Security Analysis & Portfolio Management

Professor J.P. Singh
Department of Management Studies
Indian Institute of Technology, Roorkee

Lecture: 10

Intrinsic Value of Bonds

Welcome back. So, I reiterate that the face value is the nominal value of the bond. It is the value of the bond that is given in the contract of issue. It is the value of the bond that is relevant for computing the actual cash payment on account of interest. Actual cash payment on account of interest is computed by applying the coupon rate to the face value of the bond.

Similarly, the redemption value is calculated by reference to the face value. So, face value is a notional or a nominal figure, which is given in the contract of issue of the bond. It does not change during the life of the bond. Now, another point that needs to be emphasized is that the face value is not the price of the bond. In fact, it may or may not be equal to the price of the bond.

If a bond is quoting at par, then we say that the bond is quoting at face value. But a bond may quote at above its face value, or below its face value. We will examine this feature more and more as we go further. Similarly, the redemption value may be the face value or above face value or below face value. There is no legal restriction requiring fixation the redemption value at the face value of the bond.

Coupon rates and frequency, I have already explained. Coupon rate is the contractual rate of interest. It is the nominal rate of interest which is given in the contract of issue. Again, it may or it may not be equal to the market rate of interest. Please note one fact, market rate is a dynamic rate, it changes from time to time, from one minute to another minute. Now, the market interest rates may change, may not change, but the coupon rate is fixed once and for all for the life of the bond.

Either the coupon rate itself is fixed or the manner of computation of the coupon rate is fixed. In other words, if you have a floating rate instrument, then the coupon rate may be tagged to the value of another reference rate. However, even in that case, the manner in which the coupon rate is to be computed from that reference rate is specified in the document of issue of the instruments or the bonds.

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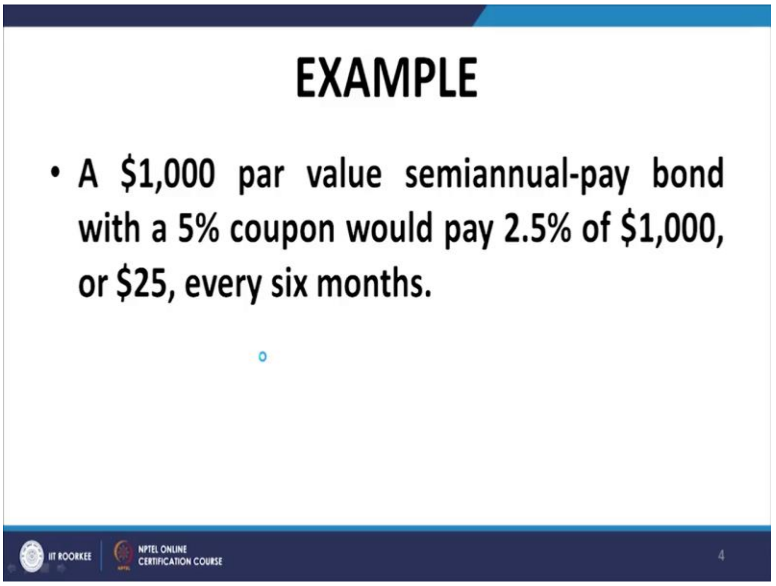

We look at an example here to clarify what I have been saying. We consider a USD 1,000 par value, semi-annual coupon bond with a 5% coupon rate. Please note that this is a semi-annual coupon payment bond. So, in other words, the interest will be paid at intervals of 6 months. The nominal rate of interest is 5% per annum. So, for each half-year, based on the convention that we follow in the bond market, this coupon rate is halved. Hence, , for each half-year an interest rate of 2.5% is paid. 2.5% of the face value of the bond i.e. 1,000. So, the actual payment of interest would be 2.5% of 1,000 that is 25 units of money at the end of every 6 months.

Now, we come to a very important concept called intrinsic value. In fact, the core objective of the Security Analysis segment of this course, is related to the determination of intrinsic values. Intrinsic values are not only security-centric (in other words, they are determined / based on the nature/amount of the security's cash flows, and the riskiness in the realization of those cash flows), but they are also investor-centric (in the sense that intrinsic value calculation by an analyst would work on the basis of certain models which the analyst identifies to be appropriate and on the basis of inputs which are estimated by the analyst). So, as far as the calculation of intrinsic value is concerned, it is not only instrument-centric, not only security-centric, but it is also investor-centric.

I repeat, investor-centric because the inputs that are required for the calculation of intrinsic value would be ascertained by the investor or the analyst. Whoever is computing the intrinsic value would use his inputs on the basis of his perception. The model that he uses for the calculation of intrinsic value is also his choice. So, the output that he is going to get is essentially his version of the intrinsic value.

So, based on what the investor's version is of the value of the particular security, (I repeat, based on the investor's valuation of the security), the investor may conclude that the security is under-priced or overpriced. Thus, by comparing by comparing his valuation with the market valuation (which is embedded in the price of the security) an investor can arrive at appropriate trading decisions. So, the investor/analyst compares the price of securities with the respective intrinsic values and locates under-priced or overpriced securities. This information may induce him to take investment decisions in the form of either buying under-priced security or selling overpriced security. So, that is the role of intrinsic value. Our role in the context of this course is to identify the most appropriate methodologies for the determination of intrinsic values. This is the core of this course, that we are now heading to.

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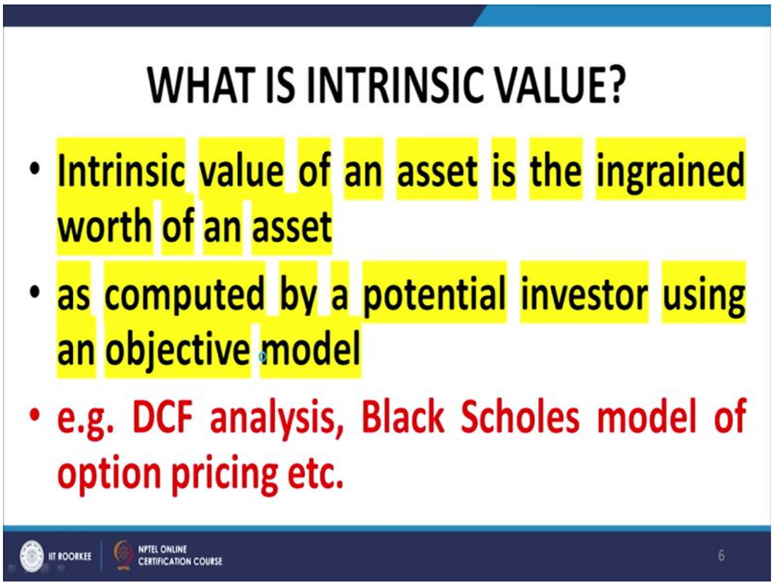

What is the intrinsic value? The intrinsic value of an asset is the ingrained worth of the asset as computed by a potential investor using an objective model. The objective model is selected by the investor, it is not dictated/selected by the market. So, the basic thing is that the computation of intrinsic value is removed from the market. It does not have a nexus with the market in the sense that the investor is doing his own evaluation as per his understanding of the worth of the security.

So, I repeat the intrinsic value of an asset is the ingrained worth of the asset as computed by a potential investor using an objective model. The commonly used objective model is DCF analysis. What is DCF analysis? Discounted cash flow analysis. Which cash flows? That is what we are going to discuss in due course. Another model is the Black Scholes model about which I will talk, when we talk about option pricing in the second segment of this course.

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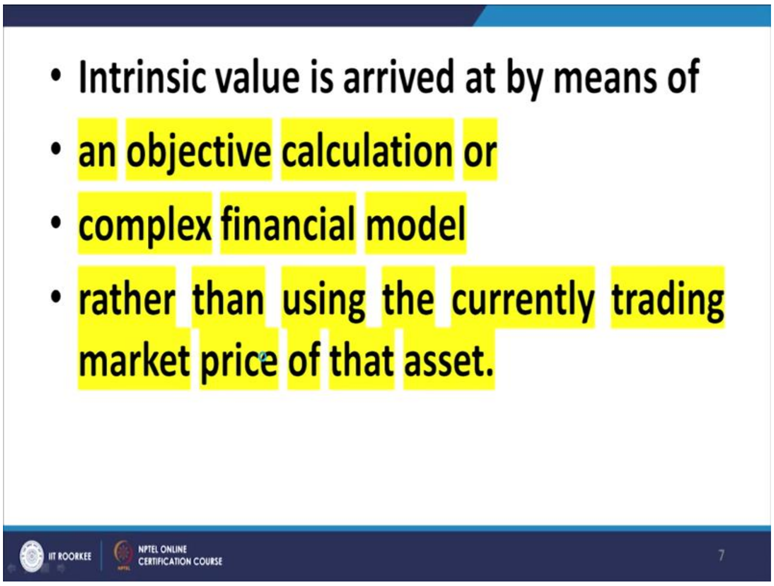

So, intrinsic value is arrived at by means of an objective calculation or a complex financial model, rather than using the currently traded price market price of the asset. This is fundamental. The intrinsic value is not determined by reference to the market valuation or the market price. It is determined by the individual on the basis of a certain model that is selected by him and on the basis of inputs that are estimated by him. So, this is what I have been saying. Intrinsic value is investor specific.

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So, I have explained all this already. By comparing his valuation, which we call intrinsic value with the market price, an investor is able to identify investment opportunities.

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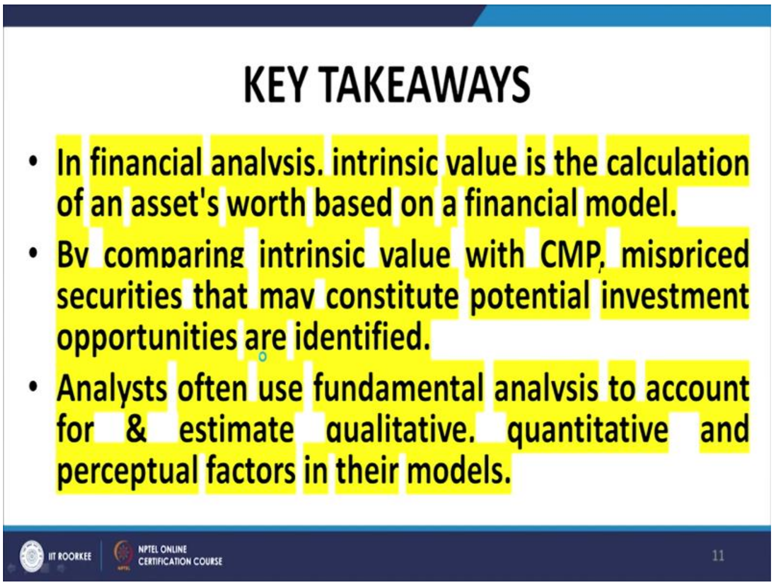

So, let us go through these key takeaways: (i) In financial analysis, intrinsic value is the calculation of an asset’s worth based on a financial model. I repeat, in financial analysis. intrinsic value is the calculation of an asset’s worth based on a financial model. (ii) By comparing the intrinsic value with the current market price, mispriced securities, that may constitute potential investment opportunities are identified. I repeat, by comparing intrinsic value with the current market price, mispriced securities that will constitute potential investment opportunities are identified.

Analysts often use fundamental analysis for working out intrinsic value.

What is fundamental analysis?

We will come back to it. Investors or analysts often use fundamental analysis to estimate qualitative, quantitative, and perceptual factors in their models.

In fact, there are three types of analysis commonly done, fundamental analysis, technical analysis, and quantitative analysis. We shall come back to this in a later part in this course.

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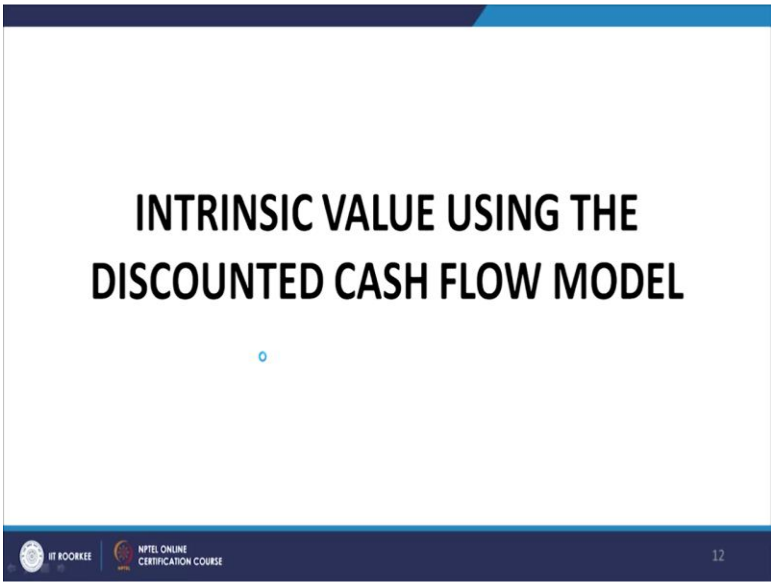

The discounted cash flow model is the most commonly uused model for intrinsic valuation. Now, this model seems (as you will see in a few minutes), the most logical model as far as the valuation of bonds and equities are concerned. So, let us move on to what we mean by the discounted cash flow model and the rationale behind using the discounted cash flow model for the valuation of securities.

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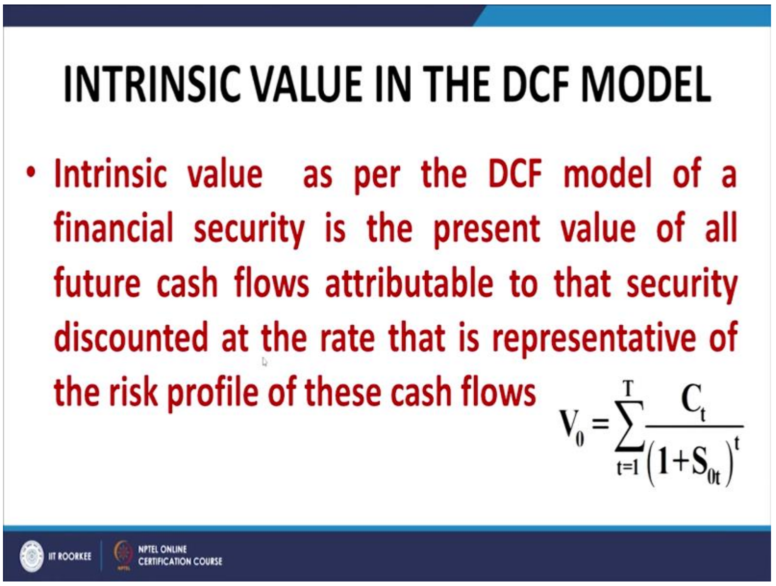

What does the discounted cash flow models say? ***The discounted cash flow model says that the intrinsic value of a security, as per the discounted cash flow model, is the present value of all future cash flows attributable to that security discounted at a rate which is appropriate for the riskiness of the realization of those cash flows.***

Let me repeat, it is worth repeating. Intrinsic value of a security, as per the discounted cash flow model is the present value of all future cash flows that are attributable to that security discounted at a rate which is appropriate to the riskiness of the realization of those cash flows. So, mathematically we can write it as: $\mathbf{V_0} = \sum_{t=1}^{T} \frac{\mathbf{C_t}}{(\mathbf{1}+\mathbf{S_{0t}})^t}$.

WE, now, examine the rationale of the DCF model:

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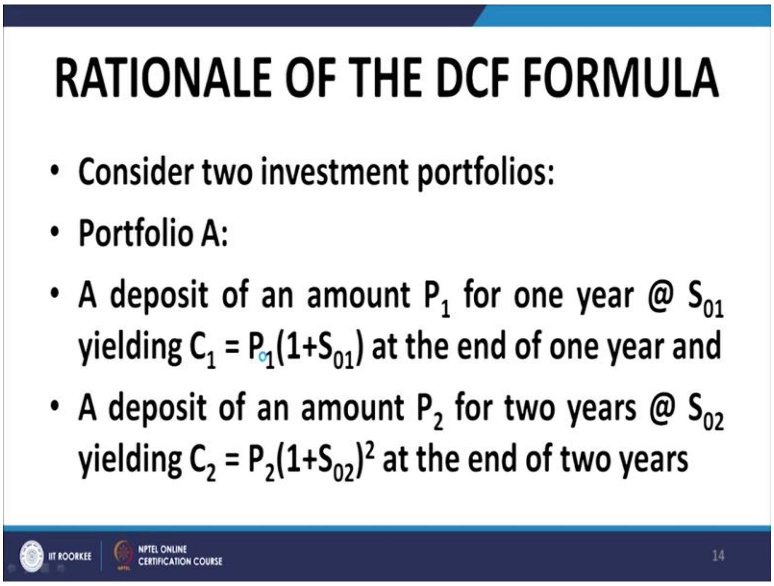

Again, we will invoke arbitrage. Let me tell you at the outset, arbitrage is literally an all-pervasive concept. It is ubiquitous as far as the pricing of financial assets are concerned. Anyway, let us come to this.

We consider two investment portfolios A & B.

Portfolio A involves the following two spot deposits:

(a) Deposit of an amount P_1 of money for 1 year at the current (spot) rate S_{01}. (S_{01} is the currently prevailing market rate for a one year deposit commencing right now, i.e. at t=0. In other words, it is the one year spot rate). The amount that is receiveable at the end of this one year deposit period is $C_1=P_1(1+S_{01})$.

(b) Deposit of an amount P_2 of money for 2 years at the current two-year (spot) rate S_{02}. (S_{02} is the currently prevailing market rate for a two year deposit commencing right now, i.e. at t=0. In other words, it is the two-year spot rate). The amount that is receivevable at the end of this two year deposit period is $C_2=P_2(1+S_{02})^2$.

We are assuming annual compounding to keep things tractable and simple. Why we are using suffixes in the interest rates? I will come back to it.

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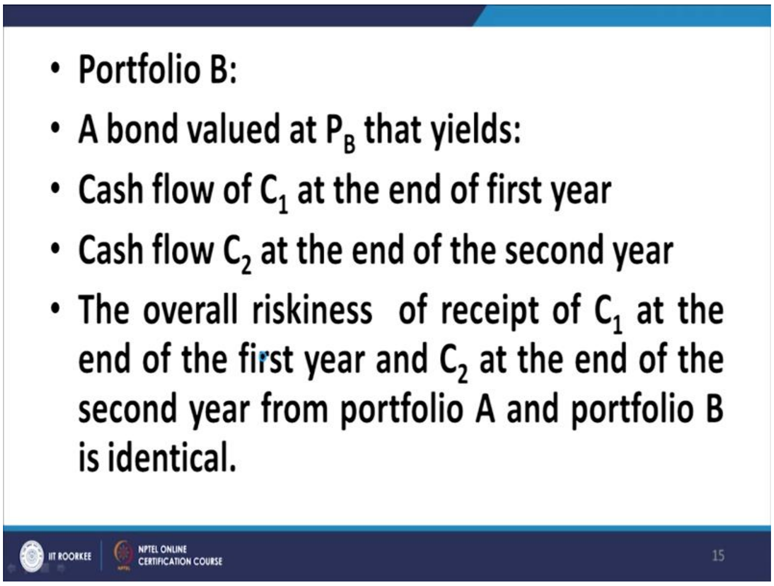

Portfolio B consists of a bond B. The bond B is going to realize a cash flow of C_1 at the end of 1 year and a cash flow of C_2 at the end of the second year.

The second feature of this bond is that the riskiness (let me keep it abstract, I will use the word riskiness instead of a default probability or some other measure of riskiness because I want to keep things simple and generalized) of the realization of the cash flows C_1 from the bond is the same as the riskiness of the recovery of the first deposit in Portfolio A on maturity, and the riskiness of the realization of cash flow C_2, at the end of year 2 from the bond B is also the same as the riskiness of the realization of the second deposit in Portfolio A on maturity.

Thus, as far as the amount, timing as well as the riskiness of the cash flows is concerned, portfolio A & B are identical. Both give cash flow of C_1 at the end of the first year and C_2 at the end of the second year with equivalent risk in each case.

What is the current value of portfolio A? It is $P_1+ P_2$. Let us assume that the value of bond B in portfolio B i.e. current value of the bond is P_B.

Then, because the amount, timing and risk of the cash flows is the same for both portfolios and there are no inequivalent intermediate cash flows, it is necessarily true by the law of one price \that the price of the two portfolios must be the same, must converge.

What does that mean? This means that the value of the bond $P_B = P_1+P_2$. In other words, the market price of the bond $P_B = P_1+P_2$. Substituting for P_1 and P_2 in terms of C_1 and C_2, we get:

$P_B=P_1+P_2 =C_1/(1+S_{01})+C_2/(1+S_{02})^2$

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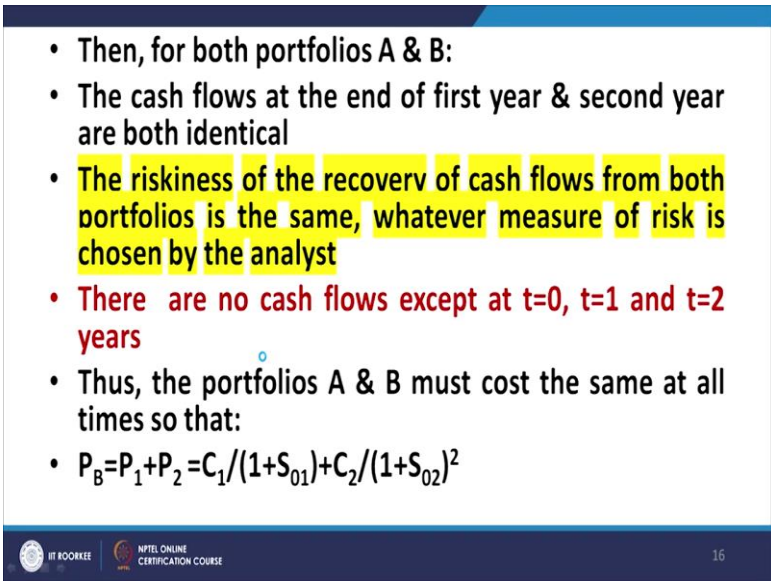

So, this is what the discounted cash flow approach tells us. The current price is equal to the discounted value of future cash flows, discounted at the market rates, which are S_{01} and S_{02}. These are the market rates of interest.

So, this was a two-year bond. The same philosophy can be extended to any number of years comprising the life of the bond.

$$C_1 = V_1(1+S_{01}),\ C_2 = V_2(1+S_{02})^2, \ldots, C_T = V_T(1+S_{0T})^T,\quad V_0 = \sum_{t=1}^{T} V_t = \sum_{t=1}^{T} \frac{C_t}{(1+S_{0t})^t}.$$

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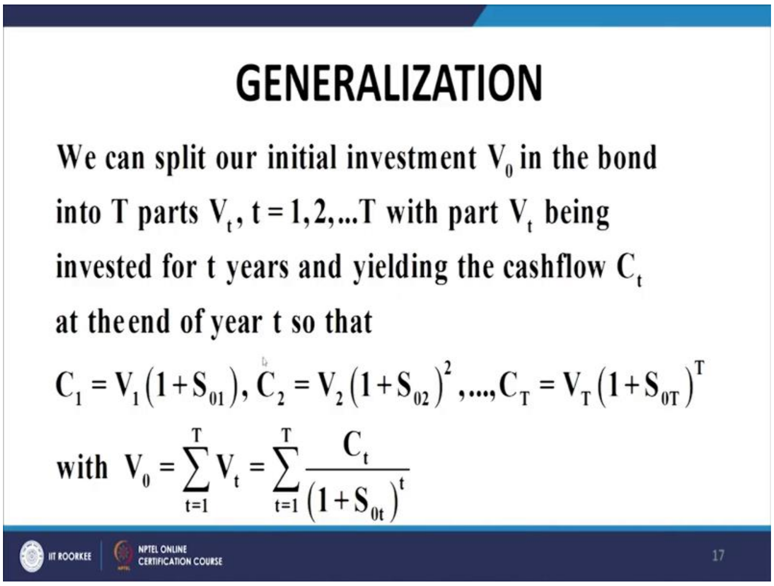

Thus, we arrive at the general formula which is $\mathbf{V_0 = \sum_{t=1}^{T} V_t = \sum_{t=1}^{T} \frac{C_t}{(1+S_{0t})^t}}$; where V_i, is the current value of the one year, two year,…, T-year deposits. V_1 is the current value of 1 year deposit, V_2 that of 2 year deposit, V_3 for the 3-year deposit and so on. And then substituting V_1 in terms of C_1, V_2 in terms of C_2 etc. we arrive at the above formula.

So, V_0 is summation over t, cash flow for year t, C_t, discounted at the appropriate spot rate, S_{0t}, for t years i.e. it is the present value of all future cash flows from the security discounted at the appropriate risk adjusted rate. The cash flow at the end of t=1 year is discounted at S_{01} for 1 year, the cash flow at the end of t=2 year is discounted at S_{02} for 2 years, and so on. So, this formula holds for the pricing of the bonds. Discounted cash flow method is a logical approach to the pricing of bonds.

Now, I have two things to say about this S_{0t}. The first thing is very important and that is that in S_{0t}, I have used two suffices. Why not simply S.

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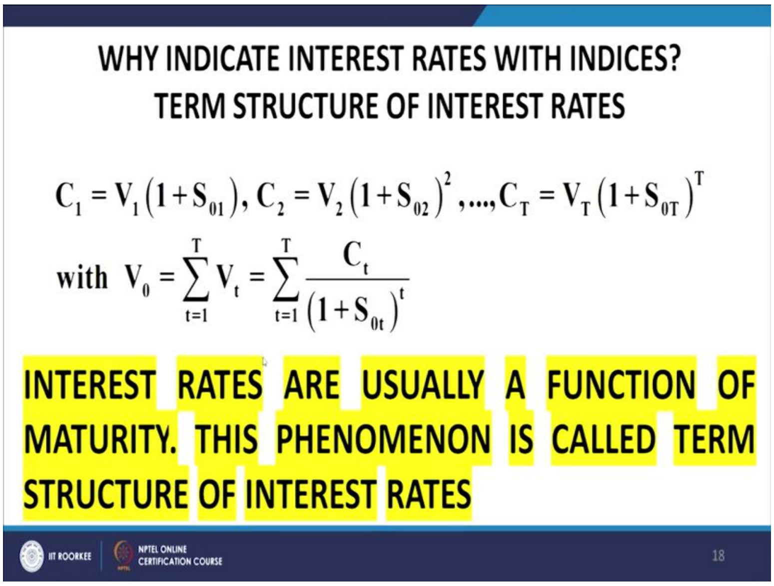

Why not keep S constant for all the maturities, instead of having S_{01}, S_{02}, S_{03} etc? The answer is that the deposit rates or the interest rates depend on the maturity of the underlying deposit. For example, if you go to a bank and make a deposit for 6 months, you will probably get a lower rate than if you go to the bank and make a deposit for 3 years. So, that is, in other words, rates of interest that prevail in the market are functions of the maturities of the underlying deposits. You usually get a different rate for a different maturity. Usually, but not always, short-term interest rates are less compared to long-term interest rates. This is usually the case. But this is not always the case. It depends on the demand and supply of money for that particular term of deposit. Now this particular phenomenon of the interest rates being a function of maturities of deposits is given a technical name. It is called the term structure of interest rates. We will revisit this later on in the next one or two lectures. But for the moment, term structure of interest rates is the term that is coined to represent the functionality between the interest rates and the time to maturity of the deposit. Therefore, because the cash flow C_1 occurs at the end of 1 year (We are representing C_1 as the redemption of a deposit for 1 year, P_1 amount deposited at t=0 for 1 year gives C_1 at t=1 year), so we need to use the rate S_{01} for discounting C_1. Similarly C_2 is equivalent to the redemption value of a two year deposit of P_2 made at t=0 for a period of 2 years that gives C_2 at t=2 years, we need use S_{02} for compounding P_2 or equivalently discounting C_2 and so on. Assuming that these rates are quoted on annual basis and compounding is annual, we discount C_2 as $P_2=C_2/(1+S_{02})^2$.

There is another important feature. I have mentioned just now, that S_{01} is the market interest rate for a deposit of 1 year, S_{02} is the market interest rate for a period of 2 years etc and by the no-arbitrage requirement, we get is the bond's market price.

Thus, the bond's market price is the present value of all future cash flows discounted at the appropriate risk-adjusted market rates for the corresponding maturities which relate to the points in time at which cash flows are expected from holding the bond. So, that is one thing.

If, instead of using the market rates, we use the interest rates that are estimated by the analyst or the investor, then the output that we will get on the left-hand side will not be the market price of the bond, it will be the intrinsic value of the bond.

Therefore, again we come back to that definition; Intrinsic value of a security is the present value of all future cash flows that may be attributable to the security discounted at the appropriate risk-adjusted discount rate as estimated by the analyst or the investor. So, that is very important.

Another feature that I would like to allude to at this point is that in the case of bonds, the calculation or estimation of the numerator i.e. the cash flows on holding the bond is not a very difficult exercise. Why? Because usually the cash flows are stated in terms of a coupon rate, which when applied to the face value gives the amount of cash flow in money terms. Further, the coupon rate is contractual, it is given in the contract of issue. So, we do not have to do much work to estimate the numerator of this valuation formula. However, the valuation of the denominator is slightly subjective in the sense that we also have to account for the riskiness of the realization of those contractual cash flows. So, to that extent, I must say that the valuation of bonds is relatively more objective and simpler compared to the valuation of equity.

In fact, this is the reason that I have taken up bond valuation prior to getting into equity valuation. Bond valuation is relatively more objective in the sense that (i) the cash flows are contractual in nature. Cash flows that arise on holding of equity are pretty much discretionary, and (ii) the assessment of interest rates or risk-adjusted discount rates is also somewhat easier because we have well-defined risk classes as assessed by credit rating agencies.

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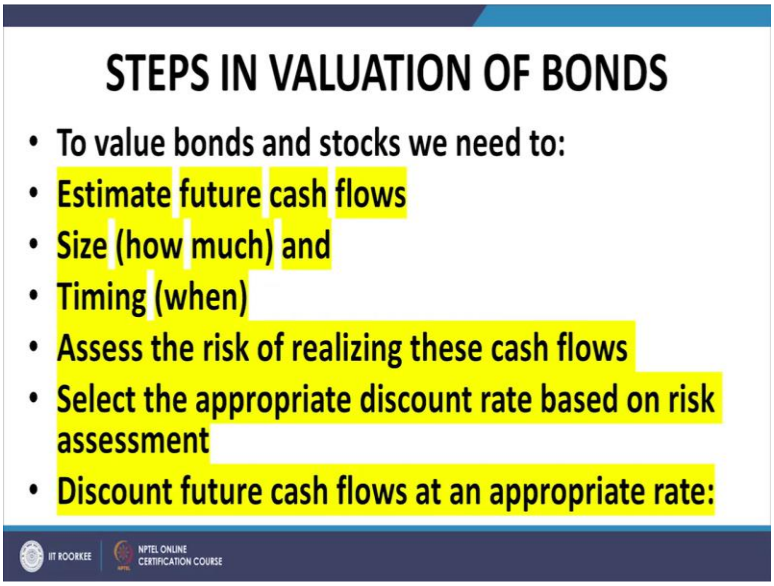

What are the steps in the valuation of bonds? Well, the steps in valuation of the bonds follow easily from the very definition of intrinsic value. (i) Estimate the future cash flows. As I mentioned, this is not a very difficult exercise, because the future cash flows are pretty much in line with the information or the provisions of the contract of issue. Of course, we have to not only estimate the magnitude of the cash flows, but you also the timing of those cash flows. (ii) Then we also have to estimate the risk profile of realizability of those cash flows. For example, if we are holding treasury bonds, the risk profile of the cash flows would be very positive, very strong in terms of a very low default risk. If we are valuating the bonds of a corporate which is not doing very well, we may have to use a higher discount rate because the riskiness of those cash flows may be significant. So, the next step is to assess the riskiness of those cash flows. (iii) Then the most difficult step. To assess and impute a discount rate, which is commensurate with the risk profile of the cash flows that form the numerator of the valuation formula.

Now, so far the exposition has assumed annual compounding and annual rates. As I mentioned in the beginning, usually the coupon payments on bonds in India are semi-annual, although the rates are quoted on annual basis.

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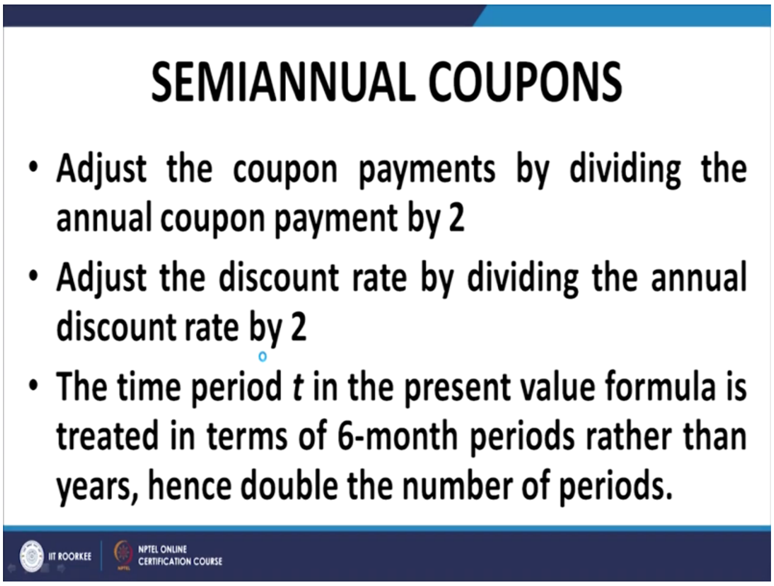

So, whenever we need to value bonds with semi-annual payments, first of all, we need to double the number of periods. For example, if we are valuing a 5-year bond, we split the number of periods to 10 half-year periods. The second step is that the coupon rate must also be divided by 2 because, usually, the coupon rate is expressed by doubling the semi-annual rate i.e. the rate that we pay for the half-year. This is a convention that holds in the bond markets. Thus, if we have a 6% bond i.e. a bond that pays 6%% per annum coupon rate, then we must divide the rate by 2 and we have a 3% per semi year coupon payment. So, that is the second thing. Thirdly, when we do the discounting, the discount rate also needs to be halved for reasons, which are the same as in the case of coupon rates. Market interest rates are usually expressed by doubling the half-year rates. Let us take an example.

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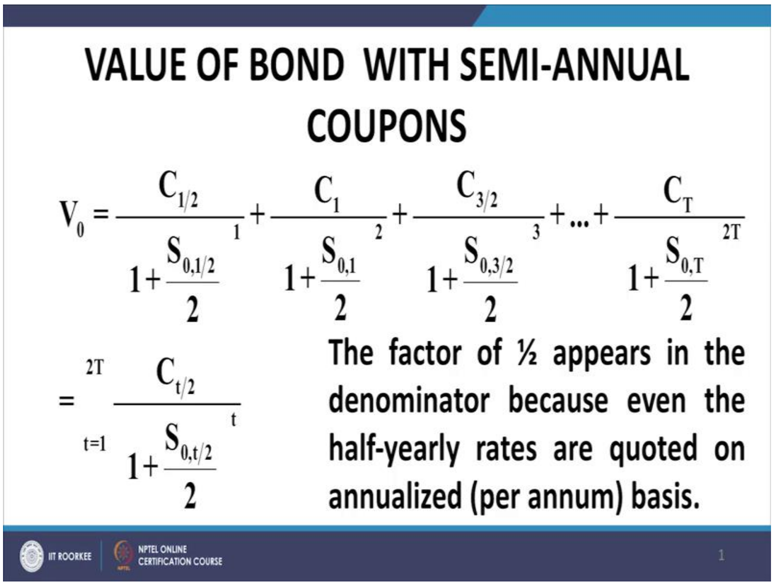

This is the expression for the valuation of a semi-annual coupon bond. $C_{1/2}$ is the coupon cash flow that we get at the end of 6 months. It is obtained by applying half of the coupon rate to the face value. The discount rate is $S_{0,1/2}/2$. $S_{0,1/2}$ is the spot rate for a 6-month spot deposit expressecd on annualized basis by doubling the rate. Thus, $S_{0,1/2}/2$ is the actual rate for the 6 month period t=0 to t=1//2. Obviously $S_{0,1/2}$ is risk-adjusted rate to reflect the risk profile of the realizability of the cash flows. Let me repeat. $S_{01/2}$ is the interest rate that would apply to a 6-month deposit but expressed as an annual rate. It is the interest rate that would apply to a 6-month deposit but annualized. S_{01} is the interest rate for a 1-year deposit. Because we are getting coupon payments at the end of half-year, we divided S_{01} by 2 and then discounted for two half year periods. Similarly, $S_{0,3/2}$ is the interest rate that would apply for a deposit of one and a half years, but it is expressed on a per annum basis. Therefore, again we divide it by 2 and because it is for 3 half years (that is one and a half year, one and a half year means 3 half years) we discount for three half year periods. So, this is how the formula is obtained.

So, I have explained this particular point, the factor of ½ appears in the denominator because even the half-yearly rates are quoted on an annualized basis. We also assume that the compounding periods coincide with the frequency and timing of coupon payments.

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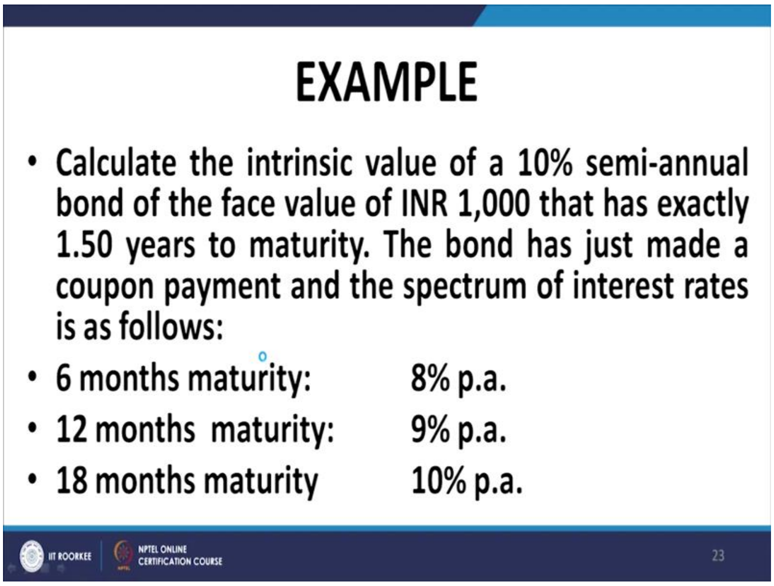

Let us take up this example. Calculate the intrinsic value of a 10% semi-annual bond of the face value of INR 1,000 that has exactly 1.50 years, (that means 3 half years) to maturity, the bond has just made a coupon payment and the spectrum of interest rates is as follows: 6-month maturity: 8% p.a.; 12-month maturity: 9% p.a.; 18-months maturity: 10% p.a.

Please note that the rates are in per annum basis. So, how do we calculate the intrinsic value? What is the cash flow at the end of each half-year? The annual coupon rate is 10% So, the half-year coupon payment is 5%. The face value of the bond is 1,000. So, the actual cash coupon that the investor will receive is 1,000*5%=50. The first coupon payment will be received at the end of the next 6-month period. So, it will be discounted for 6 months at the rate of 8% per annum i.e. 4% for the half-year. The second coupon payment will be received at the end of 1 year of an amount equal to 50 but that will be discounted for 2 half year periods at a rate which is 9% per annum or 4.5% for 2 half years. Thus, it will be discounted for 2 half-year periods at the rate of 4.5%. And similarly, the cash flow at t=1.50 years will consist of (i) third coupon payment will again be of 50 plus (ii) the redemption of 1,000 (we are assuming that that redemption is at face value of 1,000). So, the total cash flow at redemption will be 1,050. These proceeds will be discounted for 3 half-year periods at the rate of 10% per annum or 5% for each half-year period. So, it will be 5% for each half-year and discounting will be for 3 half-year periods. That is precisely what is shown in this slide. We end up with a figure of 1,000.8929 as the intrinsic value of the bond.

Now, market price vs interest rates. As I mentioned right at the beginning, when I introduced this topic, if S_{01}, S_{02}, S_{03} etc. are all market rates, then what we end up on the left-hand side of the valuation formula is not the intrinsic value, we will naturally get the market valuation. What is the market valuation? The market valuation is nothing but the market price of the bond.

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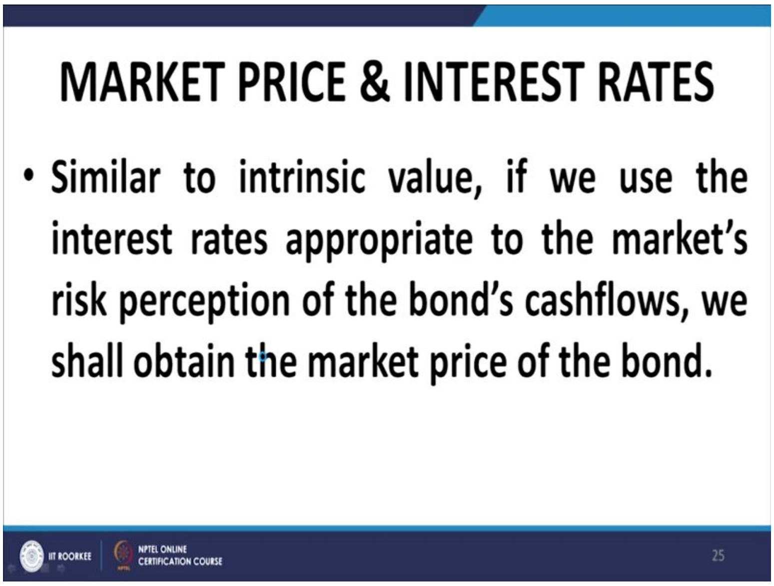

So, if I use the risk-adjusted market interest rates keeping in view the market perception of risk of realizability of the cash flows, then what I end up with is the market price. However, there is an important observation here. The important observation is that in this case, it is very difficult to assess or estimate the market interest rates relating to the riskiness of a particular bond.

So, what normally happens is the bond price is the real observable. It is the direct observable thrown up by the market. This price is actually determined at the macro-level by the forces of demand and supply, by the interaction of demand and supply. So, the objective measure does not turn out to be the interest rates. The objective measure that the market gives us by the interaction of demand and supply of the bond is the market price. Price is the output of the collective wisdom of the market. And based on that pricing by the market of the bond, we can rework or work backwards to arrive at the relevant risk-adjusted interest rates.

So, we will continue from here in the next class. We will talk about valuation of a discount bond, level coupon bond and then I will introduce the concept of yield to maturity, holding period yield, annualized holding period yield and other measures of yield. That is the agenda for the next class. Thank you.