Macroeconomics 2026
Shanghai Jiao Tong University
Summer School 2026
Quiz 2
With Solutions

Reading time: 10 minutes. **Writing time:** 60 minutes.

Total marks: 100. **Calculators are permitted.**

Instructions: Answer **all** questions. In Section A, circle the letter of the single best answer. In Sections B and C, show your working and write in clear sentences.

Structure:

- **Section A** — Multiple choice: 20 questions, 2.5 marks each (**50 marks**).
- **Section B** — One analytical problem in five parts (**30 marks**).
- **Section C** — One short interpretation (**20 marks**).

Useful formulas. Solow: $\Delta K_{t+1} = \bar{s}Y_t - \bar{d}K_t$; steady state $k^* = (\bar{s}\bar{A}/\bar{d})^{3/2}$, $y^* = \bar{A}^{3/2}(\bar{s}/\bar{d})^{1/2}$; Romer $g_y = \bar{z}\,\bar{\ell}\,\bar{L}$; Jones $g_y = \lambda\bar{n}/(1-\phi)$; bathtub $u^* = \dfrac{\bar{s}}{\bar{s}+\bar{f}}$, average spell $= 1/\bar{f}$; quantity theory $M_tV_t = P_tY_t$, $\pi = g_M + g_V - g_Y$ (with $g_V = 0$: $\pi = g_M - g_Y$); Fisher $i = r + \pi^e$.

Section A: Multiple Choice (20 questions × 2.5 marks = 50 marks)

1. In the Solow model, the capital stock changes according to $\Delta K_{t+1} = \bar{s}Y_t - \bar{d}K_t$. The two terms on the right are:

(A) consumption and investment.

(B) taxes and government spending.

(C) new investment and depreciation.

(D) exports and imports.

Solution. (C). Capital rises by the new machines built each year, the saved share $\bar{s}$ of output, and falls by the machines that wear out, the fraction $\bar{d}$ of the existing stock. The capital stock is a bathtub filled by investment and drained by depreciation; every Solow result follows from this one line.

2. The Solow economy reaches its steady state at exactly the capital stock where:

(A) total output exactly equals consumption.

(B) household saving equals total consumption.

(C) new investment equals depreciation.

(D) the capital stock equals the labour force.

Solution. (C). The steady state is where the inflow matches the outflow: $\bar{s}\bar{A}k^{1/3} = \bar{d}k$, new machines just replacing worn-out ones, so the stock stops changing. Because investment bends (diminishing returns) while depreciation is a straight line, the two must cross, and the economy settles where they do.

3. Once a Solow economy has reached its steady state, the growth rate of income per person from capital accumulation alone is:

(A) about 2% a year.

(B) zero.

(C) equal to the saving rate.

(D) slowly declining.

Solution. (B). The growth rate is exactly zero, not merely slow. At the steady state, investment only replaces wear and tear, so capital, output and income per person all stop growing. Yet the United States has grown about 2% a year for over a century; that standing contradiction is precisely why growth must come from somewhere machines cannot supply, which is the ideas half of the lecture.

4. A country permanently raises its saving rate $\bar{s}$. According to the Solow model, in the long run this produces:

(A) a permanently faster rate of growth in income per person.

(B) a higher level of income, with growth returning to zero.

(C) a permanently lower stock of capital and income per person.

(D) no change of any kind in either the level or the growth rate.

Solution. (B). A level effect, not a growth effect: the economy climbs to a higher resting point, growing during the transition, and then growth falls back to zero at the new, higher level. From $y^* = \bar{A}^{3/2}(\bar{s}/\bar{d})^{1/2}$, doubling $\bar{s}$ multiplies income by $\sqrt{2}$, about 41% more, not 100%: remember the square root.

5. Germany and Japan grew unusually fast in the decades just after 1945. In the Solow model this is because:

(A) an economy far below its resting point grows fast as it returns.

(B) wartime destruction permanently raises productivity.

(C) their saving rates fell sharply in the years after the war.

(D) their steady states themselves had been destroyed by the war.

Solution. (A). The war destroyed a large share of the capital stock, pushing both economies far below their steady states. The catch-up rule then applies: the further below the resting point, the faster the growth, fading as the gap closes. They returned to the *same* steady state; nothing about the destination changed, only the distance from it.

6. In the data since 1960, incomes have clearly converged:

(A) across essentially every country in the world, rich and poor alike.

(B) nowhere in the data, whether among rich countries or poor ones.

(C) among the rich (OECD) countries, but not across the whole world.

(D) only among the very poorest countries in the world sample.

Solution. (C). Among rich countries, those that started poorer in 1960 grew faster: a clear downward slope. Across the whole world there is no such slope, because most poor countries are not below their resting points and racing back; their resting points are themselves low. Poverty is usually a low destination, not a delayed journey.

7. The Golden Rule saving rate, the one that maximises long-run consumption per person, equals:

(A) capital's share of income, one-third.

(B) labour's share of income, two-thirds.

(C) the depreciation rate of capital.

(D) one-half of national income.

Solution. (A). Saving more always raises steady-state *output*, but past a point the extra output is eaten by maintaining the larger capital stock. Consumption $c = (1-s)y^*$ peaks when the saving rate equals capital's income share, the exponent on K: one-third.

8. An idea, unlike a machine, is *nonrival*. This means:

(A) it is expensive to produce the first time.

(B) the law can prevent others from using it.

(C) it wears out with intensive use.

(D) any number of people can use it at the same time.

Solution. (D). A machine must be shared out, one user at a time; a recipe, formula or design can be used by everyone at once and never wears out. That is nonrivalry, a fact of nature. Option (B) is *excludability*, a choice of law (a patent); the deck's warning is not to mix the two up. Nonrivalry is what lets ideas escape diminishing returns and sustain growth.

9. In the bathtub model, the separation rate is $\bar{s} = 1\%$ per month and the job-finding rate is $\bar{f} = 19\%$ per month. The natural rate of unemployment is:

(A) 1%.

(B) 19%.

(C) 20%.

(D) 5%.

Solution. (D). $u^* = \dfrac{\bar{s}}{\bar{s}+\bar{f}} = \dfrac{1}{1+19} = \dfrac{1}{20} = 5\%$. In the long run the flow into unemployment ($\bar{s}$ of the employed) balances the flow out ($\bar{f}$ of the unemployed), and only the two flow rates matter; the size of the labour force does not appear.

10. If the job-finding rate is $\bar{f} = 25\%$ per month, the average completed spell of unemployment lasts about:

(A) one month.

(B) four months.

(C) twenty-five months.

(D) one year.

Solution. (B). The average spell is $1/\bar{f} = 1/0.25 = 4$ months: if a quarter of the unemployed find work each month, the typical wait is four months. This is why the job-finding rate is the dial that controls how *long* unemployment lasts, not how often it starts.

11. During a deep recession, many discouraged workers stop searching for jobs. As a result, the measured unemployment rate can:

(A) rise even though hiring is strong.

(B) fall even though nobody found a job.

(C) never change.

(D) exceed the participation rate.

Solution. (B). A person who stops searching leaves the labour force, shrinking the numerator *and* the denominator of the unemployment rate, so the rate can fall for a bad reason. Watch the denominator: read the unemployment rate alongside the participation rate and the employment-population ratio, whose denominators cannot shrink when people give up.

12. Since about 1980, European unemployment has sat well above American unemployment. The bathtub-model account taught in the lecture is:

(A) Europeans lose their jobs much more often than Americans do.

(B) Europe's labour force is considerably older than America's.

(C) Europe's unemployed take longer to find the next job.

(D) America measures its unemployment in a more flattering way.

Solution. (C). The inflow is much the same but the outflow is slower. The separation rates are similar; what differs is the job-finding rate, roughly halved in Europe by long, generous benefits and high firing costs that make firms cautious about hiring. Halving $\bar{f}$ nearly doubles u^* and doubles the average spell: unemployment in Europe is not more frequent, it is longer.

13. Laws that make dismissing a worker very costly reduce job separations, yet they can *raise* the natural rate of unemployment, because they also:

(A) increase the size of the labour force year after year.

(B) raise the separation rate for the workers who remain.

(C) shrink the working-age population steadily over time.

(D) make firms slower to hire, cutting the job-finding rate.

Solution. (D). Firing costs turn each hire into a long commitment, so firms hire cautiously and $\bar{f}$ falls along with $\bar{s}$. In $u^* = \bar{s}/(\bar{s}+\bar{f})$, if the drain slows proportionally more than the tap, the water level rises: the European pattern. Protecting existing jobs and keeping unemployment low are not the same policy.

14. In 1914 Henry Ford doubled his workers' pay to five dollars a day, and turnover and absenteeism collapsed. The lecture uses this episode to illustrate:

(A) the minimum wage.

(B) collective bargaining.

(C) the lump-of-labour fallacy.

(D) efficiency wages.

Solution. (D). An efficiency wage is a wage set *above* the going rate because it pays for itself: better-paid workers work harder, quit less, and queue for the jobs. Ford called it one of his best cost-cutting moves. The queue it creates is also a reason unemployment can persist even in good times.

15. Money grows at 8% a year, real output grows at 3%, and velocity is constant. Long-run inflation is:

(A) 11%.

(B) 5%.

(C) 8%.

(D) 3%.

Solution. (B). From $\pi = g_M + g_V - g_Y$ with $g_V = 0$: $\pi = 8 - 3 = 5\%$. Money growth beyond what the real economy needs for its extra transactions ends up in prices. Keep the velocity term in view: if a panic made people hold more cash (velocity falling), the middle term would return.

16. "Money is neutral" is a claim that, *in the long run*, doubling the money supply:

(A) doubles prices and changes no real quantity.

(B) doubles both prices and real output.

(C) halves the price level in the long run.

(D) doubles real output while prices stay fixed.

Solution. (A). In the long run the real side of the economy (capital, ideas, institutions) determines output, and money determines only the units prices are quoted in: double M, double P, with relative prices and real choices unchanged. The claim is long run only; in the short run prices are sticky, which is where the later lectures pick up the story.

17. The real interest rate is 2% and expected inflation is 4%. By the Fisher equation, the nominal interest rate is:

(A) 2%.

(B) 8%.

(C) 6%.

(D) -2%.

Solution. (C). $i = r + \pi^e = 2 + 4 = 6\%$. The nominal rate is quoted in money, the real rate in goods; expected inflation is the wedge between them. Lenders build the inflation they *expect* into i, which is why only inflation *surprises* redistribute wealth.

18. Inflation turns out much higher than anyone expected. The main redistribution is from:

(A) lenders to borrowers.

(B) borrowers to lenders.

(C) young workers to old workers.

(D) exporters to importers.

Solution. (A). Debts are written in money, so surprise inflation lets borrowers repay in money that buys less: the homeowner with a fixed-rate mortgage gains, the bank and the retiree on a fixed pension lose. *Anticipated* inflation does not do this, because it is already priced into the nominal rate by the Fisher equation.

19. The *inflation tax* is paid mainly by:

(A) owners of shares, gold and real estate.

(B) firms that export most of their production.

(C) workers whose wages are indexed to prices.

(D) people holding cash and fixed nominal claims.

Solution. (D). When the government prints money to pay its bills, the price level rises and the purchasing power of existing cash falls: if prices double, \$200 in your pocket buys what \$100 used to. No law is passed and nobody votes, but holders of currency and fixed nominal claims have been taxed. Holders of real assets (A) largely escape.

20. "Inflation is always and everywhere a monetary phenomenon" (Friedman), yet "persistent high inflation is always and everywhere a fiscal phenomenon" (Sargent). These two claims are:

(A) compatible: money is the mechanism, the budget is the motive.

(B) contradictory: at most one of the two claims can be true.

(C) statements about the short run only, with no long-run content.

(D) both rejected by the historical evidence on inflations.

Solution. (A). Friedman describes the *proximate* cause: sustained inflation requires sustained money growth. Sargent asks why the printing happens: in every great inflation, a government that could not tax or borrow was covering its deficit with the press. Money is the lever; fiscal need is the hand that pulls it. That is also why hyperinflations stop suddenly the day the budget is credibly fixed.

Section B: Analytical Problem (30 marks)

Consider one economy, examined desk by desk. Its production side follows the Solow model with $\bar{s} = 0.3$, $\bar{A} = 1$, $\bar{d} = 0.1$. Its labour market has a monthly separation rate $\bar{s}_\ell = 1.5\%$ and a monthly job-finding rate $\bar{f} = 28.5\%$. Its central bank lets money grow at $g_M = 9\%$ a year while real output grows at $g_Y = 4\%$; velocity is constant. The long-run real interest rate is $r = 3\%$.

(a) **[6 marks]** Find the steady-state capital per person k^* and income per person y^*.

(b) **[6 marks]** The government doubles the saving rate to $\bar{s} = 0.6$. Find the new y^*, state the percentage gain, and explain in one sentence what happens to the *growth rate* of income per person in the long run.

(c) **[6 marks]** Find the natural rate of unemployment u^* and the average length of an unemployment spell.

(d) **[6 marks]** Find the long-run inflation rate, and the nominal interest rate implied by the Fisher equation (take expected inflation equal to your answer).

(e) **[6 marks]** Inflation instead comes in at 9%, surprising everyone. Compute the ex-post real return earned by someone who lent at the nominal rate from part (d), and say who gained and who lost.

Solution. (a) $k^* = \left(\dfrac{\bar{s}\bar{A}}{\bar{d}}\right)^{3/2} = \left(\dfrac{0.3}{0.1}\right)^{3/2} = 3^{3/2} = \mathbf{5.20}$, and $y^* = \bar{A}^{3/2}\left(\dfrac{\bar{s}}{\bar{d}}\right)^{1/2} = \sqrt{3} = \mathbf{1.73}$. At this capital stock, new investment $\bar{s}\bar{A}k^{1/3}$ exactly covers depreciation $\bar{d}k$, so the stock, and income, stop changing.

(b) With $\bar{s} = 0.6$: $y^* = \sqrt{0.6/0.1} = \sqrt{6} = \mathbf{2.45}$. The gain is $\sqrt{6}/\sqrt{3} = \sqrt{2} \approx +\mathbf{41}\%$: doubling the saving rate raises income by the square root of two, not by a factor of two. The long-run *growth rate* is unchanged: after a burst of growth during the transition, it returns to **zero** at the new, higher level. Saving buys a level, never a lasting growth rate.

(c) $u^* = \dfrac{\bar{s}_\ell}{\bar{s}_\ell + \bar{f}} = \dfrac{1.5}{1.5 + 28.5} = \dfrac{1.5}{30} = \mathbf{5}\%$. Average spell $= 1/\bar{f} = 1/0.285 \approx \mathbf{3.5}$ months. The two flow rates fully determine both numbers; the size of the labour force never enters.

(d) $\pi = g_M - g_Y = 9 - 4 = \mathbf{5}\%$ (velocity constant, so $g_V = 0$). Fisher: $i = r + \pi^e = 3 + 5 = \mathbf{8}\%$. The lender quotes 8% in money to earn 3% in goods.

(e) Ex-post real return $= i - \pi = 8 - 9 = -\mathbf{1}\%$. The lender expected 3% in real terms and actually *lost* 1%: four points of real wealth moved from the lender to the borrower. Surprise inflation is a transfer machine; it is the surprise, not the inflation, that redistributes, because anticipated inflation was already priced into the 8%.

Section C: Interpretation (20 marks)

Read the following and answer in **no more than five sentences**. Use the concepts from the course; you do not need any calculation.

A laboratory spends two and a half billion dollars, over a decade, discovering the formula for a new vaccine. Once the formula exists, any competent factory can produce a dose for about two dollars, and the formula itself can be used by every factory on Earth at the same time without being used up. A politician argues: "The formula already exists, and copying it costs nothing. The fair policy is to let every producer use it immediately, free of charge, so each dose sells at two dollars."

Question [20 marks]. Using the economics of ideas from the course, explain what is right about the politician's reasoning, what it overlooks, and why societies deliberately grant temporary monopolies (patents) over discoveries like this one. Answer in at most five sentences.

Solution. Model answer (nonrivalry, increasing returns, and the patent trade-off). The politician is right about the economics of the formula itself: an idea is **nonrival**, so once discovered it can be used by every factory at once, and pricing each dose at its two-dollar production cost would spread its benefits most widely today. What this overlooks is the $2.5 billion that had to be spent *before* the first dose existed: with price forced down to production cost, no revenue can ever recover the discovery cost, so under such a policy the rational laboratory never makes the discovery, and there is no formula to share. This is the problem of **increasing returns**: a large fixed cost of invention followed by cheap copies means competition at marginal cost cannot pay for invention. A **patent** answers it by making the idea *excludable* for a limited time, a choice of law layered on top of nature, allowing a price above cost that rewards the discovery, at the acknowledged price that some who need the dose today cannot afford it. Societies accept this temporary loss because the alternative, no new formulas at all, is worse: the patent is the deal that keeps ideas coming.

Marking guide (20 marks).

- **8 marks** — states the idea is **nonrival** (usable by all at once, never used up) and that at two dollars a dose the benefits spread widely: the correct part of the claim.
- **6 marks** — identifies the flaw: the **fixed cost of discovery** cannot be recovered at marginal-cost pricing (increasing returns), so free copying removes the incentive to invent.
- **4 marks** — explains the patent as chosen, temporary **excludability**: a price above cost that rewards invention, traded against reduced access today; distinguishes nonrival (nature) from excludable (law).
- **2 marks** — clear writing within the five-sentence limit.

Answers that only defend or only attack the politician earn partial credit: the question asks for both halves of the trade-off.