

## Macroeconomics Exam Questions

## 1. (Labor supply and general equilibrium, 30 points)

Consider a one-period production economy with government. There are infinite households and firms in the economy, and the mass of households and firms are both normalized to one. The household's utility function is

$$u(c, l) = c^{1-\frac{1}{\rho}} + \alpha l^{1-\frac{1}{\rho}},$$

where  $c$  is consumption and  $l$  is leisure. A household can work to obtain wage income, and wage income is equal to the wage rate  $w$  times the working hours  $n$ . A household's endowment of time is normalized to 1, so  $n+l=1$ . Households also own shares of firms, and the dividend payment they receive from firms is  $\pi$ .

There is a government. The government makes an expenditure  $G > 0$ . The expenditure is funded by a lump sum tax,  $\tau$ . The government's budget constraint is

$$G = \tau,$$

and the household's budget constraint is

$$c = wn + \pi - \tau.$$

A firm takes working hours  $n$  as inputs, and its production function is  $F(n) = zn$ , where  $z$  is technology parameter. A firm's profit comes from the revenue of selling output,  $F(n)$ , minus the wage payment  $wn$ . A firm maximizes profit, and the profit is transferred to the households as dividend payments,  $\pi$ .

- (a) (5 points) Solve the firm's profit maximization problem. Explain why the firm's demand curve for labor, denoted by  $N^d(w)$ , is infinitely elastic at  $w = z$ .
- (b) (5 points) Suppose that  $w^*$  is the competitive-equilibrium wage rate. Explain why it is never the case that households optimally choose  $n = 1$  or  $n = 0$  when the wage rate is  $w^*$ .
- (c) (5 points) From your answer in (b), the optimal  $n$  is interior,  $n^* \in (0, 1)$ . Write down all optimization conditions for the household's problem and show that the elasticity of substitution between  $c$  and  $l$  is constant and equal to  $\rho$ . Explain your result.

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- (d) (5 points) Do you agree that the household's supply curve for labor, denoted by  $N^s(w)$ , is upward-sloping? (the y-axis is  $w$  and the x-axis is  $N$ )? How does your answer depend on the parameter,  $\rho$ ? Explain your result.
- (e) (5 points) Explain why the equilibrium output increases if there is an increase in government spending.
- (f) (5 points) Given your answer in (e), suppose that the production function changes from  $F(n) = zn$  to  $F(n) = zn^{0.7}$ . Will the output increase even more? Explain your result.

2. (Overlapping generations model, 35 points)

Consider a production economy with overlapping generations. Inhabitants of this country live for just two time periods. In their first period, they are young and work full time. In the second period, they are old and retired. Although each generation dies after two periods, the economy lasts forever.

At the beginning of each period  $t$ , a new generation is born, called generation  $t$ . Denote the population of generation  $t$  by  $N_t$ . And the previous young generation passes from youth to old age. Hence, in each period  $t$ , there is always a group of young people, with the size  $N_t$ , and a group of old people, with the size  $N_{t-1}$ . Assume that the population grows at a rate  $n$ , so  $N_t = N_{t-1}(1+n)$  for all  $t$ .

Individual household saving and labor supply decisions determine aggregate supplies of capital and labor. Household decisions are summarized as follows. A member of the generation  $t$  chooses his or her lifetime consumption streams,  $(c_{yt}, c_{ot+1})$ , where  $c_{yt}$  denotes consumption when young and  $c_{ot+1}$  denotes consumption when old. He or she takes the wage incomes  $w_t$  and the interest rate,  $r_{t+1}$ , as given, and chooses  $c_{yt}$  and  $c_{ot+1}$  to maximize the utility,

$$u_t = c_{yt}^\alpha c_{ot+1}^{1-\alpha}.$$

subject to

$$c_{yt} + a_{t+1} = w_t$$

$$c_{ot+1} = (1 + r_{t+1})a_{t+1},$$

where  $a_{t+1}$  denotes saving. The total savings of generation  $t$  becomes the economy's total capital supply in the next period. Denote the economy's total capital stock at the beginning

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of time  $t+1$  be  $K_{t+1}$ , thus:

$$K_{t+1} = N_t a_{t+1}.$$

Since young work full time, the total labor supply during period  $t$  is simply the number of young workers at time  $t$ :

$$L_t = N_t.$$

There are infinitely many identical firms in this economy. The demand side of the model is determined by firms' decision to hire the capital and labor supplied by the household sector. Firms maximize profits. A firm's profit at time  $t$  is

$$\text{profit} = F(K_t, L_t) - w_t L_t - r_t K_t,$$

where  $F(K_t, L_t)$  is the production function:

$$F(K_t, L_t) = AK_t^\beta L_t^{1-\beta}.$$

- (a) (5 points) Given  $w_t$  and  $r_{t+1}$ , solve for the optimal  $(c_{yt}, a_{t+1}, c_{ot+1})$  for a household of generation  $t$ .
- (b) (10 points) Derive the law of motion for capital per worker ( $k_t \equiv \frac{K_t}{N_t}$ ). Use a diagram to show the steady state quantity of capital per worker.
- (c) (10 points) Suppose that the economy was initially at a steady state, and the steady state capital per worker is equal to  $k^* > 0$ . An unexpected temporary decrease in the oil occurs at  $t = 5$ , so  $A$  increases at  $t = 5$  then stays at the original level from  $t \geq 6$ . Draw the time path of  $(k_t, r_t, w_t, c_{yt}, c_{ot})$  and explain your result.
- (d) (10 points) Suppose that the economy was initially at a steady state, and the steady state capital per worker is equal to  $k^* > 0$ . An unexpected permanent decrease in the oil occurs at  $t = 5$ , so  $A$  increases at  $t = 5$  then stays at this new level from  $t \geq 6$ . Draw the time path of  $(k_t, r_t, w_t, c_{yt}, c_{ot})$  and explain your result.

### 3. (Open Macro Model, 21 points)

Country Nawiat is a small open economy with perfect capital mobility where the interest rate is determined by the world interest rate. Consider the following events. (A) The country's

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tax revenue was higher than had been planned, and the government decides to pass the extra revenue as tax rebate to households this year. (B) The government announces that it will purchase more weapons *in the future* in order to boost military capacity. Now, suppose the two events happen at the same time. In answering the following questions, the exchange rate is defined as the amount of foreign currency per domestic currency.

- (a) (8 points) Assume a floating exchange rate regime and disregard the Ricardian equivalence. Use the Mundell-Flaming model and the graph (where the exchange rate is on the vertical axis and the output is on the horizontal axis) to analyze the short-run impact of the tax rebate and the announcement effect in the current year. What happens to the country's interest rate, the exchange rate, the capital account, the trade account, and the output? Provide economic explanation to the analysis; the explanation determines the grade.
- (b) (8 points) Following from the above, use the AD-AS and the graph (where the general price level is on the vertical axis and the output is on the horizontal axis) to analyze the tax rebate and the announcement effect. What happens to the country's price level, the output, and the employment? Provide economic explanation to the analysis; the explanation determines the grade.
- (c) (5 points) Now assume households in Nawiat all behave in the way as described in the Ricardian equivalence. How would this added assumption change your short-run effect analysis?

4. (Phillips Curve, 14 points)

The Phillips curve is a diagram showing an inverse relationship between inflation and unemployment. It may be described by

$$\pi_t = \pi_t^e - 0.5(u_t - u_t^n),$$

where  $\pi_t$  is the inflation rate at time  $t$ ,  $\pi_t^e$  is the expected inflation rate,  $u_t$  is the unemployment rate, and  $u_t^n$  is the natural rate of unemployment. The government of Nawiat always maintains that it will do all it could to keep the inflation rate at a fixed low rate (say, 2%).

- (a) (5 points) Scenario A: The government's policy is credible and the public believes in the government's effort. That is, the public's inflation expectation is anchored at 2%. What would be the relationship between  $\pi_t$  and  $u_t$ ? Draw your graph.

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- (b) (5 points) Scenario B: The government has a history of manipulating the public information and so people don't believe in the government's policy goal. Instead, the public forms the inflation expectation by taking the average values in the past two periods. What would be the relationship between  $\pi_t$  and  $u_t$  in this scenario? You may use equations or graphs to explain the answer.
- (c) (4 points) Suppose that due to the Ukraine war and the disruption of the global supply chain, Nawiat's inflation rate and unemployment rate are both pushed higher. (1) How do these exogenous shocks affect the Phillips curve on the graph? (2) Suppose the government decides to raise the interest rate to fight the inflation. In which scenario would the government be more likely to succeed? Why? Your explanation determines the grade.

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