Lesson 09 Simple Rate and Compound Rate

Suppose that you place JPY 1,000,000 one-year deposit at the bank and the agreement stipulates that the interest rate on the deposit is 10% simple interest per annum.

This means that you will receive the following amount on the due date.

The principal: JPY 1,000,000

Interest: JPY 1,000,000 * 10% = JPY100,000

Total amount: JPY 1,000,000 + JPY 100,000 = **JPY 1,100,000**

Compound interest, also called interest on interest, is applied both to the principal and to the accumulated interest made during previous periods.

With the same example above, let's see how the compounding frequency will affect the total amount of payment. (Principal: JPY 1,000,000, interest rate: 10% per annum, investment period: one year)

When the interest rate is measured with semiannual compounding, it means that 5% (=10%/2) is earned every 6 months, with the interest being reinvested. Then the invested money will grow to the following amount at the end of one year.

JPY 1,000,000 * 1.05 * 1.05 = **JPY 1,102,500**

When the interest rate is measured with quarterly compounding, then 2.5% (=10%/4) is earned every 3 months, with the interest being reinvested. JPY 1,000,000 then grows to

JPY 1,000,000 * $(1 + 0.025)^4$ = **JPY 1,103,812**

As you have seen here, the frequencies of the compounding increases, the total amount of the money at the end of the investment period also increases.

A day count convention is presented in the form of "**number of days in the accrual period/number of days in the year**". If a deposit has a 30/360 basis, it means that the number of accrued days is counted on the basis of 360 days per year and 30 days per month.

For most of onshore JPY transactions, Actual/365 (A/365) methods are being applied. The Actual/365 basis divides the actual number of accrual days by 365.

Suppose that you borrow JPY 100,000,000 from the bank at 5% per annum (A/365) and pay it back in 124 days. What would be the total amount that you need to pay to the bank?

The total amount to pay = 100,000,000 * (1 + 5% * 124/365) = **JPY 101,698,630**

(Please note that the any interest amount below JPY 1 is usually rounded down to zero as you can see in the above example.)

Lesson 10 Discount Factor and Present Value

Receiving JPY 1,000,000 now is worth more than JPY 1,000,000 after one year from now. Why? An investor can invest the JPY 1,000,000 in one year deposit today and presumably earn an interest on it (unless the interest rate is negative).

Future value (FV) is the amount of money which can be achieved at a given date in the future by investing the money at a given interest rate, assuming compound re-investment of any interest payments received before the end.

Conversely, if we know the cashflow in the future (FV), we can calculate Present value (PV) of this cashflow by "discounting" the FV with a given interest rate. This applied interest rate is called as "Discount rate".

Q. One year interest rate: 10% and PV is JPY 1,000,000, then what the FV in one year time will be?

A. $\mathrm{FV} = \mathrm{JPY}\ 1{,}000{,}000 * (1 + 0.01) = \mathrm{JPY}\ 1{,}100{,}000.$

The ratio of the PV to the FV is called as Discount factor (DF), so the present value can be calculated by multiplying the future value by the relevant discount factor. For the above example,

$$\mathrm{DF} = \mathrm{PV}/\mathrm{FV} = \mathrm{JPY}\ 1{,}000{,}000/\mathrm{JPY}\ 1{,}100{,}000 = 1.0/1.1$$

$$\mathrm{PV} = \mathrm{FV} * \mathrm{DF} = \mathrm{JPY}\ 1{,}100{,}000 * 1.0/1.1 = \mathrm{JPY}\ 1{,}000{,}000$$

The interest rate to be applied to the present value calculation is called as the discount rate. As we shall discuss later, there are many choices for the interest rate depending on the associated credit or liquidity risks. The selection of the interest rate is essential as the present value would be higher (lower) with the lower (higher) discount rate. In risk-neutral valuation of derivatives, a risk-free rate (RFR) is used as the discount rate.

For USD, the rates on Treasury bills, Treasury notes, Treasury bonds or LIBOR (London Inter-Bank Offered Rate) have been thought to be the risk-free rates as many consider it extremely unlikely that the US government or major banks will ever default and the market for these transactions are most liquid among others.

(About LIBOR and its successor, see also Lesson 13.)

Lesson 11　Bond Yield

（１）Characteristic of bonds

The below are the main characteristic of bonds and all these items will be taken into consideration when evaluating the bond prices.

１． Face value (Par value)

Face value (par value) is the money amount the bond will be worth at maturity. When the bond matures, investors will receive the same amount as the face value of the bond, regardless of the price they bought it.

２． Coupon rate

Coupon rate is the rate of interest the bond issuer will pay on the face value of the bond, expressed as a percentage.

A bond can be purchased for its face value (at par), more than its face value (at a premium), or less than its face value (at a discount), which will change the yield an investor earns on the bond.

The coupon rate is one of the methods (and the simplest method) to measure a bond yield, which is calculated by dividing its annual total of the coupon payments by the face value of the bond.

Coupon Rate = Annual Coupon Payment / Bond Face Value

Suppose that the one-year bond has a face value of $1,000 and will pay $100 (annually), then the coupon rate will be:

Coupon Rate = $100 / $1,000 = 10% per annum

If the market interest rate for similar investments rises to 12%, how would the price of this bond react to this market change?

Buyer of the bond will still earn a coupon payment of $100 but this would be not attractive to investors who can buy one-year bonds that pay $120 as their coupon. The price of the original bond would need go down so that the yield equals to the market level, which is 12% in this case.

The bond price = $100 / 0.12 = $833.33

Thus, if market interest rates rise, the bond's price would fall and the further rates rise, the higher the bond's price will fall.

On the contrary if market interest rates fall, the bond's price would rise because its coupon payment is more attractive. The further rates fall, the higher the bond's price will rise.

3. Coupon dates

Coupon dates are the dates on which the bond issuer will make interest payments. Payments can be made in any interval, but the standard is semiannual payments (i.e., twice a year).

4. Maturity date (Redemption date)

Maturity date or redemption date is the date on which the bond will mature and the bond issuer will pay the bondholder the face value of the bond (with the final interest if any).

5. Issue price

Issue price is the price at which the bond issuer originally sells the bonds. In most cases, bonds are issued at par but can be issued at over-par or under-par.

6. Credit Quality of the issuer

If the issuer has a poor credit rating, the risk of default is greater, and hence the investors will require the higher interest for these bonds.

Credit ratings for a company and its bonds are generated by credit rating agencies like Standard and Poor’s, Moody’s, and Fitch Ratings.

The very highest quality bonds are called “investment grade (IG)” and include debt issued by the U.S. government or companies with high credit quality.

Bonds that are not considered investment grade but are not in default are called “speculative grade” or “high yield (HY)”. High yield bonds are also called “junk” bonds. These bonds have a higher risk of default in the future and investors demand a higher coupon payment to compensate them for that risk.

7. Time to maturity

Time to maturity is another main determinant of the coupon rate of the bond. Bonds with longer maturity date usually pay a higher interest rate. This higher compensation is because the bondholder is more exposed to default risk, interest rate, inflation risks and liquidity risk for an extended period.

（2） Current Yield

The current yield is calculated by dividing the annual coupon payment by the current market bond price. This is simple measure is easy to calculate but the difference between the maturity face value and the current market price of the bond is not taken into consideration.

Current Yield = Annual Coupon Payment / Current Bond Price

（3） Yield to Maturity (simple interest)

This measure is conventionally used particularly in Japanese bond market. This simple interest method is easy to calculate but the compounding effect on the investment is not considered in its calculation. Assuming that the remaining time to maturity of the bond is n (years), the formula is as follows:

YTD (simple interest) = (Annual total coupon + (Face value – Current price) /n) / Current price

（4） Duration and Convexity

Duration is a measure of the sensitivity of the price of a bond or other debt instrument to a change in interest rates.

Generally speaking, the higher the duration, the more a bond’s price will drop as interest rates rise (and the greater the interest rate risk). For example, if rates were to rise 1%, a bond or bond fund with a five-year average duration would likely lose approximately 5% of its value. Traders and investors pay close attention to duration, as it is the most basic measure of a bond’s riskiness. The longer the duration, the more the price of the bond is likely to fluctuate before maturity.

The rate of change of a bond’s or bond portfolio’s sensitivity to interest rates (duration) is called as convexity.

（5） Zero Rate/Spot Rate

A zero-coupon bond is a debt security that pays no intermediate payments but instead trades at a discount, rendering a profit at maturity, when the bond is redeemed for its full-face value.

N-year spot rate or n-year zero rate is the rate of interest earned on an investment to n-year zero coupon bond (assuming that the bond is held until maturity).

（6） Bond Price

The theoretical price of a bond can be calculated as the present value of all the cash flows that will be received by the owner of the bond.

Sometimes bond traders use the same discount rate for all the cash flows underlying a bond, but a more accurate approach is to use a different zero rate for each cash flow.

Lesson 12　Yield Curve

Interest rates of the bonds can be different for the different maturities even if they have equal quality of credit. Expectations theory suggests that the current long-term interest rates are determined based on the market expectation for the future short-term interest rates. However, there are many other forces which drive the long-term interest rates. Investors might ask for "risk premium" on the bonds with longer term as there would be higher market risks.

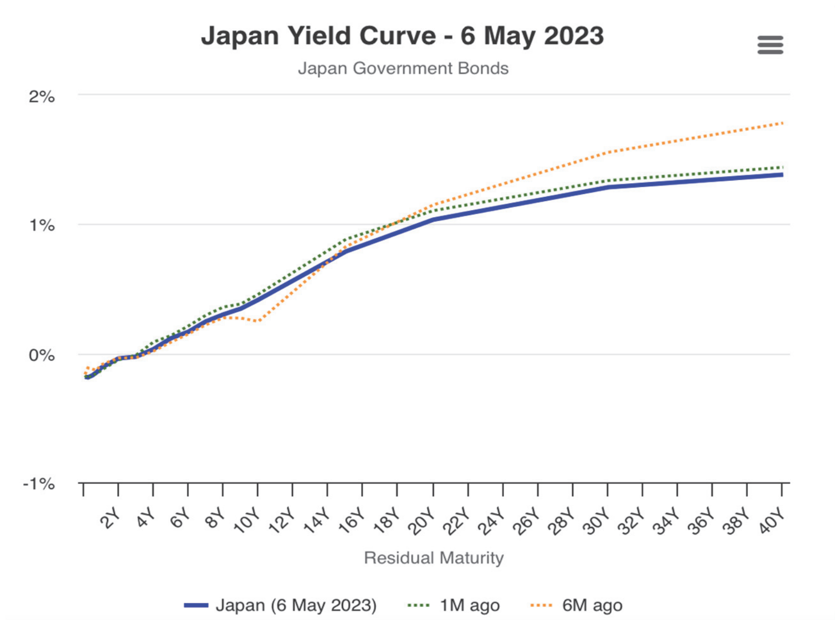
A "yield curve" is a line that plots interest rates of bonds having equal credit quality but different maturities.

There are three main shapes of yield curve shapes:

- ☑ normal (forward yield; upward sloping curve)
- ☑ inverted (reverse yield; downward sloping curve)
- ☑ flat

The below is the current shape of the yield curve of Japan Government Bonds (JGB), and you can see the rates are higher for the longer maturities (normal curve).

Figure 2　The yield curve of JGB (as of 6 May 2023)



As shown in the above, the yield curve is drawn against two axes, the vertical showing yield and the horizontal giving the maturity.

The shape of the yield curve varies from day to day. If long-term interest rates rise relative to short-term interest rates, the curve is said to steepen. Especially when the long-term interest rates rise greater than the short-term rates, it is called as “bear steepening” and when the short-term rates fall greater than the long-term rates, it is called as “bull steepening”.

And if short-term rates rise relative to long-term rates the curve flattens (it is also classified as “bull flattening” and “bear flattening”).