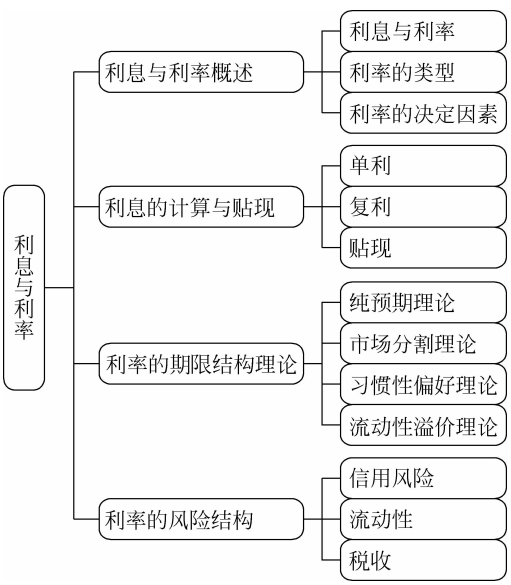
Chapter 3

Interest and Interest Rate
利息与利率

Structure of Chapter 3



Learning Objectives

1. To learn the concept of interest and interest rate. To understand the types of interest rate.

2. To grasp two methods of interest calculation: simple interest and compound interest. To understand discounting and the relationship between interest rate and bond price.

3. To learn the structure of interest rate, including term structure and risk structure.

Opening Vignette

PBC to Cut RMB Benchmark Deposit and Loan Interest Rates and Adjust Interest Rate Floating Range

The PBC has decided to cut RMB benchmark deposit and loan interest rates for financial institutions as of June 8, 2012. The one-year RMB benchmark deposit and loan interest rates will be lowered both by 0.25 percentage points. Adjustments are made correspondingly to benchmark interest rates on deposits and loans of other maturities and to deposit and loan interest rates on personal housing provident fund.

As of the same day, the upper limit of the floating range for deposit interest rates will be 1.1 times the benchmark interest rate and the lower limit of the floating range for loan interest rates 0.8 times the benchmark interest rate. Adjustment of RMB Benchmark Deposit and Loan Interest Rates see the table 3-1.

Table 3-1 Adjustment of RMB Benchmark Deposit and Loan Interest Rates

Item	Rate(after adjustment) (percent)
1. Household and corporate deposits	
1.1 Demand deposits	0.40
1.2 Time deposits of lump-sum deposit and withdrawal	
3-month	2.85
6-month	3.05
1-year	3.25
2-year	4.10
3-year	4.65
5-year	5.10
2. Loans	
6-month	5.85
1-year	6.31
1 to 3-year	6.40
3 to 5-year	6.65
Over 5-year	6.80
3. Personal housing provident fund loans	
Below 5-year (inclusive)	4.20
Above 5-year	4.70

Source: www.pbc.gov.cn

Text

3.1 An Overview of Interest and Interest Rate

3.1.1 What is Interest and Interest Rate

Interest is a fee, paid on borrowed capital. The fee is compensation to the lender for foregoing other useful investments that could have been made with the loaned money. These foregone investments are known as the **opportunity cost**. Instead of the lender using the assets directly, they are advanced to the borrower. The borrower then enjoys the benefit of using the assets ahead of the effort required to obtain them, while the lender enjoys the benefit of the fee paid by the borrower for the privilege. The amount lent, or the value of the assets lent, is called the **principal**. This principal value is held by the borrower on credit. Interest is therefore the price of credit.

The percentage of the principal that is paid as a fee (the interest), over a certain period of time, is called the interest rate which is the cost and basic price of borrowed capital that equates the demand for and supply of funds in the financial markets.

3.1.2 Types of Interest Rate

Interest rates form a very complicated system of economic variables and have various forms since people observe interest rates from different perspectives.

1. Nominal and real interest rates

People have long recognized that the prices of goods, services, and assets must be corrected for the effects of inflation in order to make meaningful economic comparison over time. To do this, economists make a distinction between nominal prices, or prices in terms of some currency, and real prices, or prices in terms of purchasing power over goods, services, and assets.

Just as we distinguish between nominal and real prices, we distinguish between nominal and real interest rates. **Nominal interest rate** is the promised amount of money you receive per unit you lend. It measures the increment in certain money.

Real interest rate is the nominal rate you earn corrected for the change in the purchasing power of money or for the expected inflation. Roughly speaking, the real interest rate is the difference between the nominal interest rate and inflation rate, or the nominal interest rate minus the inflation rate. This can be expressed by the following formula:

$$r = N - INF$$

or

$$N = r + INF$$

Here, r stands for real interest rate, N for nominal interest rate and INF for inflation rate. For example, if you earn a nominal interest rate of 8% per year and the rate of inflation is 5% per year, then the real interest rate is 3%. That is approximately correct, but not exactly so.

Although a fixed-income instrument is risk free in nominal terms, it will not be risk free in real terms because of inflation. When inflation rate is higher than the nominal interest rate, the real interest rate would be negative.

2. Official and market interest rates

Official interest rate is the rate set by the central banks or monetary authorities. The interest rate is one of levers used by governments to regulate economy. In order to let the interest rate reflect the policy intention of government, the central bank should control the level of some interest rates. Therefore, there are the official interest rates in existence.

Market interest rate is the rate wholly determined by the demand for and supply of funds in the financial markets at certain time. The market rate is an indicator of the state of the demand for and supply of funds in the financial markets. When the demand for funds exceeds supply of funds, the market rate tends to rise; on the contrary, when the supply of funds exceeds demand for funds, the market rate tends to fall. The change of the market rates adjusts the demand for and supply of funds and brings about the equilibrium of the demand for and supply of funds. The inter-bank interest rates are typical market interest rates, among which LIBOR is the most influential one in the international financial markets.

3. Fixed and floating interest rates

Fixed interest rate refers to the interest rate that is not adjusted during the period of financing. The model of financing with fixed interest rates is a traditional one.

Floating interest rate refers to the interest rate that is not static during the period of financing, but is adjusted according to the changes of market interest rates now and then. Usually, interest rates are adjusted every three or six months according to market interest rates changes. When market interest rates tend to rise, the floating rate is advantageous to the creditor, but is disadvantageous to the debtor, and vise versa when market interest rates tend to fall. In this case, the floating interest rate can avoid some disadvantages that fixed interest rate has. But floating interest rate also brings about some extra costs because of troublesome procedures and the varied accounting bases.

4. Benchmark rate and financial institutions' rate

The benchmark rate refers to the rate that leads and affects other interest rates. The benchmark rate in most countries is the central bank's discount rate at which the central bank charges commercial banks and other institutions when discounting the latter's bills. In the U. S. , it's called Federal Funds rate.

Financial institutions' rate is the rate at which commercial banks and other financial institutions do their businesses of taking in deposits and granting loans. Changes of the benchmark rate affect commercial bank's interest rates, which will further affect other kinds of interest rates in financial markets.

5. General and prime interest rates

General interest rate refers to the interest rate that is charged by banks and other financial institutions according to a general standard when loans are granted and deposit are taken in.

Prime interest rate refers to the interest rate that enjoys preferential conditions and is higher than the general deposit rate and lower than the general lending rate. Prime interest rate is usually given when banks make loans to the sectors, businesses and projects that are supported by national government industrial policies. In international financial markets, LIBOR is taken as a measure of prime rates.

6. Yearly, monthly and daily interest rates

Based on maturities, there are three ways to express interest rates, which are the yearly rate, monthly rate, and daily rate. The yearly interest rate is accounted on the basis of years and is quoted as % of the principal. The monthly interest rate is accounted on the basis of months and is quoted as ‰ of the principal. The daily interest rate is accounted on the basis of days and is quoted as ‱ of the principal. The formulas to make interchange among these three types of interest rates are as follows:

Yearly interest rate/12 = monthly interest rate

Monthly interest rate/30 = daily interest rate

Yearly interest rate/360 = daily interest rate

Western industrialized countries are in the habit of accounting interest rate with the yearly interest rate, while our country is accustomed to the monthly interest rate.

3.1.3 Determinants of Interest Rates

Determinants of interest rates are quite complicated. When interest rates are formulated and adjusted, the following factors should be taken into account.

1. Social average rate of profit

Interest itself is a part of profit that borrowers pay to lenders for the use of borrowed funds. So no matter how high the interest rate is, it won't exceed the social average rate of profit, which is a basic element in determining interest rates. The higher the average rate of profit, the higher the interest rate. But the upper ceiling of interest rate is the average rate of profit. If the

interest rate is higher than the social average rate of profit, business firms won't borrow funds. Of course, the interest rate won't be equal to zero, if so, nobody will lend out any money. So interest rates always fluctuate between zero and the social average rate of profit.

2. Demand for and supply of funds

The interest rate is in essence the price of credit or money borrowed—the price that lenders receive and borrowers have to pay. Because the interest rate is a price, like all other kinds of prices, it's determined by supply of and demand for credit or funds which lenders are willing to make available for borrowers in a market economy. When the supply of funds exceeds the demand for funds, the interest rate will decrease. When the demand for funds exceeds the supply of funds, the interest rate will increase. The level of interest rates not only reflects the supply of and demand for funds, but also adjusts the supply of and demand for funds.

3. National economic policies

The interest rate policy, as a part of country's economic policies and a component of monetary policy, should coordinate with other economic policies and strategies of economic development. The strategies of a country's economic development with the speed and direction during a certain period determine the supply of and demand for funds, further interest rate. The interest rate policy always shows clearly a national government's intention that industry or sector is to be supported or restricted. For example, to those industries or economic sectors that a government wants to support, preferential interest rates, or low interest rate policy should be applied. Otherwise, the high interest rate policy should be applied. Besides, a national government can cut down interest rates when it wants to expand the economy and stimulate demand. Conversely, a national government can raise interest rates when it wants to slow down an over-heated economy.

4. Business cycle

Interest rates tend to show an upward trend during the periods of business cyclical expansion and downward trend during periods of cyclical recession. Due to increased income of businesses and households when businesses conditions are good in prosperity, the demand of businesses and households for funds will increase. Businesses will borrow more to accumulate inventories in an anticipation of increased sales, and households will buy more goods and services on credit because the future looks bright for them. In this case, interest rates will rise. On the contrary, when in recession, both businesses and households will cut down their use of credit. As a result, the demand for funds decreases and interest rates fall.

5. Inflation

Inflation is another element affecting interest rates and therefore deserves our special

attention. When inflation goes up, money will depreciate and the real interest rate will go down. So inflation is an "invisible tax" on creditors and a kind of "allowance" to debtors. Borrowers expecting a speed up in inflation will increase their demand for funds, because they anticipate repaying their borrowings in depreciated money. On the other hand, lenders expecting a rise in inflation will decrease their supply of funds, because they anticipate being repaid with money of diminished purchasing power. In both cases, there will be higher nominal interest rates. On the contrary, when inflation declines, the real interest rate will rise. Expectations of a slowdown in inflation will decrease demand, increase supply, thus inducing lower nominal interest rates.

6. Level of international interest rates

Under the condition of an open economy, capital can flow freely. Domestic interest rates have close relation with international interest rates through interest rate arbitrage. So the level of international interest rates does affect a country's domestic interest rates. When domestic rates are higher than international rates, there will be a large amount of capital flowing into the country to seek for profits from higher interest rates, which will bring domestic rates down to the international level. On the other hand, when domestic rates are lower than international rates, there will be capital flowing out of the country, which will push domestic rates up to the international level because of the arbitrage.

CHECKPOINT

How to understand interest rate and exchange rate from the point of the financial prices?

Interest rate is the cost of obtaining money to borrowers and the return on money to lenders. Thus, just as rent is the cost to apartment dwellers and the return to the landlord, the interest rate is the rental price of money that is rented out.

Exchange rate specifies the purchasing power of one currency in terms of how much it can buy anther currency. In other words, the exchange rate is merely the sale or purchase price of one currency in terms of another currency when we sell or buy it.

3.2 Calculation of Interest and Discounting

3.2.1 Simple Interest

Simple interest refers to the interest that is earned only on the principal of the initial investment.

Example:

Let us suppose that you lend someone $1,000 at 6% annual interest rate. How much

would you get back at the end of the first year, the second year and the third year if you are only paid simple interest?

The amount you would get back at the end of the first year would be:

the principal(1,000) + the interest (1,000 × 6% = 60)

or a total future amount of $1,060;

The amount you would get back at the end of the second year would be:

the principal(1,000) + the interest (1,000 × 6% × 2 = 120)

or a total future amount of $1,120;

The amount you would get back at the end of the third year would be:

the principal(1,000) + the interest (1,000 × 6% × 3 = 180)

or a total future amount of $1,180.

There is a formula for calculating the amount of interest and future value:

$$\text{interest} = \text{principal} \times \text{rate} \times \text{time}$$

$$\text{future value} = \text{principal} + \text{interest}$$

$$= \text{principal} \times [1 + (\text{rate} \times \text{time})]$$

expressed symbolically

$$V_n = V_0(1 + i \times n)$$

where V_n = the funds to be received by the lender at the end of year n, note that this is a future value;

V_0 = the funds lent (and borrowed) now, note that this is a present value.

3.2.2 Compound Interest

Compound interest involves earning interest on interest in addition to interest earned on the principal or initial investment. With annual compounding, the interest that accumulates during a year is added to the principal at year's end, so that the following year your money earns interest on interest.

Example:

If you agree to lend a friend $1,000 for one year at an interest rate of 6%.

The general relationship is

Future value = Amount repaid = principal + interest

The amount of interest at the end of year 1 is:

Interest = principal × interest rate

Interest = principal × i

Substituting, we get

Amount repaid = principal × (1 + i) or $V_1 = V_0(1 + i)$

In this example,

$V_1 = V_0(1 + i) = \$1,000 \times (1 + 0.06) = \$1,000 \times (1.06) = \$1,060$

What if your friend wants to borrow the money for two years? Assume that he makes no

payments until the end of the loan. This is where compounding comes into play.

$$V_2 = V_0 + iV_0 + i(V_0 + iV_0)$$

We can reduce this equation to

$$V_2 = V_0(1 + i)^2$$

In fact, this equation can be generalized for any maturity of n years

$$V_n = V_0(1 + i)^n$$

In our example, $V_0 = \$1,000$, $i = 0.06$, and $n = 2$

$$V_2 = \$1,000(1 + 0.06)^2 = \$1,000 \times (1.1236) = \$1,123.60$$

3.2.3 Discounting

Compounding is forward looking. Discounting is backward looking. It addresses this question: what is the **present value** of money to be received(or paid) in the future?

Continue the above example, if $1,000 today at 6% interest rate is worth $1,123.6 two years from now, we can work backward and say that $1,123.6 two years from now must be worth only $1,000 today. When we work backward, we are discounting a future sum back to its present value. To calculate present value, we can simply rearrange the formula for future value.

This time, we solve for V_0

$$V_0 = \frac{V_n}{(1+i)^n}$$

V_0: present value V_n: future value

The above formula is used to evaluate the present value of an instrument calling for a one-time payment at maturity. Obviously calling for a one-time payment of $1,123.6 in two years it is worth only $1,000 today since an individual with $1,000 today could place the funds in a saving account(or other interest-bearing asset) and come out with more than $1,000 in two years.

Besides, there are also assets, such as coupon bonds, calling for a stream of returns in future years. Therefore, we can get the following equation to calculate their present value:

$$P = \frac{C_1}{(1+i)^1} + \frac{C_2}{(1+i)^2} + \cdots + \frac{C_n}{(1+i)^n} + \frac{F}{(1+i)^n}$$

In this equation, P represents the present value(or price) of the asset; $C_1, C_2, C_3, \ldots, C_n$ indicate the annual returns currently expected from the asset in year $1, 2, \ldots, n$; i represents the interest rate used to discount these expected future returns, F stands for face value or principal.

There are assets that hold the promise of yielding a stream of returns in future years($C_1, C_2, C_3, \ldots, C_n$). Most corporate, municipal, and government bonds promise a finite series of returns, involving constant annual or semiannual payments for 10, 20, or 30 years. For some securities, the promise may involve only one return, to be received in one year(C_1, or perhaps in 30 years (C_{30})). An example of the former is a ten-year treasury note. An example of the

latter is a 30-year zero-coupon bond, that is, a bond that makes no annual payments, but merely agrees to return a specific principal(say $1,000) at maturity in 30 years.

The concept of present value is often used to compare returns or costs in daily economic life.

Example:

Suppose that you are about to buy a bond that will mature in one year, the face value is $1,000 and the coupon payment is $60 (the coupon rate 6%).

1) The prevailing market interest rate is 6%

How much will you be willing to pay

$$P = \frac{\$60}{(1.06)^1} + \frac{\$1,000}{(1.06)^1} = \$1,000$$

This is called at par.

2) When the interest rate rises

Suppose that the market interest rate rises to 8%

The price of the bond now becomes

$$P = \frac{\$60}{(1.08)^1} + \frac{\$1,000}{(1.08)^1} = \$981.48$$

You would be buying the bond for a price below its par value ($981.48 < 1,000), this is called a discount from par, which raises the yield to maturity on the bond.

3) When the interest rate falls

Suppose that the market interest rate falls to 4%

The price of the bond now becomes

$$P = \frac{\$60}{(1.04)^1} + \frac{\$1,000}{(1.04)^1} = \$1,019.23$$

You would be buying the bond for a price above its par value ($1,019.23 > 1,000), this is called a premium above par, which lowers the yield to maturity on the bond.

4) Conclusion

The price of a bond is the discounted value of the future stream of income over the life of the bond.

When the interest rate increases, the price of the bond decreases.

When the interest rate decreases, the price of the bond increases.

CHECKPOINT

Tom and Sally just had a baby. How much will they have to invest today for the baby to have $100,000 for college in 18 years if the interest rate is 5 percent? If the interest rate is 10 percent?

To answer the question, you need to find the present value of $100,000 in 18 years. If the interest rate is 5 percent, the present value is $41,493.70 ($100,000/1.05^{18}). If the interest rate is 10 percent, the present value is $17,985.61 ($100,000/1.1^{18}).