which of the following will not increase equilibrium output in the short run?

   A. increases in R&D

   B. increases in consumer confidence

   C. increases in investment demand

   D. increases in government spending

   E. decreases in taxes

   (2) (1 point) Which of the following would tend to make the government expenditure multiplier smaller?

   A. an increase in the marginal propensity to consume

   B. an increase in the marginal propensity to save

   C. a reduction in taxes

   D. a reduction in government spending

   E. none of the above

   (3) (1 point) Based on our understanding of the paradox of thrift, we know that a reduction in the desire to save will cause:

   A. an increase in equilibrium GDP.

   B. a reduction in GDP.

   C. an increase in the desire to invest.

   D. no change in equilibrium GDP.

   E. a permanent reduction in the level of saving.

   (4) (1 point) Suppose that the consumption function is given by $C(Y_D) = 250 + 0.75Y_D$, then private saving is:

   A. $-250 + 0.25Y_D$**.**

   B. $-250 + 0.75Y_D$.

   C. $-1000 + 0.25Y_D$.

   D. $-1000 + 0.75Y_D$.

   E. $-250 - 0.75Y_D$.

   (5) (1 point) If $C(Y_D) = 2000 + .9Y_D$, investment is exogenous, and the economy is closed, what decrease in taxes must occur for equilibrium output to increase by 1000?

   A. 900.

   B. 111.

   C. 100.

   D. 1000.

   E. 500.

(6) (1 point) Based on the Keynesian Cross model, an equal and simultaneous reduction in G and T will cause:

    A. an increase in output.

    B. no change in output.

    C. a reduction in output.

    D. an increase in investment.

(7) (1 point) Suppose that the marginal propensity to consume is 0.8, given this information, which of the following events will cause the largest increase in output?

    A. G increases by 200.

    B. T decreases by 200.

    C. I increases by 150.

    D. both A and B.

(8) (1 point) Which of the following will cause the money multiplier (the ratio M^d/H^d) to become smaller?

    A. an increase in high powered money

    B. a decrease in the ratio of reserves to checkable deposits

    C. an increase in the public's preference for checking deposits as opposed to holding currency

    D. a reduction in high powered money

    E. none of the above

(9) (1 point) The money supply will tend to fall when which of the following occurs?

    A. a central bank sale of bonds

    B. a decrease in the ratio of reserves to deposits

    C. a shift in public preferences away from currency to checkable deposits

    D. all of the above

    E. none of the above

(10) (1 point) For this question, assume that individuals hold both currency and checkable deposits. The fraction of currency they hold is c. Assume that each unit of deposit must be backed by θ units of reserves. The money multiplier (the ratio M^d/H^d) is then equal to:

    A. $1/c$.

    B. $1/[c + \theta(1 - c)]$.

    C. $c + \theta(1 - c)$.

    D. $1/\theta$.

    E. $1/(1 - c)$.

(11) (1 point) In 2014, what was the fraction of US GDP in total world output?

    A. 13%

    B. 23%

    C. 33%

    D. 43%

(12) (1 point) In 2014, output per capita in the US was approximately equal to :

    A. $15,000

    B. $35,000

    C. $55,000

    D. $75,000

    E. None of these answers are correct.

(13) (1 point) What is the largest component of national income?

    A. Corporate profits

    B. Proprietors' income

    C. Rental income of persons

    D. Compensation of employees

    E. Indirect taxes

(14) (1 point) For the US economy, which of the following represents the largest component of GDP?

    A. imports

    B. investment

    C. government spending

    D. exports

    E. none of the above: there exists a component of GDP that is greater than all the above in the US economy

(15) (1 point) Which of the following statements is false?

    A. Aggregate data suggests that the MPC is between 0.58 and 0.66.

    B. The MPC may be estimated using individual-level data on saving behavior, or proprietary data from major credit card companies.

    C. The level of the MPC is a matter of strong consensus among economists.

    D. Depending on the value for the MPC, stimulus policy may be more or less effective.

(16) (1 point) Which of the following is an asset of a central bank?

      A. currency

      B. bonds

      C. reserves

      D. none of the above

(17) (1 point) Suppose investment spending is not very sensitive to the interest rate. Given this information, we know that

      A. the IS curve should be relatively flat.

      B. the IS curve should be relatively steep.

      C. the LM curve should be relatively flat.

      D. the LM curve should be relatively steep.

      E. neither the IS nor the LM curve will be affected.

(18) (1 point) For this question, assume that the Phillips curve equation is represented by the following: $\pi_t - \pi_{t-1} = (m + z) - \alpha u_t$. Which of the following will cause a reduction in the natural rate of unemployment?

      A. an increase in m

      B. an increase in z

      C. an increase in α

      D. an increase in actual inflation

      E. an increase in expected inflation

(19) (1 point) Which of the following best defines the IS curve?

      A. the combinations of i and Y that maintain equilibrium in the goods market

      B. illustrates the effects of changes in i on investment

      C. illustrates the effects of changes in i on desired money holdings by individuals

      D. the combinations of i and Y that maintain equilibrium in financial markets

(20) (1 point) Which of the following individuals would be considered unemployed?

      A. an individual who works only part-time

      B. an individual who works full-time in a family business, but is not paid

      C. an individual who is not working and is not looking for work

      D. all of the above

      E. none of the above

(21) (1 point) In the Phillips curve equation, which of the following will cause an increase in the current inflation rate?

    A. an increase in the expected inflation rate.

    B. a reduction in the unemployment rate.

    C. an increase in the markup, m.

    D. all of the above.

    E. none of the above.

(22) (1 point) Which country was first used to illustrate the relationship between unemployment and inflation (i.e., the original Phillips curve)?

    A. France.

    B. The United Kingdom.

    C. The United States.

    D. Italy.

    E. Germany.

(23) (1 point) Since approximately 1970, the most stable Phillips-type relationship for the United States has been between which of the following?

    A. the rate of inflation and the change in the unemployment rate

    B. the unemployment rate and the change in the rate of inflation

    C. the change in the unemployment rate and the change in the rate of inflation

    D. the inverse of the unemployment rate and the rate of inflation

    E. the unemployment rate and the rate of inflation

(24) (1 point) The original Phillips curve implied or assumed that:

    A. the markup over labor costs was zero.

    B. the expected rate of inflation would be zero.

    C. the actual and expected rates of inflation would always be equal.

    D. all of the above

    E. none of the above

(25) (1 point) Suppose two countries are identical in every way with the following exception: economy A has a higher rate of depreciation (δ) than economy B. Given this information, we know with certainty that:

    A. steady state consumption in A is higher than in B.

    B. steady state consumption in A is lower than in B.

    C. steady state consumption in A and in B are equal.

    D. steady state growth of output per worker is higher in A than in B.

    E. none of the above.

(26) (1 point) In the absence of technological progress, we know with certainty that an decrease in the saving rate will cause which of the following?
    A. decrease steady state consumption
    B. increase steady state consumption
    C. have no effect on steady state consumption
    D. decrease steady state consumption only if the decrease in saving exceeds the increase in depreciation
    E. decrease steady state consumption only if the decrease in saving is less than the decrease in depreciation

(27) (1 point) Which of the following will cause the real exchange rate to increase?
    A. a nominal depreciation
    B. a reduction in the foreign price level
    C. a reduction in the domestic price level
    D. all of the above
    E. none of the above

(28) (1 point) Suppose that over the past decade, U.S. inflation is less than that in Mexico. Further assume that during this same period, the dollar depreciates relative to the Mexican peso. Given this information,
    A. the U.S. real exchange rate remains unchanged.
    B. the U.S. real exchange rate must decrease.
    C. the U.S. real exchange rate must increase.
    D. the U.S. real exchange rate can increase or remain the same, but not decrease.
    E. the U.S. real exchange rate can decrease or remain the same, but not increase.

(29) (1 point) Assume that the uncovered interest parity condition holds. Also assume that the U.S. nominal interest rate is less than the U.K. nominal interest rate. Given this information, we know that investors expect:
    A. the pound to depreciate.
    B. the pound to appreciate.
    C. the dollar-pound exchange rate to remain fixed.
    D. the U.S. interest rate to fall.
    E. none of the above.

(30) (1 point) Exports will decrease when there is:
    A. an increase in the real exchange rate.
    B. an increase in domestic output.
    C. an increase in foreign output.
    D. all of the above.
    E. none of the above.

(31) (1 point) In an open economy, which of the following will cause an increase in the size of the multiplier?

    A. a reduction in the marginal propensity to import

    B. a reduction in foreign output

    C. an increase in the marginal propensity to save

    D. all of the above

    E. none of the above

(32) (1 point) Suppose there is a reduction in foreign output (Y^*). This reduction in Y^* will cause which of the following in the domestic country?

    A. a reduction in output.

    B. a reduction in consumption.

    C. a reduction in net exports.

    D. all of the above.

    E. none of the above.

(33) (1 point) An increase in government spending will have a greater impact on net exports when:

    A. the marginal propensity to save is smaller.

    B. the economy is closed.

    C. the sensitivity of investment to income is smaller.

    D. all of the above.

    E. none of the above.

(34) (1 point) Which of the following will occur in a small country with a high marginal propensity to import?

    A. Changes in government spending will cause large changes in output.

    B. Changes in government spending will cause large changes in the trade balance.

    C. A depreciation will cause only small changes in the trade balance.

    D. There is no combination of policies that can eliminate the trade deficit.

    E. all of the above.

(35) (1 point) Which of the following would make the spending multiplier smaller?

    A. a reduction in marginal propensity to save.

    B. a small initial trade deficit.

    C. a reduction in the marginal propensity to import.

    D. a real appreciation.

    E. none of the above.

(36) (1 point) Which of the following will occur as a result of a tax increase?

      A. private saving increases.

      B. investment increases.

      C. the trade balance improves.

      D. the trade balance worsens.

      E. the budget deficit increases.

(37) (1 point) An open economy with a low saving rate (private and public) must have:

      A. low investment only.

      B. high investment only.

      C. a trade surplus only.

      D. low investment or a trade deficit.

      E. low investment or a trade surplus.

(38) (1 point) Assume a country is closed. Given this information, which of the following must occur?

      A. demand for domestic goods will be less than the domestic demand for goods.

      B. demand for domestic goods will be greater than the domestic demand for goods.

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

      D. a budget surplus exists.

      E. $S = I$.

(39) (1 point) Suppose there is a real appreciation. This real appreciation is more likely to cause a reduction in net exports when:

      A. domestic output is relatively low.

      B. foreign output is relatively high.

      C. the Marshall-Lerner condition does not hold.

      D. imports are not at all sensitive to price changes.

      E. exports and imports are relatively sensitive to price changes.

(40) (1 point) Suppose policy makers want to increase Y and increase NX. Which of the following policies would most likely achieve this?

      A. an increase in government spending.

      B. a real depreciation.

      C. a reduction in taxes and an increase in the real exchange rate.

      D. an increase in the real exchange rate.

Exercise 1 (10 points)

2. (10 points) Consider the closed economy goods market model where consumption is linear in disposable income with $C(Y_D) = c_0 + c_1 Y_D$, investment is exogenous and equal to $\bar{I}$. However, there are two modifications to this basic model. First, government spending depends on the level of output. For example, the government systematically spends more when GDP is higher (it builds new roads, hires new teachers, etc.), and conversely when GDP is lower (it then stops construction projects, fires teachers, etc.). Thus, government spending is given by $G = g_0 + g_1 Y$, with $g_1 > 0$. Second, there are automatic stabilizers, so that taxes depend on output as well through $T = t_0 + t_1 Y$.

   (a) (2 points) Solve for equilibrium output. What is the value of the tax multiplier?

   > **Solution:** We write that Output = Demand:
   >
   > $$Y = Z = C + \bar{I} + G$$
   > $$Y = c_0 + c_1 (Y - T) + g_0 + g_1 Y + G$$
   > $$Y = \left(c_0 - c_1 t_0 + g_0 + \bar{I}\right) + (c_1(1 - t_1) + g_1) Y$$
   > $$\Rightarrow \boxed{Y = \frac{1}{1 - (1 - t_1)c_1 - g_1} \left(c_0 - c_1 t_0 + g_0 + \bar{I}\right)}.$$
   >
   > If $\Delta t_0 = -\$1$, the change in output is $\frac{c_1}{1-(1-t_1)c_1-g_1}$. (The assumption here is that $1 - (1 - t_1)c_1 - g_1 < 1$, so that the multiplier remains finite.) Therefore:
   >
   > $$\boxed{\text{Tax Multiplier} = \frac{c_1}{1 - (1 - t_1)c_1 - g_1}}.$$

   (b) (2 points) If $g_1 > 0$, is the multiplier higher or lower than when government spending does not depend on GDP ($g_1 = 0$)? What is the intuition for this?

   > **Solution:**
   > The multiplier is higher in this economy since:
   >
   > $$\frac{1}{1 - (1 - t_1)c_1 - g_1} > \frac{1}{1 - (1 - t_1)c_1}.$$
   >
   > The intuition is that government spending automatically increases when GDP increases, which increases demand further. Thus, the multiplier is higher.

   (c) (2 points) Give an algebraic justification for the value of the tax multiplier.

   > **Solution:** The impulse to autonomous spending is given by $\$c_1$. This increase leads to a first round of increased consumption and increased investment $c_1((1-$

$t_1)c_1 + g_1$): in the first round, one dollar of additional income leads to $1 - t_1$ more dollars of disposable income, and therefore to $c_1(1 - t_1)$ more dollars in consumption. In addition, there is g_1 more dollars in government spending. Thus, an impulse of c_1 leads to a rise in income of $c_1((1 - t_1)c_1 + g_1)$. In the second round, the increase in income is $c_1((1 - t_1)c_1 + g_1)^2$, etc. The sum is:

$$\text{Tax Multiplier} = c_1 + c_1((1 - t_1)c_1 + g_1) + ... + c_1((1 - t_1)c_1 + g_1)^n + ...$$
$$= c_1 \left(1 + ((1 - t_1)c_1 + g_1) + ... + ((1 - t_1)c_1 + g_1)^n + ...\right)$$
$$\text{Tax Multiplier} = c_1 \sum_{i=0}^{+\infty}((1 - t_1)c_1 + g_1)^i = \frac{c_1}{1 - (1 - t_1)c_1 - g_1}$$

(d) (2 points) Give a graphical justification for the value of the tax multiplier.

Solution: The (ZZ) curve in this problem has a slope equal to $(1 - t_1)c_1 + g_1$.
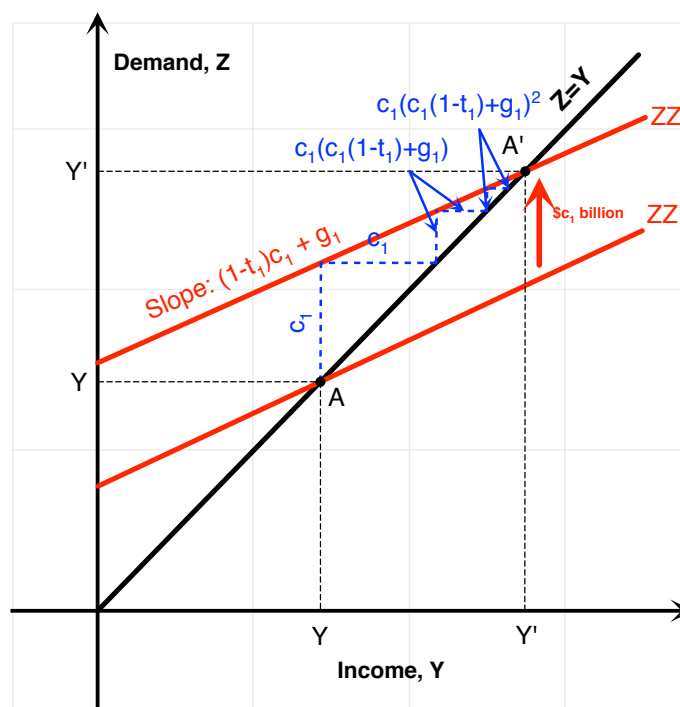
(e) (2 points) Under which assumption is the multiplier finite? What happens if it is not? Explain using the multiplier intuition.

Solution: If $g_1 + (1 - t_1)c_1 > 1$, then each new round of spending leads to an even greater new round of new income and new spending. Therefore, the above infinite sum if infinite, and the tax multiplier is infinite:

$$\text{Tax Multiplier} = +\infty.$$

Exercise 2 (10 points)

3. (10 points) Consider the closed economy goods market model where consumption is linear in disposable income, disposable income is income minus taxes, investment is exogenous and equal to $\bar{I}$, and government spending and taxes are exogenous as well. Recall that in the basic goods market model, we define taxes, T, as net of transfers. In other words: $T = \textbf{Taxes} - \textbf{Transfer Payments}$.

   (a) (2 points) 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 using the (YY-ZZ) diagram how this policy affects equilibrium output. Explain.

   > **Solution:** Using $T = \textbf{Taxes} - \textbf{Transfer Payments}$, an increase in transfer payments is equivalent to a reduction in taxes T. If the government borrows to pay for this transfer payment, this means that the government is not changing G to offset the potential impact on $T - G$ of this reduction in net taxes. Therefore, output increases directly because of the increase in disposable income $Y - T$ which raises consumption and thus, demand Z, and indirectly because the higher output further stimulates consumption through $C = c_0 + c_1(Y - T)$. The direct as well as the multiplier effect are shown in the diagram below, if the increase is transfer payments is given by \$1 billion. Then the impulse to autonomous spending is \$$c_1$ billion, and the total impact on output is \$$c_1/(1 - c_1)$ billion.
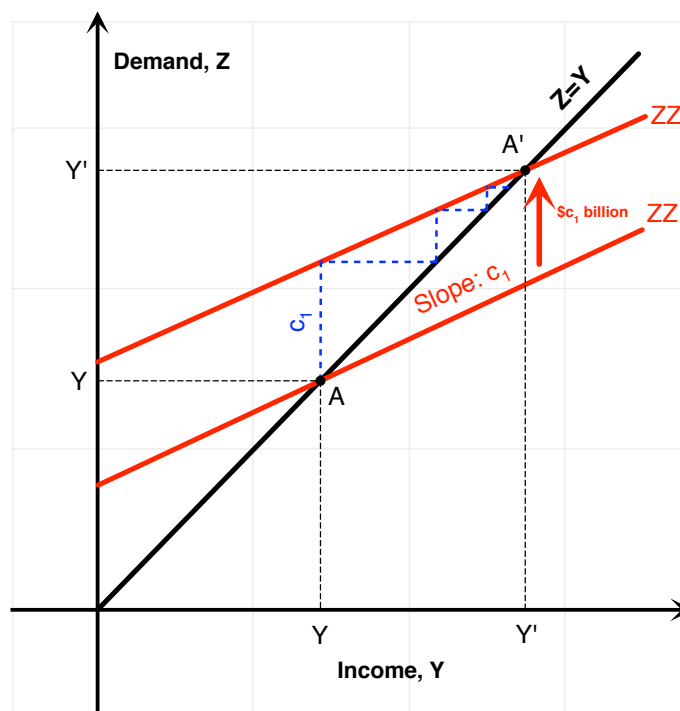
(b) (2 points) Suppose instead that the government pays for the increase in transfer payments with an equivalent increase in taxes. How does the increase in transfer payments affect equilibrium output in this case?

> **Solution:** Since $T = \text{Taxes} - \text{Transfer Payments}$, 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 that we have done is to change how much different people are consuming, based on how much taxes they are paying and how much transfers they are receiving, but since they all have the same Marginal Propensity to Consume the only thing that matters is **aggregate net taxes**, which are unaffected by the change.

(c) (4 points) Now suppose that the population includes two kinds of people: those with high propensity to consume (the poor) and those with low propensity to consume (the rich). Suppose that 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? Explain. (without any algebra)

> **Solution:** When we transfer \$1 of spending from a low MPC person (with c_1^L) to a high MPC person (with $c_1^H > c_1^L$), 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) (2 points) Is the following logic correct: "if we redistribute income from the poor to the rich, then this will increase aggregate saving, and therefore raise investment"? Explain under the lens of this particular model.

> **Solution:** The introduction of this section says that investment is fixed, thus by construction it cannot increase. However appealing the above reasoning is, it is incorrect in the context of the present model. The reason is that the increase in individual saving is offset by a reduction in income which comes from lower aggregate consumption, and therefore lower aggregate demand. In equilibrium, the direct effect of more saving because of anti-redistributive policies is offset by a fall in aggregate income.
>
> <u>Comment</u>. This does not mean that redistributive policies should necessarily be undertaken ! This just means that through the lens of this particular model, redistributive policies can be good in the short run to boost aggregate demand. In the long run, there are other reasons why redistributive taxation may be bad: it may discourage innovation, entrepreneurship, and incentives to work in general...

Exercise 3 (10 points)

4. (10 points) Consider the closed economy goods market model where consumption is linear in disposable income with $C(Y_D) = c_0 + c_1 Y_D$, disposable income is income minus taxes, government spending and taxes are exogenous and equal to $\bar{G}$ and $\bar{T}$ respectively, but investment depends on output through $I = b_0 + b_1 Y$.

   (a) (2 points) Solve for equilibrium output.

   > **Solution:** Total aggregate demand Z in the closed economy is given by:
   >
   > $$Z = C + I + \bar{G}$$
   > $$Z = c_0 + c_1(Y - \bar{T}) + b_0 + b_1 Y + \bar{G}$$
   > $$Z = c_0 + b_0 - c_1 \bar{T} + \bar{G} + (c_1 + b_1) Y.$$
   >
   > Thus, using $Z = Y$:
   >
   > $$\boxed{Y = \frac{1}{1 - c_1 - b_1} \left(c_0 + b_0 - c_1 \bar{T} + \bar{G}\right)}$$

   (b) (2 points) Assume that there is a fall in autonomous spending given by $\Delta c_0 < 0$. Show that there is a direct effect on private saving of the change in autonomous spending as well as an indirect effect. What is the sign of the direct effect? (Hint: the direct effect is $\Delta(-c_0)$)

   > **Solution:** Private saving is equal to disposable income minus consumption, as always:
   >
   > $$S = \left(Y - \bar{T}\right) - C$$
   > $$= Y - \bar{T} - \left(c_0 + c_1(Y - \bar{T})\right)$$
   > $$= -c_0 + (1 - c_1)\left(Y - \bar{T}\right)$$
   >
   > This allows to decompose into a direct and an indirect effect (the hint allows us to recognize the direct effect, so the other part has to be the indirect effect):
   >
   > $$\boxed{\Delta S = \underbrace{\Delta(-c_0)}_{\text{direct effect}} + \underbrace{\Delta \left[(1 - c_1)\left(Y - \bar{T}\right)\right]}_{\text{indirect effect}}}$$
   >
   > Note that the indirect effect is also equal to $(1 - c_1)\Delta Y$, since taxes are assumed to be fixed. This was an equally valid answer to the computation of the indirect effect. Obviously, since $\Delta(-c_0) > 0$, the direct effect is positive. There is a straightforward economic interpretation: a decrease in consumption leads to an increase in saving.

(c) (2 points) What is the value of the indirect effect, as a function of the change $\Delta c_0 < 0$?

Solution: We see that the indirect effect involves the change in income, which we therefore need to calculate. From the above equation, a given change in $\Delta c_0 < 0$ leads to decline in output given by:

$$\Delta Y = \frac{\Delta c_0}{1 - c_1 - b_1}$$

This allows to calculate the magnitude of the indirect effect.

$$\Delta \left[(1 - c_1)\left(Y - \bar{T}\right)\right] = (1 - c_1)\Delta Y$$

$$\Delta \left[(1 - c_1)\left(Y - \bar{T}\right)\right] = (1 - c_1)\frac{\Delta c_0}{1 - c_1 - b_1}$$

$$\boxed{\Delta \left[(1 - c_1)\left(Y - \bar{T}\right)\right] = \frac{1 - c_1}{1 - c_1 - b_1}\Delta c_0}.$$

(d) (2 points) Compute the total effect of the change $\Delta c_0 < 0$ on private saving S (direct + indirect effect).

Solution: Therefore, the total effect on saving is:

$$\Delta S = \Delta(-c_0) + \Delta \left[(1 - c_1)\left(Y - \bar{T}\right)\right]$$

$$= -\Delta c_0 + \frac{1 - c_1}{1 - c_1 - b_1}\Delta c_0$$

$$= \frac{1 - c_1 - (1 - c_1 - b_1)}{1 - c_1 - b_1}\Delta c_0$$

Finally:

$$\boxed{\Delta S = \frac{b_1}{1 - c_1 - b_1}\Delta c_0}.$$

(e) (2 points) Why is the total effect on private saving a paradox?

Solution: Total saving falls, as $\Delta S < 0$. This phenomenon is a paradox (of thrift, or of saving) because a fall in consumption $\Delta c_0 < 0$ should intuitively lead to an increase in saving, but in fact leads to a decrease in saving. This is explained by the fact that the indirect effect going through a decline in income which reduces saving, more than offsets the direct effect.

Exercise 4 (10 points)

5. (10 points) Consider the open economy goods market model where consumption is linear in disposable income with $C(Y_D) = c_0 + c_1 Y_D$, disposable income is income minus taxes, investment depends on output with $I = b_0 + b_1 Y$ imports depend on output and the real exchange rate with $IM = \epsilon m_1 Y$, exports depend on foreign output and the real exchange rate with $X = \frac{x_1 Y^*}{\epsilon}$, and government spending and taxes are fixed and equal to $\bar{G}$ and $\bar{T}$. Assume throughout that Net Income NI and Net Transfers NT are zero.

(a) (2 points) Treating ϵ and Y^* as fixed, solve for equilibrium output.

Solution: Total aggregate demand Z in the open economy is given by:

$$Z = C + I + G - \frac{IM}{\epsilon} + X$$

$$= c_0 + c_1 \left(Y - \bar{T}\right) + b_0 + b_1 Y + \bar{G} - m_1 Y + \frac{x_1 Y^*}{\epsilon}$$

$$Z = \left(c_0 - c_1 \bar{T} + b_0 + \bar{G} + \frac{x_1 Y^*}{\epsilon}\right) + (c_1 + b_1 - m_1) Y$$

Therefore, using that $Z = Y$, we arrive at the result:

$$Y = \frac{1}{1 - (c_1 + b_1 - m_1)} \left(c_0 - c_1 \bar{T} + b_0 + \bar{G} + \frac{x_1 Y^*}{\epsilon}\right)$$

(b) (2 points) Using that the Current Account is equal to Saving minus Investment, calculate the effect of a decrease in taxes $\Delta \bar{T} < 0$ on the Current Account. Show the intermediate steps.

Solution: The increase in output is given by:

$$\Delta Y = -\frac{c_1}{1 - (c_1 + b_1 - m_1)} \Delta \bar{T} > 0$$

Therefore, using that $CA = \Delta S + \Delta \left(\bar{T} - \bar{G}\right) - \Delta I$:

$$\Delta CA = \Delta S + \Delta \left(\bar{T} - \bar{G}\right) - \Delta I$$

$$= (1 - c_1) \left(\Delta Y - \Delta \bar{T}\right) + \Delta \bar{T} - \Delta I$$

$$= (1 - c_1 - b_1) \Delta Y + c_1 \Delta \bar{T}$$

$$= -\frac{1 - c_1 - b_1}{1 - (c_1 + b_1 - m_1)} c_1 \Delta \bar{T} + c_1 \Delta \bar{T}$$

$$= \left(1 - \frac{1 - c_1 - b_1}{1 - (c_1 + b_1 - m_1)}\right) c_1 \Delta \bar{T}$$

$$\Delta CA = \frac{m_1}{1 - (c_1 + b_1 - m_1)} c_1 \Delta \bar{T} < 0$$

(c) (2 points) Using that the Current Account is equal to Exports minus Imports, calculate the effect of a decrease in taxes $\Delta\bar{T} < 0$ on the Current Account. Show the intermediate steps. What is the intuition for its sign?

> **Solution:** The effect of a decrease in taxes:
>
> $$\Delta\left(X - \frac{IM}{\epsilon}\right) = -\Delta\left(\frac{IM}{\epsilon}\right) = -m_1\Delta Y = \frac{m_1 c_1}{1 - (c_1 + b_1 - m_1)}\Delta T.$$
>
> There is a trade / current account deficit, because some of the additional aggregate demand falls on other countries' imports.

(d) (2 points) Using that the Current Account is equal to Saving minus Investment, calculate the effect of an increase in foreign demand $\Delta Y^* > 0$ on the Current Account. Show the intermediate steps.

> **Solution:** The increase in foreign demand $\Delta Y^* > 0$ leads to an increase in output given by:
>
> $$\Delta Y = \frac{1}{\epsilon}\frac{x_1}{1 - (c_1 + b_1 - m_1)}\Delta Y^* > 0$$
>
> Therefore the change in the Current Account CA is again the change in private saving, plus the change in public saving (equal to $\Delta(T - G) = 0$), minus the change in investment:
>
> $$\begin{aligned}\Delta CA &= \Delta S + \Delta\left(\bar{T} - \bar{G}\right) - \Delta I \\ &= (1 - c_1)\Delta Y - b_1\Delta Y \\ &= (1 - c_1 - b_1)\Delta Y \\ \Delta CA &= \frac{1}{\epsilon}\frac{x_1(1 - c_1 - b_1)}{1 - (c_1 + b_1 - m_1)}\Delta Y^* > 0\end{aligned}$$

(e) (2 points) Using that the Current Account is equal to Exports minus Imports, calculate the effect of an increase in foreign demand $\Delta Y^* > 0$ on the Current Account. Show the intermediate steps.

> **Solution:**
>
> $$\begin{aligned}\Delta\left(X - \frac{IM}{\epsilon}\right) &= \frac{x_1}{\epsilon}\Delta Y^* - m_1\Delta Y \\ &= \frac{x_1}{\epsilon}\Delta Y^* - \frac{1}{\epsilon}\frac{m_1 x_1}{1 - (c_1 + b_1 - m_1)}\Delta Y^* \\ \Delta\left(X - \frac{IM}{\epsilon}\right) &= \frac{1 - (c_1 + b_1)}{1 - (c_1 + b_1 - m_1)}\frac{x_1}{\epsilon}\Delta Y^* > 0\end{aligned}$$

Exercise 5 (10 points)

6. (10 points) Consider the standard Solow growth model. We assume that the economy's production function is $Y = F(K, N) = K^{1/4}N^{3/4}$. Assume no population growth.

   (a) (1 point) What is the name of this production function?

   > **Solution:** This production function is called a Cobb-Douglas production function.

   (b) (1 point) Show that this production function has constant returns to scale.

   > **Solution:** This production function has constant returns to scale because for all x:
   >
   > $$F(xK, xN) = (xK)^{1/4}(xN)^{3/4} = xK^{1/4}N^{3/4} = xF(K, N)$$

   (c) (2 points) For a given saving rate, s, and depreciation rate, δ, derive an expression for capital per worker in the steady state. Give the intermediate steps.

   > **Solution:** We write the evolution of the capital stock as:
   >
   > $$\begin{aligned} K_{t+1} &= (1 - \delta)K_t + I_t \\ &= (1 - \delta)K_t + sY_t \\ K_{t+1} &= (1 - \delta)K_t + sK_t^{1/4}N^{3/4} \end{aligned}$$
   >
   > Dividing both sides by N :
   >
   > $$\frac{K_{t+1}}{N} = (1 - \delta)\frac{K_t}{N} + s\left(\frac{K_t}{N}\right)^{1/4}$$
   >
   > In steady state, $\frac{K_{t+1}}{N} = \frac{K_t}{N} = \frac{K^*}{N}$, so we have:
   >
   > $$\delta\frac{K^*}{N} = s\left(\frac{K^*}{N}\right)^{1/4}$$
   >
   > Therefore:
   >
   > $$\left(\frac{K^*}{N}\right)^{3/4} = \frac{s}{\delta}$$
   >
   > Finally, the capital per worker in the steady state is given by:
   >
   > $$\boxed{\frac{K^*}{N} = \left(\frac{s}{\delta}\right)^{4/3}}.$$

(d) (2 points) Derive an expression for output per worker in the steady state. What is it equal to if $s = 24\%$ and $\delta = 3\%$?

> **Solution:** Using that: $Y^* = K^{*1/4}N^{3/4}$, we have:
>
> $$\frac{Y^*}{N} = \left(\frac{K^*}{N}\right)^{1/4} \quad \Rightarrow \quad \boxed{\frac{Y^*}{N} = \left(\frac{s}{\delta}\right)^{1/3}}.$$
>
> The numerical application gives:
>
> $$\frac{Y^*}{N} = \left(\frac{s}{\delta}\right)^{1/3} = \left(\frac{0.24}{0.03}\right)^{1/3} = 8^{1/3} = 2.$$
>
> (since $2^3 = 8$)

(e) (2 points) Give an expression for consumption per worker in the steady state. What is it equal to if $s = 24\%$ and $\delta = 3\%$?

> **Solution:**
>
> $$\frac{C^*}{N} = (1-s)\frac{Y^*}{N} = (1-s)\left(\frac{s}{\delta}\right)^{1/3}.$$
>
> The numerical application gives:
>
> $$\frac{C^*}{N} = (1-s)\frac{Y^*}{N} = \frac{76}{100} * 2 = \frac{152}{100} = 1.52.$$

(f) (2 points) Derive the saving rate corresponding to the Golden Rule level of capital accumulation. Show the intermediate steps.

> **Solution:** The Golden Rule level of capital accumulation is such that the level of steady-state consumption per capita C^*/N is maximized. Therefore, the saving rate must maximize:
>
> $$\max_{s} \quad (1-s)s^{1/3} = s^{1/3} - s^{4/3}$$
>
> Setting the derivative to zero (using $(s^a)' = as^{a-1}$ for $a = 1/3$ and $a = 4/3$):
>
> $$\frac{1}{3}s^{-2/3} - \frac{4}{3}s^{1/3} = 0 \quad \Rightarrow \quad \boxed{s = \frac{1}{4} = 25\%}.$$
>
> <u>Comment</u>: you should have gotten the same if you maximized $(1-s)\left(\frac{s}{\delta}\right)^{1/3}$ instead.

Exercise 6 (10 points)

7. (10 points) Consider an open economy where $\epsilon = 1$. Consumption is given by $C(Y_D) = 10 + 0.8Y_D$, investment is given by $I = 8 + 0.1Y$, government spending is given by $G = g_0 + 0.1Y$, taxes are given by $T = 10 + 0.5Y$, and imports and exports are given by $IM = 0.1Y$ and $X = 0.1Y^*$, where Y^* denotes foreign output.

(a) (2 points) Solve for equilibrium output in the domestic economy, given Y^*. What is the multiplier in this economy?

> **Solution:** Because the real exchange rate is fixed and equal to 1, $\epsilon = 1$, so that:
>
> $$\begin{aligned} Z &= C + I + G + X - IM \\ &= 10 + 0.8(Y - 10 - 0.5Y) + 8 + 0.1Y + g_0 + 0.1Y + 0.1Y^* - 0.1Y \\ Z &= 0.5Y + 10 + g_0 + 0.1Y^* \end{aligned}$$
>
> Setting $Y = Z$ gives:
>
> $$\boxed{Y = 20 + 2g_0 + 0.2Y^*}.$$
>
> Therefore, <u>the multiplier is 2</u> since:
>
> $$\Delta Y = 2\Delta g_0.$$

(b) (2 points) If we were to close the economy - so exports and imports were identical and equal to zero - what would be the multiplier be? Why would the multiplier be different in a closed economy?

> **Solution:** 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: $Y = 25 + 2.5g_0$. Therefore, <u>the multiplier is 2.5</u> since $\Delta Y = 2.5\Delta g_0$.
>
> 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.

(c) (2 points) **From now on, you may keep fractions for numbers, since you do not have a calculator.** Assume that the foreign economy is characterized by the same equations as the domestic economy (with asterisks reversed). Use the two sets of equations to solve for the equilibrium output of each country.

> **Solution:** We similarly have: $Y^* = 20 + 2g_0^* + 0.2Y$. Therefore:
>
> $$Y = 20 + 2g_0 + 0.2Y^*$$
> $$= 20 + 2g_0 + 0.2\left(20 + 2g_0^* + 0.2Y\right)$$
> $$Y = 24 + 2g_0 + 0.4g_0^* + 0.04Y$$
>
> This gives output Y, and symmetrically foreign output Y^*:
>
> $$\boxed{Y = \frac{24}{0.96} + \frac{2}{0.96}g_0 + \frac{0.4}{0.96}g_0^*} \qquad \boxed{Y^* = \frac{24}{0.96} + \frac{2}{0.96}g_0^* + \frac{0.4}{0.96}g_0}.$$

(d) (2 points) What is the multiplier in each country now? Why is it different from the open economy multiplier in part (a)?

> **Solution:** The multiplier is now given by $2/0.96$. Indeed:
>
> $$\Delta Y = \frac{2}{0.96}\Delta g_0.$$
>
> This is higher than 2. The reason is that increasing G in the home economy increases IM from the foreign economy and therefore, Y in the foreign economy, which in turn increases demand for X in the home economy.

(e) (1 point) What is the multiplier for a coordinated increase in government spending, such that $\Delta g_0 = \Delta g_0^*$?

> **Solution:**
>
> $$\Delta Y = \frac{2}{0.96}\Delta g_0 + \frac{0.4}{0.96}\Delta g_0^* = \frac{2.4}{0.96}\Delta g_0$$
>
> The multiplier for a coordinated increase in government spending is $2.4/0.96$. <u>Comment.</u> This is also the closed economy multiplier, which you could have guessed it from the economic intuition (not required to get full credit).

(f) (1 point) Is the multiplier then higher or lower than in the previous question? What is the economic intuition?

> **Solution:** 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.