

Chapter 7 : A Monetary Intertemporal Model

EE312

Macroeconomics, Stephen Williamson, Chapter 12

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Definitions of the money supply

- **M0**: the monetary base, outside money, or high-powered money.
 - Liabilities of the central bank to the public.
 - Currency outside the central bank + deposits of financial institutions at the central bank.
- **M1** = currency + demand deposits + other checkable accounts.
 - The most liquid form of money.
- **M2** = M1 + savings deposits + small time deposits + retail money market mutual funds.
 - M1 plus highly liquid non-money assets.
- **M3** = M2 + large time deposits + institutional money market mutual funds + repurchase agreements.
 - M2 plus less liquid non-money assets.
 - Take time and cost to change to liquid assets.

The inflation rate

- Inflation is the rate of change of the price level.
- P = the current price level;
- P' = the future price level;
- i = the inflation rate.

$$i = \frac{P' - P}{P}$$

$$(1 + i) = \frac{P'}{P}$$

The Fisher relation

- R = nominal interest rate, the rate of return on a nominal bond in units of money.
- $(1+R)$ = the return on a nominal bond in terms of money in the future period.
- The buyer must give up $\frac{1}{P}$ goods in the current period for $\left(\frac{1+R}{P'}\right)$ goods in the future period.
- r = real interest rate, the rate of return in terms of goods. The gross rate of return on the nominal bond in real terms:

$$\begin{aligned} 1 + r &= \frac{\frac{1+R}{P'}}{\frac{1}{P}} \\ &= \frac{1+R}{1} \times \frac{P}{P'} \end{aligned}$$

The rate of return on money

- The nominal rate of return on money is zero.
- The nominal rate of return on a nominal bond is positive, or $R > 0$.
- So the real rate of return on money (r^m) :

$$1 + r^m = \frac{1 + 0}{1 + i} = \frac{1}{1 + i} < 1 + r = \frac{1 + R}{1 + i}$$

Simplified Fisher Relation

- Multiply each side of the Fisher relation by $1 + i$. If i and r are very small, then ir is negligible.

$$1 + r = \frac{1 + R}{1 + i}$$

$$(1 + r)(1 + i) = 1 + R$$

$$1 + r + ri + i = 1 + R$$

$$r = R - ri - i$$

$$r \approx R - i$$

Real interest Rate $\approx$ Nominal Interest Rate - Inflation Rate

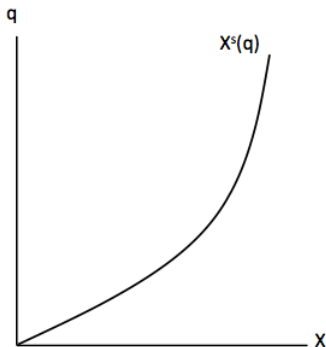
- **The labor market:** labor demand and supply, the real wage, employment.
- **The goods market:** output supply and demand, total output.
- **The credit market:** the real interest rate.
- **The money market:**
 - **Demand for money:** the consumer and the firm.
 - **Supply of money:** the central bank.
- **The market for credit card services**
 - **The supply of credit card services** by banks.
 - **The demand for credit card services** by consumers and firms.
 - The market equilibrium for credit card services.
 - The determination of the **demand for money**.

Currency and credit card services

- Money = money outside banks = currency.
- The economic agents (the consumer, the firm and the government) purchase goods.
 - Choices between currency and credit cards.
- Firms sell goods at the same price (P) for payments in money or credit cards.
- **Credit card services** are provided by banks with increasing costs.
- The economic agent buys goods using a credit card.
 - The agent acquires a debt with the bank.
 - Zero interest when paid off at the end of the current period.
- Credit card services are provided for purchase transactions only.
- The consumer, the firm and the government borrow or lend in the credit market.

Supply of credit card services

- q = the price of credit card services in terms of goods in transaction.
- X = quantity of credit card services in terms of goods.



- Y = units of goods to be purchased by the economic agents.
- $X^d(q)$ = quantity of goods purchased by credit cards.
- $Y - X^d(q)$ = quantity of goods purchased by currency.
- Marginal benefit = marginal cost of buying one more unit of goods using credit cards.

- **Marginal benefit (MB)** of credit card services:

- One additional unit of goods purchased with a credit card = P units of money available for lending in the credit market to receive $P(1+R)$ units in the future.

$$MB = P(1 + R)$$

- **Marginal cost (MC)** of credit card services:

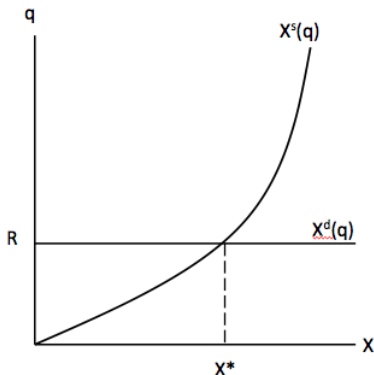
- The agent pays off the credit card debt and fees at the end of the current period = $P(1+q)$ units of money.

$$MC = P(1 + q)$$

- If $P(1 + R) > P(1 + q)$ or $R > q$, the agent will purchase all goods with the credit card.
- If $P(1 + R) < P(1 + q)$ or $R < q$, the agent will purchase all goods with currency.
- If $R = q$, the agent is indifferent between currency and the credit card.
- The demand for credit card services is perfectly elastic at $q = R$.

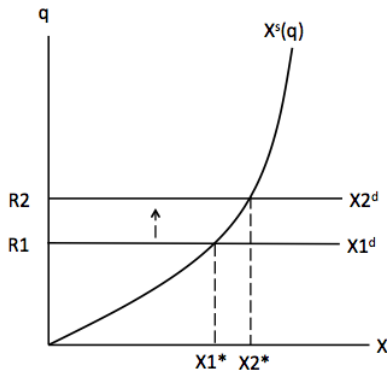
Market equilibrium

- R = equilibrium price for credit card services.
- X^* = equilibrium quantity of credit card services.



X^* as a function of R

- If R increases, X^* will also increase.
- So X^d is a function of R , or
- $X^d = X^*(R)$ while $R = q$.



The nominal money demand

$$M^d = P[Y - X^*(R)]$$

$$M^d = P \times L(Y, R)$$

- The nominal demand for money is an increasing function of Y and decreasing function of R .
 - Equilibrium relationship in the bank's choices of supply and the agent's choice of currency and credit card uses.

$$M^d = PL(Y, R); \frac{\partial M^d}{\partial Y} > 0, \frac{\partial M^d}{\partial R} < 0$$

- The function is proportional to the price level.
- The consumer's and the firms' choices on the real quantity of money ($\frac{M^d}{P}$). Real money demand rises with real income (Y).
- Negative relationship with the nominal interest rate (R) — opportunity cost of holding cash.

Nominal money demand function

$$M^d = PL(Y, R)$$

as $r = R - i$

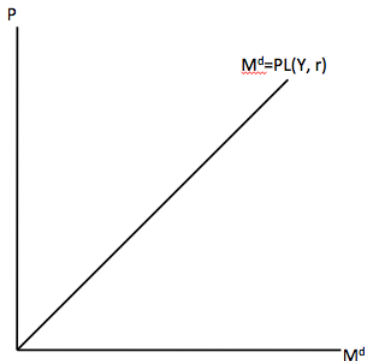
$$M^d = PL(Y, r + i)$$

$$M^d = PL(Y, r); \quad \frac{\partial M^d}{\partial Y} > 0, \quad \frac{\partial M^d}{\partial r} < 0$$

when i is negligible.

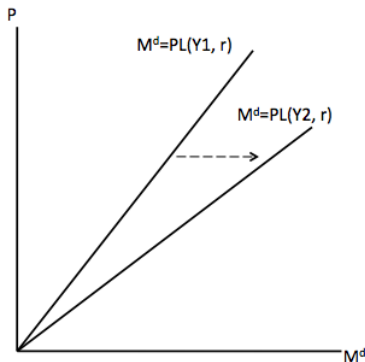
Money demand curve

- Money demand is a linear function of the price level with slope $L(Y, r)$.



Shift in Money Demand

- An increase in Y or a decrease in r rotates the M^d curve rightwards (more money demand).

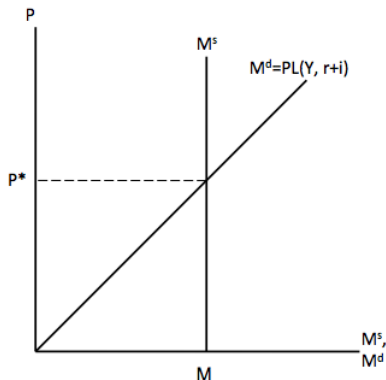


- The government purchases consumption goods (PG) and pays nominal interest and principal on past bonds, $(1+R^-)B^-$.
- The revenue constraint consists of nominal taxes (PT), current bond issue (B) and money creation ($M-M^-$).

$$PG + (1 + R^-)B^- = PT + B + M - M^-$$

The money market

- The money supply (M^s) is exogenously determined by the central bank.
- $M^s = M^d$ determines the equilibrium price.

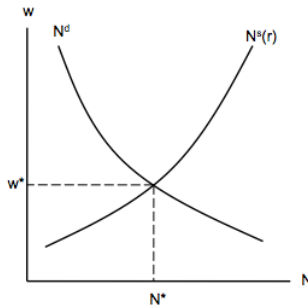


Complete monetary model

- The current labor market:
 - The real wage and employment.
- The current goods market:
 - Output demand and output supply.
- The current money market:
 - The price level; demand and supply of money.
- The credit market:
 - The real interest rate.

The current labor market

$$\begin{aligned}N^s &= h - \ell(w) \\ N^d &= MP_N = w \\ N^s(r) &= N^d\end{aligned}$$



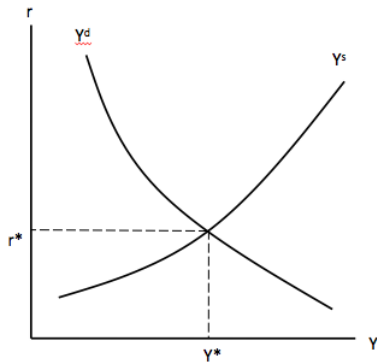
The current goods market

$$Y^s = Y(r)$$

$$Y^d = C^d(Y_d, r) + I(r) +$$

$$G$$

$$Y^s = Y^d$$

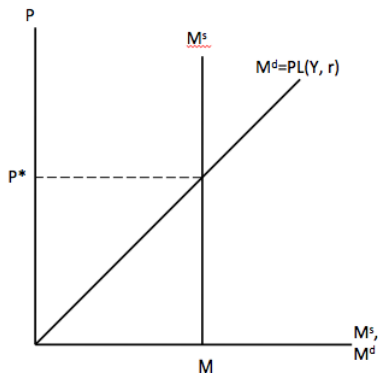


The current money market

$$M^d = L(Y, r)$$

$$M^s = M$$

$$M^d = M^s$$



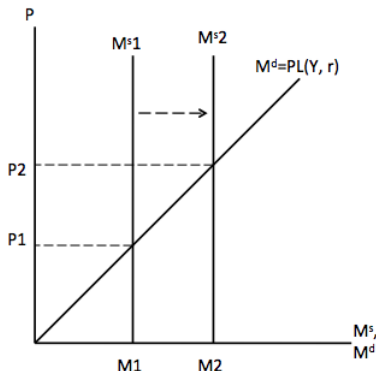
Competitive equilibrium

- The current goods market determines the equilibrium output (Y^*).
- The credit market gives the real interest rate.
- Given r^* , the current labor market determines the equilibrium real wage (w^*) and employment (N^*).
- Given Y^* and r^* , the current money market determines the price level (P^*).

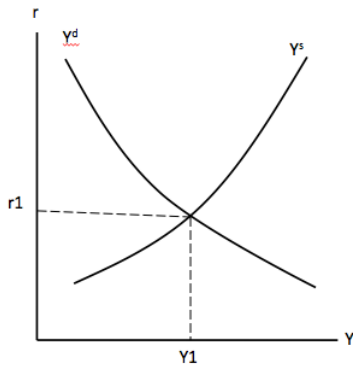
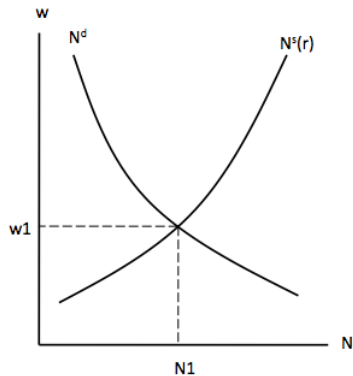
- Assume an one-time increase in the money supply:
 $M - M^- = M_2 - M_1 = \Delta M > 0$.
 - A decrease in taxes (T) increases household disposable income.
 - An open market purchase of bonds by the central bank.
 - An increase in government spending (G) financed by printing new money.
- The M^s curve shifts to the right.
 - The price level increases proportionally to ΔM .

An one-time increase in M^s

- An increase in M^s from $M1$ to $M2$ causes the price to rise proportionally from $P1$ to $P2$, given Y and r .



No change in other markets



The classical dichotomy

- All the real variables (r^* , w^* , Y^* and N^*) remain the same.
- The real variables are separated completely from the nominal variables (M^s , M^d and P).
 - The current labor market (N_s and N_d) and the current goods market (Y^s and Y^d) are not affected.
- The real money demand is not affected:
 - $\frac{M^d}{P} = L(Y, r)$ is constant; $\Delta M = \Delta P$
 - One-time inflation until the new price is reached.

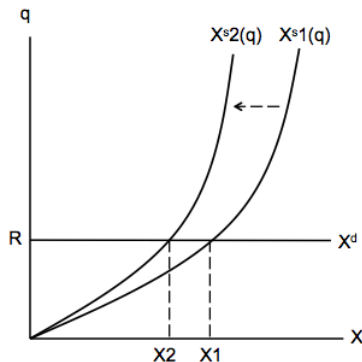
- The monetary neutrality holds in the long run.
- In the short run, money may not be neutral, depending on:
 - The method of injecting money into the economy.
 - Who receive the additional purchasing power first?

- In the long run, a money-increase has no effects on real variables.
 - Only one-time inflation and the higher price level.
- Short-run effects on real variables disappear in the long run — but how?
- What is the transmission mechanism from money to the price level?
 - The real balance effect? The wealth effect?

- Factors that affect the supply or demand for credit card services shift the money demand curve.
- Assume the supply of credit card services shifts left:
 - Ex: communication failure between banks and retailers.
 - The amount of service decreases; the price = q .

Supply of credit card services

- The supply of credit services shifts left.
- The amount of service decreases from X_1 to X_2 .
- The service price is still $R = q$.



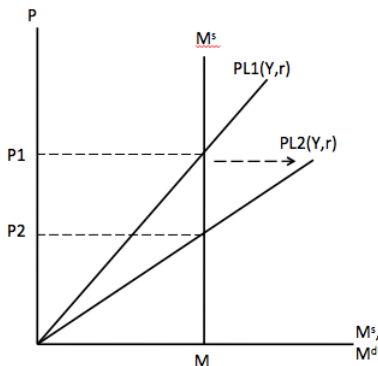
$$M^d = P[Y - X^*(R)]$$

$$M^d = P \times L(Y, R)$$

- As X decreases, money demand increases.
 - The money demand curve shifts right.
 - The price level decreases.
- No effects on other markets.

An increase in money demand

- A decrease in supply of credit card services raises the money demand.
- The price level decreases.



Changes in demand/supply of credit card services

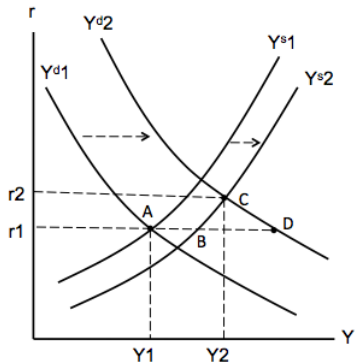
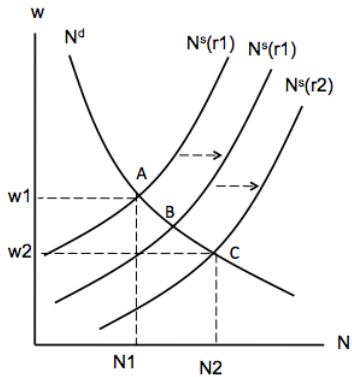
- New technology reducing the cost of banking services.
- New financial instrument reducing the bank's operating costs.
- A change in government regulations.
- A change in the perceived riskiness of banks.
- Shocks in the financial systems.

Shock experiments

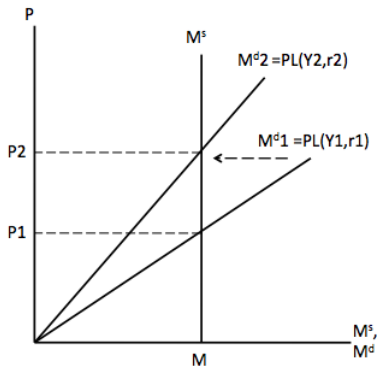
- 1 Current government purchases increase temporarily (G);
- 2 Current capital stock decreases due to a natural disaster or war (K);
- 3 A temporary increase in current total factor productivity (z);
- 4 An increase in future total factor productivity (z').

1. A temporary increase in G

- Higher lifetime taxes; lower lifetime wealth.
 - Leisure decreases; labor supply increases (Y_s).
 - Current consumption decreases (Y_d) .
- The G increase raises total demand for goods (Y_d); higher income and real interest rate.
 - Leisure decreases and labor supply (N_s) increases.
 - Lower current consumption and investment demand.



- Higher Y raises money demand but rising r decreases it.
- If the latter is strong, M^d shifts left and P rises.



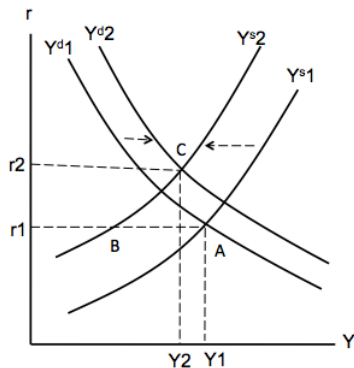
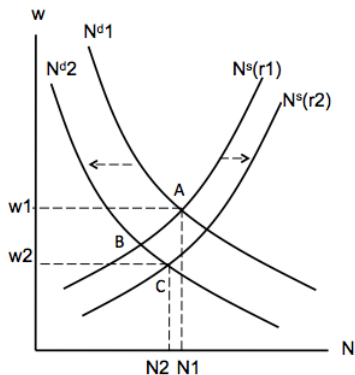
Overall effects of rising G

- Higher income and a higher real interest rate.
 - The effect of rising G on Y^d in the current period is stronger.
- Lower current consumption and investment.
- Higher employment and a lower real wage.
- The higher price level.

2. A decrease in current capital stock

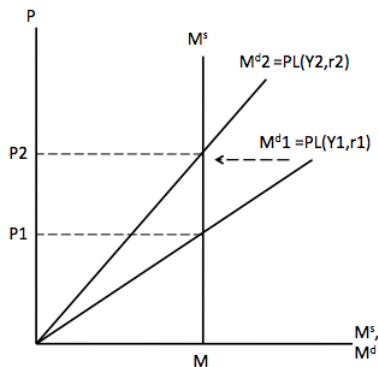
- A lower MP_N , falling labor demand (Y^s shifts left).
- A lower K' and higher MP'_K ; investment demand increases (Y^d shifts right).
 - The higher real interest rate reduces leisure (labor supply, N^S), current consumption and investment demand.
 - The real wage, employment and output fall.

Falling K: labor and goods markets



Falling K: money market

- Lower income and higher real interest rate decrease money demand.
- The price level increases.



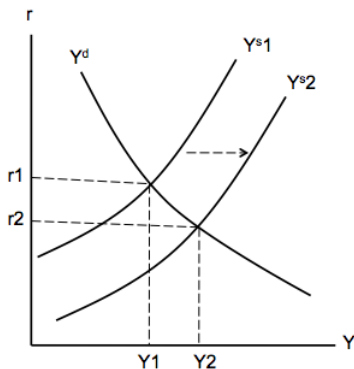
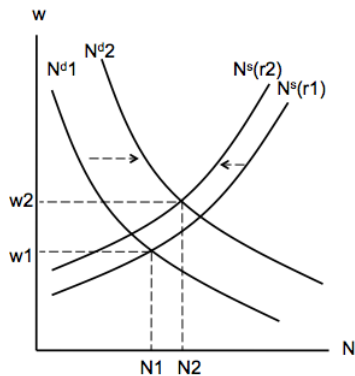
Overall effects of falling K

- Output and income are lower.
- The real interest rate is higher.
- Current consumption decreases; investment increases (net effect).
- Employment and the real wage decrease.
- The price level is higher.

3. An increase in current z

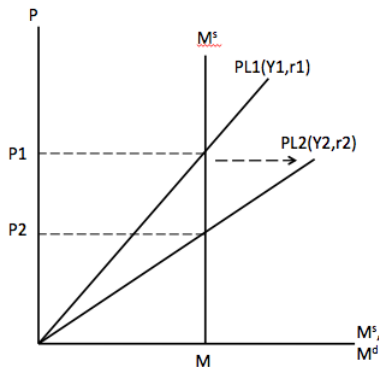
- Current MP_N and labor demand increase; Y^S shifts right.
- The real interest rate decreases.
- Leisure increases; labor supply (N^S) decreases.
- The real wage increases.
- Employment and output increases.
- Current consumption and investment increase.
- Higher money demand and price level.

A rising z : labor and goods markets



A rising z : money market

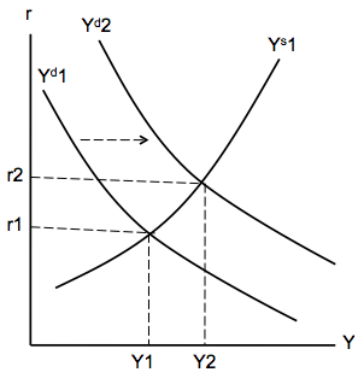
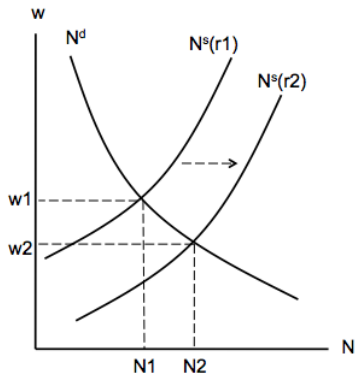
- A lower real interest rate and higher income raise money demand.
- The price level decreases.



4. An increase in z'

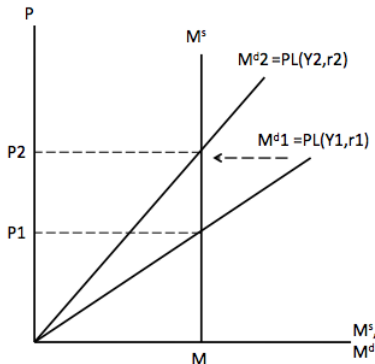
- Higher MP'_K and investment demand; Y^d shifts right.
 - Higher output and real interest rate.
 - Lower leisure, more labor supply (N^S).
 - Employment and the real wage increase.
 - Current consumption is uncertain; investment increases (net effect).
- If M^d decreases, the price level increases.

Rising z' : labor and goods markets



Rising z' : money market

- Higher Y raises money demand, but higher r reduces it.
- If the latter is strong, the price level increases.



Discretionary monetary policy

- Keynesians believe that the market is not efficient and too slow in adjusting to shocks
- Fiscal policy to stabilize the economy.
- **Discretionary monetary policy** by the central bank (to influence private spending).
 - Easy-money policy in times of a slowdown.
 - Tight-money policy in times of expansion.
- But the central bank never has the full information about the economy.
 - Discretionary monetary policy is difficult and costly; targets are missed most of the time.
 - Persistent high inflation in the 1970s discredited such policy.
- **Monetary policy rules** are recommended.
 - The rules for the central bank to control the money supply in response to observable variables in the economy.

The monetary policy rule

- Inflation affects consumers' welfare.
 - Price stability is preferred by consumers and firms.
- Types of monetary policy rules:
 - Money supply targeting.
 - Interest rate targeting.
 - Inflation targeting.
 - Nominal GDP (NGDP) targeting.

- Recommended by Milton Friedman in 1968.
 - The doctrine of monetarism (1970s).
- The constant money-growth rule:
 - Set a constant growth rate of some monetary aggregates (e.g., M1 or M2).
 - Popular in the 1970s and 1980s, then abandoned.
 - Missing the targets due to shocks from Md.
- Good for reducing runaway inflation.

- The Fisher relation: $R = r + i$. ($R = r + \pi$; π is inflation rate)
- The central bank targets $R = R^*$.
- If $R^* = r$, then $i = 0$ (or $\pi = 0$). Good for M^d shocks.
- If $R > R^*$, the central bank reduces M growth.
- If $R < R^*$, the central bank raises M growth.
- Not efficient if shocks from real variables.

- The central bank sets a target inflation rate (π^*).
 - If $\pi > \pi^*$, the central bank raises the nominal interest rate.
 - Short-run interest rate targeting to achieve medium-run inflation target.
- But other shocks may cause the central bank to miss the target.

- The central bank sets a future path of nominal GDP growth ($NGDP^*$).
 - Then it uses short-run targeting (e.g., interest rate targeting) to achieve the medium-run target.
 - If $NGDP > NGDP^*$, it raises the nominal interest rate.
 - If $NGDP < NGDP^*$, it lowers the nominal rate.