Classical Theory

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Content

- **Output**
- Unemployment
- Income Distribution
- Real Interest Rate and Investment
- Inflation and Nominal Interest Rate
- Exchange Rate

Output of an Economy as a Whole

- An economy's output of goods and services depends on:
  - Aggregate Supply (AS, the supply side)
    - Quantity of inputs (called the factors of production): labor, capital, land, etc.
    - The technology that transforms inputs into outputs
  - Aggregate Demand (AD, the demand side)
   - Consumption, investment, government expenditure, and net foreign demand

The AD and AS

- AD is the "sum" of all demand for goods and services.
- AS is the "sum" of all supply of goods and services.
  - Both AD and AS are in the "real" sense: when we say AD or AS changes, it is the quantity of goods and services that changes.
  - The summation is tricky for heterogeneous goods and services.
  - The solution: add up the value of these goods and services at constant prices.

The AD and AS Curves

- Generally, both AD and AS may be functions of the general price level (P).

- The AD curve: as P declines, AD may increase.
  - Pigou's wealth effect, Keynes' interest rate effect, etc.

- The AS curve: as P increases, AS may increase.
  - Misperception, some firms facing sticky prices, etc.

The Classical AD and AS Curves

The AD and AS Curves
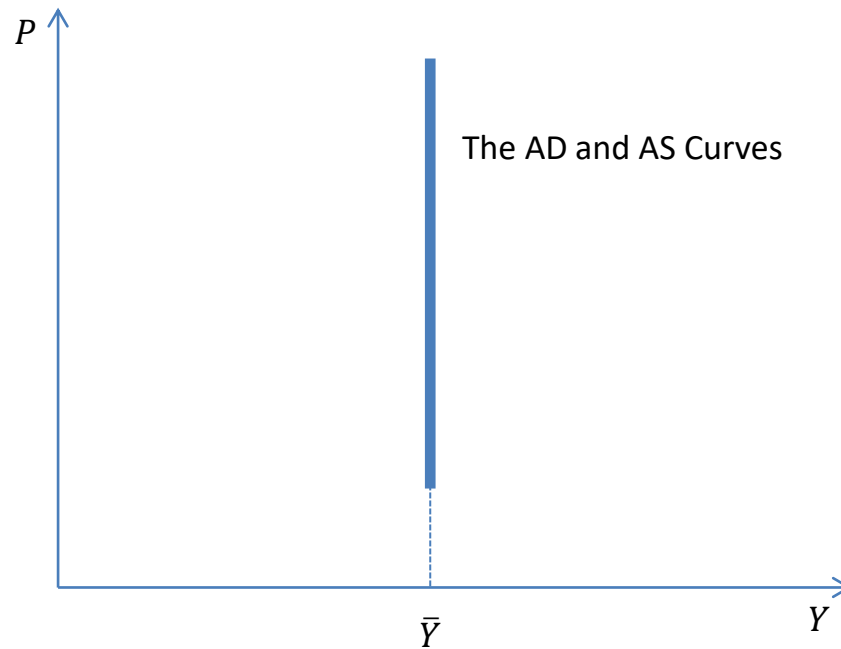
Say's Law

- Say's Law states: supply creates its own demand.
  - It necessarily holds in a barter economy.
  - It does not generally hold in the modern monetary economy.
- One implication of Say's Law: the AD curve coincides with the AS curve at all price level.
  - The general price level is determined by money supply (quantity theory of money) and is irrelevant to "real" activity of the economy.

The Output Potential

- We may call the level of production that utilizes almost all capital and labor inputs the "potential output," which we denote $\overline{Y}$.

- In the classical economy, competition between entrepreneurs will always push production to $\overline{Y}$.

- Capacity utilization is always below the maximum level
  - Option value of extra capacity
  - It takes time for a worker to find a new job.

Factors of Production

- Factors of production are the inputs for producing goods and services.

- The two most important factors of productions are capital and labor. (Land is also regarded as a factor of production.)

- Capital refers to the set of tools that workers use. We use *K* to denote the amount of capital.

- Labor refers to the time workers spend working. We use *L* to denote the amount of labor.

A Simplification Assumption

- In this chapter we assume that both capital and labor are fixed:

$$K = \overline{K}$$
$$L = \overline{L}$$

Production Function

- Macroeconomists use production function to characterize <u>technology</u>, which transforms given amounts of capital and labor into outputs.
- Technology here should be understood in broad terms. It is determined not only by the scientific and engineering knowhow, but also manufacturing organization, marketing and sales skills, transportation, communication, etc.
- Let *Y* be the amount of output, we write the production function as

$$Y = F(K, L).$$

Assumptions on the Production Function

- We assume that the production function is fixed and satisfies:
  - Constant return to scale

    For any $z > 0, F(zK, zL) = zY$

  - Increasing in both K and L.

    $$F_1 \equiv \frac{\partial F}{\partial K} > 0, \text{ and } F_2 \equiv \frac{\partial F}{\partial L} > 0$$

  - Decreasing marginal product of capital and labor, and capital-labor complementarity:

$$F_{11} \equiv \frac{\partial^2 F}{\partial K^2} < 0, \ F_{22} \equiv \frac{\partial^2 F}{\partial L^2} < 0, \text{ and } F_{12} \equiv \frac{\partial^2 F}{\partial K \partial L} > 0.$$

The Cobb-Douglas Production Function

- The celebrated Cobb-Douglas production is given by

$$F(K, L) = AK^{\alpha}L^{\beta},$$

  where A is a constant that denotes level of production efficiency.

- To satisfy the constant-return-to-scale assumption, we must impose $\alpha + \beta = 1$ and we have

$$F(K, L) = AK^{\alpha}L^{1-\alpha}$$

- Check whether the remaining assumptions holds.

The Output of Goods and Services

- If both factor inputs and the technology are fixed, then the classical economy produces a fixed amount of goods and services,
$$Y = F(\overline{K}, \overline{L}) = \overline{Y}.$$

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Unemployment

- There is no unemployment problem when factor inputs are (almost) fully utilized. However, the unemployment rate is nonzero even in the idealized classical economy.

- In this part of the lecture, we discuss the "natural rate of unemployment" that happens in the classical economy with flexible prices (wages).

  - A simple model
  - Frictional unemployment

The Unemployment Rate and the Natural Rate of Unemployment in US

Intermediate Macroeconomics
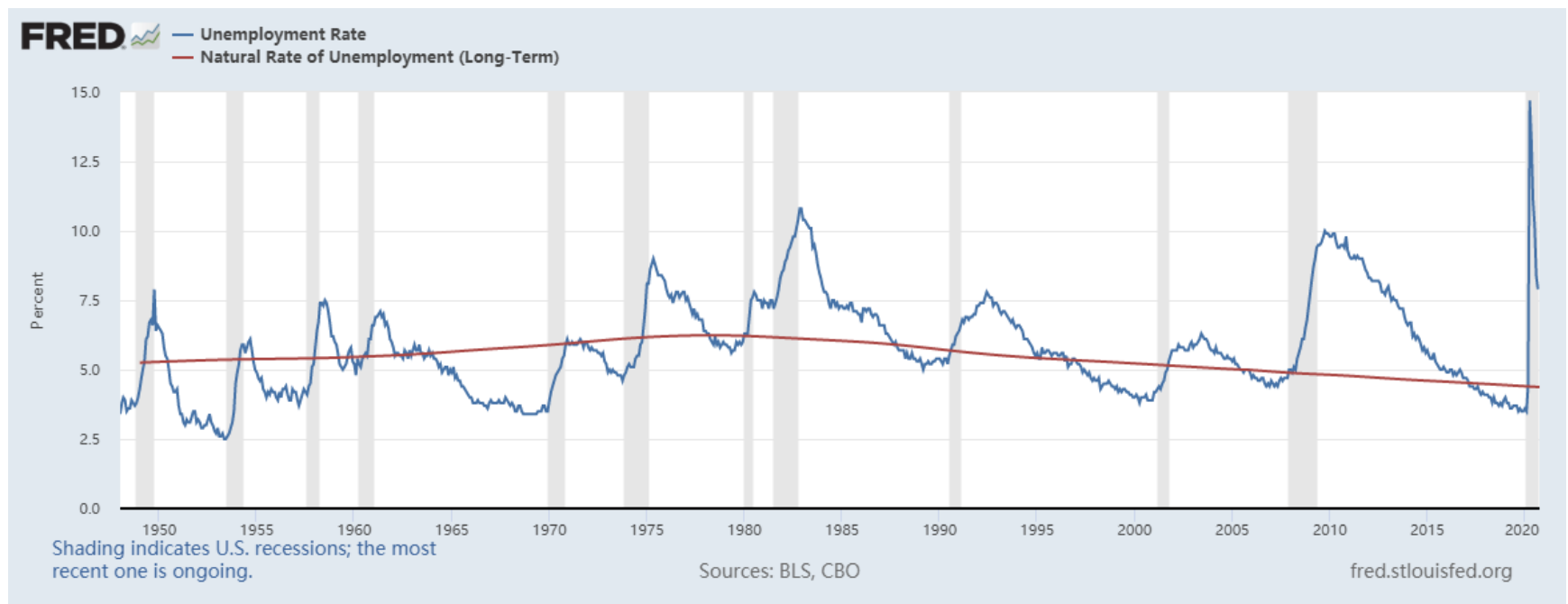
A Model of Natural Unemployment

- Let L denote the labor force, E the number of the employed, U the number of the unemployed. We know that $L = E + U$ and U/L is the unemployment rate.

- Let s be the <u>rate of job separation</u>, f the <u>rate of job finding</u>. We assume that in a period of time, there are (sE) of those employed losing their job and (fU) of the unemployed finding job.

- Assume that the unemployment rate is in a <u>steady state</u>, i.e.,

$$sE = fU.$$

The Natural Unemployment Rate

- From the steady state, we have

$$\frac{fU}{L} = \frac{s(L-U)}{L}.$$

- Writing differently, we have

$$f\frac{U}{L} = s\left(1 - \frac{U}{L}\right),$$

which gives

$$\frac{U}{L} = \frac{s}{s+f} = \frac{1}{1+f/s}.$$

The Implications

- This simple model relates the natural unemployment rate to the rate of job separation and the rate of job finding.

- Any policy aiming to lower natural unemployment rate must either decrease the rate of job separation or make it easier to find jobs.

- The model, however, does not explain what causes unemployment.

Frictional Unemployment

- It takes time to find a job or find a worker. The unemployment due to this simple fact is called <u>frictional unemployment</u>.
- The friction comes from
    - Heterogeneities of jobs and workers,
    - Imperfect information,
    - Imperfect labor mobility,
    - Sectoral shifts.

Policy Responses to Frictional Unemployment

- Frictional unemployment is an important component of natural unemployment.
- To reduce frictional unemployment, governments usually do the following:
  - Help disseminate information about jobs.
  - Provide training programs
- The government may also provide unemployment insurance.
  - Unemployment insurance helps soften the economic hardship of the unemployed. Hence it may contribute to higher natural unemployment.
  - However, unemployment insurance reduces workers' uncertainties about their income and also, helps to achieve a better matching between workers and jobs.

Structural Unemployment

- The structural unemployment is caused by <u>wage rigidity</u>, the failure of real wage adjustments.
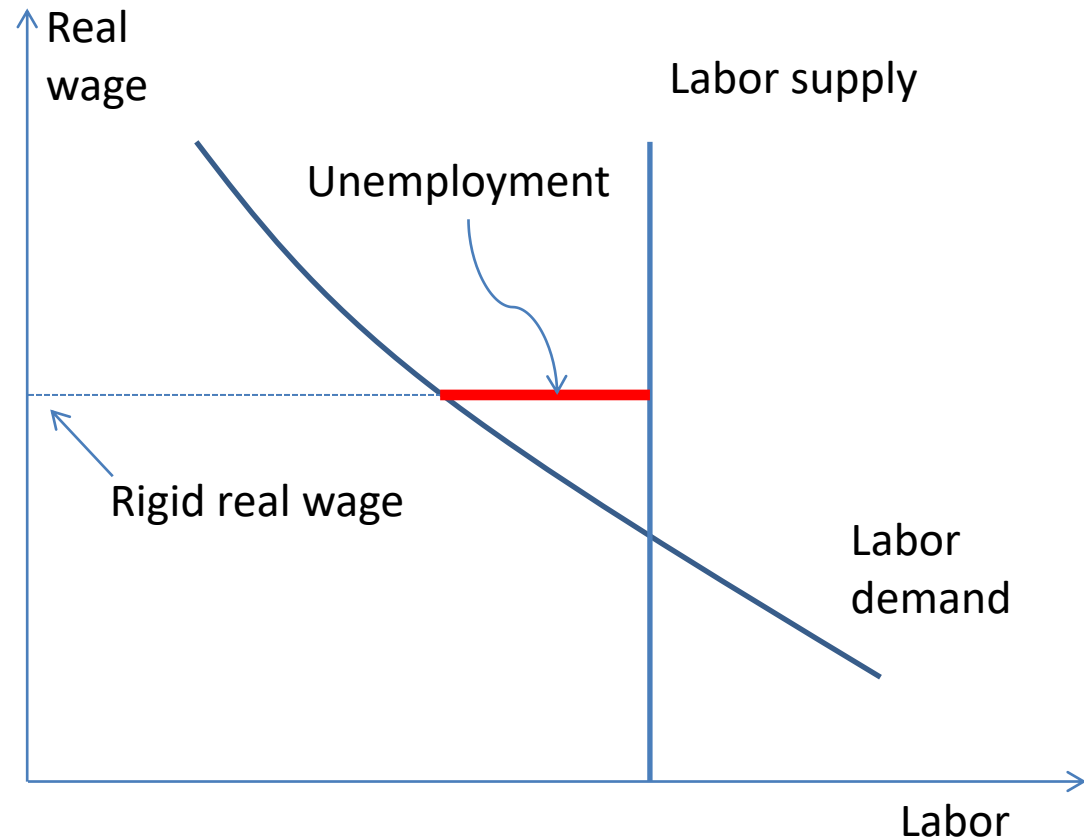
Causes of Wage Rigidity

- Minimum wage
  - The minimum wage v.s. <u>earned income tax credit</u> debate
- Labor union
  - "Insiders", through collective bargaining, achieves to keep their firm's wage high.
  - To give more influence to "outsiders", wage bargaining can take place at national level (e.g., Sweden).
- Efficiency wage
  - High wage reduces <u>labor turnover</u>.
  - High wage mitigates the problem of <u>adverse selection</u>.
  - High wage mitigates the problem of <u>moral hazards</u>.

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Distribution of Income

- Under the classical assumptions, the total output is fixed, so the total income is also fixed. We now discuss how the income is distributed.

- The income is distributed to those who provide inputs, that is, <u>those who provide capital</u> and <u>those who provide labor</u>.

- Factor prices (real wage and real rental price of capital) are crucial for the determination of the distribution.

Factor Prices

- Real wage is the payment to labor measured in units of output, $\frac{W}{P}$, where W is nominal wage and P is the price of output. (In empirical studies, P would be CPI or GDP deflator).

- Real rental price of capital is the rental price paid to the owner of capital in units of output, $\frac{R}{P}$, where R is the rent. (In most cases, firm owners also own capital.)

Competitive Markets

- Markets for goods and services are competitive.

- Markets for factors of production (labor and capital) are competitive.

(A market is competitive if no participants are large enough to affect prices. In other words, all market participants are price takers.)

Decisions of A Competitive Firm

- A competitive firm <u>takes as given</u> the price of its output (P), wage (W), and real rental price of capital (R), and solves the following problem:

$$\max_{K,L} P \cdot F(K, L) - W \cdot L - R \cdot K.$$

The Solution

- The first-order condition for K yields:

$$F_1(K, L) = \frac{R}{P}.$$

  This says that the firm would employ capital up to the point where marginal product of capital (MPK) equals the real rental price of capital.

- The first-order condition for L yields:

$$F_2(K, L) = \frac{W}{P}.$$

  This says that the firm would employ labor up to the point where marginal product of labor (MPL) equals the real wage.
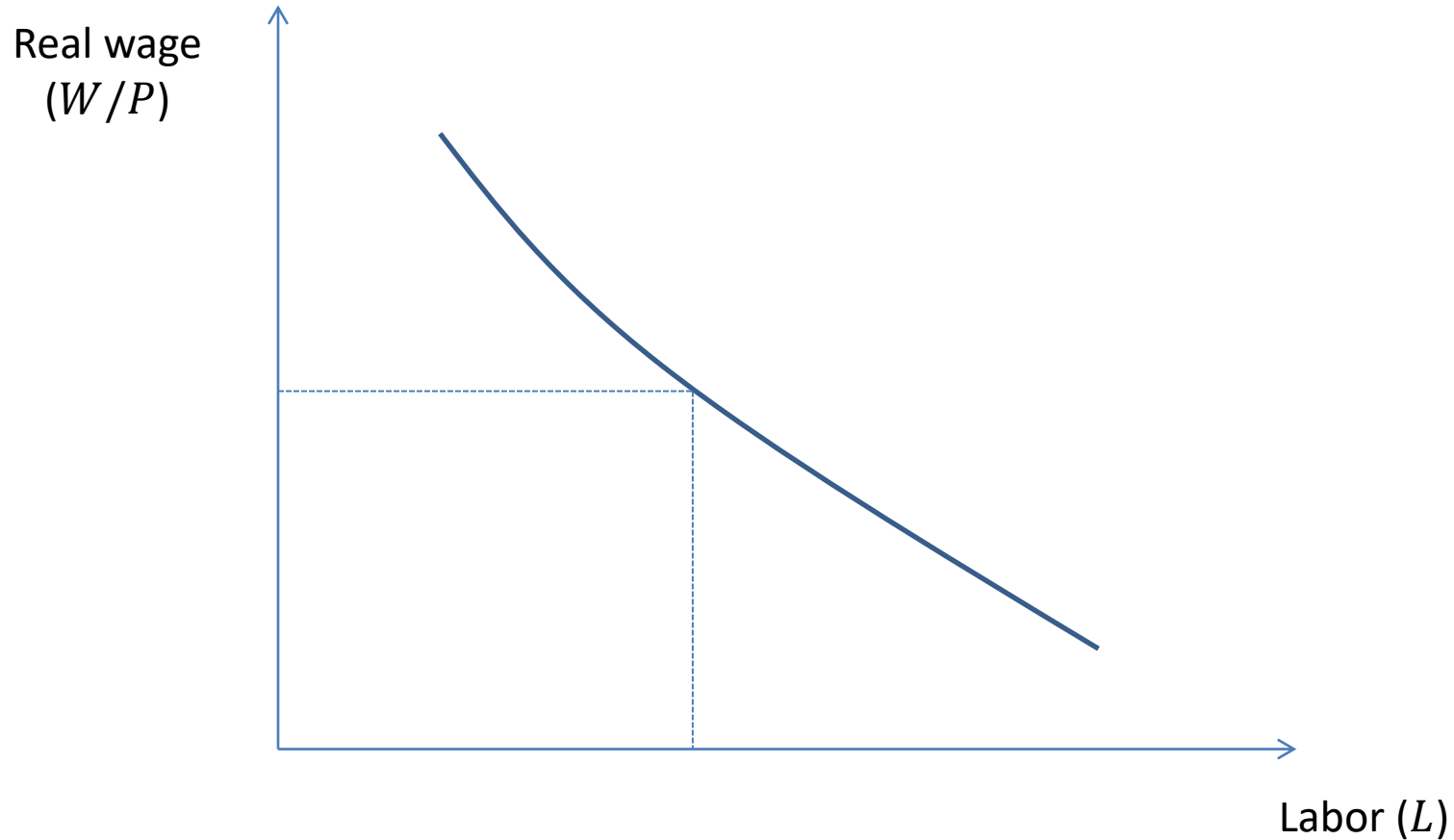
Demand for Labor

- Fix $K = \overline{K}$, the first-order condition for L gives us the demand curve for labor, i.e., the relationship between real wage ($\frac{W}{P}$) and the labor demanded:

$$F_2(\overline{K}, L) = \frac{W}{P}.$$

- Since we assume decreasing marginal product of labor, a lower real wage would correspond to a higher demand for labor.

A Labor Demand Curve

Real wage
(W/P)

Labor (L)

Economic Profit and Accounting Profit

- Real <u>economic profit</u> is defined by
$$Y - MPL \cdot L - MPK \cdot K$$

- Accounting profit is defined by the sum of economic profit and the return to capital, since most firms own capital rather than rent them.

  Accounting profit=economic profit + $MPK \cdot K$

Distribution of National Income

- Under our assumptions, the owner of labor receives $F_2(\overline{K}, \overline{L}) \cdot \overline{L}$, the owner of capital receives $F_1(\overline{K}, \overline{L}) \cdot \overline{K}$, and there is no economic profit.

- To see why there is no economic profit, note that under the constant-return-to-scale assumption on the production function, we have $F(zK, zL) = zF(K, L)$ for any $z > 0$. Then it follows from $\frac{dF(zK, zL)}{dz} = \frac{d(zF(K, L))}{dz}$ that $F_1(zK, zL)K + F_2(zK, zL)L = F(K, L)$. Let $z = 1$ and plug in $K = \overline{K}$ and $L = \overline{L}$, we have

$$F_1(\overline{K}, \overline{L})\overline{K} + F_2(\overline{K}, \overline{L})\overline{L} = F(\overline{K}, \overline{L}) = \overline{Y}.$$

The Cobb-Douglas Economy

- Suppose $F(K,L) = AK^\alpha L^{1-\alpha}$, we have

$$\text{MPK} = F_1(K,L) = \frac{\alpha AK^\alpha L^{1-\alpha}}{K} = \frac{\alpha F(K,L)}{K}$$

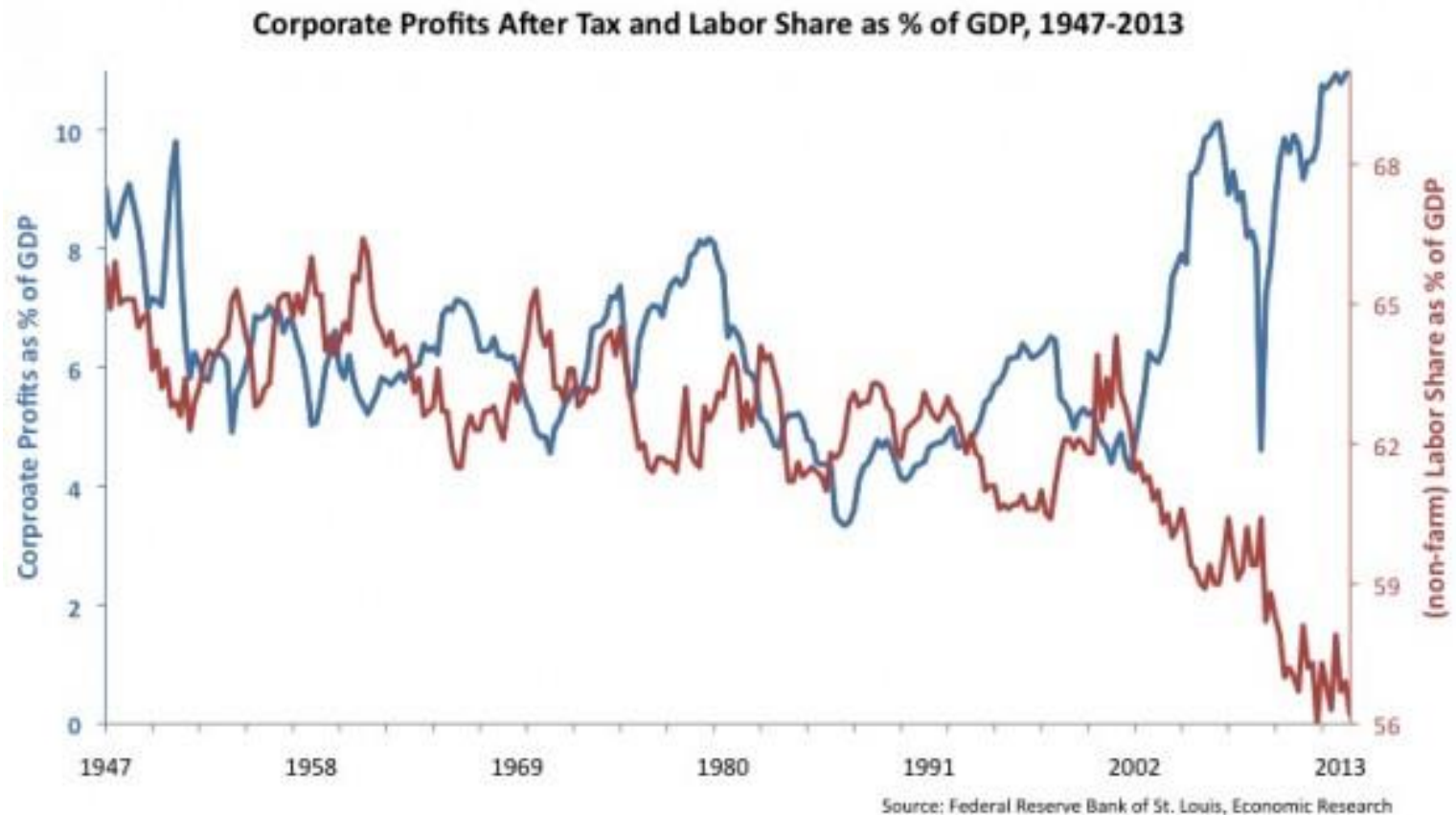$$\text{MPL} = F_2(K,L) = \frac{(1-\alpha)AK^\alpha L^{1-\alpha}}{L} = \frac{(1-\alpha)F(K,L)}{L}$$

- The capital's share of income is

$$F_1(\overline{K},\overline{L}) \cdot \overline{K} = \alpha F(\overline{K},\overline{L}) = \alpha \overline{Y}$$

- The labor's share of income is

$$F_2(\overline{K},\overline{L}) \cdot \overline{L} = (1-\alpha)F(\overline{K},\overline{L}) = (1-\alpha)\overline{Y}$$

Case Study: Labor's Share of Income in USA

Corporate Profits After Tax and Labor Share as % of GDP, 1947-2013

Source: Federal Reserve Bank of St. Louis, Economic Research

Case Study: Labor's Share of Income in China

Intermediate Macroeconomics
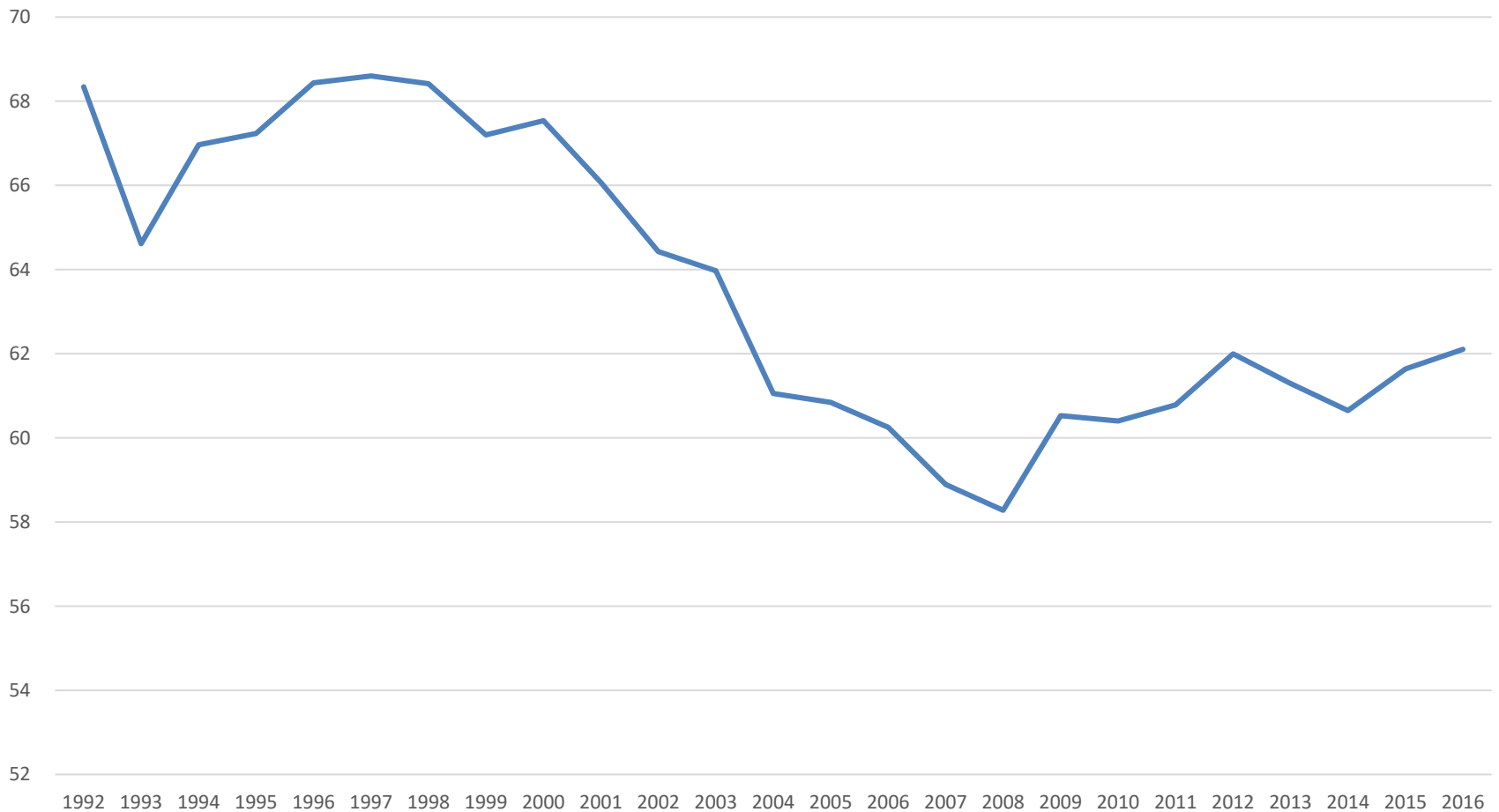
Average Labor Productivity and Real Wage

- Average labor productivity of an economy is defined by the average output, $\frac{Y}{L}$.

- In the Cobb-Douglas economy,

$$\text{MPL} = F_2(K, L) = \frac{(1-\alpha)AK^{\alpha}L^{1-\alpha}}{L} = (1-\alpha)\frac{Y}{L}$$

- Hence the MPL is proportional to average labor productivity in the Cobb-Douglas economy.

Case Study: Labor Productivity and Real Wage in USA

	Growth in labor productivity (%)	Growth in real nonfarm compensation (%)
1959-1972	2.8	2.3
1973-1994	1.6	0.7
1995-2007	2.7	1.6
2008-2019	1.3	0.8
1959-2019	**2.1**	**1.3**

Why does real wage growth lag behind
the labor productivity growth?

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A Classical Model of Real Interest Rate

- In the following we present a classical macroeconomic model of real interest rate.

- The model contains an equilibrium restriction and a set of behavioral assumptions.

- We will use the model to examine the effects of external shocks on a closed economy.

Another Interpretation of the National Income Accounting Identity

- Let Y denote GDP, which have four components on the expenditure side: $Y = C + I + G + NX$,
  - Consumption expenditure (C)
  - Investment expenditure (I)
  - Government expenditure (G)
  - Net export (NX)
- One interpretation of the identity is: "supply equals demand",
  - Y is the aggregate supply of goods and services
  - $(C + I + G + NX)$ is the aggregate demand.
    - C : Consumption demand
    - I : Investment demand
    - G : Government demand
    - NX : Net foreign demand

A Simplification: Closed Economy

- We first consider a closed-economy model. That is $NX = 0$. We have
$$Y = C + I + G.$$

- To build the model, we make a set of behavioral assumptions on
  - the consumption expenditure (C)
  - investment expenditure (I)

- The government expenditure (G) and tax (T) are exogenous variables.

Consumption Function

- Let T denote the tax on households. The disposable income is defined by income minus tax, $(Y - T)$.

- The consumption function characterizes the consumption component (C) by a function of the disposable income, $C(Y - T)$.

- We assume that $C(\cdot)$ is an increasing function. That is, more disposable income leads to more consumption.

Marginal Propensity to Consume

- The <u>marginal propensity to consume</u> (MPC) is defined by the amount of additional consumption given unit increase in disposable income, or mathematically, $\frac{dC(Y)}{dY}$, where Y denotes disposable income.

- If $C(\cdot)$ is a linear function, e.g.,
$$C(Y - T) = 100 + 0.7(Y - T),$$
then MPC is a constant. In the above example, we have MPC=0.7.

Investment Function

- We assume that the demand for investment goods depends on <u>real interest rate</u>, which is the rate of interest a lender receives after allowing for inflation.

- We characterize the investment component of GDP by a function of the real interest rate (r), $I(r)$.

- We assume that $I(r)$ is a decreasing function.

Nominal and Real Interest Rates

- Two interest rates:
  - Nominal interest rate (i, directly observable)
  - Real interest rate (r, unobservable but can be estimated)
- The <u>ex-post real interest rate</u> is defined as

$$r = i - \pi,$$

      where π denotes inflation.

- The ex post real interest rate is a "realized" real interest rate.
- Rearrange the above equation, we obtain the Fisher equation

$$i = r + \pi.$$

Ex-ante Real Interest Rate

- An alternative definition of the real interest rate is:
$$r = i - E\pi.$$

- When loaner and debtor negotiate an interest rate, they would an expectation of future inflation and calculate the real interest rate.

- The real interest rate defined here is called <u>ex ante real interest rate</u>, meaning that it is not yet "realized".

- Re-arrange the above equation, we obtain the modified Fisher equation,
$$i = r + E\pi.$$

Fiscal Policy

- The fiscal policy determines how much to tax and how much to spend by the government.
- The fiscal policy is characterized by T, the tax revenue of the government, and by G, the government purchases of goods and services.
  - If $G = T$, we have a <u>balanced budget</u>.
  - If $G > T$, we have <u>budget deficit</u>.
  - If $G < T$, we have <u>budget surplus</u>.
- We assume both G and T are exogenous variables,
$$G = \bar{G}, T = \overline{T}.$$

Equilibrium in the Goods Market

- In the goods market, the demand side is characterized by
$$Y^d = C(\bar{Y} - \bar{T}) + I(r) + \bar{G}$$

- The supply side is
$$Y^s = \bar{Y}$$

- In equilibrium, we must have demand equals supply,
$$\bar{Y} = C(\bar{Y} - \bar{T}) + I(r) + \bar{G}.$$

National Saving

- The <u>national saving</u> is defined by $S = Y - C - G$, which is total income minus expenditures by the households and the government.

- The national saving can be decomposed into two, $S = S_{ng} + S_g$, where
  - S_{ng} is private (non-government) saving,
  $$S_{ng} = Y - C - T$$
  - S_g is public saving, $S_g = T - G$

- We have:
  $$S_{ng} - I - NX = G - T$$

Equilibrium in the Financial Market

- We assume a simple <u>financial market</u> for <u>loanable funds</u>. Those with savings would lend their savings to borrowers (investors) in this market.
  - Supply of loanable funds: the national saving $\bar{S} \equiv \bar{Y} - C(\bar{Y} - \bar{T}) - \bar{G}$
  - Demand for loanable funds: the investment need $I(r)$
- In equilibrium, the real interest rate (r) must adjust so that saving equals investment:
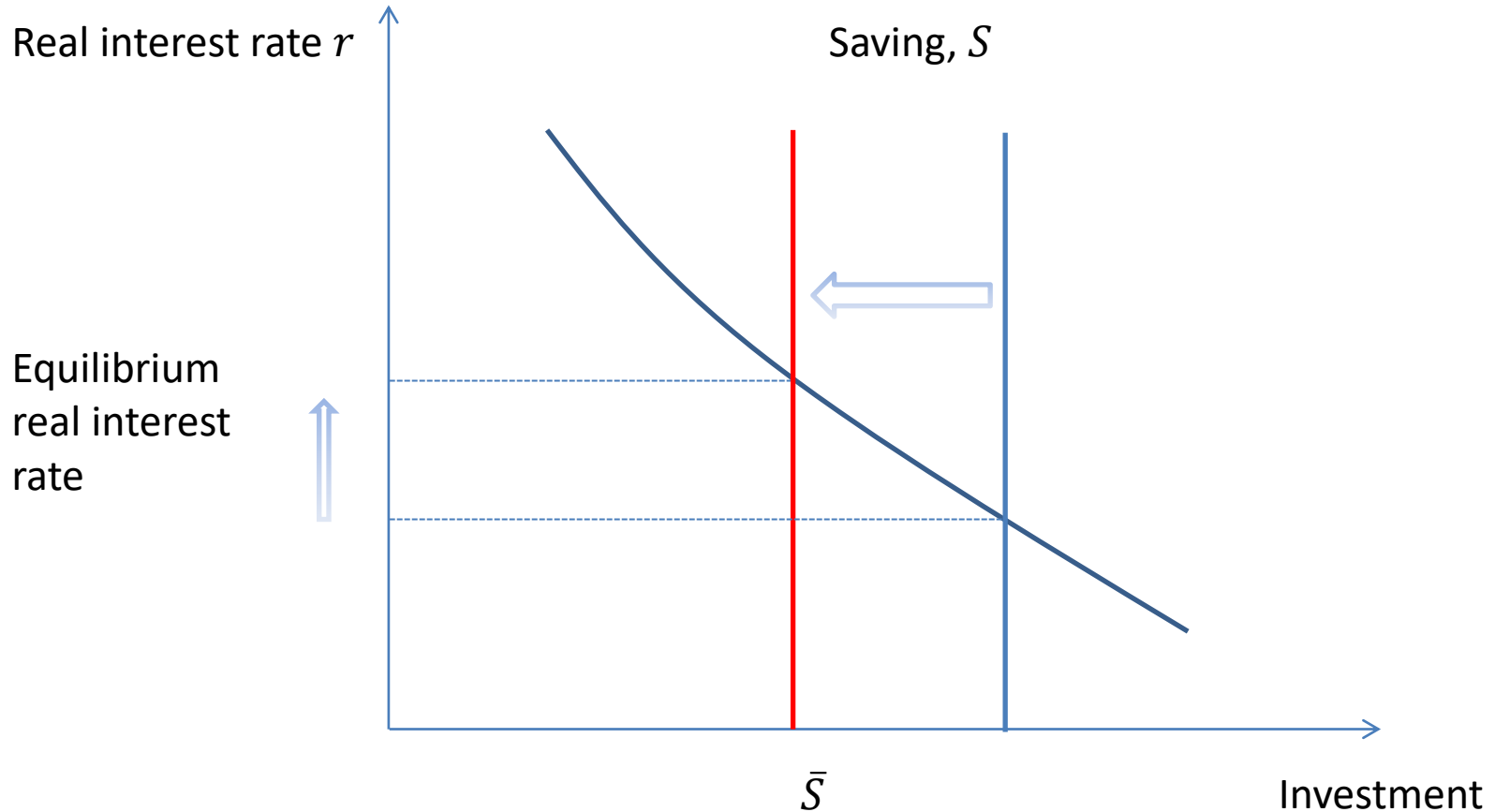$$\bar{S} = I(r).$$

Determination of Real Interest Rate

Real interest rate r

Saving, S

Equilibrium real interest rate

Demand for loanable funds, $I(r)$

$\bar{S}$

Investment
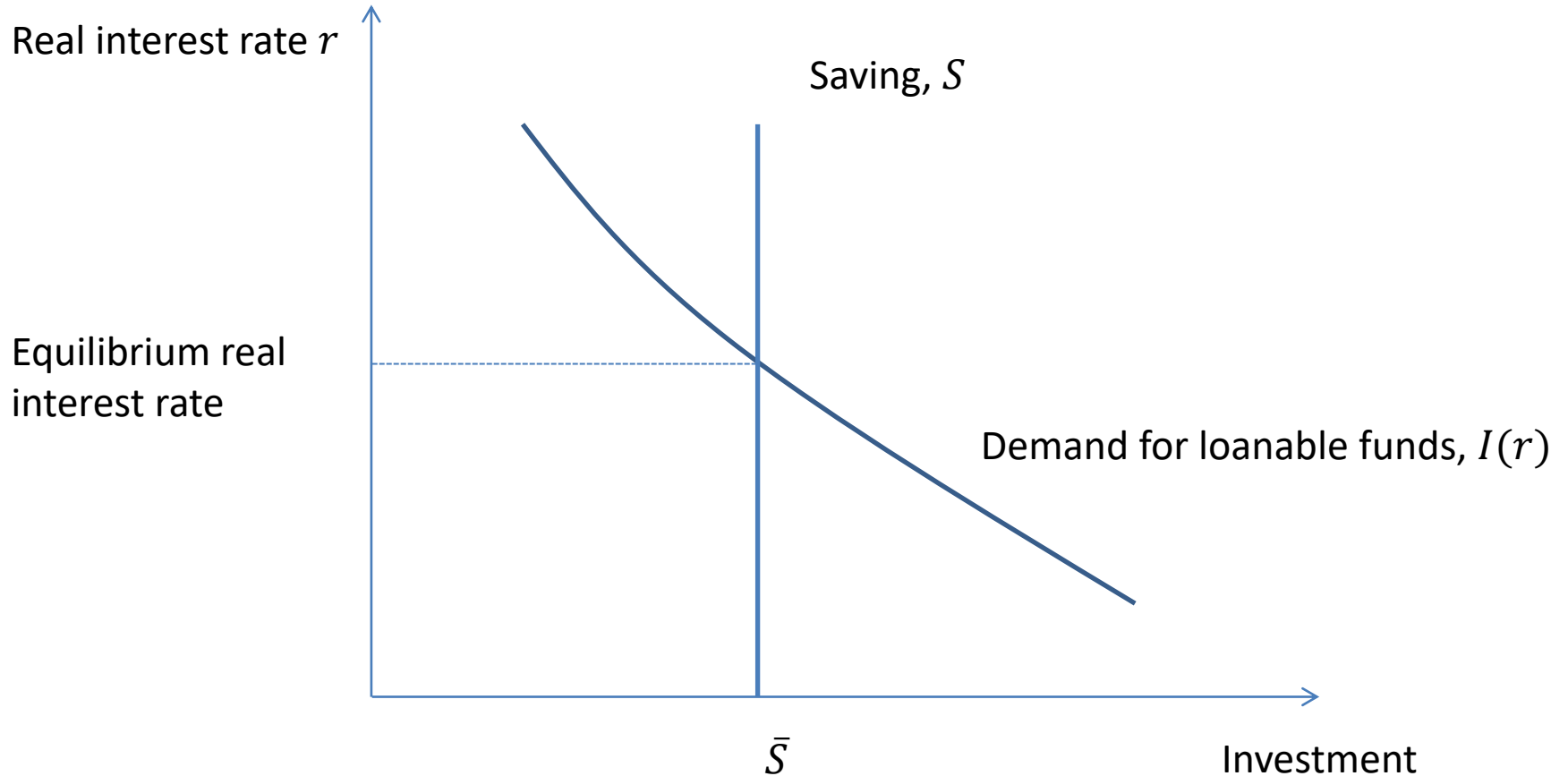
The Effects of Fiscal Policies

- We now use our model to examine the effects of fiscal policies on the economy.
  - An increase in government spending
  - A tax reduction

An Increase in Government Spending

The Crowding-Out Effect

- The model predicts that an increase in government expenditure would reduce national saving. This leads to higher interest rate and lower investment. Economists would say that government spending "crowds out" the private investment.

- What about the effect of tax reduction on the economy?

A Surge in Investment Enthusiasm

- A surge in investment enthusiasm implies that, given any real interest rate, the investment demand for the loanable funds would increase.

- That is, the demand curve would shift to the right.

Changes in Investment Demand
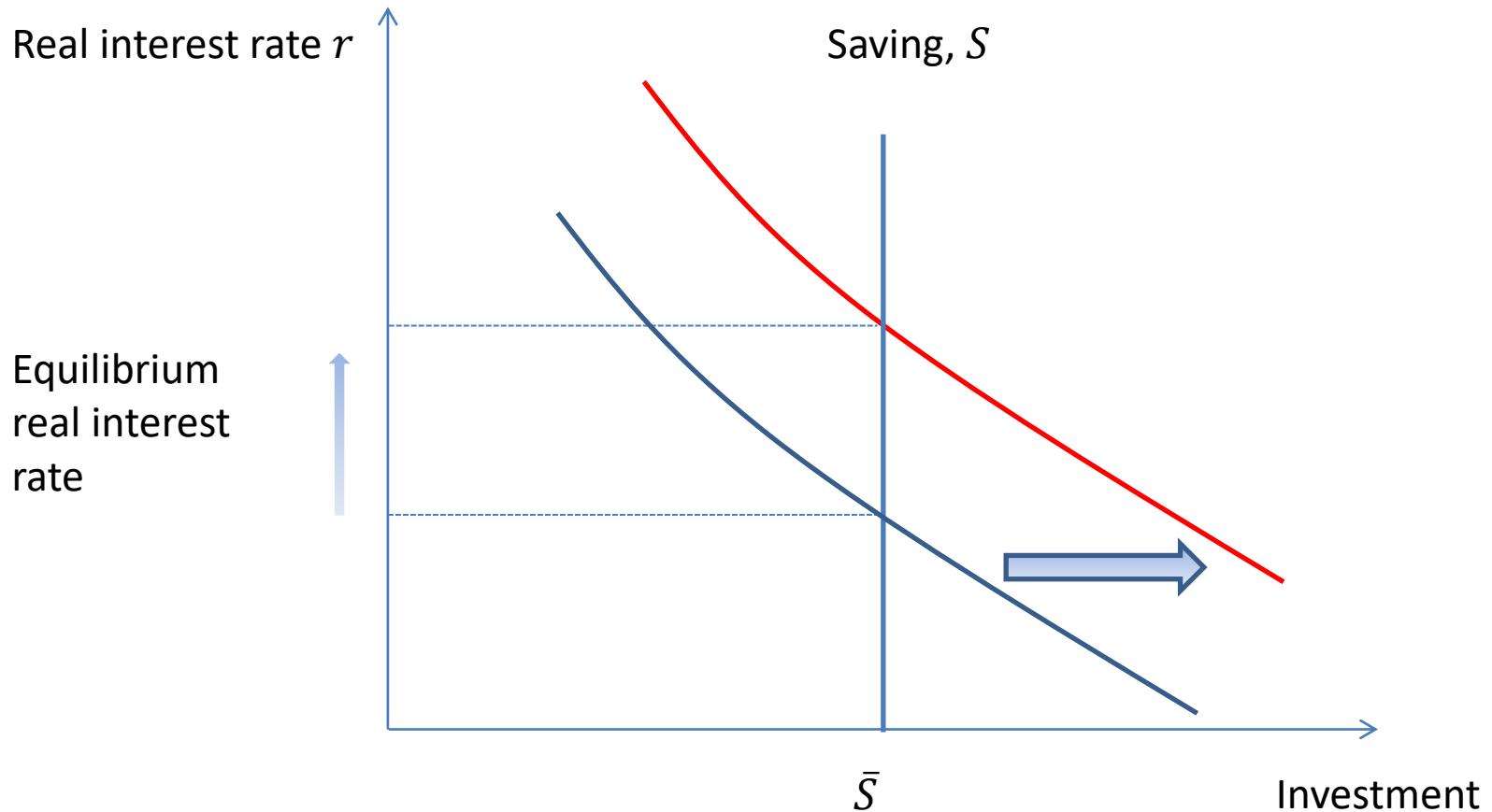
A Modified Model

- The model predicts that the real interest rate increases and the total investment remain unchanged.
- At this point, we may doubt whether the model gives a correct prediction.
- A more realistic saving curve would be upward-sloping so that higher interest rate encourages saving.
- To improve the model, we may specify the consumption function as

$$C = C(Y - T, r),$$

where we assume that C is decreasing in r. Now the national saving becomes an increasing function of real interest rate,

$$S(r) = Y - C(Y - T, r) - G.$$

A More Realistic Saving Curve

Real interest rate r

Saving, $S(r)$

Equilibrium real interest rate
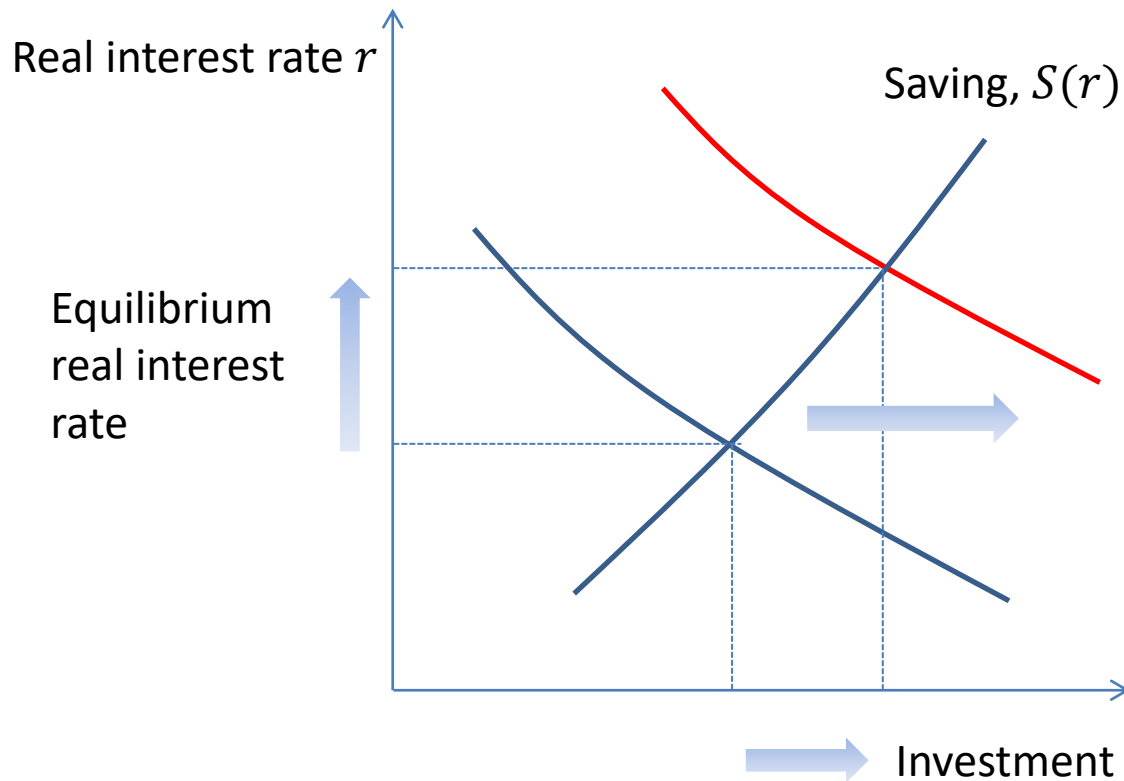
Investment

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Money

- Money is the stock of assets that can be readily used to make transactions.
- Functions of money:
  - Store of value
  - Unit of account
  - Medium of exchange
- Types of money:
  - Commodity money (gold, silver)
  - Fiat money

How Fiat Money Comes About

- Transactions using commodity money (say <u>gold</u>) is costly.
- To reduce transaction cost, a bank may mint <u>gold coins</u> of known purity and weight.
- To further reduce cost, the bank may issue <u>gold certificates</u>, which can be redeemed for gold. The gold certificate becomes <u>gold-backed money</u>.
- The need for transactions is unlimited, but the supply of gold is limited. Hence the limited supply of gold has a <u>deflationary effect</u> on the economy, if the bank sticks to the gold standard of money.
- If people do not care about the option of redeeming gold, however, the bank can issue certificates that are not backed by gold in vault. The modern central bank does exactly this, and these certificates are <u>fiat money</u>.
- <u>Fiat money is valued because people expect it's valued by everyone else.</u>

Case Studies

- Money in a POW (prison of war) Camp
- Money on the Island of Yap

Monetary Policy

- Monetary policy is the process by which the <u>monetary authority</u> of a country controls the <u>supply of money</u>, often targeting <u>an interest rate</u> for the purpose of <u>promoting economic growth and stability</u>.

- The monetary authority in China is People's Bank of China (PBC), that in USA is the Federal Reserve (the Fed).

Seigniorage: Another Reason for Printing Money

- In normal times, the central bank increase money supply to accommodate increasing demand for money.

- At the same time, by printing money, the central bank contributes revenue to the government, often by purchasing government bonds. The revenue from printing money is called seigniorage, or "inflation tax".

- In normal times, seigniorage is moderate. In some extreme situations (war, hyperinflation, etc), seigniorage may contribute the majority of government revenue.

Money in Modern Economy

- Money in a modern economy may include:
  - Cash
  - Demand deposits
  - Saving deposits
  - Money market funds

How Money Supply is Measured in USA

Measures of Money Stock		Amount (billion USD)	
	Assets included	2008	2014
C	Currency	818.9	1254.1
M1	Currency plus demand deposits, traveler's checks, and other checkable deposits	1631.9	2973.4
M2	M1 plus retail money market mutual fund balances, saving deposits (including money market deposit accounts), and small time deposits.	8207.5	11714.3

How Money Supply is Measured in China

- M0：流通中现金，即在银行体系以外流通的现金；2017年末，中国M0为7.06万亿。

- M1：狭义货币供应量，即M0＋活期存款；2017年末，中国M1为54.38万亿。

- M2：广义货币供应量，即M1＋准货币；其中准货币指企事业单位定期存款、自筹基本建设存款、个人储蓄存款和其他存款。2017年末，中国M2为167.68万亿。

Case Study: M2/GDP Ratio

- The ratios of M2/GDP differ across economies.

	M2/GDP (%, 2012)
China	180.1
USA	64.2
EU	92.4
Japan	170.4

- Generally speaking, M2/GDP is high in economies where banks dominate the financial sectors.

Inflation

- Definition: Inflation is a <u>sustained increase in the general price level</u> of goods and services in an economy over a period of time.

- Measurement: CPI and GDP deflator.

- Relationship between money and inflation: <u>Inflation erodes purchasing power of money</u>.

Costs of Inflation

- Expected Inflation
  - Shoeleather cost
  - Menu cost
  - Relative price distortion
  - Unfair tax treatment
  - General inconveniences
- Unexpected inflation
  - Arbitrary redistributions of purchasing power
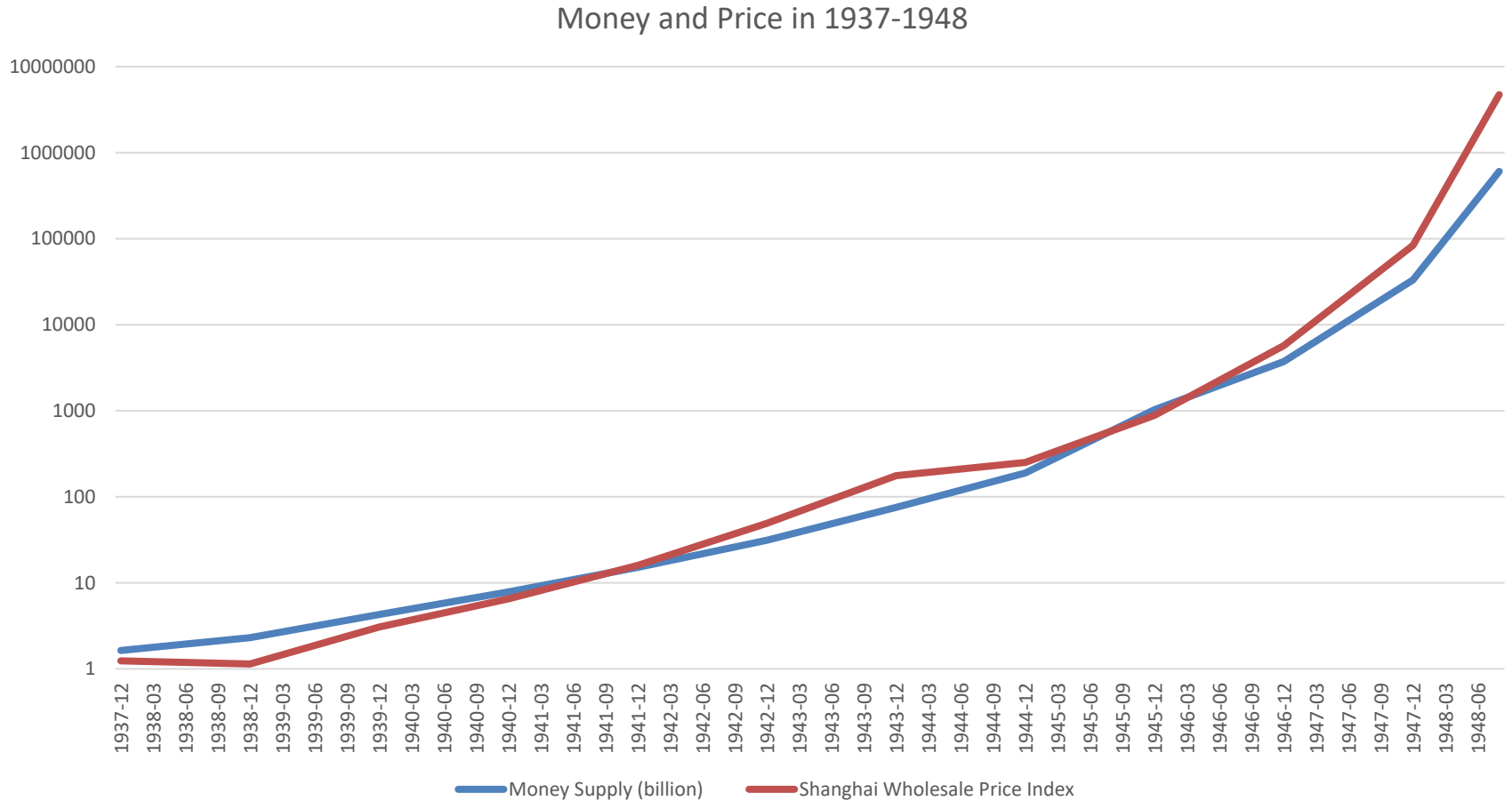 - Increased uncertainty

One Benefit of Inflation

- Nominal wages are rarely reduced, even when the equilibrium real wage falls.

- Inflation allows the real wages to reach equilibrium levels without nominal wage cuts.

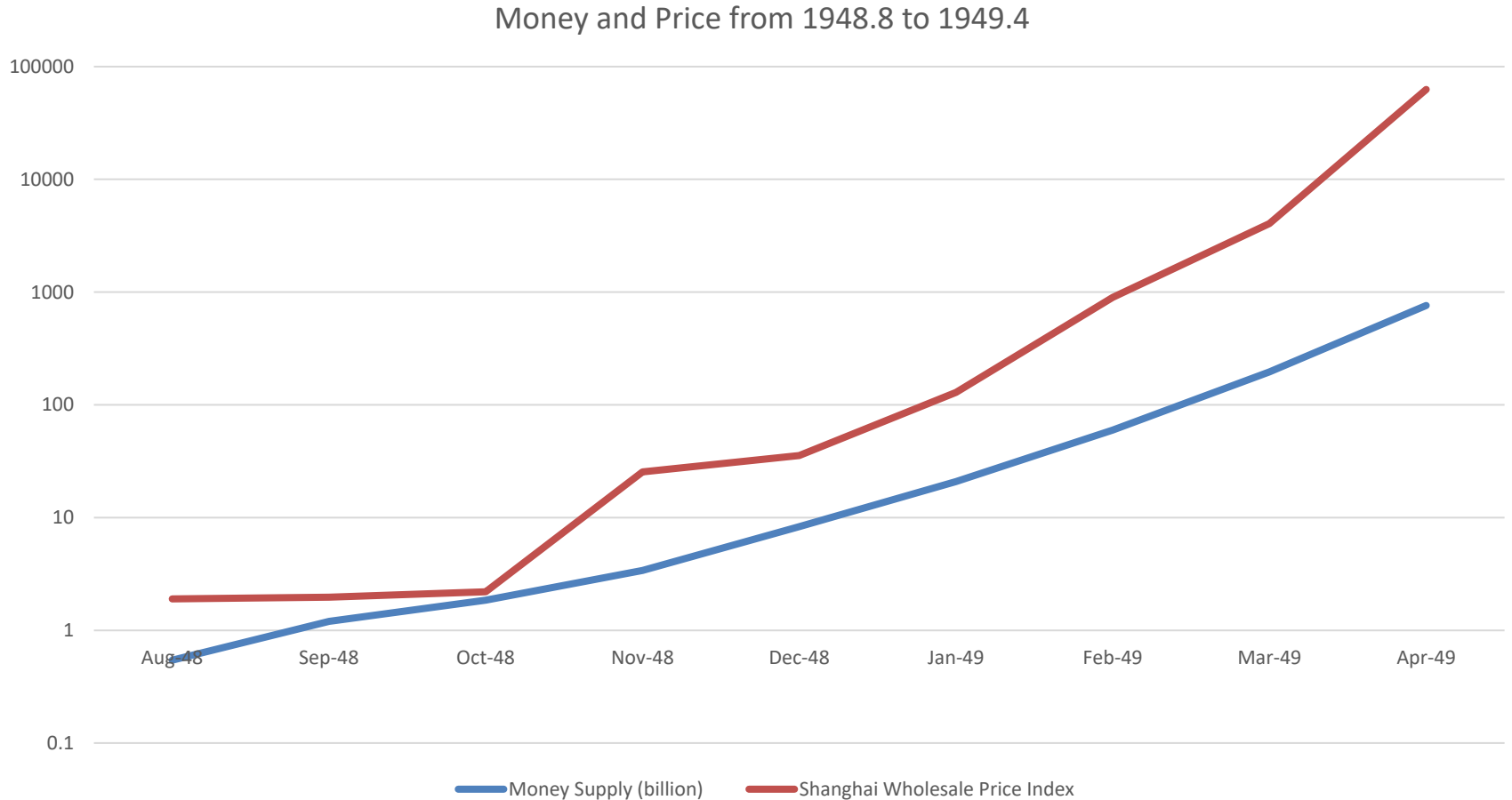- Therefore, moderate inflation improves the functioning of labor markets

Hyperinflation

- Definition: Inflation exceeds 50% per month
- All the costs of moderate inflation described above become HUGE under hyperinflation.
- Money ceases to function as a store of value, and may not serve its other functions (unit of account, medium of exchange).
- People may have to barter or use a stable foreign currency.

Case Study: Hyperinflation in Nationalist China

Money and Price in 1937-1948

Intermediate Macroeconomics

Case Study: Hyperinflation in Nationalist China

Money and Price from 1948.8 to 1949.4

100000	
10000	
1000	
100	
10	
1	
0.1	

Aug-48   Sep-48   Oct-48   Nov-48   Dec-48   Jan-49   Feb-49   Mar-49   Apr-49

— Money Supply (billion)   — Shanghai Wholesale Price Index

Intermediate Macroeconomics

What Causes Hyperinflation?

- An easy answer is: hyperinflation is caused by excessive money supply growth.

- When the central bank prints money, the price level rises. If it prints money rapidly enough, the result is hyperinflation.

- But why do central bank print money? It's the fiscal problem, in most cases!

- How can hyperinflation be halted? Fiscal reform in most cases.

Quantity Theory of Money: From The Perspective of Transactions

- Let T be the total number of transactions during a period of time, P the overall price, and M the money in circulation. We may define the transaction velocity of money by

$$V \equiv \frac{PT}{M}.$$

- The quantity theory of money is thus stated as

$$MV = PT.$$

Quantity Theory of Money: From The Perspective of Income

- Transactions are difficult to measure, but they are related with the total income (or output) of the economy.

- Proxy the total transactions by the total income (e.g., real GDP), we obtain a more practical quantity theory of money:

$$MV = PY,$$

  where Y denotes total income (e.g., real GDP).

- Note that the new version of quantity theory is nothing but an alternative definition of the velocity of money.

Quantity Theory of Money: From The Perspective of Money Demand and Supply

- Define $k = \frac{1}{V}$, we can arrange the quantity theory of money as

$$\frac{M}{P} = kY.$$

- Assume that k is constant. We may understand the right-hand side as a simple form of money demand.

- The left-hand side, called real money balances, is the money supply. We read the above equation as

  "real money supply" = "money demand".

- k characterizes how much money people wish to hold for each unit of income. It is by definition inversely proportional to V: when people hold lots of money relative to their incomes, money changes hands infrequently.
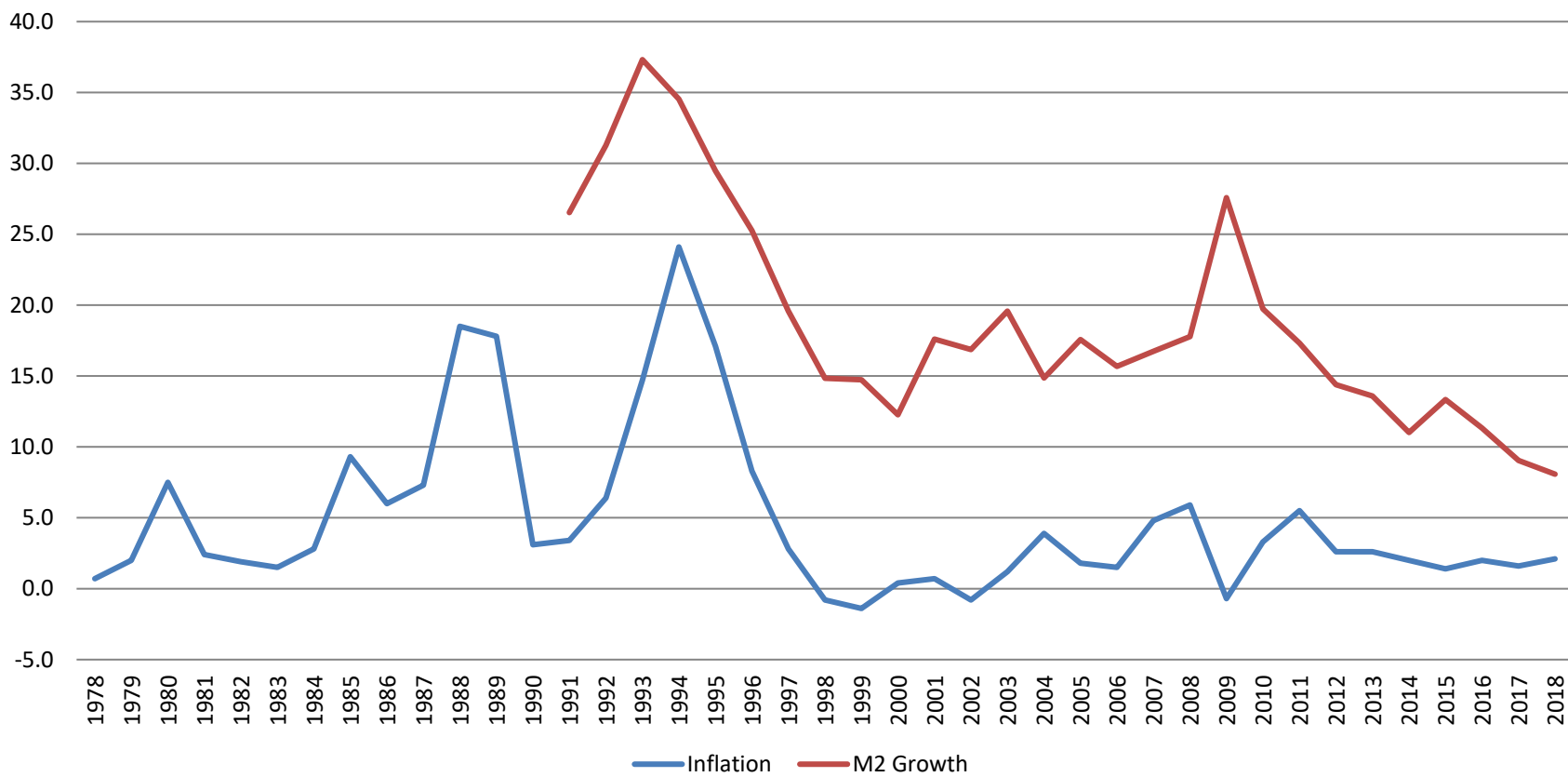
Money and Inflation

- From quantity theory of money, we can obtain

$$\frac{dM}{M} + \frac{dV}{V} = \frac{dP}{P} + \frac{dY}{Y}.$$
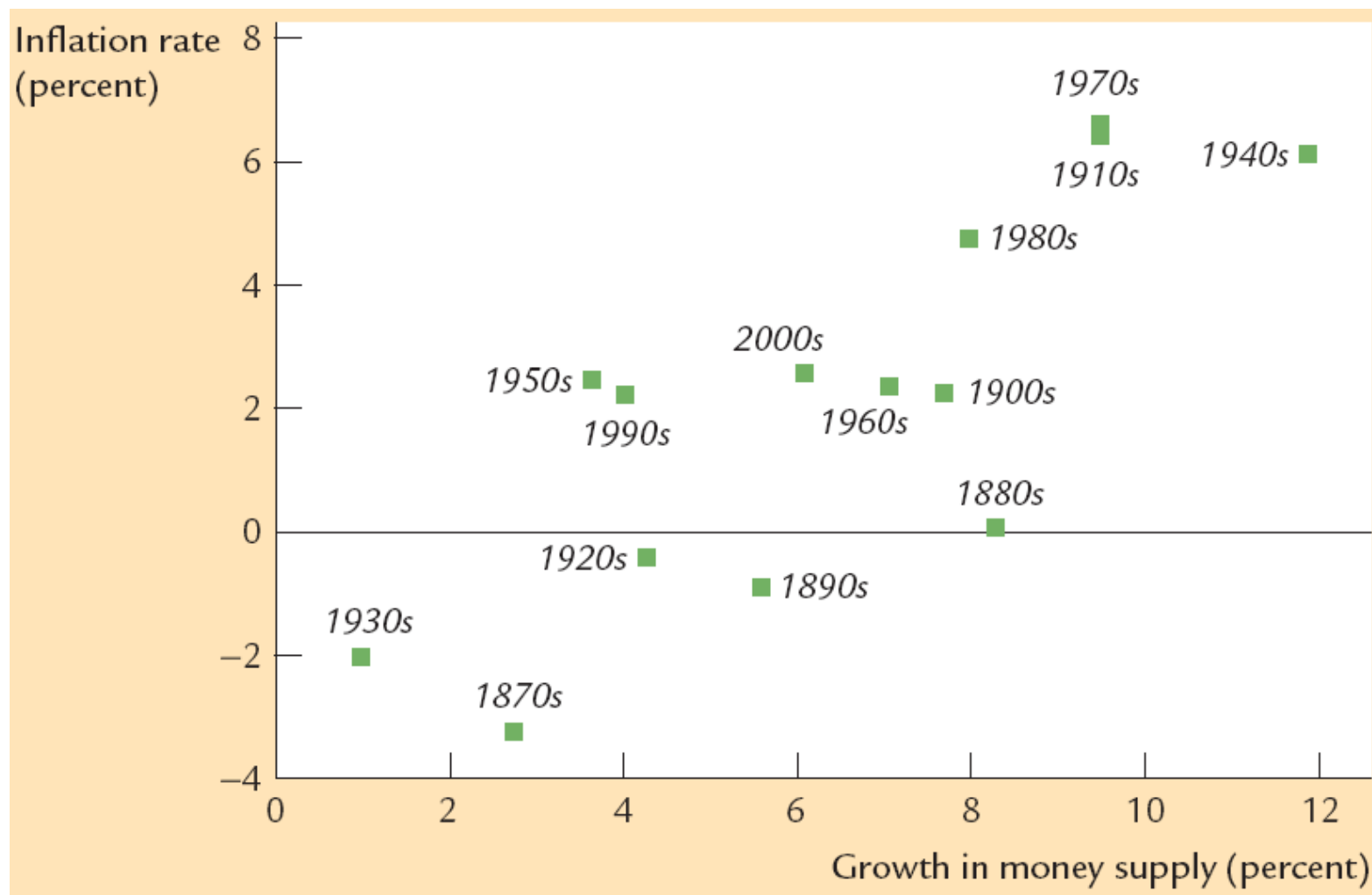
  - $\frac{dM}{M}$ and $\frac{dY}{Y}$ are growth rates of money supply and real GDP, respectively.

  - $\frac{dP}{P}$ is the inflation rate.

  - If we assume constant velocity, $\frac{dV}{V} = 0$.

- Given the real GDP growth rate, higher growth rate of money supply leads to higher inflation.
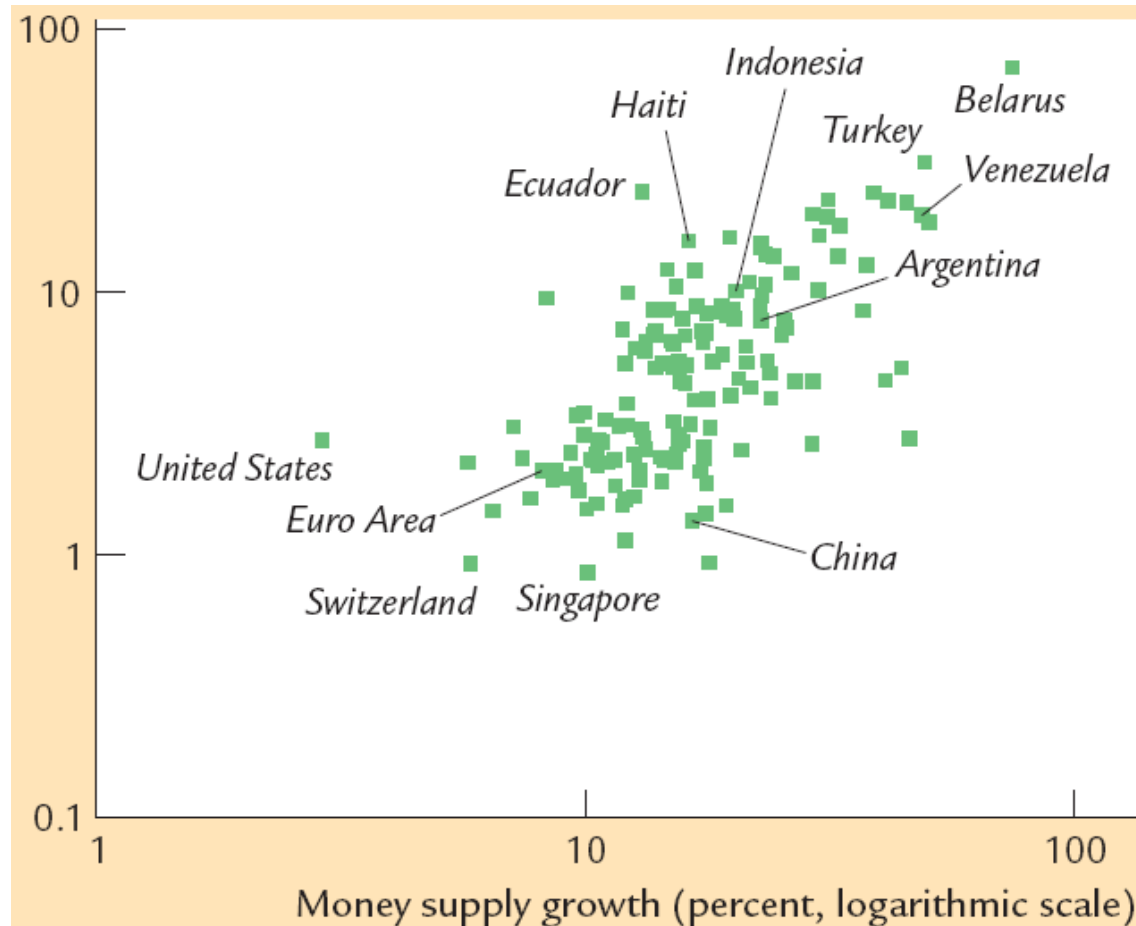
Case Study: M2 Growth and Inflation in China
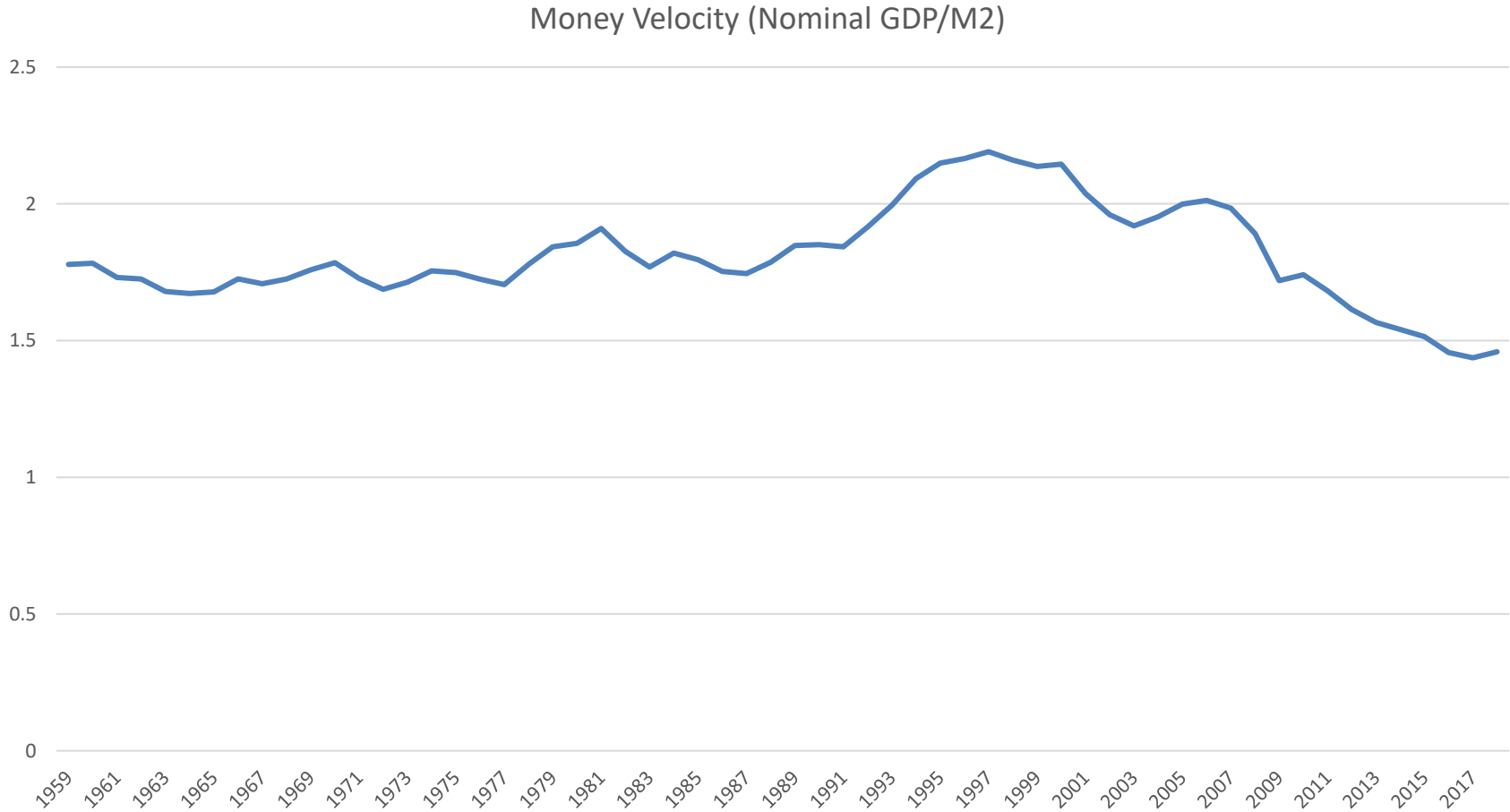

Infaltion and Money Growth

Case Study: U.S. Inflation and Money Growth

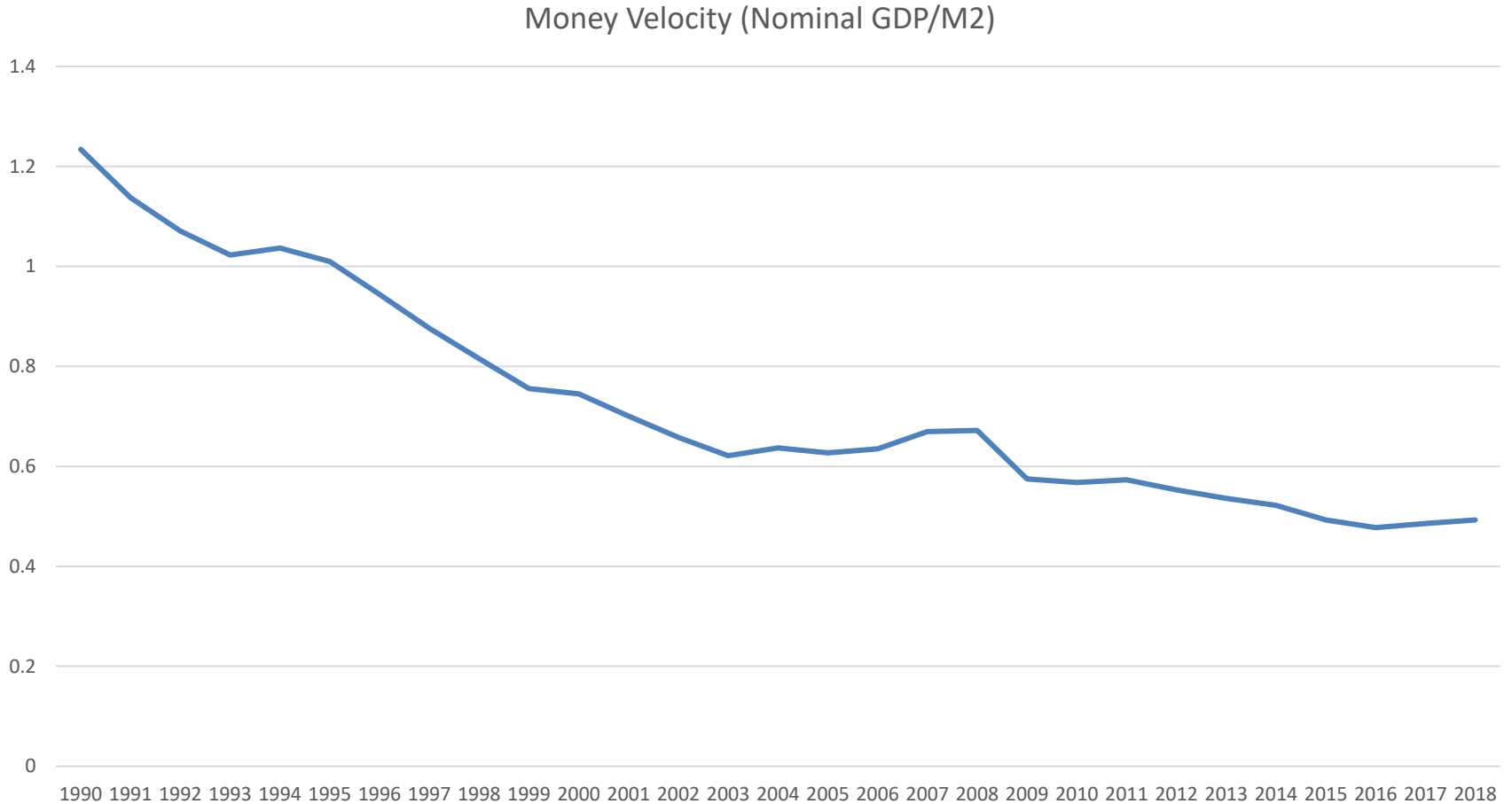# Case Study: Money Growth and Inflation Across Countries

Intermediate Macroeconomics

Case Study: Money Velocity of USA

Money Velocity (Nominal GDP/M2)

Intermediate Macroeconomics

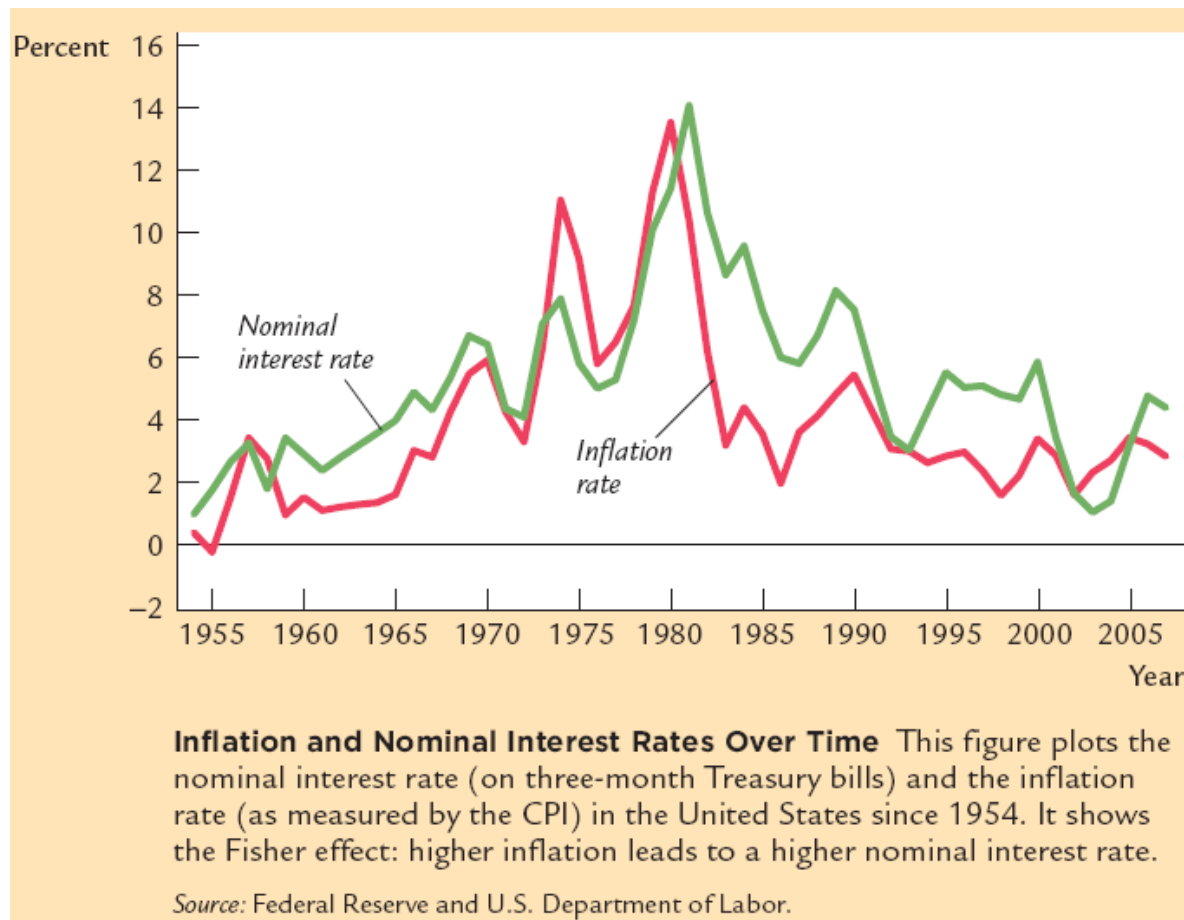# Case Study: Money Velocity of China

Money Velocity (Nominal GDP/M2)

Inflation and Nominal Interest Rate

- Recall that the real interest rate is determined in the market for loanable funds, $I(r) = \bar{S}$.

- If the real variables (Y, C, G) are given, so is r.

- Then the nominal interest rate, according to the Fisher's equation $(i = r + \pi)$, has a one-to-one relationship with the inflation rate (Fisher effect).

- For example, in a static economy $(Y = \bar{Y})$, a 1% increase in growth rate of money supply causes 1% increase in inflation rate, and then 1% increase in nominal interest rate.

Case Study: Inflation and Nominal Interest Rate in USA

Inflation and Nominal Interest Rates Over Time This figure plots the nominal interest rate (on three-month Treasury bills) and the inflation rate (as measured by the CPI) in the United States since 1954. It shows the Fisher effect: higher inflation leads to a higher nominal interest rate.

Source: Federal Reserve and U.S. Department of Labor.

Intermediate Macroeconomics

Case Study: Inflation and Nominal Interest Rate Across Countries

Nominal interest rate (percent, logarithmic scale)

Inflation rate (percent, logarithmic scale)

Zimbabwe
Romania
Brazil
Turkey
Israel
Germany
Switzerland
United States
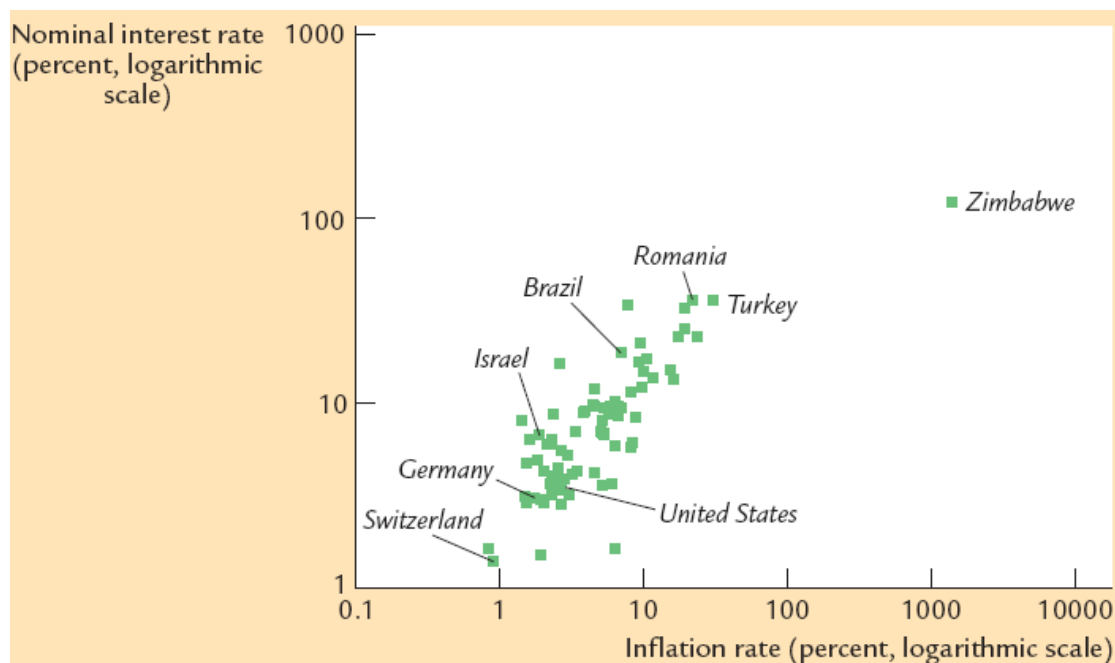
Inflation and Nominal Interest Rates Across Countries
This scatterplot shows the average nominal interest rate on short-term Treasury bills and the average inflation rate in 81 countries during the period 1999 to 2007. The positive correlation between the inflation rate and the nominal interest rate is evidence for the Fisher effect.

Source: International Monetary Fund.

An Integrated Model

- The classical AD-AS model:
$$Y = \bar{Y}$$

- The classical model of real interest rate:
$$Y = C(Y - T) + I(r) + G$$

- The quantity theory of money:
$$\frac{M}{P} = kY$$

- The Fisher equation:
$$i = r + \pi$$

Classical Dichotomy

- Real variables can be fully studied without considering money.
  - Y, r, unemployment rate, etc.
- Money only influences the nominal values.
  - Price level, nominal GDP, nominal interest rate, etc.
- The idea of separating real from nominal analysis is called the <u>classical dichotomy</u>.
- If the classical dichotomy holds, we also say that money is neutral.

Criticism of the Classical Dichotomy

- The model of money demand is too simplistic. Money demand may well depend on other factors than Y. For example, interest rate, consumer and investor confidence, debt level, etc. Indeed, money velocity is very unstable in history.

- The quantity theory of money implies that monetary policy is irrelevant. However, it is quite evident that monetary policy has <u>real effects</u> on outputs.

Money Demand and Nominal Interest Rate

- The Quantity Theory of Money assumes that the demand for real money balances depends only on real income Y.

- We now consider another determinant of money demand: the nominal interest rate.

- The nominal interest rate i is the opportunity cost of holding money (instead of bonds or other interest-earning assets).

- Hence, an increase in i lowers money demand.

The Money Demand Function

- We may write the money demand function as

$$\left(\frac{M}{P}\right)^d = L(i, Y)$$

- The function $L(i, Y)$ would be decreasing in i and increasing in Y.

(L is used for the money demand function because money is the most liquid asset.)

Money and Inflation

- Equate demand to supply, we obtain
$$\frac{M}{P} = L(i, Y) = L(r + E\pi, Y).$$

- This equilibrium condition establishes a relationship between expected inflation and money supply.
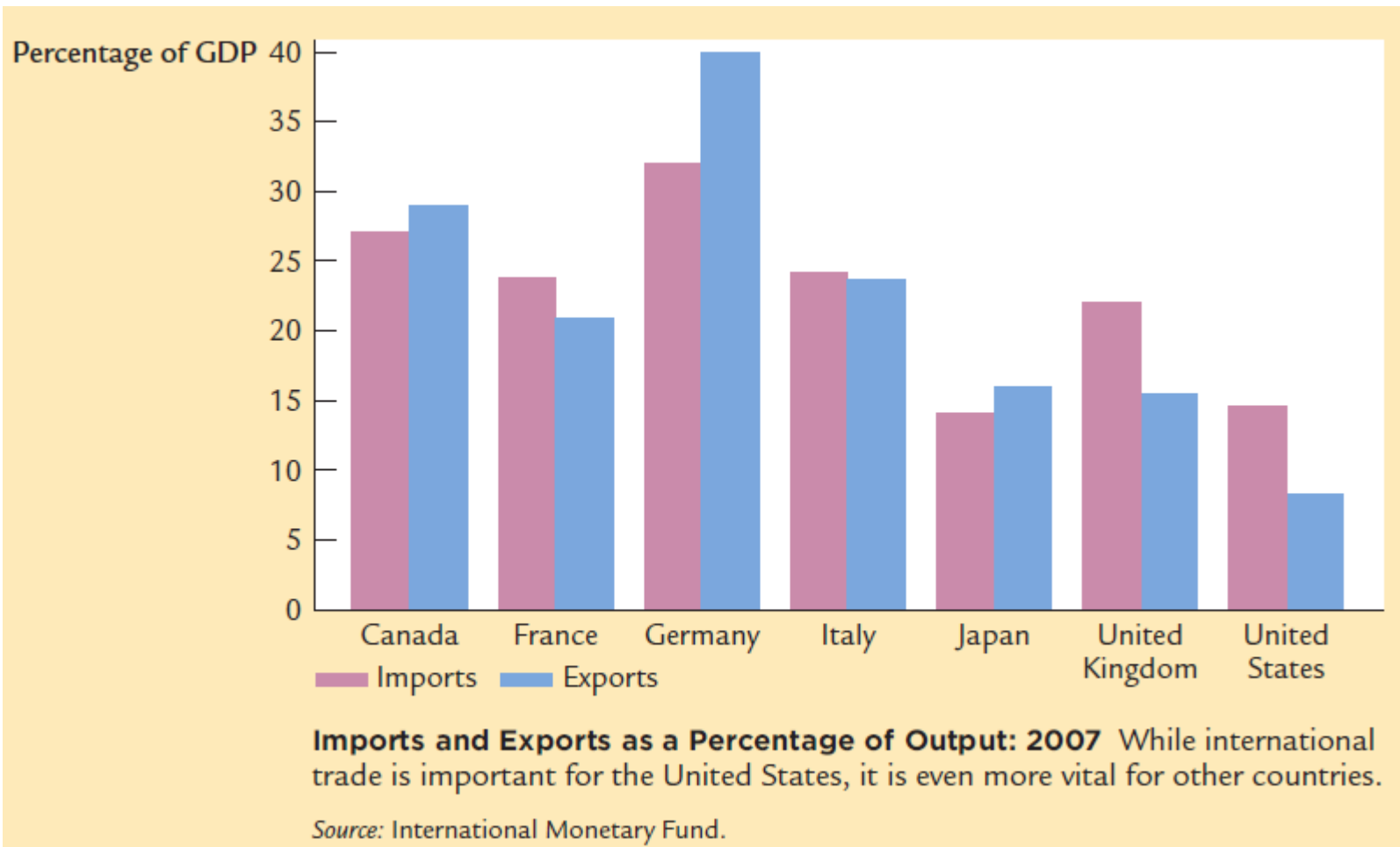
Content

- Output
- Unemployment
- Income Distribution
- Real Interest Rate and Investment
- Inflation and Nominal Interest Rate
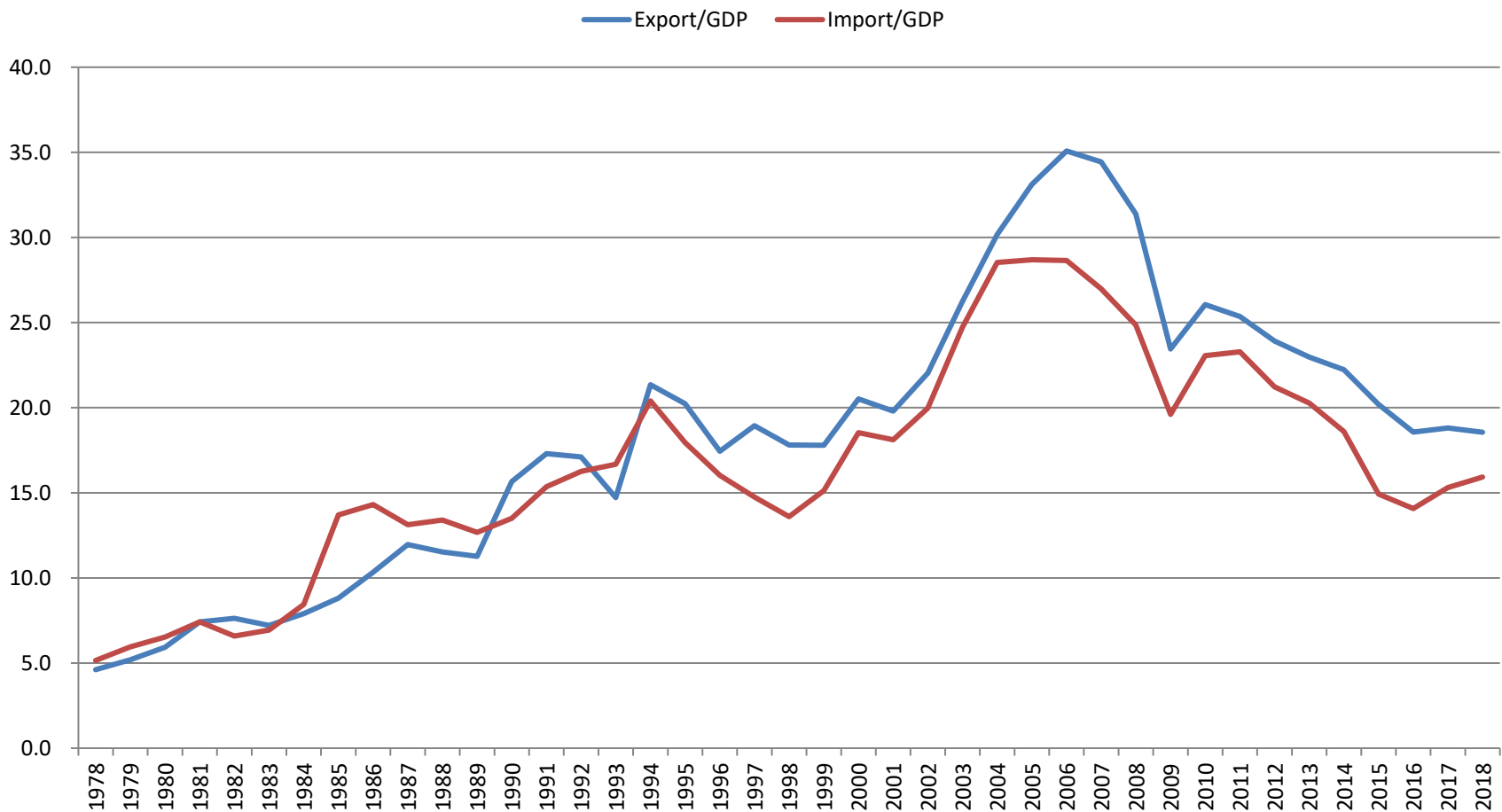- **Exchange Rate**

The Open Economy

- An open economy trades with other economies in the world.

- In this part of the lecture, we discuss
  - The international flows of goods and capital
  - Exchange rate
  - A model of small open economy
  - A model of large open economy

The Importance of Trade

Imports and Exports as a Percentage of Output: 2007 While international trade is important for the United States, it is even more vital for other countries.

Source: International Monetary Fund.

How China Depends on Trade

Intermediate Macroeconomics

Net Export

- In an open economy, domestic spending need not equal its output of goods and services. The difference is the net export, which is the export of domestic goods and services minus the import of foreign goods and services. In short,
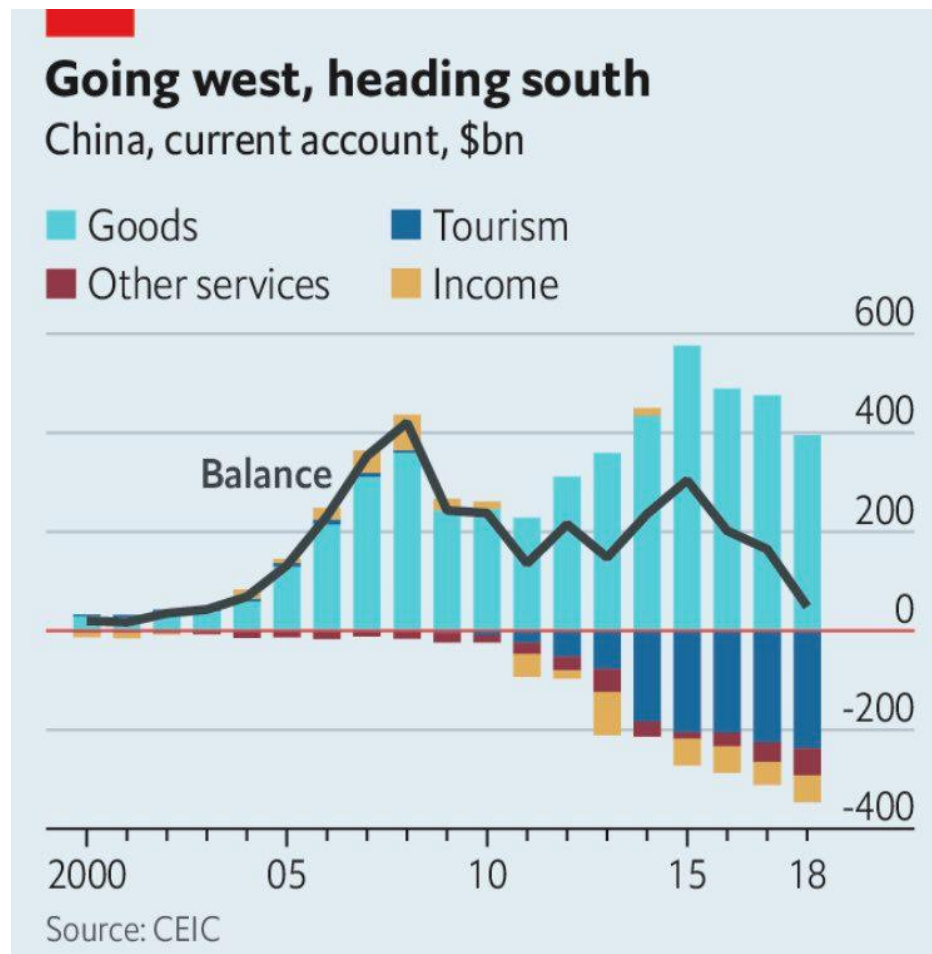
$$Y - (C + I + G) = NX = EX - IM,$$

  where Y is <u>output</u>, $(C + I + G)$ is <u>domestic spending</u>, NX stands for <u>net export</u>, EX is <u>export</u>, and IM is <u>import</u>.

- If the domestic spending is less than the output, then $NX > 0$ and it is lent to foreigners. If the domestic spending exceeds the output, then $NX < 0$ and the country borrows $(-NX)$ from abroad.

- Net export is also called <u>trade balance</u>.

Current Account

- Trade balance is the most important part of the <u>current account</u>. We have

  CA = trade balance + net factor income + net cash transfer

- Current account surplus: if CA>0

- Current account deficit: if CA<0

- In this course we ignore net factor income and cash transfer and treat current account balance as the same thing as trade balance.

The Recent Trend of China's Current Account

Going west, heading south
China, current account, $bn

Goods / Tourism / Other services / Income

Source: CEIC

Capital Flow

- The flow of goods and services is mirrored by capital flow. Let $S = Y - (C + G)$ be the national saving, we have
  - If $S - I = NX > 0$, the country lend its surplus saving to foreigners.
  - If $S - I = NX < 0$, then the country borrows $(-NX)$, the saving deficit, from abroad.
- We call $(S - I)$ <u>net capital outflow.</u> The net capital outflow always equals the net export.

An Imagined Example

- If BYD sells an electric car to a US consumer for $10,000, how does the sale change China's trade and capital flow?

Capital Account

- Capital flow is recorded in the capital account (or financial account) of the balance of payments.

- We have the following identity of the balance of payments:

  Current account + capital account + statistical error = 0

- In theoretical analysis, we may ignore the statistical error. Thus a current account surplus (positive) is exactly matched by a
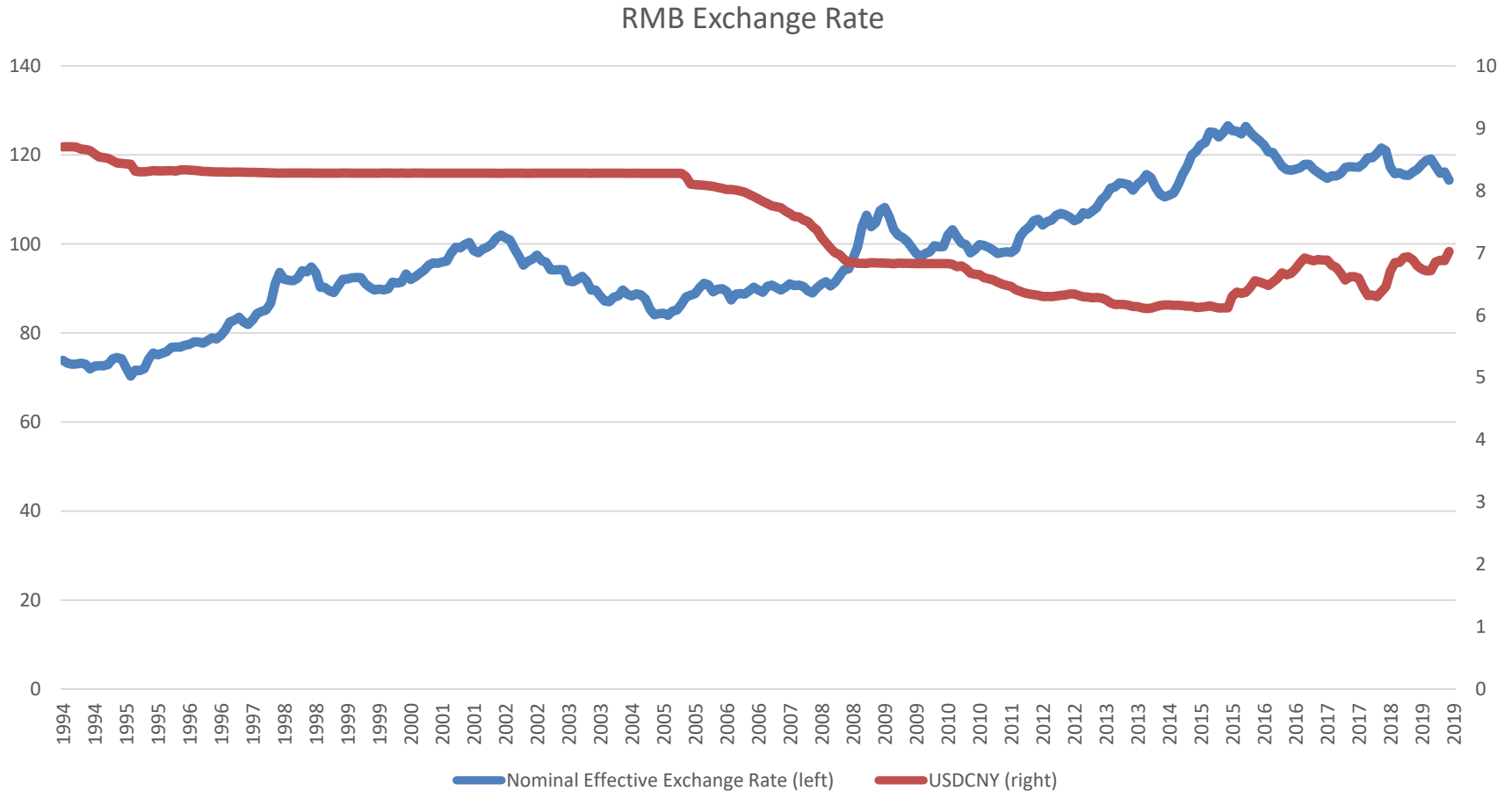
Exchange Rate

- The exchange rate (also known as foreign-exchange rate, or forex rate) between two currencies is the rate at which one currency will be exchanged for another.

- We may express the exchange rate in units of foreign currency per the domestic currency. For example, the exchange rate of Korean Won is currently around 175 Won/Yuan.

- The exchange rate may also be in units of domestic currency per foreign currency. For example, the exchange rate of USD is currently around 7 Yuan/USD.
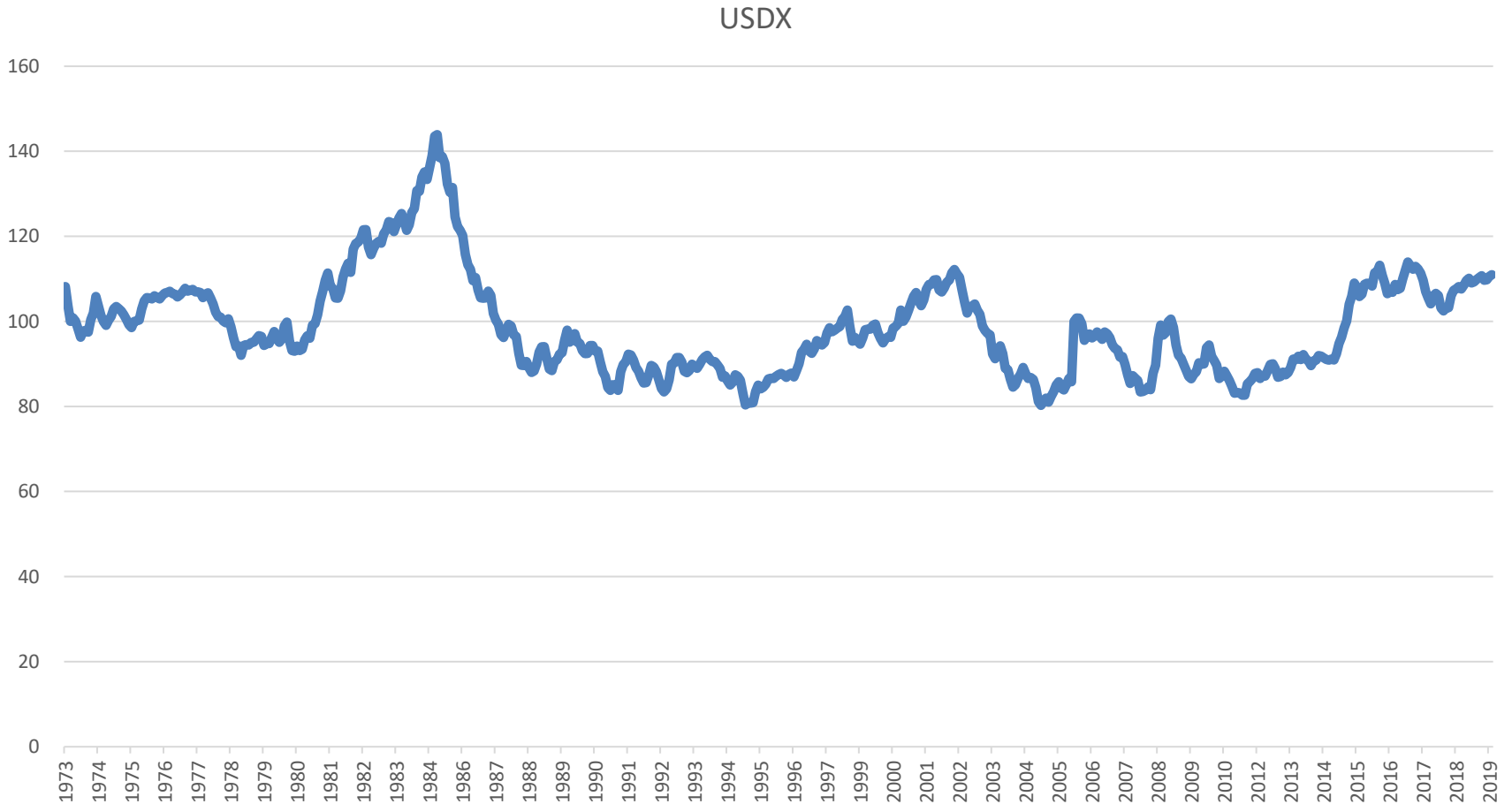
The Convention

- In this course, we adopt the convention that the exchange rate is in units of foreign currency per the domestic currency (Yuan).

- Under this convention, a rise in the exchange rate is called an <u>appreciation</u> of RMB; a fall in the exchange rate is called a <u>depreciation</u>.

- Appreciation is also called <u>strengthening</u>, while depreciation is also called <u>weakening</u>.

Case Study: RMB Exchange Rate

RMB Exchange Rate

Nominal Effective Exchange Rate (left) — USDCNY (right)

Intermediate Macroeconomics

Case Study: The USD Index

USDX

Intermediate Macroeconomics

Real Exchange Rate

- The real exchange rate is the <u>purchasing power</u> of a currency relative to another at current exchange rates and prices.

- Let e be the nominal exchange rate, P the domestic price level, P^* the foreign price level. Then the real exchange rate is defined by

$$\varepsilon = \frac{eP}{P^*}.$$

Purchasing Power Parity

- If $\varepsilon = 1$, we say that the exchange rates are at purchasing power parity. Theoretically, PPP is implied by "the law of one price".

- If $\varepsilon > 1$, the domestic currency is over-valued in terms of purchasing power.

- If $\varepsilon < 1$, the domestic currency is under-valued in terms of purchasing power.

An Example

- Suppose both China and USA produce and consume one good, the Big Mac.

- The Big Mac costs 20 Yuan in China and 4 USD in USA. The nominal exchange rate is 6 RMB/USD.

- Then the real exchange rate between China and USA is

$$\frac{1}{6} \cdot \frac{20}{4} = \frac{5}{6}.$$

- Since the real exchange rate is less than 1, we say that PPP does not hold and RMB is undervalued: One Chinese Big Mac costs 5/6 of what an American Big Mac costs.

The Implications of PPP

- If PPP holds, we have

$$e_t = \frac{P_t^*}{P_t}.$$

  Taking log difference, we have

$$\frac{\Delta e_t}{e_{t-1}} = \pi_t^* - \pi_t,$$

  where π_t^* and π_t are foreign and domestic inflations, respectively.

- PPP implies that if foreign inflation is higher than domestic inflation, the domestic currency would appreciate by the inflation gap $(\pi_t^* - \pi_t)$.

Interest Rate Parity

- If we further assume a common real interest rate, then we have

$$\frac{\Delta e_t}{e_{t-1}} = i_t^* - i_t.$$

- This says that if foreign nominal interest rate is higher than the domestic one, the domestic currency tends to appreciate.

- This equation is often called "uncovered interest rate parity".

Why PPP May Not Hold

- PPP must hold if the "law of one price" applies.
- However, PPP may not hold, especially in the short term, since
  - Not all goods are tradable.
  - There are trading barriers and trading costs.
- In the long run, however, PPP roughly holds.

# Case Study: Long-Term Validity of PPP
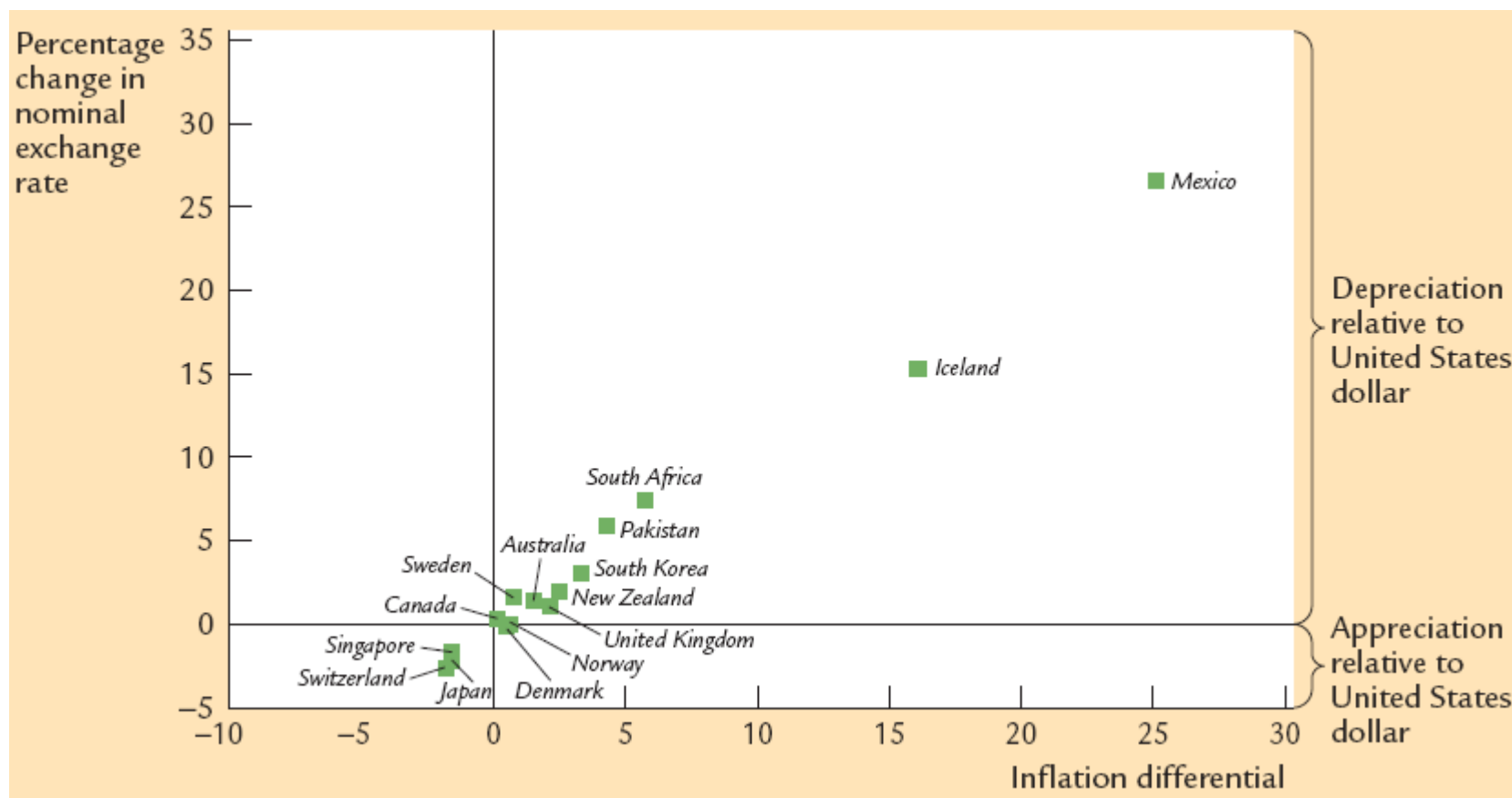
A Model of Small Open Economy

- Assumptions:
  - Capital is perfectly mobile across borders.
  - The real interest rate is determined in the world market, r^*.
  - The net export is a decreasing function of the real exchange rate (ε).
- In the foreign exchange market, the supply of foreign currencies are the net export, and the demand is the <u>net capital outflow</u> (F), or <u>excess national saving</u>.
- In equilibrium,
$$F(r^*) = S - I(r^*) = NX(\varepsilon).$$

The Equilibrium of Foreign Exchange Market

Real exchange rate ε

Excess saving, $S - I$

Equilibrium real exchange rate

$X(\varepsilon)$

Net export
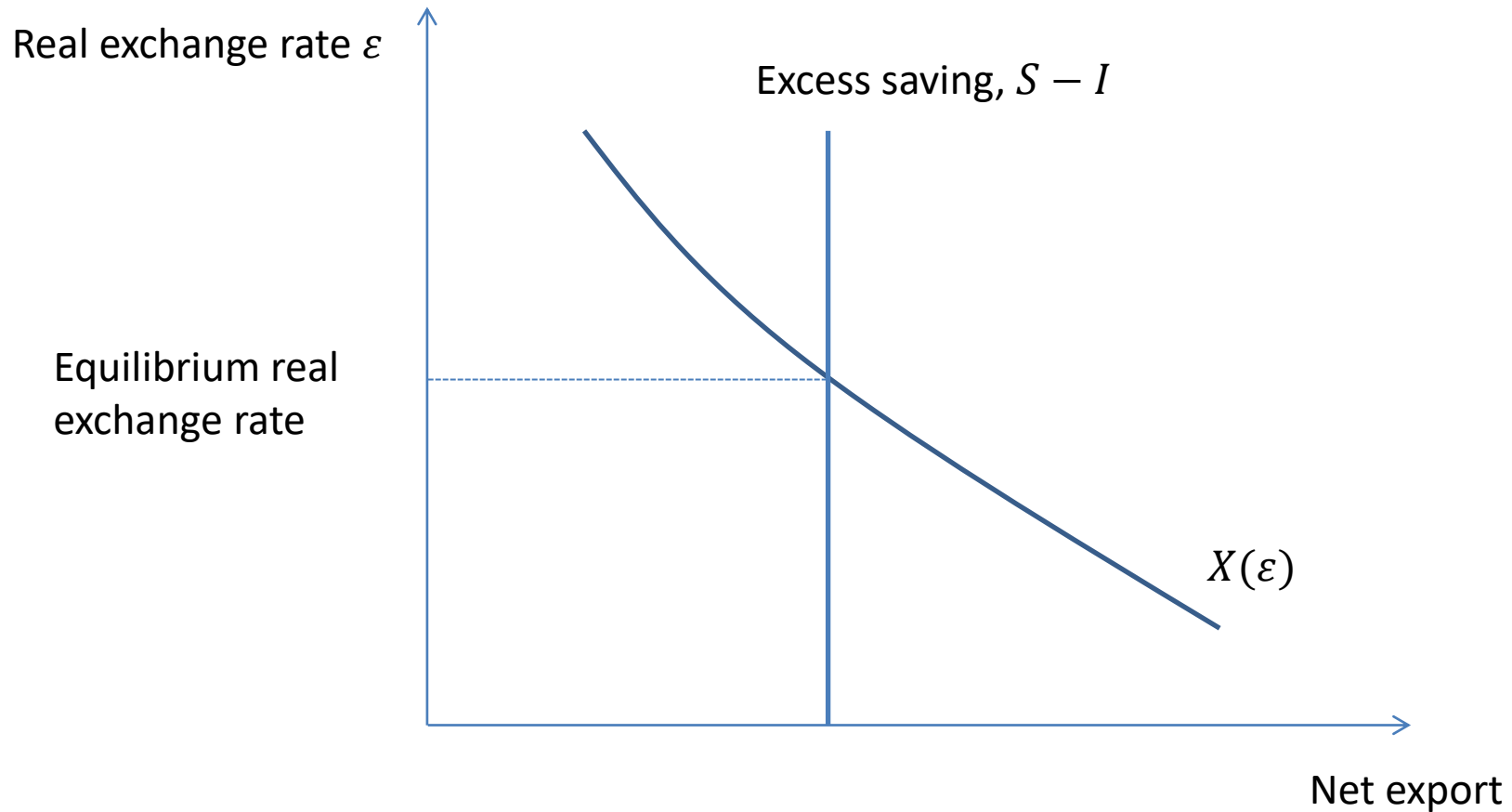
Thought Experiments on A Small Open Economy

- How might the real exchange rate be affected by the following?
  - Expansionary fiscal policy at home
  - A rise in the world interest rate
  - The effect of protectionist trade policy
 - The effect of financial market development

The Determinants of Nominal Exchange Rate

- Nominal exchange rate is fixed in some economies.

- Under PPP, nominal exchange rate is solely determined by the domestic and the foreign price levels.

- In reality, nominal exchange rate for those economies with floating exchange rates depend on many factors including interest rates, growth prospects, etc., as well as inflation expectations.

A Model of Large Open Economy

- Assumptions:
  - Capital is perfectly mobile across borders.
  - The net capital outflow of the large economy influences the world interest rate r: $F(r)$ is decreasing in r.
  - The net export is a decreasing function of the real exchange rate (ε).
- Two markets:
  - The market for loanable funds
  - The forex market
- In equilibrium, we have
$$S = I(r) + F(r)$$
$$X(\varepsilon) = F(r)$$
- r and ε are simultaneously determined in the market for loanable funds and the forex market.

The Model of Large Open Economy

Real exchange rate ε

$$S = I(r) + F(r)$$

$$X(\varepsilon) = F(r)$$

Equilibrium real exchange rate ε^*

Equilibrium real exchange rate r^*

World interest rate r
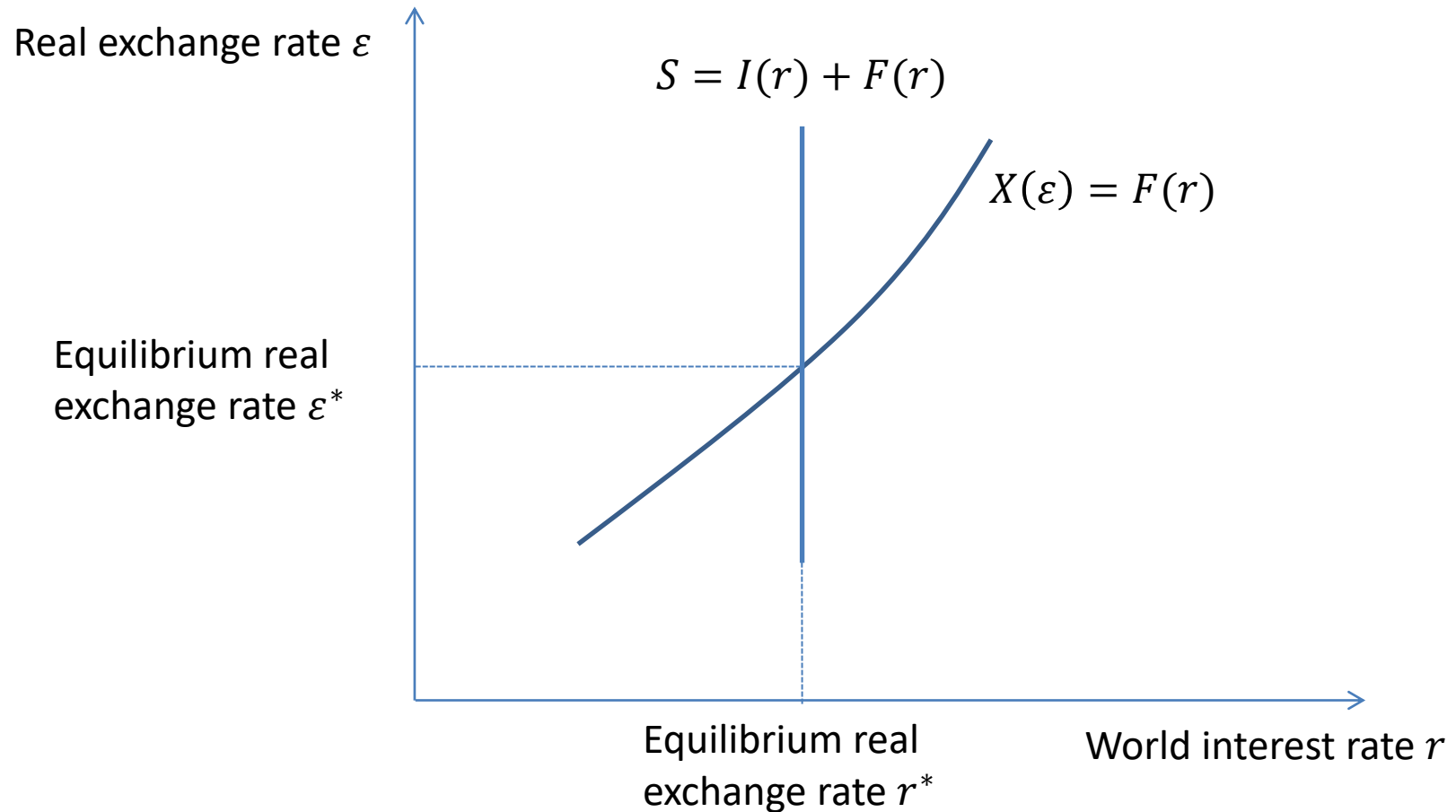
Thought Experiments on A Large Open Economy

- How would r and ε change if the following happens?
  - A fiscal stimulus (tax reduction or increased government spending)
  - An protectionist shock

Fiscal Stimulus

Real exchange rate ε

$S = I(r) + F(r)$

$X(\varepsilon) = F(r)$

Equilibrium real
exchange rate ε^*

World interest rate r

Equilibrium real
exchange rate r^*

Intermediate Macroeconomics

Protectionist Shock

Real exchange rate ε

$S = I(r) + F(r)$

$X(\varepsilon) = F(r)$

Equilibrium real exchange rate ε^*

Equilibrium real exchange rate r^*

World interest rate