Macroeconomics 2026
Shanghai Jiao Tong University
Summer School 2026
Quiz 1
With Solutions

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

Total marks: 100. **Calculators are NOT permitted.** Every calculation is designed to be done by hand.

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**).

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

1. Which of the following is the correct definition of gross domestic product (GDP)?

(A) The market value of all *final* goods and services *produced within a country* in a given period.

(B) The market value of all final goods and services *sold* within a country in a given period.

(C) The market value of all final goods and services produced by a country's *citizens* in a given period.

(D) The total *quantity* of *all* goods and services produced within a country in a given period.

Solution. (A). Every word is chosen with care. GDP counts *production*, not sales, so newly produced goods added to inventory count even if unsold, while the resale of an old good does not (B is wrong). It counts output *within a country's borders*, whoever owns the firm; counting by nationality instead gives GNP, not GDP (C). And it is a *market value* of *final* goods: adding up quantities of unlike goods is meaningless, and counting all goods (including intermediate ones) would double-count (D).

2. Which of the following transactions is included in *this year's* GDP?

(A) A family buys a 20-year-old house from another family.

(B) A firm builds and installs a new piece of factory machinery this year.

(C) An investor buys \$10,000 of shares in a listed company.

(D) The government sends a pension payment to a retired teacher.

Solution. (B). New machinery is current-period production of a capital good, so it enters GDP as investment I. The 20-year-old house was produced long ago (only the estate agent's fee would count now); buying shares is a swap of financial assets, which economists call saving, not investment; and a pension is a transfer payment, which buys no new production.

3. In the national accounts, "investment" (I) means:

(A) buying stocks and bonds.

(B) any purchase made by the government.

(C) household spending on durable goods such as cars.

(D) firms' purchases of new capital goods, such as machines and new buildings.

Solution. (D). In economics, investment means newly produced capital goods (plant, equipment, new housing, added inventories), not the everyday sense of "buying financial assets." Buying shares (A) is saving; government purchases (B) are G; and household car purchases (C) are consumption C.

4. An economy has consumption $C = 60$, investment $I = 20$, government purchases $G = 25$, exports $= 10$ and imports $= 15$ (all in billions). Using $Y = C + I + G + NX$, its GDP is:

(A) 130

(B) 115

(C) 100

(D) 105

Solution. (C). $C+I+G = 105$, and net exports NX = exports$-$imports $= 10-15 = -5$, so $Y = 105 + (-5) = 100$. Option (A) adds imports instead of subtracting them; (D) forgets net exports altogether; (B) adds exports but forgets imports. The country runs a trade deficit, which subtracts from GDP.

5. A farmer grows wheat and sells it to a miller for \$30. The miller grinds flour and sells it to a baker for \$50. The baker makes bread and sells it to shoppers for \$90. How much do these activities add to GDP?

(A) \$90

(B) \$170

(C) \$60

(D) \$40

Solution. (A). Counting only the *final* good (bread) gives \$90. Equivalently, sum the value added at each stage: \$30 (farmer) + \$20 (miller, $50 - 30$) + \$40 (baker, $90 - 50$) = \$90. Option (B), \$170, double-counts by adding every sale ($30 + 50 + 90$); the wheat and flour are intermediate goods already embodied in the bread.

6. An economy produces only cars. In 2025 it made 100 cars at \$20,000 each; in 2026 it made 110 cars at \$22,000 each. Measured at constant 2025 prices, *real* GDP growth from 2025 to 2026 is:

(A) 21%

(B) 10%

(C) 0%

(D) 31%

Solution. (B). Real GDP holds prices fixed at 2025 levels, so only quantities move it: $110 \times \$20{,}000 = \$2.2\text{m}$ against $100 \times \$20{,}000 = \$2.0\text{m}$, a rise of 10%, exactly the growth in the number of cars. Option (A), 21%, is *nominal* growth ($\$2.42\text{m}/\$2.0\text{m} - 1$), which wrongly mixes in the price rise.

7. A country's income per person grows at a steady 7% a year. Using the Rule of 70, about how long does income per person take to double?

(A) About 35 years

(B) About 14 years

(C) About 49 years

(D) About 10 years

Solution. (D). Doubling time $\approx 70/g = 70/7 = 10$ years. (For comparison, a 2% economy doubles about every 35 years and a 5% economy about every 14 years, which is why small, sustained differences in the growth rate compound into large gaps in living standards.)

8. A country's total real GDP grows at 6% a year while its population grows at 2% a year. Since total GDP = GDP per person × population, GDP per person grows at about:

(A) 12%

(B) 8%

(C) 4%

(D) 3%

Solution. (C). For a product, growth rates *add*, so $g_Y = g_{Y/L} + g_L$, which rearranges to $g_{Y/L} = g_Y - g_L = 6\% - 2\% = 4\%$. Living standards track this per-person figure: total output can rise simply because there are more people.

9. When a country's GDP per person is plotted on a ratio (logarithmic) scale, a variable growing at a *constant percentage rate* appears as:

(A) a straight line, whose slope equals the growth rate.

(B) an upward-bending curve that gets steeper over time.

(C) a downward-sloping line.

(D) a flat, horizontal line.

Solution. (A). On a ratio scale the axis marks equal *ratios* $(1, 2, 4, 8)$ as equal distances, so constant proportional growth is a straight line and its slope is the growth rate. On an ordinary scale (B) the same series bends upward, because a constant percentage of an ever larger base is a rising absolute increase.

10. The Big Mac index, published by *The Economist*, uses the price of one standardised product to:

(A) measure how much inflation a country has each year.

(B) gauge whether a currency is over- or undervalued relative to purchasing power parity.

(C) rank countries by the quality of their fast food.

(D) measure the cost of producing beef in different countries.

Solution. (B). The Big Mac is nearly the same product everywhere, built from similar local ingredients and labour. If purchasing power parity held, it would cost the same in every country once converted to dollars; a large gap therefore signals that a currency is cheap (undervalued) or dear (overvalued) relative to PPP. It is a light, one-good version of the PPP idea, not a measure of inflation or of beef costs.

11. A Big Mac costs \$6.00 in the United States and 30 yuan in China, and the market exchange rate is 6 yuan per dollar. Judged by the Big Mac index, the yuan is:

(A) overvalued, because 30 yuan is a larger number than 6 dollars.

(B) correctly valued, because the burger costs the same once converted.

(C) overvalued by about 20%.

(D) undervalued, because the burger costs about \$5 in China against \$6 in the United States.

Solution. (D). Convert the Chinese price at the market rate: $30 \div 6 = \$5$, cheaper than the \$6 U.S. burger, so the same good is cheaper in China and the yuan is undervalued. Equivalently, the burger-implied PPP rate is $30/\$6 = 5$ yuan per dollar; since the market actually charges 6 yuan per dollar, it takes *more* yuan to buy a dollar than PPP suggests,

again meaning the yuan is undervalued. Option (A) compares raw numbers in different currencies, which is meaningless.

12. Converting China's GDP into dollars at the *market exchange rate* rather than at *purchasing power parity* (PPP) makes China's output look smaller. The main reason is that:

(A) China deliberately keeps its currency strong to look richer.

(B) PPP comparisons leave out services such as haircuts.

(C) many goods and services, such as haircuts and housing, are cheaper where wages are lower, so market rates undervalue what poorer countries produce.

(D) the market exchange rate counts only exports, not domestic output.

Solution. (C). A haircut is the same service everywhere but costs far less where wages are low. Market exchange rates value such non-traded services almost at nothing for lower-wage economies, biasing the comparison downward. PPP instead values output at common prices, so China rises from about 67% of U.S. GDP at market rates to about 98% at PPP. Option (A) is the opposite of reality.

13. Compared with a purchasing-power-parity (PPP) comparison, converting incomes at market exchange rates tends to:

(A) overstate the gap in living standards between rich and poor countries.

(B) understate the gap between rich and poor countries.

(C) leave the measured gap unchanged.

(D) make all countries appear equally rich.

Solution. (A). Rich countries have higher price levels and poor countries lower ones, mainly because of wage differences. Market exchange rates therefore make poor countries look even poorer than their real output, overstating the gap; PPP corrects the prices and narrows it. Option (D) is nonsense: PPP corrects prices, it does not equalise output.

14. Output is produced with $Y = \bar{A}\,K^{1/3}L^{2/3}$. If a country doubles *both* its capital K and its labour L (holding $\bar{A}$ fixed), output:

(A) more than doubles.

(B) exactly doubles.

(C) less than doubles.

(D) stays the same.

Solution. (B). Scaling both inputs by 2 multiplies output by $2^{1/3} \cdot 2^{2/3} = 2^{1/3+2/3} = 2$, so output exactly doubles. This is constant returns to scale, and it holds because the exponents sum to one. The replication argument gives the intuition: build a second identical factory beside the first and you get twice the output.

15. Using output per worker $y = \bar{A}\, k^{1/3}$, a country with *eight times* as much capital per worker as another (and the same productivity $\bar{A}$) produces about how many times as much output per worker?

(A) 8 times.

(B) 24 times.

(C) about 1.5 times.

(D) 2 times.

Solution. (D). Because capital per worker enters as a cube root, $(8)^{1/3} = 2$: eight times the capital yields only twice the output per worker. This is diminishing returns to capital, and it is exactly why capital differences alone cannot explain the huge income gaps we observe across countries.

16. With $Y = \bar{A}\, K^{1/3} L^{2/3}$ and competitive factor markets, the share of total income paid to *capital* is:

(A) two-thirds, the exponent on labour.

(B) it depends on the level of productivity $\bar{A}$.

(C) one-third, equal to the exponent on capital.

(D) one-half, split evenly with labour.

Solution. (C). With each factor paid its marginal product, capital earns $MPK \cdot K = \frac{1}{3}\frac{Y}{K} \cdot K = \frac{1}{3}Y$, so its income share is the exponent $\frac{1}{3}$; labour earns the remaining $\frac{2}{3}$. The shares equal the Cobb–Douglas exponents whatever the level of $\bar{A}$ or the amounts of capital and labour, matching the stable two-thirds labour share in the data.

17. Which statement about $Y = \bar{A}\, K^{1/3} L^{2/3}$ is correct?

(A) Because each exponent is less than one, it has decreasing returns to scale.

(B) It has constant returns to scale in K and L together, yet the marginal product of capital diminishes as K rises with L held fixed.

(C) It has increasing returns to scale because both exponents are positive.

(D) The marginal product of capital is constant, because the exponent on K is fixed at one-third.

Solution. (B). Scaling *both* inputs together multiplies output by the same factor (the exponents sum to one), so returns to scale are constant. But adding capital *alone*, with labour fixed, raises output by less and less: $MPK = \frac{1}{3}\bar{A}K^{-2/3}L^{2/3}$ is positive but falling in K. Constant returns to all inputs together and diminishing returns to a single input are perfectly consistent, and this is the central property of the production model.

18. Development accounting compares rich and poor countries using $y = \bar{A}\,k^{1/3}$. Its central finding is that, of the large gaps in income per person between rich and poor countries:

(A) differences in capital per person explain about one-third, and differences in total factor productivity (TFP) explain about two-thirds.

(B) differences in capital per person explain almost all of the gap.

(C) differences in TFP explain almost none, once capital is measured properly.

(D) capital and TFP each explain exactly one-half.

Solution. (A). Because capital enters as a cube root, even large capital gaps map into modest predicted income gaps, so capital per person alone accounts for only about a third of the observed differences. Backing out the residual $\bar{A} = y/k^{1/3}$ shows TFP, how efficiently inputs are used, explains the other two-thirds. Rich countries are rich mostly because they use their inputs more productively, not simply because they own more machines.

19. North and South Korea share the same geography, climate, culture and history, and were one country until 1948. Today the South is among the world's richest economies and the North among the poorest. Economists usually explain this contrast mainly by differences in:

(A) natural resources and geography.

(B) religion and culture.

(C) population size.

(D) institutions: the rules, property rights and policies that govern the economy.

Solution. (D). The two Koreas hold geography, climate, culture and history roughly constant, so those cannot be the source of so vast a gap. What differs is institutions, the rules and policies that decide how productively an economy uses its people and resources. Institutions are one of the deepest reasons total factor productivity differs across countries; the divided Germany before 1989 tells the same story.

20. After 1950, Germany and Japan grew very fast for several decades and then slowed as their incomes approached those of the richest countries, settling at around three-quarters of the U.S. level. This catch-up pattern suggests that:

(A) fast-growing economies always overtake the leaders.

(B) a country's growth rate never changes over time.

(C) a country far below the frontier can grow quickly by adopting technology that already works elsewhere, but growth based on piling up capital slows as diminishing returns set in.

(D) catch-up growth, once it begins, continues forever.

Solution. (C). Being behind can itself be a source of fast growth, because a poor country can adopt technology and methods the leaders already use; this is convergence. But growth driven by capital accumulation runs into diminishing returns, so the pace eventually slows, which is exactly why Germany and Japan levelled off rather than overtaking the United States. It is the open question for every fast-growing, capital-driven economy.

Section B: Analytical Problem (30 marks)

An economy produces a single good with the Cobb–Douglas technology

$$Y = \bar{A}\, K^{1/3} L^{2/3},$$

where Y is output, K is capital, L is labour, and $\bar{A}$ is total factor productivity. Factor markets are competitive, and output is the numeraire (its price is 1). Take productivity $\bar{A} = 12$, capital $K = 8$ and labour $L = 8$.

Useful values: $8^{1/3} = 2$ *and* $8^{2/3} = 4$. *No calculator is needed anywhere in this question.*

(a) **[6 marks]** Compute total output Y. Then suppose the economy doubles *both* its capital and its labour, to $K = 16$ and $L = 16$. Using constant returns to scale, state the new level of output *without* recomputing any cube roots, and explain in one sentence why you are allowed to do this.

(b) **[6 marks]** With competitive markets, capital is paid its marginal product $r = \frac{1}{3} Y/K$ and labour is paid $w = \frac{2}{3} Y/L$. Using the original figures ($\bar{A} = 12,\ K = 8,\ L = 8$), compute r and w, verify that factor payments exhaust output ($rK + wL = Y$), and state the share of income going to capital and to labour.

(c) **[6 marks]** Write output per worker as $y \equiv Y/L = \bar{A}\, k^{1/3}$, where $k \equiv K/L$. Country R has *eight times* the capital per worker of Country P, and the two share the same productivity $\bar{A}$. How many times as much output per worker does the model predict for R? Explain what this shows about diminishing returns to capital.

(d) **[6 marks]** In fact Country R produces *eight times* as much output per worker as Country P. Since capital alone (from part c) predicts only a two-fold gap, what must be true about the two countries' productivities? Compute the ratio $\bar{A}_R/\bar{A}_P$, and write the eight-fold income gap as (a capital factor) $\times$ (a productivity factor).

(e) **[6 marks]** Growth accounting splits output growth as $g_Y = g_A + \frac{1}{3} g_K + \frac{2}{3} g_L$. An economy's capital grows at 6% a year and its labour at 3% a year, while its productivity is flat ($g_A = 0$). (i) Compute the growth rate of output. (ii) This economy is accumulating capital quickly, but its growth is expected to slow as diminishing returns set in. Which term in the equation must rise for growth to be sustained, and what does raising it mean in practice?

Solution. (a) $Y = 12 \times 8^{1/3} \times 8^{2/3} = 12 \times 2 \times 4 = \mathbf{96}$. Doubling both inputs doubles output, to **192**, because the technology has constant returns to scale (the exponents sum to one): scaling K and L by 2 scales Y by $2^{1/3+2/3} = 2$. No cube roots of 16 are needed.

(b) $r = \frac{1}{3} \cdot \frac{96}{8} = \frac{1}{3} \cdot 12 = \mathbf{4}$ and $w = \frac{2}{3} \cdot \frac{96}{8} = \frac{2}{3} \cdot 12 = \mathbf{8}$. Check: $rK + wL = 4 \times 8 + 8 \times 8 = 32 + 64 = 96 = Y$. Factor payments exactly exhaust output (zero economic profit), and the shares are $rK/Y = 32/96 = \frac{1}{3}$ to capital and $wL/Y = 64/96 = \frac{2}{3}$ to labour, equal to the exponents.

(c) $\dfrac{y_R}{y_P} = \left(\dfrac{k_R}{k_P}\right)^{1/3} = 8^{1/3} = \mathbf{2}$. Eight times the capital per worker gives only twice the output per worker. Because capital enters as a cube root, each extra unit of capital adds less than the one before: this is diminishing returns to capital.

(d) If capital alone predicts a factor of 2 but R is actually 8 times richer, the difference must be productivity. The TFP ratio is $\dfrac{\bar{A}_R}{\bar{A}_P} = \dfrac{\text{actual}}{\text{capital-predicted}} = \dfrac{8}{2} = \mathbf{4}$. So the income gap splits as $8 = \underbrace{2}_{\text{capital}} \times \underbrace{4}_{\text{TFP}}$: capital contributes a factor of two, and productivity a factor of four. Being rich is mainly about productivity.

(e) (i) $g_Y = 0 + \frac{1}{3}(6\%) + \frac{2}{3}(3\%) = 2\% + 2\% = \mathbf{4}\%$. (ii) The term that must rise is g_A, the growth of total factor productivity. In practice that means moving beyond simply adding capital toward raising productivity, through new technology, innovation, stronger institutions and a shift into higher-value-added activities; capital accumulation alone runs into diminishing returns and cannot sustain growth indefinitely.

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.

An economy grew rapidly for about thirty years. It did so mainly by saving and investing an enormous share of its output, building factories, roads, ports and housing, and by moving millions of workers out of agriculture and into industry, so that its capital per worker climbed year after year. Even so, an average worker there still produces far less per hour than a worker in the richest economies, and in the last few years the economy's growth has slowed noticeably, although it continues to invest heavily. Some observers expect it to keep converging on the living standards of the richest countries; others think it will level off well below them, as several once fast-growing economies did in the past.

Question [20 marks]. What single, deeper factor would most economists point to as decisive for whether this economy keeps catching up, and why is continuing to add capital alone unlikely to be enough? Explain in at most five sentences.

Solution. Model answer (the decisive factor is total factor productivity). The decisive factor is total factor productivity (TFP), that is, how efficiently the economy turns its inputs into output rather than how much capital it piles up. Capital has diminishing returns, so once an economy already has a great deal of capital per worker, each additional unit adds less and less output, and growth driven purely by investment must slow, which is what this economy is now experiencing. Development accounting shows that most of the income gap between rich and poor countries is explained by TFP, not by capital per worker, which is why this economy's workers remain far less productive than those at the frontier despite heavy investment. To keep catching up it must raise its TFP, through better technology, innovation, stronger institutions and a shift into higher-value-added activities, rather than simply accumulating more capital. This is the lesson of earlier fast-growing economies, whose input-driven booms eventually gave way to slower growth once diminishing returns set in.

Marking guide (20 marks).

- **8 marks** — identifies **total factor productivity / productivity / how efficiently inputs are used** as the decisive factor (not just "more investment" or "more capital").
- **6 marks** — explains that **capital has diminishing returns**, so input-driven growth slows and adding capital alone cannot sustain catch-up.
- **4 marks** — links to **development accounting / the frontier**: TFP explains most of the cross-country income gap, so closing it needs productivity, e.g. technology, innovation, institutions, higher-value-added sectors.
- **2 marks** — clear, well-organised writing within the five-sentence limit.

Full credit does not require naming any country. Answers that stop at "it should in-

vest more" or "it needs more capital" earn little, because that is precisely the strategy diminishing returns undermine.