Intermediate Macroeconomics (UN3213)
Recitation 4

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February 25, 2025

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Question 1

Exercise 1 (Adaptive Expectations). Consider an economy where the Phillips curve is

$$\hat{\pi} = \beta\hat{\pi}^e + \kappa\hat{y} + \epsilon^{cp}$$

and the IS curve is

$$\hat{y} = -\gamma(\hat{i} - \hat{\pi}^e) + \epsilon^d,$$

where $\hat{\pi}$ denotes the deviation of inflation from the intended target, $\hat{y}$ denotes the deviation of output from full employment, $\hat{\pi}^e$ denotes the deviation of expected inflation from the inflation target, ϵ^{cp} is a cost-push shock, and ϵ^d is a demand shock. Let $\beta = 0.5$, $\kappa = 0.25$, and $\gamma = 0.75$. Suppose also that there are no cost-push shocks ($\epsilon^{cp} = 0$), but that the economy is hit by a negative demand shock of 1 percent, that is, $\epsilon^d = -1$. Suppose that the normal nominal interest rate is 5 percent ($\bar{i} = 5$) and that the central bank does not respond to the shock ($\hat{i} = 0$).

1. Calculate the equilibrium values of $\hat{\pi}$ and $\hat{y}$ under the following two expectation formation hypothesis:
   (a) Expectatons are anchored at the inflation target $\bar{\pi}$, taht is, $\hat{\pi}^e = 0$.
   (b) Agents form expectations in an adaptive way. Specifically, people expect taht future inflaiton will equal current inflation, $\hat{\pi}^e = \hat{\pi}$.
2. Now assume that the central bank does intervene to ensure full employment ($\hat{y} = 0$) and price stability ($\hat{\pi} = 0$). Calculate $\hat{i}$ under assumptions (a) and (b) above.

Question 1

Question 1

Question 2

Exercise 2 (Changes in the interest rate along the modified IS curve). The figure on the next page displays the modified IS curve. Show that $\hat{i}$ (the deviation of the nominal interest rate from its normal value) is higher at point b than at point a.

Question 2

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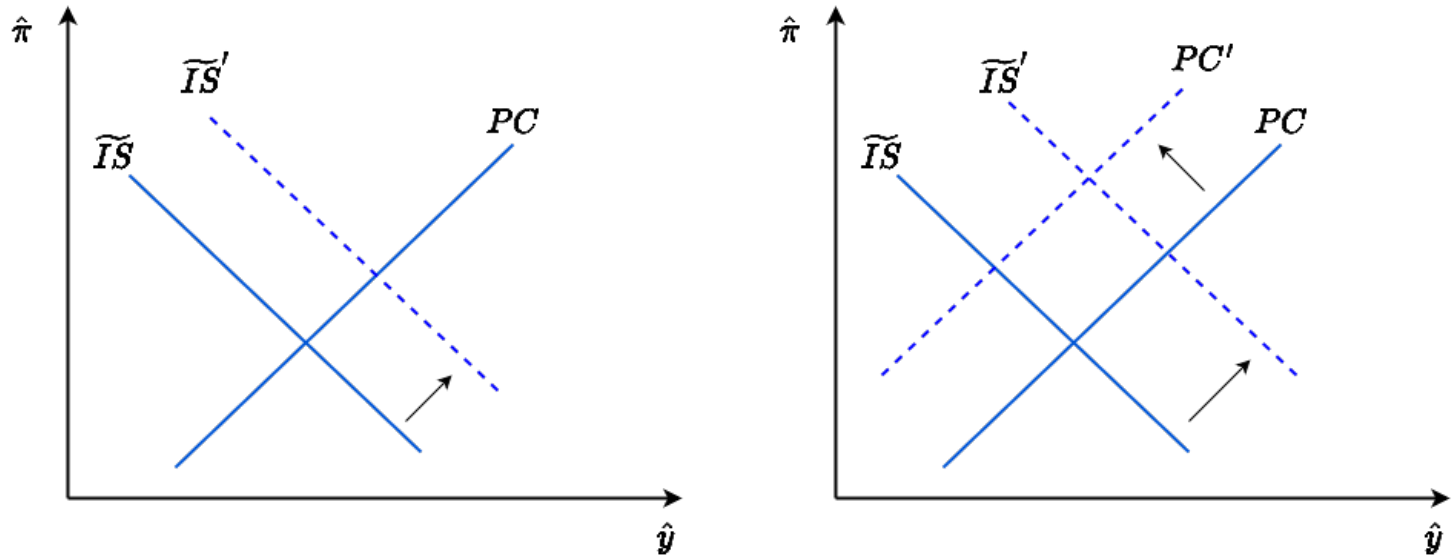
Interference in monetary policy



There are two effects of an accommodative monetary policy.

- A direct effect of government influence (which appears as a monetary shock). A cut in interest rates shifts $\tilde{IS}$ rightwards.
- An indirect effect through increase in inflation expectations. Shifts $\tilde{IS}$ further and PC upward.

A debt erosion motive

- Apart from electoral reasons, there is another motive for the Treasury to prefer an expansionary monetary policy and high inflation.
- The fiscal surplus for the government can be defined in simple terms as $F = T - B$
- Taxes (T) increase in nominal terms with inflation (both wages and prices rise). But government debt (B) remains fixed in nominal terms
- High inflation devalues debt $\Rightarrow$ Government pays back less in real terms (repaying debt with cheaper dollars).

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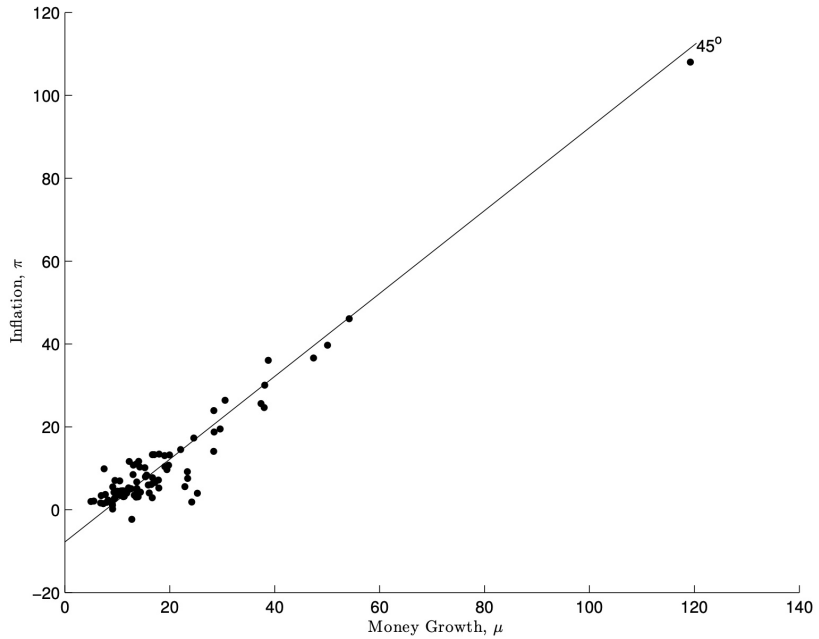
Measures of money

- Monetary aggregates:
  - *Money in circulation:* Notes and coins
  - *Monetary base (M0):* Money in circulation + central bank reserves
  - *Narrow money (M1):* Money in circulation + checking deposits,
  - *Broad money (M2):* M1 + time deposits + savings deposits
- Some ways the central bank adjusts the amount of money in the economy:
  - Open market operations (OMOs): buying/selling government securities (exchanging illiquid for a liquid asset),
  - Reserve requirements on banks: Lower reserve requirements $\rightarrow$ Banks can lend more $\rightarrow$ Money supply increases.
  - Other forms of quantitative easing.

Fact 1: Money supply vs. Inflation (Cross-section)

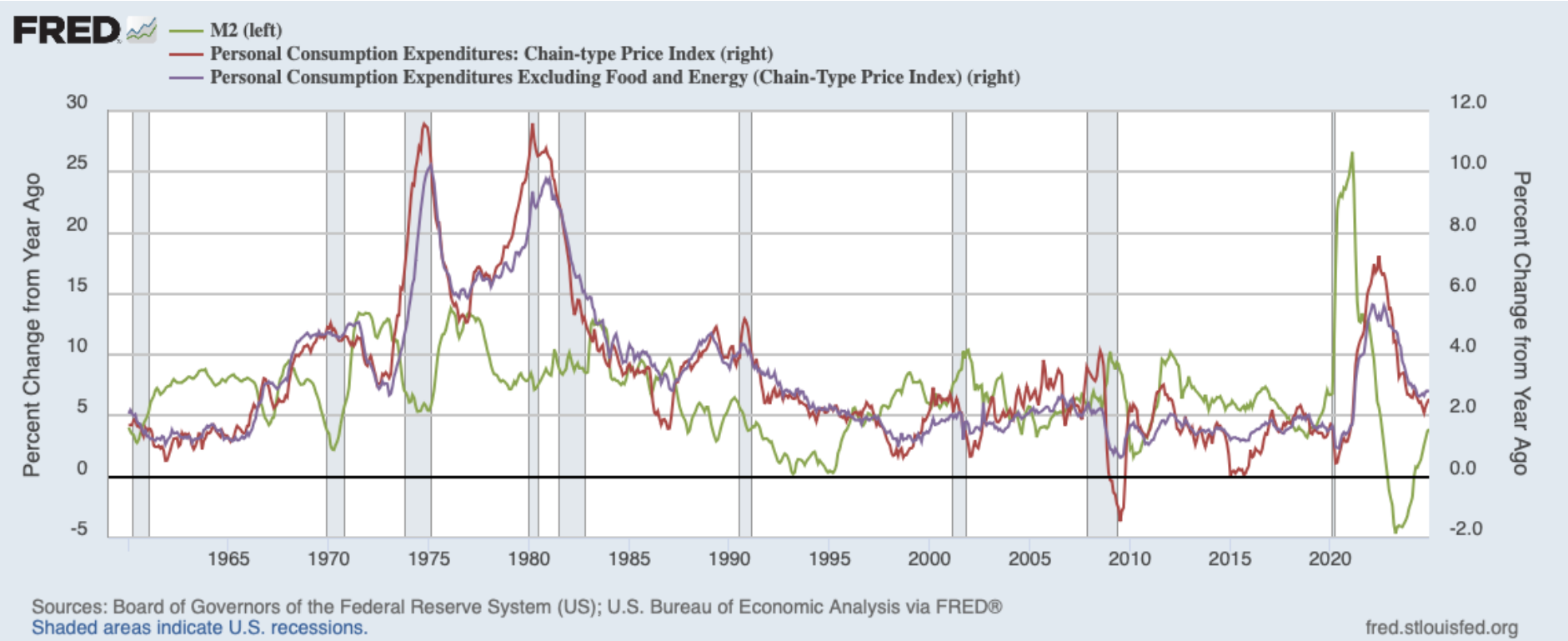
There is a strong (almost one-to-one) correlation between growth rate of money and inflation across countries.



Note that inflation and money growth rate are annualized averages:

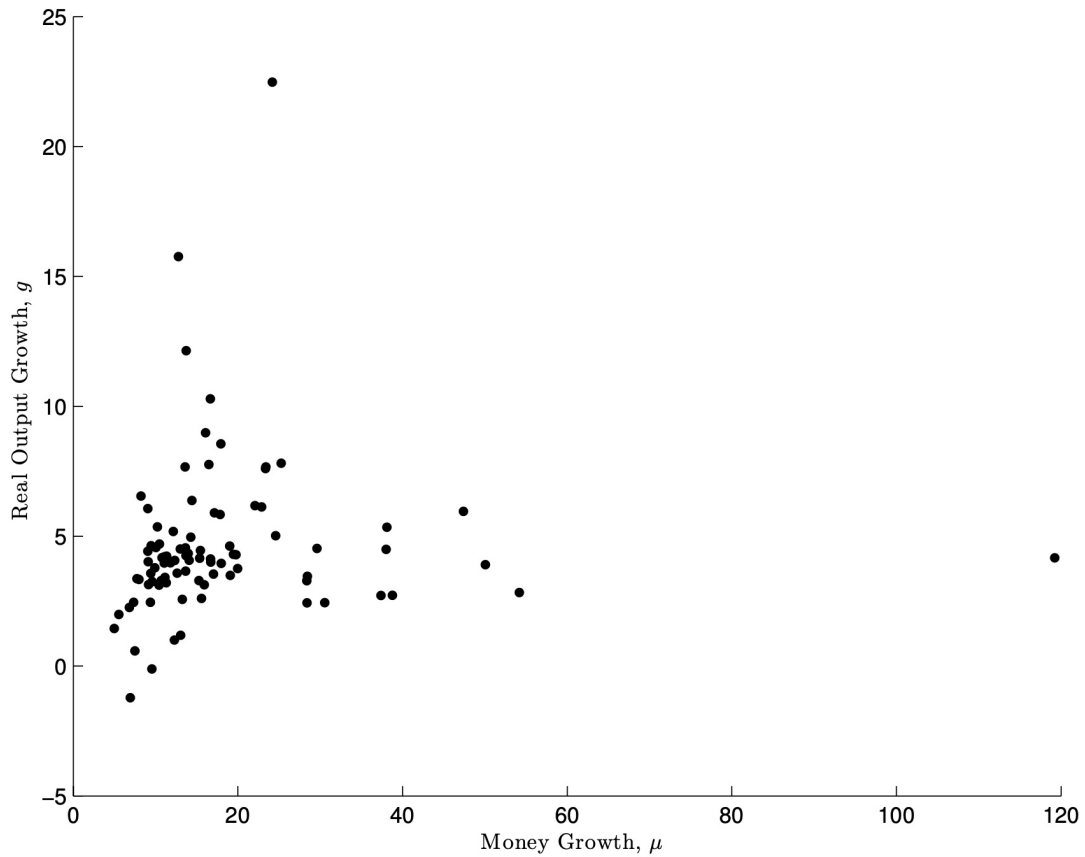
$$\pi = \left[\left(\frac{P_{2014}}{P_{1960}}\right)^{1/54} - 1\right] \times 100, \quad \mu = \left[\left(\frac{M_{2014}}{M_{1960}}\right)^{1/54} - 1\right] \times 100$$

Fact 1: Money supply vs. Inflation (Time series)



Fact 2: Money supply vs. Growth rate

There is no correlation between growth rate of money and growth rate of output in a cross-section of countries (super-neutrality of money).



Motivation

- The quantity theory of money tries to reconcile these two empirical facts in the long run:
  - Average inflation moves one-for-one with the average growth rate of the money supply,
  - Average growth rate of output is unrelated to the average growth rate of the money supply
- Disconnect between real and nominal quantities:
  - Neutrality: A **level change** in money supply does not affect real variables,
  - Super-neutrality: A **change in the growth rate of money** has no long-run real effects.
- *Why the long run is important?*
  Prices are sticky in the short-run (as the New Keynesian model assumes). In the short-run, it is not neutral. But once prices have had enough time to adjust, does money still matter?

Money market equilibrium

- Demand for money:

$$M_t^d = \frac{1}{\bar{v}} P_t y_t$$

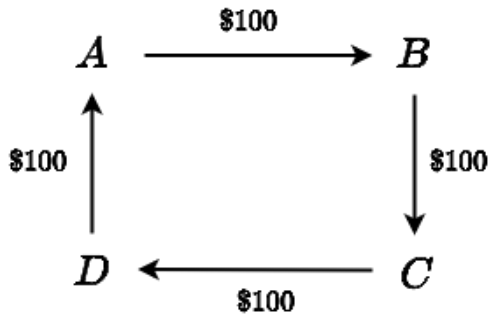
  - M_t^d : Money demand in period t,
  - y_t: Real output
  - P_t: Price level
  - $\bar{v}$: Velocity of money (how frequently money changes hands)
- Supply of money is something the central bank decides: M_t
- Equilibrium:

$$M_t = \frac{1}{\bar{v}} P_t y_t$$

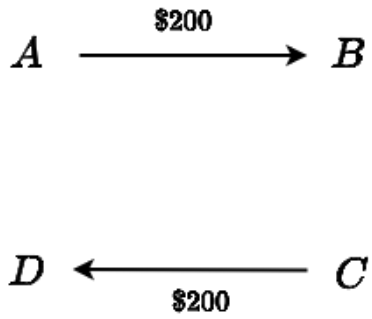
- **Key assumption:** y_t (real output) is not affected by changes in M_t (matches Fact 2).
  Implication: Given a level of money velocity and real output, prices P_t vary one-for-one with money M_t.

Money velocity: An illustrative example

Consider two economies populated by four people. Goods and services are bought with money. The transactions between people in the two economies are represented as below.



Scenario 1



Scenario 2

The total nominal output (sum of all transactions) is the same in both the countries (=$400).
In the first scenario, less money is required. Simply endow A with $100 which then circulates among the rest. In the second scenario, need to endow A and C with $200 each.
Money velocity is higher in the first scenario (changes hands more often).

Growth rates

Assuming money velocity does not change, write the equilibrium condition for two successive time periods $t-1$ and t.

$$\frac{P_t}{P_{t-1}} = \frac{M_t}{M_{t-1}} \cdot \frac{Y_{t-1}}{Y_t}$$
$$\iff 1+\pi_t = \frac{1+\mu_t}{1+g_t}$$

Taking logs on both sides and taking approximation $ln(1+x) \approx x$ for $x \approx 0$

$$ln(1+\pi_t) = ln(1+\mu_t) - ln(1+g_t)$$
$$\iff \pi_t \approx \mu_t - g_t$$

This relation must also hold for the long-run averages.

$$\pi = \mu - g$$

Recall the assumption that y_t (therefore g_t) is completely independent of M_t (therefore μ_t). Inflation moves one-for-one with nominal money growth rate (matches Fact 1)

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Cagan model

- Builds upon QTM by incorporating an interest-elastic demand for money
- Demand for money in the QTM was purely transactive. But in the Cagan model,

$$\frac{M_t^d}{P_t} = L(i_t, Y_t)$$

  which is decreasing in i_t and increasing in Y_t.
  i_t is like the opportunity cost of holding money (interest forgone).
- Recall from the Fisher equation

$$1 + i_t = (1 + r_t)(1 + \pi_{t+1}^e)$$

  r_t is assumed to be exogenous and constant (not in control of the central bank). The above is approximated as

$$i_t = r_t + \pi_{t+1}^e$$

Formation of expectations

- **Adaptive expectations:** Expectation is determined by past levels of inflation. Two examples:
  - Depends on only the previous period's inflation

$$\pi^e_{t+1} = \pi_t$$

  - Depends on inflation in all the past periods

$$\pi^e_{t+1} = (1-\beta)(\pi_t + \beta\pi_{t-1} + \beta^2\pi_{t-2} + \dots)$$

    Weights are decreasing and add up to 1.
- **Rational expectations:** People do not commit systematic mistakes:

$$\pi^e_{t+1} = \pi_{t+1}$$

  Actual inflation matches expected inflation when there are no shocks (perfect foresight).

Building blocks of the Cagan model

- Money market equilibrium
$$\frac{M_t}{P_t} = L(i_t, Y_t)$$
- Fisher equation
$$1 + i_t = (1 + r_t)(1 + \pi^e_{t+1})$$
- An assumption about formation of inflation expectations, e.g. whether it is adaptive or rational
- A specification of monetary policy.

Use the above to solve the model, i.e. the equilibrium paths of prices $\{P_t, \pi^e_t, i_t\}_{t=0}^{\infty}$