

Exam 1. Econ520. Fall 2026

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Instructions

- Answer all questions.
- **Write legibly.** I cannot grade what I cannot read.
- Write your answers on the question sheets. Use additional pages, if needed.
- **Explain** your answers – do not just state them.
- Show your derivations – do not just state the final result.
- Do not refer to any **notes or books**. You may use a calculator.
- The total time is **75 minutes**.
- The total number of points is **100**.

Name	PID

1. Short Questions

1. (25 points) The labor market equilibrium with sticky price expectations is given by

$$N^S = \hat{F}\left(\frac{1}{1+m} \frac{P}{P^e}, z\right)$$

- Explain in words why higher prices P lead to a higher labor supply N^S , but only when price expectations are sticky and not when they are correct ($P = P^e$).
- What does this result imply for the ability of monetary policy to affect employment in the medium run? Think of monetary policy as an increase in P .

Answer: Workers set labor supply based on the perceived real wage $\frac{W}{P^e}$. Higher P implies higher W because the real wage is fixed at $\frac{1}{1+m}$. Workers see a higher nominal wage and think their real wage is higher (because P^e is sticky). They supply more labor. But with correct price expectations, $P = P^e$, so the perceived real wage is unchanged. Labor supply does not change. Implication: monetary policy can affect employment in the short run, but not in the medium run. In the medium run, price expectations adjust and workers see that their real wage is unchanged. They do not supply more labor.

2. (25 points) Edward Prescott (2004) argued that Europeans work fewer hours than Americans mainly because they pay higher taxes on labor income. Use the labor supply model to evaluate this argument.

- How does a **permanent** increase in the labor income tax rate τ affect hours worked?
- Why does the answer depend on what the government does with the revenue? Compare three cases:
 1. The revenue is returned to households as lump-sum transfers.
 2. The revenue is spent on goods that households do not value.
 3. The revenue finances generous unemployment benefits.

Recall that the first-order condition for hours worked is

$$v'(l_t) = \lambda((1 - \tau)w_t - b)$$

where l_t is hours worked, w_t is the real wage, b is the income a household receives when it does not work, and $\lambda = u'(c_t)$ is the marginal utility of consumption.

Answer: A higher tax lowers the net return to an hour of work, $(1 - \tau)w_t - b$.

- Substitution effect: leisure becomes cheaper relative to consumption. Hours fall.
- Income effect: if the tax makes households poorer, λ rises and hours rise.

What the government does with the revenue decides whether the income effect is there at all.

Case (i), revenue returned as lump-sum transfers: on average, households get their money back. Lifetime income is roughly unchanged, so λ is unchanged and there is no income effect. Only the substitution effect remains: hours fall. Each household still faces the lower after-tax wage at the margin, because its transfer does not depend on how much it works.

Case (ii), revenue spent on goods households do not value: households are poorer, so λ rises. The income effect works against the substitution effect. The net effect is ambiguous and may be small (recall that permanent wage changes barely affect hours in the long run).

Case (iii), revenue finances generous unemployment benefits: this raises b . As in case (i), households get the money back on average, so lifetime income and λ are roughly unchanged. But the transfer is **not** lump sum – it is paid only when the household does not work, which is why b enters the household's income as $b(1 - l_t)$. The net return to an hour of work, $(1 - \tau)w_t - b$, is now cut twice: once by the tax, once by the benefit. The substitution effect is larger than in case (i), so hours fall by more.

Evaluation: Prescott's argument is strongest in cases (i) and (iii), where the revenue comes back to households and taxes work purely through the substitution effect. European taxes largely finance transfers and services that households value (pensions, health care, education), and European benefit systems are generous, so both channels push the same way. How large the effect is depends on the size of the substitution effect, which economists debate.

2. The Rate the Fed Sets vs. the Rate Firms Pay

In the IS/LM model, there is only one interest rate. In reality, the Fed controls a very short-term interest rate (the federal funds rate, FFR) whereas firms care about long-term rates.

This question examines what happens if changes in the FFR do not fully feed through into long rates. To capture this, we assume that

$$i^I = a + xi$$

where i is the FFR and i^I is the rate firms pay when they borrow to invest. The parameter $a > 0$ is a constant spread (a term and risk premium). The parameter $0 < x \leq 1$ determines how much long rates respond when the Fed changes the FFR. When the Fed cuts the FFR by one percentage point, i^I falls by only x points.

The rest of the model is standard: $Y = C + I + G$ where

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

$$I = \bar{I} + b_1 Y - b_2 i^I$$

$$\frac{M}{P} = Y \star L(i)$$

Questions:

1. (9 points) Show that the slope of the IS curve is now given by

$$\frac{di}{dY} = -\frac{1 - c_1 - b_1}{b_2 x}.$$

Answer: Substitute $i^I = a + xi$ into investment. Goods market clearing gives

$$Y = \bar{Z} + (c_1 + b_1)Y - b_2 xi, \quad \bar{Z} = c_0 - c_1 T + \bar{I} + G - b_2 a$$

Solving for i :

$$\text{IS : } i = \frac{\bar{Z} - (1 - c_1 - b_1)Y}{b_2 x}$$

A smaller x makes the IS curve **steeper**. The spread a enters only through $\bar{Z}$: it shifts IS left, but leaves the slope alone.

2. (9 points) Explain the economic reason why a lower x makes the IS curve steeper. To answer this part, you need to explain what happens as the economy moves along IS.

Answer: Move along IS. When Y rises by \$1, demand rises by only $c_1 + b_1 < 1$, so there is excess supply. To clear the goods market, investment must rise, so i^I must fall by a given amount. But only the fraction x of a cut in the FFR reaches firms. So the FFR must fall by more. A larger fall in i for each unit of Y means a steeper IS curve. Weak pass-through works like a low interest sensitivity of investment: the effective sensitivity is $b_2 x$.

3. (20 points) The economy is in a recession. The Fed wants to raise output by a given amount ΔY . How much must it cut the FFR? How does the answer depend on x ? Illustrate your answer in an IS/LM diagram and explain the intuition.

Answer: The new equilibrium must lie on the IS curve at output $Y + \Delta Y$. Moving along IS,

$$\Delta i = -\frac{1 - c_1 - b_1}{b_2 x} \Delta Y$$

i^I must fall by $(1 - c_1 - b_1)\Delta Y/b_2$, the same for every x : this is what it takes to raise investment enough. But only the fraction x of each cut in the FFR reaches firms. So the Fed must cut the FFR by $1/x$ times as much. For example, with $x = 1/2$ it must cut twice as much. The spread a is a constant, so it drops out of the **change** in i^I and plays no role in this part.

Diagram: draw two IS curves through the initial equilibrium A , a flat one (large x) and a steep one (small x). Mark the target output $Y + \Delta Y$. With the flat IS, a small shift of LM reaches the target. With the steep IS, LM must shift much further right, and i falls much more.

The Fed must also expand M by more. In the new equilibrium, Y is the same in both cases, but i is lower when x is small, so households want to hold more money.

Intuition: monetary policy is less effective per unit change in the FFR. The Fed pulls on the FFR, but the long rates that drive investment move only partly.

4. (12 points) If the FFR cannot fall below zero, how low can the Fed push i^I ? If this level of i^I does not generate enough additional demand, what other options does the Fed have?

Answer: Set $i = 0$ in $i^I = a + xi$. The lowest rate firms can face is

$$i_{\min}^I = a > 0$$

Even with the FFR at zero, borrowing is not free. The Fed cannot push the cost of capital below the spread. If this amount of stimulus is insufficient, conventional monetary policy runs out of room.

Options:

- Act directly on long rates: buy long-term bonds (quantitative easing). This compresses the spread, so it works on a rather than on i .
- Forward guidance: promise to keep the FFR low for a long time. If investment depends on expected future rates, this can help to lower the cost of capital.
- Forward guidance could also raise inflation expectations, which lowers real rates. That stimulates investment and consumption.

End of exam