

14.02 - Principles of Macroeconomics

Quiz 1

Spring 2023

EXAM RULES - READ CAREFULLY:

- Problem 1 A contains 10 true/false questions about various topics covered in the course so far, Problem 1 B contains a short question about national accounts, and Problem 2 contains four parts A,B,C and D about the IS-LM model. This quiz will be graded on a 100-point scale, according to the breakdown specified below.
- Please write your answer below each question in the space provided, and do not remove the staple.
- Please write your name on every page.
- Read the questions carefully and keep your answers short and to the point. Points will be deducted for ambiguous or illegible answers, while partial credit will be assigned in case of a mistake carried over from earlier to later parts of the same problem.
- For Problem 1 A, you are not required to explain your answers. Explanations will not be taken into consideration when grading.
- You will be asked to draw a graph. Please make sure to always label axes and curves, add arrows to denote shifts in the relevant curves, and mark the axes in the locations corresponding to equilibrium.
- **By signing below, you agree to comply with the MIT honor code and one additional rule specific to this quiz: No discussing the quiz with anyone until after the quiz.**
- Good luck!

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Problem 1 [33 Points]

A) True or false? [30 Points]

(Just answer “true” or “false” - no need to provide an explanation.)

1. [3 points] The unemployment rate is the ratio of the total number of employed people and the total population.

False: The employment rate is the ratio of employed and labor force.

2. [3 points] All else equal, if two firms merge, GDP does not change.

True.

3. [3 points] At the natural rate of unemployment, the price level equals the expected price level.

True.

4. [3 points] All else equal, if markups rise, then the natural rate of unemployment decreases.

False: The natural rate rises.

5. [3 points] In an open market operation the central bank changes the supply of money by buying or selling bonds in the bond market.

True.

6. [3 points] The higher the interest rate, the higher the price of a bond today.

False: price is lower.

7. [3 points] Consider an economy in which there are two firms, a wheat producer that grows wheat and a bread company that produces bread. In a given year, their respective input costs and sales are:

<u>Wheat producer</u>		<u>Bread company</u>	
Revenue from sales	\$300	Revenue from sales	\$500
Expenses	\$250	Expenses	\$450
Wages	\$250	Wheat purchases	\$250
		Wages	\$200
<hr/>		<hr/>	
Profits	\$50	Profits	\$50

In this economy, nominal GDP is \$100.

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False. Using e.g. the sum of incomes, GDP is $250 + 200 + 50 + 50 = 550$.

8. [3 points] The real interest rate is always lower than the nominal interest rate.

False. Recall the Fisher equation: the real rate equals the nominal rate minus expected inflation. The real rate is lower than the nominal rate if expected inflation is positive, but if expected inflation is negative (i.e. deflation) then the real rate is higher.

9. [3 points] Suppose investment is exogenously fixed. All else equal, if saving increases due to a decline in autonomous consumption, then equilibrium output must decrease.

True.

10. [3 points] Consider the Basic IS-LM model where investment is exogenously fixed. If the marginal propensity to consume out of disposable income is 0.5, then the multiplier is 2.0.

True.

B) Computing Real GDP Growth [3 Points]

Consider an economy in which there are three goods produced: hamburgers, hand sanitizer. The following table gives the prices and quantities produced of the three goods for 2021 and 2022:

	2021		2022	
	Price	Quantity	Price	Quantity
Hand sanitizer	1	2	2	4
Hamburgers	2	3	4	3

Compute real GDP for each year, using 2021 as the base year. What's the growth rate in real GDP between 2021 and 2022?

$$RGDP_{2021}(2021) = 1 * 2 + 2 * 3 = 2 + 6 = 8$$

$$RGDP_{2022}(2021) = 1 * 4 + 2 * 3 = 4 + 6 = 10$$

The growth rate is

$$\frac{RGDP_{2022}(2021) - RGDP_{2021}(2021)}{RGDP_{2021}(2021)} = \frac{10 - 8}{8} = 1/4$$

Problem 2: IS-LM Model [67 points]

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A) Money Demand [8 points]

Assume that the demand for money (M), the sum of currency and transaction balances, in the US can be described by

$$M = \gamma \cdot (\$Y) \cdot (1 - i)$$

where $\$Y$ is nominal GDP, i is the nominal interest rate, and γ is a parameter which shifts the money demand curve.

1. [4 points] Explain why this demand function depends on i , the nominal interest rate, rather than r , the real interest rate.

Money demand depends on the *nominal* interest rate, because this is the opportunity cost of holding money.

2. [4 points] If the supply of money equals \$5 trillion, nominal GDP is \$10 trillion, $\gamma = 1$, and money supply equals money demand, what will the nominal interest rate be?

$$5 = 1 \cdot (10) \cdot (1 - i)$$

$$\Rightarrow 0.5 = 1 - i$$

$$\Rightarrow i = 0.5$$

B) Shock to Investment in the Basic IS-LM Model [24 points]

Consider the following IS-LM model:

$$Y = Z$$

$$Z = C + I + G$$

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

$$I = b_0 + b_1Y - b_2r$$

$$r = i$$

$$i = \bar{i}$$

where C is consumption, I is investment, G is government spending, T is taxes, i is the nominal interest rate, and r is the real interest rate. Initially assume that the central bank sets the nominal interest rate $i = \bar{i}$, and that T and G are exogenous. Note the inflation rate is assumed to be zero, so that the real interest rate equals the nominal interest rate, so $r = i$. Parameters $(c_0, c_1, b_0, b_1, b_2)$ are positive; $c_1, b_1 < 1$; and $c_1 + b_1 < 1$.

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1. [4 points] Solve for equilibrium output Y as a function of the policy variables \bar{i}, G, T and the various parameters.

$$Y = Z = C + I + G = c_0 + c_1(Y - T) + b_0 + b_1Y - b_2\bar{i} + G$$
$$\Rightarrow Y = \frac{1}{1-c_1-b_1} [c_0 + b_0 - c_1T - b_2\bar{i} + G]$$

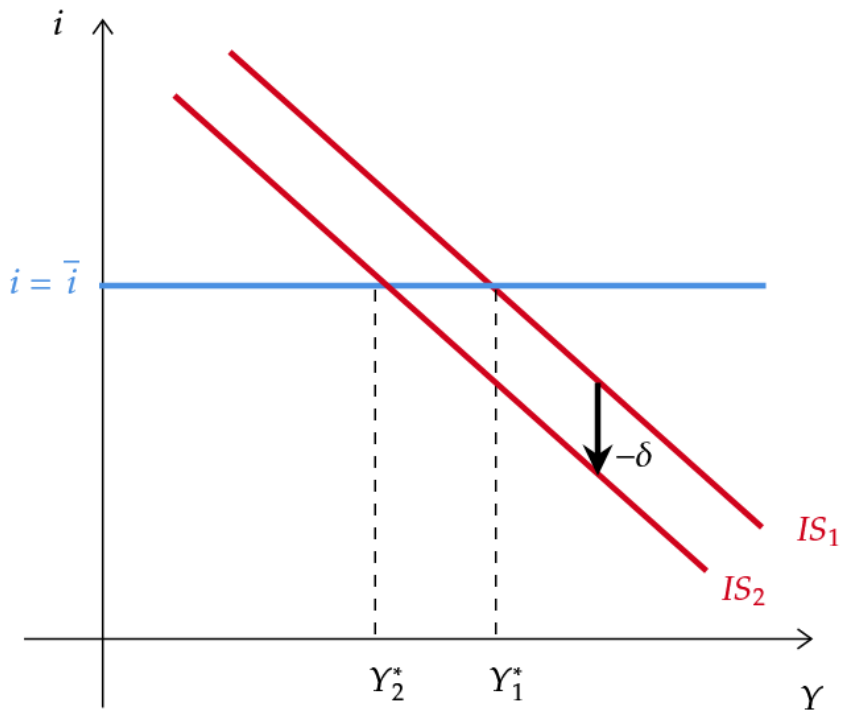
2. [8 points] Holding all else constant, how much does output change in response to a one unit increase in government spending, G ? Holding all else constant, how much does output change in response to a one unit increase in the target interest rate, \bar{i} ?

$$\frac{dY}{dG} = \frac{1}{1-c_1-b_1}$$
$$\frac{dY}{d\bar{i}} = \frac{-b_2}{1-c_1-b_1}$$

3. [8 points] Suppose that investors become more cautious and reduce their investment spending, so the intercept term in the investment equation falls from b_0 to $b_0 - \delta$, for some $\delta > 0$. How much does output change as a result of this shock to investment? Provide an algebraic answer in terms of the various parameters of the economy.

Graph the IS and LM curves and equilibrium both before and after this shock. Make sure to label the axes, the equilibrium level of output before the shock Y_1^* , and the equilibrium level of output after the shock Y_2^* .

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Output changes by $-\frac{\delta}{1-c_1-b_1}$.

4. [4 points] Building on part 3, if the government wants to ensure output is unchanged from its initial level (Y_1^*) even though investment has declined, how much should it adjust taxes in response to this shock?

Using our answer to part 1, taxes need to fall by $\frac{\delta}{c_1}$ to offset the investor caution.

C) Taxation and Budget Balance in the Basic IS-LM Model [13 points]

We now suppose that the government sets a tax schedule given by $T = t_0 + t_1Y$, where t_0 and t_1 are positive parameters. Moreover, assume that the government adjusts government spending G to balance the budget, i.e. the government sets $G = T$. In this case our IS-LM model is given by the following system of equations

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

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$$I = b_0 + b_1 Y - b_2 i$$

$$T = t_0 + t_1 Y$$

$$G = T$$

$$i = \bar{i}$$

where C is consumption, I is investment, G is government spending, T is taxes and i is the nominal interest rate. Assume that the central bank sets the nominal interest rate $i = \bar{i}$. The parameters $(c_0, c_1, b_0, b_1, b_2, t_0, t_1)$ are positive, satisfy $c_1, b_1, t_1 < 1$ and $c_1 + b_1 + t_1 < 1 + c_1 t_1$.

1. [8 points] Solve for equilibrium output Y as a function of \bar{i} and various parameters.

$$Y = Z = C + I + G = c_0 + c_1(Y - T) + b_0 + b_1 Y - b_2 \bar{i} + G$$

$$\Rightarrow Y = \frac{1}{1 - c_1 - b_1} [c_0 + b_0 - c_1 T - b_2 \bar{i} + G]$$

Then using $T = t_0 + t_1 Y$ and $G = T$ we have

$$Y = \frac{1}{1 - c_1 - b_1} [c_0 + b_0 - c_1 t_0 - c_1 t_1 Y - b_2 \bar{i} + t_0 + t_1 Y]$$

Solving for Y ,

$$Y = \frac{1}{1 - c_1 - b_1 + (c_1 - 1)t_1} [c_0 + b_0 + (1 - c_1)t_0 - b_2 \bar{i}]$$

2. [5 points] Suppose the government increases t_0 by one unit. What will be the impact on equilibrium output, Y ? Does equilibrium output increase? Explain your answer.

Y changes by $\frac{1 - c_1}{1 - c_1 - b_1 + (c_1 - 1)t_1}$. Since $c_1 < 1$ and $c_1 + b_1 + t_1 < 1 + c_1 t_1$ this change is positive.

D) Financial Shock in the Extended IS-LM Model [22 points]

Consider the following extended IS-LM model:

$$Y = Z$$

$$Z = C + I + G$$

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

$$I = b_0 + b_1 Y - b_2(i - \pi^e + x)$$

$$i = \bar{i}$$

where C is consumption, I is investment, G is government spending, T is taxes, i is the nominal interest rate, π^e is expected inflation and x is the risk premium. We assume that the central bank

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sets the nominal interest rate $i = \bar{i}$, and that T and G are exogenous. Parameters $(c_0, c_1, b_0, b_1, b_2)$ are positive and satisfy $c_1 + b_1 < 1$.

1. [4 points] Solve for equilibrium output Y as a function of the policy variables \bar{i}, G, T , expected inflation π^e , the risk premium x , and the various parameters.

$$Y = Z = C + I + G = c_0 + c_1(Y - T) + b_0 + b_1Y - b_2(\bar{i} - \pi^e + x) + G$$
$$\Rightarrow Y = \frac{1}{1 - c_1 - b_1} [c_0 + b_0 - c_1T - b_2(\bar{i} - \pi^e + x) + G]$$

2. [6 points] Suppose expected inflation rises by one unit. What is the impact of this change on the equilibrium level of investment? What is the effect on the equilibrium level of consumption?

Using the fact that $\frac{dY}{d\pi^e} = \frac{b_2}{1 - c_1 - b_1}$,

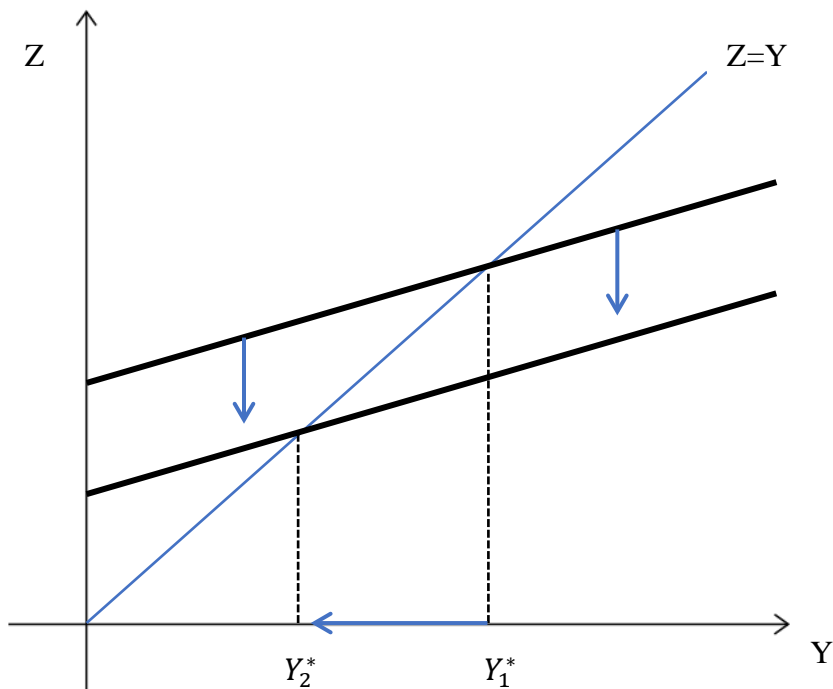
$$\text{For investment: } \frac{dI}{d\pi^e} = b_1 \frac{dY}{d\pi^e} + b_2 = b_1 \frac{b_2}{1 - c_1 - b_1} + b_2.$$

$$\text{For Consumption: } \frac{dC}{d\pi^e} = c_1 \frac{dY}{d\pi^e} = c_1 \frac{b_2}{1 - c_1 - b_1}.$$

3. [8 points] Suppose the risk premium x increases by one unit. By how much does aggregate output change? Plot aggregate demand Z as a function of Y and the equilibrium condition $Z = Y$ both before and after the shock. Make sure to label the axes, the equilibrium level of output before the shock Y_1^* , and the equilibrium level of output after the shock Y_2^* .

$$\frac{dY}{dx} = \frac{-b_2}{1 - c_1 - b_1}$$

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4. [4 points] Suppose the risk premium α increased by 0.1 units and the nominal interest rate \bar{i} is equal to 0.01. What problem will the central bank face if it tries to adjust the nominal interest rate \bar{i} so that this shock has no effect on equilibrium output? Explain briefly why this problem arises.

The central bank would have to decrease the nominal interest rate by 0.1 to keep output unchanged. The central bank would be hitting the zero lower bound. Nominal interest rates cannot go too far below zero because there is an opportunity cost of buying bonds: holding money which has zero return.

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