Chapter 3 Classical Theory

In this chapter we study what the classical theory has to say about the economy as a whole. The classical theory assumes that prices (including wage) are flexible and that markets (goods and services, factors) are competitive. Under these assumptions, total output/income of an economy is determined by the factor inputs (e.g., labor and capital) that are available and the technology that transforms the factor inputs into product. If we assume that factor inputs are given, then the total output/income is also given. Then the remaining question is how the total output/income is distributed among those who contribute to the production (e.g., owners of capital and labor).

In the first section we discuss how we use production function to model the economy as a whole. Under the classical assumptions, we discuss how total output/income would be distributed among owners of factor inputs. In the second section we present a classical equilibrium model. We use the model to analyze the effects of fiscal policies. In the third section we introduce how the classical theory treats money and inflation. In the fourth section we consider the economy with trade and present an open-economy equilibrium model. Finally we discuss how unemployment is treated in classical theory.

1. Output and Distribution

An economy's output of goods and services depend on the quantity of inputs and the technology that transforms inputs into outputs. We often call inputs as factor inputs, which include labor, capital, land, etc. 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.

The two most important factors of productions are capital and labor. 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.

Assumption 1: In this chapter we assume that both capital and labor are fixed:

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

Macroeconomists use production function to characterize technology, which transforms given amounts of capital and labor into outputs. Let Y be the amount of output, we write the production function as

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

Assumption 2: We assume that the production function is fixed and satisfies:
(a) Constant return to scale
For any $z > 0$, $F(zK, zL) = zY$

(b) Increasing in both K and L.
$F_1 \equiv \frac{\partial F}{\partial K} > 0$, and $F_2 \equiv \frac{\partial F}{\partial L} > 0$

(c) Decreasing marginal product of capital and decreasing marginal product of labor.
$F_{11} \equiv \frac{\partial^2 F}{\partial K^2} < 0$, and $F_{22} \equiv \frac{\partial^2 F}{\partial L^2} < 0$

The production function characterizes how the economy turns capital and labor into "output", which includes millions of goods and services. As such, it is reasonable to assume constant return to scale. Otherwise, the performance of an economy would overwhelmingly depend on its size. Big countries would have advantages in the increasing-return-to-scale world, and small countries would excel in the decreasing-return-to-scale world. In our real world, however, there is no evidence that size plays any crucial role in the contest of economic performance. Both the US and Singapore are competitive, and both Pakistan and Bolivia are uncompetitive.

Perhaps the most famous production function is the Cobb-Douglas production, which 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 $\alpha + \beta = 1$. As such we rewrite the production function as

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

Readers can check whether the remaining assumptions in Assumption 2 hold.

It is obvious that under Assumptions 1 and 2, the economy produces a fixed amount of goods and services,

$$Y = F(\bar{K}, \bar{L}) = \bar{Y}.$$

As previously discussed, the total output of an economy equals its total income. So under our assumptions, the total income is also fixed. The remaining question is how the income would be distributed among owners of factor inputs, that is, those who provide capital and those who provide labor. As we can imagine, factor prices (real wage and real rental price of capital) would be crucial for the determination of the distribution. So the question hinges on the determination of factor prices.

Factor prices are real wage and real rental price of capital. 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.)

Assumptions 3: The Markets for goods and services are competitive. And the markets for factors of production (labor and capital) are competitive.

Note that a market is competitive if no participants are large enough to affect prices. In other words, all market participants are price takers.

To determine real wage and real rental price of capital, we look at the decision of a competitive firm. A competitive firm takes as given 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 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:

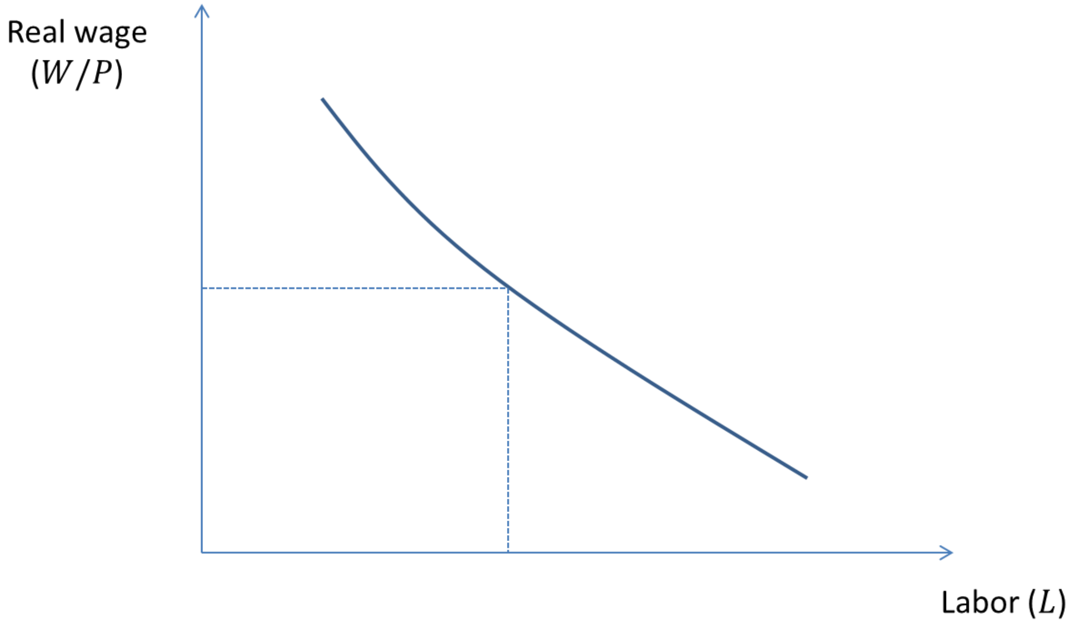
$$F_2(K,L) = \frac{W}{P}.$$

This says that the firm would employ labor up to the point where marginal product of labor (MPL) equals the real wage. If we Fix $K = \bar{K}$, 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:

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

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

Figure 1: A Labor Demand Curve



Under Assumptions 1, 2, and 3, 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

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

Suppose the economy is characterized by a Cobb-Douglas production fuction, $F(K,L)=AK^{\alpha}L^{1-\alpha}$, 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

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

It would be an interesting empirical problem to check whether the shares of capital and labor are indeed constants, and how much.

Case Study: Labor's share of income.

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. Once again, it would be interesting to investigate whether this is the case in the real economy.

Case Study: Labor productivity and real wage.

2. A Classical Model

In the following we present a classical macroeconomic model. The model specifies a set of behavioral assumptions and imposes an equilibrium condition. We will use the model to examine the effects of external shocks (e.g., change in fiscal policy) on a closed economy.

Recall that total expenditure of an economy can be decomposed into four components:

On the expenditure side, GDP have four components:

- Consumption (C)
- Investment (I)
- Government purchases (G)
- Net export (NX)

In a closed economy, we have $NX = 0$. So we represent the total expenditure as

$$Y = C + I + G.$$

In the following we make a set of behavioral assumptions on each component. Specifically, we use a consumption function and an investment function to characterize total consumption and investment in the economy, respectively.

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.

The marginal propensity to consume (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. For example, 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 interest rate, which is price for getting financing. Here we need to differentiate real interest rate and nominal interest rate.

Real interest rate is the interest rate corrected for the effects of inflation. Nominal interest rate is the uncorrected interest rate that we observe in the market. Let i be nominal interest rate, r be real interest rate, and π be inflation rate, then we have

$$i = r + \pi.$$

The above relationship is often called the Fisher Equation, named after Irving Fisher. For example: If nominal interest rate is 5% and the inflation rate is 3%, then the real interest rate is 2%. Obviously the real interest rate is the "real" return on deposit or the "real" burden for a loan.

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.

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 balanced budget.
- If $G > T$, we have budget deficit.
- If $G < T$, we have budget surplus.

We assume both G and T are fixed by the government,

$$G = \bar{G},\ T = \bar{T}.$$

That is, G and T are exogenous variables to our model.

Equilibrium in the Market for Goods and Services

In the market for goods and services, the demand side is characterized by

$$Y = C(Y - \bar{T}) + I(r) + \bar{G}$$

The supply side is

$$Y = \bar{Y}$$

In equilibrium, we must have demand equals supply,

$$\bar{Y} = C(\bar{Y} - \bar{T}) + I(r) + \bar{G}. \tag{1}$$

This equilibrium completes the model. Obviously, this is one equation for one unknown (r). The unknown real interest rate is the only endogenous variable in the model. And the remaining variables are exogenous.

Equilibrium in the Financial Market

We can also interpret the previous equilibrium condition as an equilibrium in the financial market.

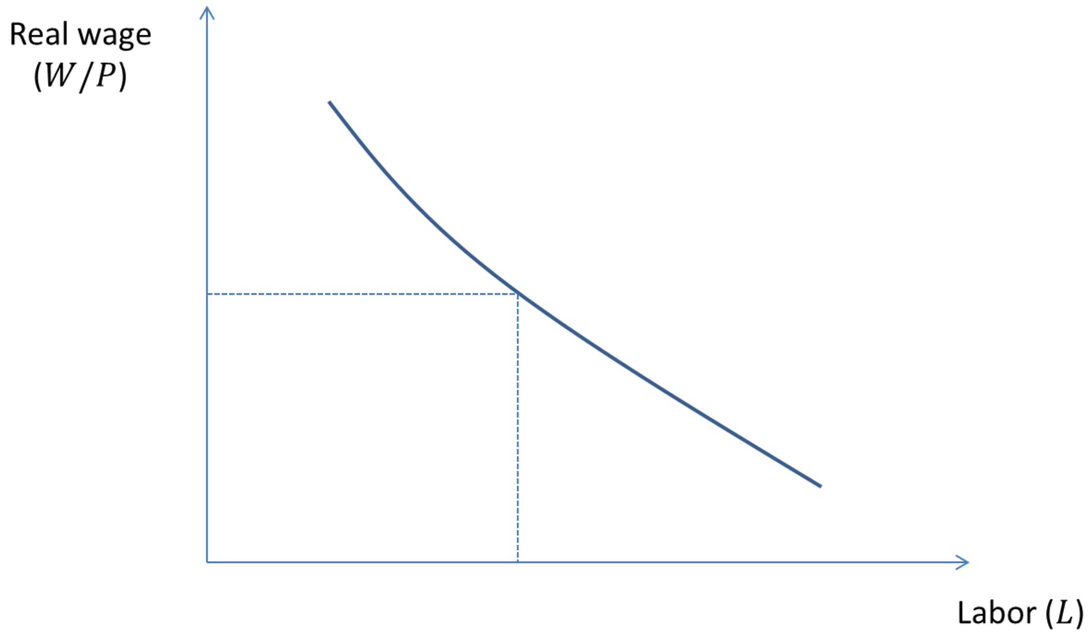
We assume there exists a simple financial market for loanable funds. Those with savings would lend their savings to borrowers (investors) in this market. The national saving is defined by $Y - C - G$, which is total income minus expenditures by the households and the government. The national saving is the supplier of loanable funds in the financial market. On the other hand, the demand for loanable funds comes from investment need, $I(r)$.

In equilibrium, the real interest rate (r) must adjust so that saving equals investment:

$$\bar{S} \equiv \bar{Y} - C(\bar{Y} - \bar{T}) - \bar{G} = I(r). \quad (2)$$

Note that in this model, saving does not depend on interest rate. The solution of the above equilibrium equation is depicted in Figure.

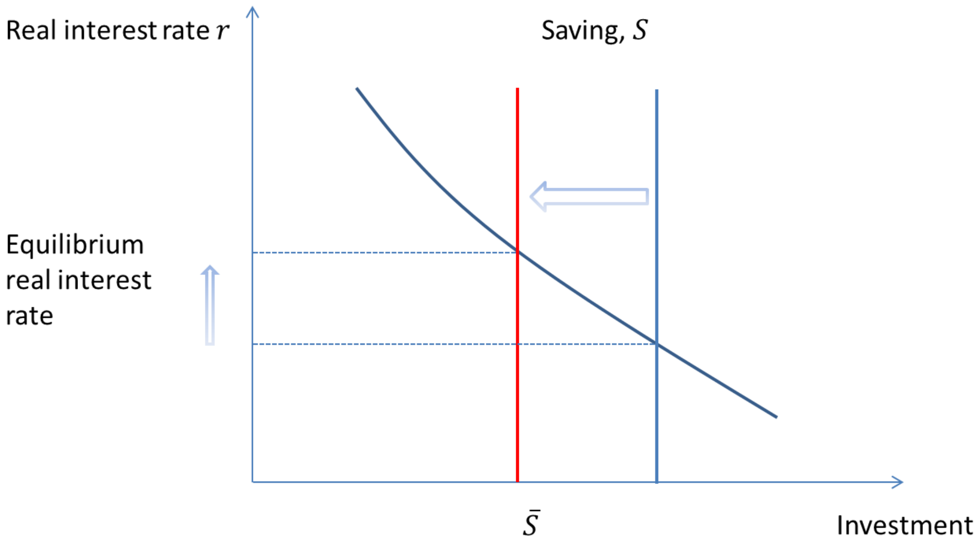
Figure 2: Determination of Real Interest Rate



The Effects of Fiscal Policies

We may use our model to examine the effects of fiscal policies on the economy. For example, we consider an increase in government spending. Examining the equation in (2), we find that an increase in government spending would reduce national saving on the left-hand side. To make the equation hold, real interest rate has to increase, so that demand for loanable funds decreases and the equilibrium in the financial market is restored. Graphically, as shown in Figure 3, the vertical supply curve shifts to the left and the real interest rate increases.

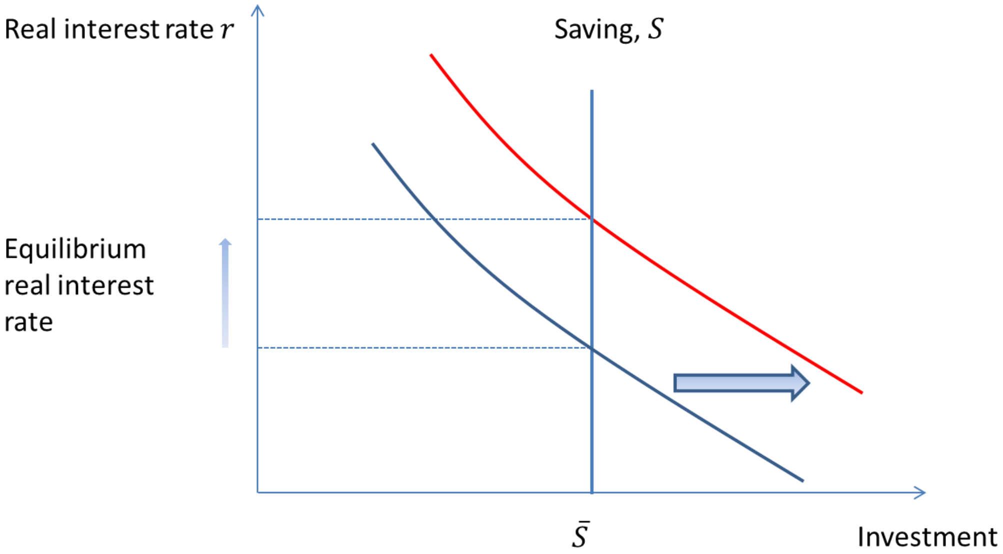
Figure 3: An Increase in Government Spending



This example shows that an increase in government spending would reduce national saving, resulting in 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?

For another example, we consider the case where there appears a surge in investment enthusiasm. That is, given a real interest rate, the investment demand for loanable funds would increase. But the national saving on the left-hand side of the equation in (2) does not change. To make the equation hold, the real interest rate has to increase and the total investment does not change. Graphically, the downward sloping demand curve shifts to the right. The equilibrium real interest rate increases and the total investment remain unchanged. See Figure 4.

Figure 4: Changes in Investment Demand

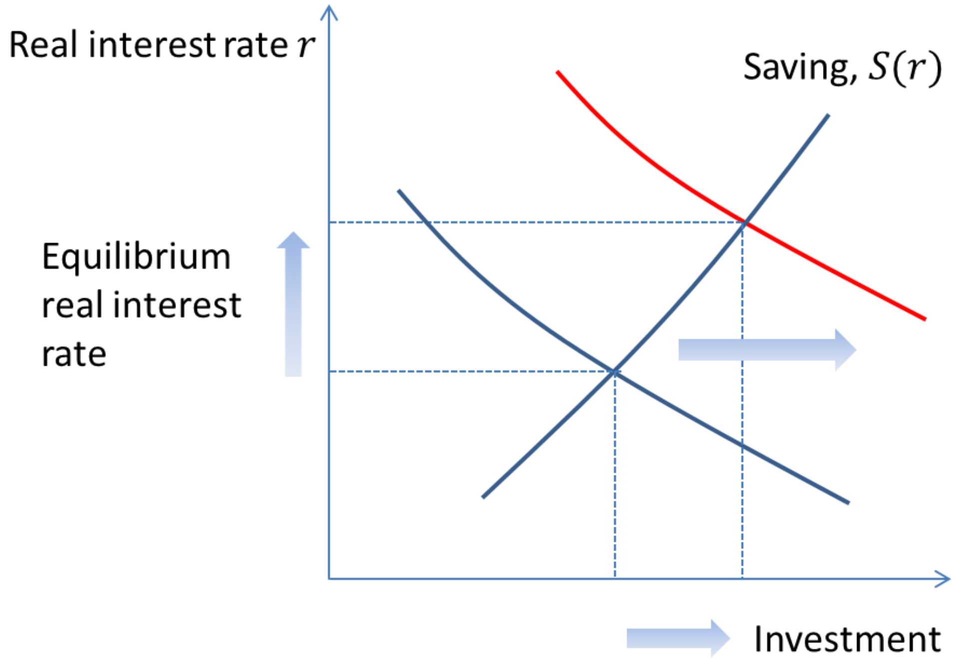


Of course, this is not a very realistic diagnosis. In reality, we may expect to see increases in both interest rate and the total investment. To improve the model, we may specify the consumption function as

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

which is a function of both income and real interest rate. Since a higher real interest rate discourages consumption, this consumption function should be decreasing in r. Now the national saving would depend on real interest rate, $S(r) = Y - C(Y - T, r)$. Obviously, $S(r)$ is increasing in r, in agreement with the intuition that higher interest rate encourages saving. As shown in Figure 5, this augmented model would produce the prediction that a surge in investment demand would result in both higher real interest rate and total investment.

Figure 5: A More Realistic Saving Curve



3. Money and Inflation

Inflation, Deflation, and Disinflation

Inflation is a <u>sustained</u> increase in the <u>general</u> price level of goods and services. Temporary fluctuations in price level do not constitute inflation. For example, seasonal increase in price before and during the Spring Festival in China may not be inflation, since the price would often decline after the holiday, as demand wanes and supply recovers. Price increases in some particular goods or services are also not regarded as inflation unless they are accompanied by the rise in the general price level.

If there is a sustained decrease in the general price level, we call it deflation. A related concept is disinflation, which refers to the case where inflation rate declines to lower level. As discussed in the previous chapter, we use CPI or GDP deflator to measure inflation (deflation).

When there is inflation, the purchasing power of money declines. The effect of inflation, however, is not evenly distributed in the economy. There are losers and winners from inflation. Losers include people who save, people who hold bonds, and people who receive fixed income. The retired pensioners are especially vulnerable. Unexpected inflation is equivalent to redistribution of wealth from savers to borrowers, who are winners of inflation. Unexpected inflation also increases sense of uncertainty in the economy, discouraging investment and growth.

Even expected inflation has costs. First, high inflation leads to high frequency of price changes, which are costly because sellers and buyers have to renegotiate prices and new menus have to be printed (metaphorically, menu costs). Second, high inflation leads to high opportunity cost in holding cash, causing inconveniences of insufficient cash holding (metaphorically, shoeleather cost, meaning that more frequent visits to banks would cause one's shoes wear out more quickly). Third, high inflation makes price signal noisy, affecting the ability of the "invisible hand" to allocate resources. Fourth, tax brackets are often fixed in nominal terms (e.g., the minimum taxable monthly salary is 3500 Yuan in China), high inflation would make tax burden heavier than what is intended to.

When prices lose control and inflation skyrockets, the economy may fall into full crisis. According to a loose definition, if inflation exceeds 50% per month, we call the phenomenon hyperinflation. All the costs of moderate inflation described above become prohibitive 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 conduct transactions with barter or using a stable foreign currency.

What causes hyperinflation? An easy answer is that 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? In most cases, it is due to fiscal problems. When a government experiences fiscal crisis, due to either extraordinary expenditure (war, indemnity, etc.) or impaired tax power or both, the government may resort to excessive money printing.

These said, there is however one benefit of moderate inflation, which proves important for the health of macroeconomy. It is a fact that nominal wages are rarely reduced, even when the equilibrium real wage falls during recessions. Inflation allows the real wages to reach equilibrium levels without cutting nominal wage. Therefore, moderate inflation improves the functioning of labor markets.

On the other hand, deflation may look good, since it implies increased purchasing power of money. But even a small dose of deflation is intolerable in a modern economy, as it makes debt more difficult to service, discourages investment, and aggravates unemployment problem. This explains why, recently, central banks around the world have been conducting aggressive monetary policies (quantitative easing, negative interest rate) to maintain a positive inflation.

Money

Money is the stock of assets that can be readily used to make transactions. Functions of money include: store of value, unit of account, and medium of exchange. The last function, to intermediate the exchange of goods and services, is especially important.

If there is no money and people barter goods and services with each other, trading opportunities would be much reduced, since it is improbable or costless to find "coincident of wants". The introduction of money, which is acceptable by everybody for everything, solves this problem. In addition, money makes pricing simple. Imagine a market with N different goods but without money, we need $N(N-1)/2$ pairs of price quotes. But if money is used to intermediate exchanges, only N price quotes are needed. Given such convenience afforded by money, it is not surprising that human society uses money, in one form or another, from very early history.

At first, people use commodity money (e.g., shells, gold, and silver). But transactions using commodity money (say gold) is costly, since the purity and weight of a piece of gold has to be examined in every transaction. To reduce transaction cost, a bank (possibly with authorization from government) may mint gold coins of known purity and weight. To further reduce cost, the bank may issue gold certificates, which can be redeemed for gold. The gold certificate eventually becomes gold-backed paper money (e.g., Jiaozi (交子) in Song Dynasty).

In modern time, especially after the industrial revolution, economic growth speeds up. The need for transactions grows faster than the growth of gold supply. Hence the limited supply of gold has a deflationary effect on the economy, if countries stick to the gold standard of money. Eventually it is realized that if people do not care about the option of redeeming gold, the bank can issue certificates that are not backed by gold in vault. The modern central bank does exactly this, and these certificates are fiat money. Fiat money is valued because people expect it's valued by everyone else.

Money in a modern economy may include: cash, demand deposits, saving deposits, money market funds, and so on. The supply of money is controlled by the monetary authority (the central bank), which deliberate and implement monetary policy for the purpose of maintaining low unemployment and moderate inflation. The monetary authority in China is People's Bank of China (PBC). In the US, the monetary authority is the Federal Reserve (the Fed).

Different types of money differ mainly in liquidity. Cash is the most liquid money, while saving deposit is much less liquid. This poses problem for the measurement of total money supply in the economy. We usually use several measures (M0, M1, M2, etc.), classified along a spectrum between the narrowest and the broadest measurements. Narrow measures include the most liquid types of money, while broad measures include illiquid money. In China, M0 includes only cash in circulation, M1 includes demand deposits in addition to M0, and M2 is roughly M1 plus saving deposits. In 2015, M0, M1, and M2 are 6.3, 40.1, 139.2 trillion Yuan, respectively.

Case Study: M2/GDP Ratio

Quantity Theory of Money

Quantity theory of money is the centerpiece of what classical theory has to say about the macro-economy.

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 an identity,

$$MV = PT.$$

The number of transactions is difficult to measure, even in a small economy. But it is intuitively clear that number of transactions is closely related with the total income (or output) of the economy, since each transaction brings income to the parties involved.

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

$$MV = PY, \tag{3}$$

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.

We may also interpret the equation in (3) as an equilibrium condition in the money market. Rewrite (3) as

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

where $k \equiv 1/V$. If V is, as usual, assumed to be a constant, so is k. We may interpret the left-hand side as real money supply and the right-hand side as money demand, which is assumed to depend on the total income only. The equilibrium condition is thus read 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 the quantity theory of money, we can obtain

$$\frac{dM}{M} + \frac{dV}{V} = \frac{dP}{P} + \frac{dY}{Y}.$$

Note that $\frac{dM}{M}$ and $\frac{dY}{Y}$ are growth rates of money supply and real GDP, respectively, and that $\frac{dP}{P}$ is the inflation rate. If we assume that the velocity V is constant , then

$\frac{dV}{V} = 0$. The quantity theory of money implies that, given the real GDP growth rate, higher growth rate of money supply leads to higher inflation.

Case Study: M2 Growth and Inflation in China

Case Study: Money Growth and Inflation Across Countries

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 would cause 1% increase in inflation rate, and then 1% increase in nominal interest rate.

Case Study: Inflation and Nominal Interest Rate in the USA

Classical Dichotomy

We can see from the above analysis, real variables (Y, r) can be fully studied without considering money. Money only influences the nominal values such as nominal GDP, nominal interest rate, etc. This 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.

Naturally, monetary policy is irrelevant if money is indeed neutral. The expansion of money supply, according to the theory, only drives up the price level and does not influence the output/employment. However, evidence abounds that monetary policy has <u>real effects</u> on the output/employment.

Criticism of the Quantity Theory of Money

As we can see from the above case studies, the quantity theory of money roughly holds in the long run. However, for the purpose of describe short-term relationships between money, inflation, and output, it is way too simplistic. In particular, the simple model of money demand ($\left(\frac{M}{P}\right)^d = kY$) is not realistic. Money demand may well depend on other factors than the total income Y. For example, variables like interest rates, consumer and investor confidence, debt level, etc., may also significantly influence money demand. Indeed, money velocity is highly unstable in history.

Case Study: Money Velocity in China and the US.

To improve the quantity theory of money, we may write the money demand function as

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

where i is 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, and the function $L(i, Y)$ would be decreasing in i and increasing in Y. (L is used to denote the money demand function because money is the most liquid asset.)

Equate demand to supply, we obtain

$$\frac{M}{P} = L(i, Y) = L(r + \pi, Y),$$

This equilibrium condition establishes a relationship between inflation and money supply. In this case, the money velocity would be given by

$$V \equiv \frac{PY}{M} = \frac{Y}{L(r + \pi, Y)},$$

which allows more volatility. We may also consider a modified Fisher equation,

$$i = r + E\pi,$$

where $E\pi$ is the expectation of inflation. The modified Fisher equation comes from the definition of ex ante real interest rate, $r = i - E\pi$. This is generally more reasonable than the ex post real interest rate, $r = i - \pi$, since when loaners and debtors negotiate (nominal) interest rate, they need to worry about the inflation in the future. If we use the modified Fisher equation, we have

$$V \equiv \frac{PY}{M} = \frac{Y}{L(r + E\pi, Y)}.$$

This version can explain even more volatility in observed money velocity, since a change in inflation can swiftly change money velocity.

4. Open Economy

In the section we consider open economy, which trades with other economies in the world. We first study the international flows of goods and capital in national accounting. We then introduce exchange rate, which is the most important variable in the discussion of open economy. Next we study a model of small open economy and a model of large open economy. Small and large economies differ in whether their saving and investment may affect world interest rate.

Case Study: The Importance of Trade

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 output, $(C + I + G)$ is domestic spending, NX stands for net export, EX is export, and IM is import.

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 trade balance.

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 $(S - I)$ net capital outflow (CF). It is clear that the net capital outflow always equals the net export, $NX = CF$.

To understand this identity, we examine 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? On trade, The Chinese export rises by $10,000. On capital flow, if BYD invests the $10,000 in the US securities (e.g., stocks or bonds), then Chinese capital outflow rises by $10,000. The same is true even if BYD keeps the cash. If BYD converts the $10,000 into RMB at a local Chinese bank, then the bank also has to do something about it. If the bank chooses to purchase the US securities or to keep the dollar cash, then Chinese capital outflow again rises by $10,000. If the bank sells the dollar to PBC and PBC uses the $10,000 to purchase US treasury bills, we still see $10,000 rise in capital outflow.

Exchange Rate

The exchange rate (also known as foreign-exchange rate, or forex rate) between two currencies is the rate at which one currency would 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 6.5 Yuan/USD.

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, rise in the exchange rate is called appreciation of RMB; fall in the exchange rate is called depreciation. Appreciation is also called strengthening, while depreciation is also called weakening.

The real exchange rate is the <u>purchasing power</u> of a currency relative to another currency at current nominal 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

$$\varepsilon = \frac{eP}{P^*}. \tag{4}$$

It is obvious that the lower the real exchange rate, the less expensive are domestic goods and services relative to foreign ones.

Because a country trades with many countries, it is often useful to calculate effective exchange rate, which is an index that measures weighted average appreciation of a basket of foreign exchange rates. The nominal effective exchange rate (NEER) is calculated with nominal exchange rates. The real effective exchange rate (REER) is calculated with real exchange rates.

Case Study: RMB/USD Exchange Rate
Case Study: RMB Effective Exchange Rates

It is interesting to note that during 2015 the Chinese RMB depreciated about 8% against the US dollar. But in terms of effective exchange rates, RMB actually appreciated approximately 10% relative to its trading partners. So looking at one particular bilateral exchange rate, however important it is, can miss the big picture of a countries overall price competitiveness.

Purchasing Power Parity (PPP)

Examining the definition of real exchange rate in (4), we can see that if domestic and foreign currencies have identical purchasing power, then the real exchange rate (ε) should be exactly one. Indeed, 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.

For 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.

If PPP holds, we have

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

Taking log difference ($\log(x_t) - \log(x_{t-1})$), 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. In particular, note that $\pi_t = \log(P_t/P_{t-1})$. This is to say, PPP implies that if foreign inflation is higher than domestic inflation, the domestic currency would appreciate by the inflation gap ($\pi_t^* - \pi_t$).

PPP must hold if the "law of one price" applies. However, PPP may not hold, especially in the short term. First, not all goods are tradable. Second, there are trading barriers and trading costs. These make cross-country arbitrage of price differences incomplete and costly. In the long run, however, PPP roughly holds.

Case Study: Long-Term Validity of PPP

A Model of Small Open Economy

We make the following 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).

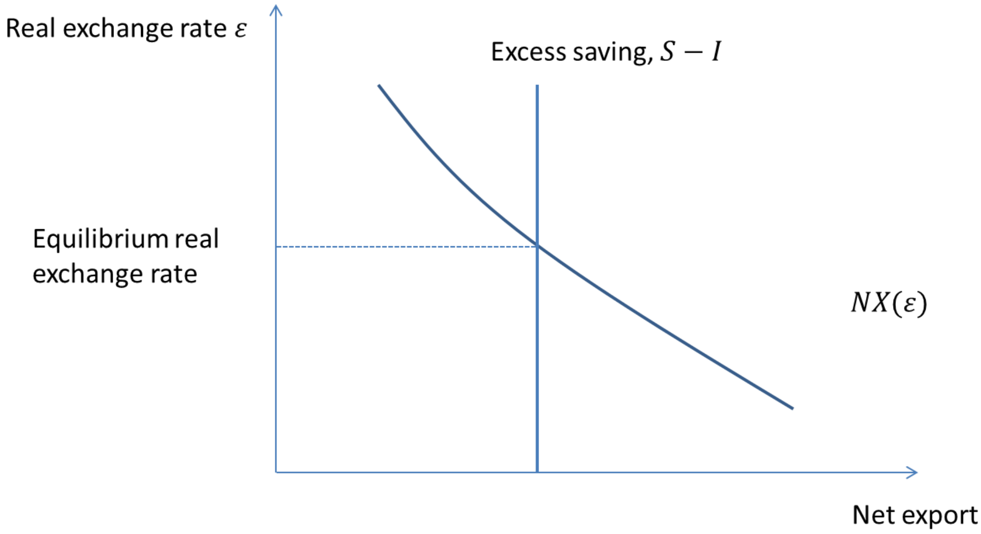
The first two assumptions define a small open economy. The last assumption is reasonable in that higher real exchange rate encourages import and makes the export sector less competitive.

In the foreign exchange market, the supply of foreign currencies are the net export, and the demand is the net capital outflow (CF), or excess national saving. In equilibrium, we have

$$CF(r^*) = S - I(r^*) = NX(\varepsilon).$$

Figure 6 illustrates the equilibrium graphically.

Figure 6: The Equilibrium of Foreign Exchange Market



Using the model, we may conduct 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

A Model of Large Open Economy

We make the following assumptions:

- Capital is perfectly mobile across borders.
- The net capital outflow of the large economy influences the world interest rate r: $CF(r)$ is decreasing in r.
- The net export is a decreasing function of the real exchange rate (ε).

Again, the first two assumptions define a large open economy. To see why it is reasonable to assume that CF(r) is decreasing, note that net capital outflow of a large economy would depress the world interest rate.

In this model, there are two markets, one for loanable funds, the other for foreign exchange. In equilibrium, we have

$$S = I(r) + CF(r)$$
$$NX(\varepsilon) = CF(r)$$

The world real interest rate (r) and the real exchange rate (ε) are simultaneously determined in the market for loanable funds and the forex market.

Using the model, we may conduct 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)
- A tax incentive for corporate investment

- An import restriction (*)

We focus on the third experiment and show how we may use mathematics to arrive at more quantitative conclusions. We write the equilibria as

$$S = I(r) + F(r)$$
$$X(\varepsilon, \tau) = F(r)$$

where F and X are short-hands for CF and NX, respectively, and τ stands for import tax. A higher import tax obviously discourages (restricts) import. Assume that all functions are differentiable, and $I'(r) < 0$, $F'(r) < 0$, $X_1 < 0$, $X_2 > 0$.

Negative Shock to National Saving

Suppose we fix τ and there is a negative shock to S, what would happen to r and ? A negative shock to national saving can occur when the government implements a fiscal stimulus, either in the form of government purchases or tax reduction. Define $G(r, S) = I(r) + F(r) - S = 0$. It follows from the implicit function theorem that

$$\frac{dr}{dS} = -\frac{\frac{\partial G}{\partial S}}{\frac{\partial G}{\partial r}} = -\frac{-1}{I' + F'} < 0.$$

Similarly, we may define $G(r, \varepsilon, S) = X(\varepsilon, \tau) - S + I(r) = 0$. It follows from the implicit function theorem that

$$\frac{\partial \varepsilon}{\partial S} = -\frac{\frac{\partial G}{\partial S}(r, \varepsilon, S)}{\frac{\partial G}{\partial \varepsilon}(r, \varepsilon, S)} = -\frac{-1}{X_1} < 0.$$

Hence a negative shock to national saving would result in higher real interest rate and appreciation of the domestic currency.

Protectionist Shock

Now we fix S and suppose there is a positive shock to τ, what would happen to r and ? Fixing S, the real interest rate r is determined in the market for loanable funds. In the foreign exchange market, define $G(\varepsilon, \tau) = X(\varepsilon, \tau) - F(r) = 0$. Apply the implicit function theorem, we have

$$\frac{\partial \varepsilon}{\partial \tau} = -\frac{\frac{\partial G}{\partial \tau}(\varepsilon, \tau)}{\frac{\partial G}{\partial \varepsilon}(\varepsilon, \tau)} = -\frac{X_2}{X_1} > 0$$

Hence a protectionist shock (e.g., raising import tax) would result in the appreciation of domestic currency.

An Example: A Protectionist Shock

Let $=1,\ \tau=0.1$, and

$$I(r)=4-200r,$$
$$F(r)=2-50r$$
$$X(\varepsilon,\tau)=50\tau-\varepsilon$$

Solving the system of equations, we obtain

$$r=0.02,\ \varepsilon=4.$$

Now we raise τ to 0.15, the new equilibrium is

$$r=0.02,\ \varepsilon=6.5.$$

These are consistent with the prediction that

$$\Delta\varepsilon\approx-\frac{X_2}{X_1}\Delta\tau=-\frac{50}{-1}0.05=2.5.$$

5. Unemployment

Unemployment is perhaps the most stressful experience for most people. In this part of the lecture, we introduce the classical view of the unemployment problem, which holds that there is a "natural rate" of unemployment even in an efficient labor market. We present a simple model that relates the natural unemployment rate to the ease (difficulty) of finding and losing jobs. We then discuss the reason why it takes time to find jobs, which results in the so-called frictional unemployment. We also discuss structural unemployment, which is caused by the inflexibility of wage.

The unemployment rate fluctuates around a rather smooth trend, which may be calculated as 5-year or 10-year moving averages. We call the smooth trend as the natural rate of unemployment. The moving averages, in contrast to the full-sample average, allow the natural unemployment rate to change over time, reflecting fundamental changes in the economy.

Case Study: The Unemployment Rate and the Natural Rate of Unemployment in the US

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 given 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.,

$$sE=fU.$$

In 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 yields

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

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

In classical view, wage is assumed to be flexible. But even when wage is flexible, it still takes time to find a job or find a worker. The unemployment due to this simple fact is called frictional unemployment. The friction can come from heterogeneities of jobs and workers, imperfect information, imperfect labor mobility, sectoral shifts, and so on.

To reduce frictional unemployment, the government can help disseminate information about jobs and even provide training programs. The private sector can do at least equally well on information dissemination, especially in the digital age. But on training programs, the government may be helpful since training may cost more than profit for a particular employer.

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 helps to achieve a better matching between workers and jobs, hence enhancing the efficiency of the labor market.

Structural Unemployment

The structural unemployment is caused by a rigid wage level that is higher than the market equilibrium.

The wage rigidity may come from the law of minimum wage, the labor union, and the so-called efficiency wage. The law of minimum wage would obviously increase unemployment among individuals with low or impaired skills (e.g., young or disabled people). In countries with strong labor unions, union members ("insiders") may, through collective bargaining, manage to keep their wage artificially high. To combat this and to give more influence to “outsiders”, wage bargaining can take place at national level (e.g., Sweden).

Efficiency wage refers to the incentive for firm managers to pay employees more than the market-equilibrium wage in order to increase productivity or efficiency, or reduce costs associated with turnover. High wage mitigates the problem of adverse selection since higher wage attracts and retains able employees. High wage also mitigates the problem of moral hazards since high wage increases the cost of possible job loss, the ultimate penalty of shirking.