

## Macro module 11: Capital utilization and unemployment practice problems

### *Practice problems and illustrative test questions for the final exam*

(The attached PDF file has better formatting.)

This posting gives sample final exam problems. Other topics from the textbook are asked as well; these problems are just examples. All final exam problems are multiple choice; practice problems are not multiple choice so that the solutions can be better explained.

#### \*\* Exercise 11.1: Capital utilization ( $\kappa$ )

Changes in the capital stock for automobile manufacturing take several years, but the capital utilization rate ( $\kappa$ ) can change more quickly.

Suppose business production in the country is entirely auto manufacturing. In 20X2, the auto industry is in a recession, since consumers do not want to buy gas powered cars when the price of gas is high. On January 1, 20X3, engineers develop a battery powered car with the same range and efficiency as gas powered cars.

- A. The invention of a battery powered car is a change in what part of the equilibrium business cycle model?
- B. What is the effect of this invention on R/P, the real rental price?
- C. What is the effect of this invention on  $\delta(\kappa)$ , the depreciation rate function?
- D. What is the effect of this invention on  $\kappa$ , the capital utilization rate?
- E. What is the effect of this invention on the real interest rate?
- F. What is the effect of this invention on the quantity of labor supplied?

*Part A:* The invention of a battery powered car is a change in the technology level A. The new knowledge enables businesses to produce better cars, though the production of cars requires labor and capital.

*Question:* Do changes in the technology level have material effects on the real economy? Aren't these changes slow and gradual, whereas changes in real GDP occur each year?

*Answer:* Cell phones, better farming methods, and medical care are examples of changes in the technology level that greatly affect the real GDP of developing countries in Africa and Asia.

*Part B:* The real rental price R/P increases. In 20X2, factories and equipment for making cars were not too useful, since consumers didn't want gas powered vehicles. The real rental price is low, reflecting low demand for this capital. In 20X3, the same factories and equipment is more useful, since consumers want to buy the electric cars, so R/P increases.

*Question:* The textbook discusses the rental price, the real rental price, the real return on capital, and the real interest rate. What is the relation among these?

*Answer:* The rental price R is the cost of renting capital equipment. If one unit of capital can be rented for \$100 a year, the rental price is \$100 a year.

The rental price depends on the price level. If inflation is 10% a year, the rental price the next year may be \$110 a year. To adjust for inflation, we use the real rental price, or R/P, where P is the price level.

The rental price has two flaws. First, not all capital is used. Suppose the country has 1,000 units of capital, each one of which can be rented for \$100 a year. If only 800 units of capital are being used, the average rental price is \$80 per unit of capital. Second, capital depreciates. If each unit of capital depreciates \$20 a year, the net real return on capital is  $\$80 - \$20 = \$60$ .

The real interest rate is the same as the real return on capital.

The real wage rate is a currency (dollar) amount, such as \$10 an hour. The rental price, real rental price, and real return on capital are shown as percentages. The real rental price may be 20% of the capital's value, the capital utilization rate ( $\kappa$ ) may be 80%, and the depreciation rate may be 5%, giving a real return on capital of  $20\% \times 80\% - 5\% = 11\%$ .

*Part C:* The depreciation rate function does not change. If capital is used more, it depreciates more quickly.

*Question:* Doesn't the depreciation rate depend on the capital utilization rate ( $\kappa$ )? Capital depreciates more quickly when  $\kappa$  is higher.

*Answer:* The depreciation rate function shows the depreciation rate as a function of  $\kappa$ . The function doesn't change when  $\kappa$  changes.

*Part D:* The capital utilization rate  $\kappa$  is chosen by businesses to maximize the real return on capital. A higher real rental price causes a higher  $\kappa$ . See the practice problems on maximizing the real return on capital by selecting the capital utilization rate ( $\kappa$ ).

*Part E:* The real interest rate is the real return on capital. The higher real rental rate and the higher  $\kappa$  cause a higher real return on capital and a higher real interest rate.

*Part F:* The increase in capital services used,  $\kappa \times K$ , increases the marginal product of labor, which increases the quantity of labor supplied.

See Barro, macroeconomics, chapter 9, capital utilization and unemployment, page 153, top paragraphs, and Figure 9.4 on page 154.

Alternative for exam problems: increase in technology level from a decrease in the cost of oil from new oil finds, or a decrease in the cost of oil from an oil spill that shuts down Gulf oil production; assume demand for autos is inversely related to cost of gas

**\*\* Exercise 11.2: Accepting job offers**

Two actuarial candidates receive job offers. Explain how each of the following items affects the likelihood of accepting the job offer; that is, which candidate is more likely to accept the offer? For each row, assume other parts of the scenario are the same for the two candidates,

How do each of the items in the table below affect the likelihood of accepting a job offer?

	<i>Candidate Y</i>	<i>Candidate Z</i>
A. job duration	temporary job offer (3 months)	permanent job offer
B. marginal product of labor	no actuarial experience	much actuarial experience
C. income from not working ( $\omega$ )	college graduate	recently unemployed
D. non-work income / wealth	investment income from stocks	no investment income
E. value of leisure time	not studying for exams	studying for exams

*Part A:* Persons are more likely to accept permanent jobs than temporary jobs. A temporary job requires another job search in a few months.

*Question:* If so, why are so many new jobs temporary, especially in some European countries?

*Answer:* Employment laws in some countries require costly benefits for permanent workers, such as medical benefits, maternity benefits, vacations, and pensions. In some countries, permanent workers can not be easily fired, so employers are extremely reluctant to offer permanent positions.

*Part B:* The education and experience of the job candidate are human capital. Higher human capital means a higher marginal product of labor. A new college graduate needs much training and does not contribute much to an actuarial department. A candidate with much experience works more efficiently.

The candidate with a higher marginal product of labor (more human capital) expects a better job offer. For a given real wage rate, the candidate with the lower human capital is more likely to accept the job offer.

*Part C:* Persons who are recently unemployed receive unemployment benefits, which reduce the net value of the job offer. For a given real wage rate, the new college graduate who is not receiving unemployment benefits, is more likely to accept the job offer.

*Part D:* The income effect says that a person receiving other income needs money less and is less likely to accept a job offer.

*Part E:* The net benefit of a job is the real wage rate minus the value of leisure time. Higher value of leisure time, such as the value of study time, reduces the net benefit of a job and makes it less likely that the person will accept the job offer.

\*\* Exercise 11.3: Unemployment rate

- The labor market is at the natural unemployment rate in December 20X2, with a job finding rate of 0.45 per month and a job separation rate of 0.05 per month.
- On January 1, 20X3, with the onset of a recession, the job finding rate changes to 0.35 per month, and the job separation rate does not change.

What is unemployment rate on February 1, 20X3, after one month of the 0.35 job finding rate?

Solution 11.3: Assume the labor force has 1 million workers. The natural unemployment rate in December 20X2 is  $0.05 / (0.45 + 0.05) = 10\%$ : 900,000 workers are employed and 100,000 are unemployed.

To verify that the natural unemployment rate is 10%:

$$0.05 \times 900,000 = 45,000 = 0.45 \times 100,000$$

Between January 1, 20X3, and February 1, 20X3,  $0.05 \times 900,000 = 45,000$  workers leave their jobs and  $0.35 \times 100,000 = 35,000$  find jobs. Unemployed workers rise to 110,000, and the unemployment rate is 11%.

\*\* Exercise 11.4: Unemployment rate

- The labor market is at the natural unemployment rate in December 20X2, with a job finding rate of 0.45 per month and a job separation rate of 0.05 per month.
- On January 1, 20X3, with the onset of a recession, the job finding rate changes to 0.35 per month, and the job separation rate does not change.

What is unemployment rate on February 1, 20X3, after one month of the 0.35 job finding rate?

Solution 11.4: Assume the labor force has 1 million workers. The natural unemployment rate in December 20X2 is  $0.05 / (0.45 + 0.05) = 10\%$ : 900,000 workers are employed and 100,000 are unemployed.

To verify that the natural unemployment rate is 10%:

$$0.05 \times 900,000 = 45,000 = 0.45 \times 100,000$$

Between January 1, 20X3, and February 1, 20X3,  $5\% \times 900,000 = 45,000$  workers leave their jobs and  $35\% \times 100,000 = 35,000$  find jobs. Unemployed workers rise to 110,000, and the unemployment rate is 11%.

\*\* Question 11.5: Unemployment rate

- The labor market is at the natural unemployment rate in December 20X2, with a job finding rate of 0.45 per month and a job separation rate of 0.05 per month.
- On January 1, 20X3, with the onset of a recession, the job finding rate changes to 0.35 per month, and the job separation rate does not change.

What is unemployment rate on February 1, 20X3, after one month of the 0.35 job finding rate?

Solution 11.5: Assume the labor force has 1 million workers. The natural unemployment rate in December 20X2 is  $0.05 / (0.45 + 0.05) = 10\%$ : 900,000 workers are employed and 100,000 are unemployed.

To verify that the natural unemployment rate is 10%:

$$0.05 \times 900,000 = 45,000 = 0.45 \times 100,000$$

Between January 1, 20X3, and February 1, 20X3,  $0.05 \times 900,000 = 45,000$  workers leave their jobs and  $0.35 \times 100,000 = 35,000$  find jobs. Unemployed workers rise to 110,000, and the unemployment rate is 11%.

**\*\* Exercise 11.6: Job vacancies**

- A. How does the marginal product of labor (MPL) affect the number of job vacancies?
- B. How does the real wage rate affect the number of job vacancies?
- C. How does the cost of interviewing candidates affect the number of job vacancies?
- D. How does the technology level affect the number of job vacancies?
- E. Are job vacancies pro-cyclical, anti-cyclical, or a-cyclical?

*Part A:* If the marginal product of labor rises, workers provide more value for employers, so more jobs are offered and the number of job vacancies increases.

*Part B:* If the real wage rate required to induce workers to accept a job increases, fewer jobs are offered, and the number of job vacancies decreases.

*Part C:* If the costs of interviewing candidates increases, fewer jobs are offered, and the number of job vacancies decreases.

*Question:* What affects the costs of interviewing candidates?

*Answer:* Lower transportation costs, phone interviews, and internet job-search sites lower the costs of interviewing job candidates.

*Question:* In a recession, there are fewer employed workers; doesn't that mean there are more vacancies?

*Answer:* Job vacancies decline in recessions for two reasons: First, there is less work to be done and so fewer jobs. Second, workers still employed are working less ( $\kappa$  is lower). Business have their current employees work more; they don't advertize for new workers.

**\*\*Question 11.7: Capital utilization and labor supply**

Businesses choose the demand for capital services and the demand for labor to maximize profits.

Which equation expresses real business profits in terms of  $\kappa K$  and  $L$ ? (The superscript “d” represents the demand for labor or capital services; the superscript “s” represents the supply of labor or capital services. Choices A, B, and E have a “d” superscript; choices C and D have an “s” superscript.)

- A.  $\pi/P = A \times F[(\kappa K)^d, L^d] - (w/P) \times L^d - (R/P) \times (\kappa K)^d$
- B.  $\pi/P = A \times F[(\kappa K)^d, L^d] + (w/P) \times L^d + (R/P) \times (\kappa K)^d$
- C.  $\pi/P = A \times F[(\kappa K)^d, L^d] - (w/P) \times L^s - (R/P) \times (\kappa K)^s$
- D.  $\pi/P = A \times F[(\kappa K)^d, L^d] + (w/P) \times L^s + (R/P) \times (\kappa K)^s$
- E.  $\pi/P = A \times F[(\kappa K)^d, L^d] - (w/P) \times L^d + (R/P) \times (\kappa K)^d$

Answer 11.7: A

*Question:* Why does the equation have quantities demanded instead of quantities supplied?

*Answer:* Businesses determine how much labor and capital to demand based on the expected profits from using the capital and labor to produce goods.

- $A \times F[(\kappa K)^d, L^d]$  is the real revenue from producing goods.
- $(w/P) \times L^d + (R/P) \times (\kappa K)^d$  is the real expense of capital and labor.

See Barro, macroeconomics, chapter 9, equation 9.2 on page 150

\*\* Question 11.8: Demand for capital services

The demand for capital services is drawn on a graph, where the vertical axis is the real rental price  $R/P$  and the horizontal axis is the demand for capital services.

Which of the following is true?

- A. A higher technology level shifts the curve to the right.
- B. A higher technology level shifts the curve to the left.
- C. A higher depreciation rate shifts the curve to the right.
- D. A higher marginal product of capital shifts the curve to the right.
- E. A higher marginal product of capital shifts the curve to the left.

Answer 11.8: A

A higher technology level causes higher  $\kappa$  at any given real rental price.

The marginal product of capital is the real rental price. A higher marginal product of capital causes a movement *along* the curve (to the left), not a shift of the curve itself.

A higher depreciation rate shifts the curve to the left: less capital demanded for each real rental price.

See Barro, Macroeconomics, chapter 9, page 151, Figure 9.2.

**\*\* Exercise 11.9: Real rental rate and depreciation rate**

How does the real rental rate affect the depreciation rate of capital?

Solution 11.9: Businesses maximize the real return on capital to determine the capital utilization rate ( $\kappa$ ).

$$= (R/P) \times \kappa - \delta(\kappa)$$

As  $R/P$  increases, the equilibrium  $\kappa$  increases, which raises the depreciation rate  $\delta(\kappa)$ .

**\*\*Question 11.10: Unemployment rate**

During recessions, more people give up looking for work and are not counted in the labor force.

Which of the following is true?

- A. The unemployment rate is anti-cyclical; if it included people who stop searching for work, it would be even more anti-cyclical.
- B. The unemployment rate is anti-cyclical; if it included people who stop searching for work, it would be pro-cyclical.
- C. The unemployment rate is pro-cyclical; if it included people who stop searching for work, it would be even more pro-cyclical.
- D. The unemployment rate is pro-cyclical; if it included people who stop searching for work, it would be anti-cyclical.
- E. The unemployment rate is a-cyclical; if it included people who stop searching for work, it would be anti-cyclical.

Answer 11.10: A

Suppose the economy has 500 workers, of whom 450 have jobs in prosperous years and 400 have jobs in recessions. If 20 workers give up looking for work during recessions, they are not counted in the labor force. The unemployment rate is  $450/500 = 90\%$  in prosperous years and  $400/(500 - 20) = 83.33\%$  in recessions: it is anti-cyclical. If persons who stop looking for work were counted in the work force, the unemployment rate would be  $400 / 500 = 80\%$  in recessions – even more anti-cyclical.

Reported unemployment rates are distorted another way. During recessions, more people do not have jobs but work in the black market. A person who loses his job as a janitor may work cleaning buildings without an official job. A nurse who loses her job may work as an aide to a disabled retiree. These persons continue to look for work in the regular economy, so they are counted an unemployed.

See Barro, Macroeconomics, chapter 9

**\*\*Question 11.11: Job finding rate**

Which of the following is true regarding the job finding rate?

- A. The job finding rate is pro-cyclical because wage offers are better and jobs are easier to find during prosperous years.
- B. The job finding rate is anti-cyclical because more workers search for jobs during recessions.
- C. The job finding rate is pro-cyclical because more workers search for jobs during recessions.
- D. The job finding rate is anti-cyclical because more workers accept low pay during recessions.
- E. The job finding rate is a-cyclical because workers accept jobs based on their reservation wage, whether in good years or bad years.

Answer 11.11: A

*Statement A* gives the two reasons that the job finding rate is pro-cyclical: the real wage rate is higher and the demand for labor is higher.

*Statement B* is false. More workers are unemployed during recessions (unemployment rate is anti-cyclical), so more people are looking for jobs. But the job finding rate is likelihood of finding a job for each job search. This ratio is lower during recessions.

*Statement C*: more workers searching for jobs doesn't raise the job finding rate.

*Statements D and E* are false empirically, since the job finding rate is pro-cyclical. The real wage rate declines during recessions, causing more workers to prefer unemployment benefits or leisure time to work. If the pay is higher, more workers accept jobs. The reservation wage affects the likelihood of accepting a job given a job offer with a real wage rate; it does not affect the likelihood of the job offer or the real wage rate.

See Barro, Macroeconomics, chapter 9, page 169