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Research Article

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Understanding Bond Pricing Calculation

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Abstract The fundamentals of bond pricing revolve around the present value of future cash flows generated by the bond. Calculating Bond Pricing could be tedious as well as complex, especially when differences in terminologies like Face value of the Bond and Current Price of the bond, Coupon rate and Yield are not clear. Understanding bonds and bond pricing is crucial for investors to make informed investment decisions. In this paper, we would study different parameters impacting Bond Price calculation, a simplified formulae to calculate current Price of the Bond with some assumptions and some examples of how that formulae can be used under different scenarios.

Keywords Bond Trading; Investment Banking; Fixed Income; Bond Price Calculation; Bond Valuation; Test scenarios

1. Introduction

In simplified terms, A bond contract is a financial instrument that pays the owner of the bond, also called the bondholder, fixed amounts of money on fixed future dates, which is why this asset class is also called Fixed Income Securities [1]. Bonds are typically issued by governments, municipalities, corporations, or other institutions to raise capital. When an investor purchases a bond, they are effectively lending money to the issuer in exchange for periodic interest payments called coupons and the return of the bond's face value called Principal at the time of maturity. Bonds are issued in the Primary Market and Traded in Secondary Market.

Investing in bonds can offer a range of benefits like income generation, diversification of portfolio, or capital preservation. By understanding the factors that affect bond prices, investors can better navigate the fixed-income market and build resilient investment portfolios. When to invest in a Bond and at what Price is critical to get the desired benefits. One of the areas that Bond Valuation deals with is calculating the Present value of the Bond based on the future cash flows. Bond Valuation can be a complex topic to deal with, considering different varieties of Bonds, coupon payments with respect to the changes in Interest Rates, credit risk, market liquidity, etc.

Bond pricing involves complex financial calculations but is essential for assessing the fair value and potential return of fixed-income investments. This paper deal with understanding different parameters influencing Bond Calculations, how those parameters are linked to calculate Bond Prices and would study some scenarios of what it means when current Bond Price is less than or more than the face value of the Bond.

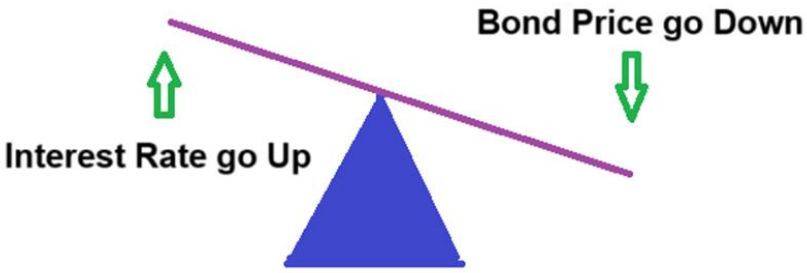
2. Parametrs Influencing Bond Pricing Calculations?

There are various parameters influencing price of the bond, some of them are described below:

Face Value of the Bond: A bond's face value is the value that the bondholder receives when their investment fully matures, with the assumption that the issuer doesn't call the bond, or it defaults. In other words, it refers to how much a bond will be worth on its maturity date.

The price one pays for the bond may be different from its face value, and will change over the life of the bond, depending on factors like the bond's time to maturity and the interest rate environment. But the face value does not change [2].

Bond Price: Bond prices are determined by what someone is willing to pay. Bonds can be bought at a higher price than the face value of the bond, called a premium bond or can be bought at a discount. The price of the bond being bought or sold at a higher or lower than the face value of the bond depending on issuer, its credit rating, coupon rate, time left to maturity and special redemption features [3]. Bond prices are also influenced by supply and demand dynamics in the bond market. Factors such as investor sentiment, economic conditions, and market liquidity can impact bond prices independent of changes in interest rates or credit quality. For Example, if new bonds are issued with a higher interest rate than those currently on the market, the price of existing bonds will decline as demand for those bonds falls. On similar lines, if new bonds are issued with a lower interest rate than bonds currently on the market, the price of existing bonds will increase in line with demand.



Coupon Rate: The coupon rate is the amount of annual interest income paid to a bondholder, based on the face value of the bond [4]

Coupon Rate = (Annual Coupon Payment) / (Face Value of Bond)

Bond Yield: Bond Yield is the amount of annual interest income paid to a bondholder, based on the present value of the bond. Bond Yield is inversely proportional to Bond Price. If Bond Price go up, then Bond Yield goes down, and vice versa.

Bond Yield = (Annual Coupon Payment) / (Bond Price)

If a bond is bought at par and held to maturity, the bond yield and the coupon rate are the same. However, for a bond purchased at a premium or a discount to its face value, the yield and the coupon rate are different [5].

Yield to Maturity (YTM): The yield to maturity (YTM) of a bond is considered as a long-term bond yield. YTM represents the annual rate of return for the full life of the bond. The YTM assumes the investor will hold the bond to maturity, and that all interest payments will be reinvested at the YTM rate [6].

Yield to maturity is a more accurate reflection of the return on a bond if you hold it until its maturity date. It considers not only the bond's interest rate, principal, time to maturity, and purchase price, but also the value of the interest payments as you receive them over the life of the bond [7].

The price of a bond is the present value of its expected cash flow. Most bonds have more than one cash flow, and therefore each cash flow needs to be discounted in order to find the present value of the Bond. Below is the simplified version of the formula considering annual coupon Payments [8]:

Present Value of the Bond = [Cash Flow / $(1+r)^1$] + [Cash Flow / $(1+r)^2$] + ... + [(Cash Flow + Face Value) / $(1+r)^t$]

Cash Flow = Coupon Rate x Face Value of the Bond

r is yield to maturity (YTM)

t is time to maturity

If Coupon Payments are made semi-annually, above formulae will be modified to below:

Present Value of the Bond = [(Cash Flow/2) / $(1+r/2)^1$] + [(Cash Flow/2) / $(1+r/2)^2$] + ... + [{(Cash Flow/2) + Face Value} / $(1+r/2)^t$]

The formula calculates the present value of all future cash flows from the bond and sums them up to find the present value of the bond. Note that the last cash flow also includes the Face value of the Bond which Bondholder

will get at the time of maturity, along with the last coupon payment. This is with the assumption that bondholder holds the bond until maturity and that the bond pays fixed coupon payments. If the bond has variable coupon payments, or other complexities, additional adjustments to the formula will be required.

3. Examples And Scenarios To Calculate Bond Prices

Let's take a few examples to show how the present value of the Bond is calculated.

Scenario 1: Consider an Apple Bond has below parameters with Coupon Rate < Yield to Maturity (YTM):

- Face Value of the Bond = $1,000
- Coupon Rate = 5% per annum
- Maturity = 5 years
- Coupon Payments = Annual
- Yield to Maturity (YTM) = 4%

Using the formulas mentioned above, firstly Cash Flow of the Bond is calculated

Cash Flow = (5/100) * 1000 = 50

So, Present Value of the Bond (P):

$[50 / (1+0.04)^1] + [50 / (1+0.04)^2] + [50 / (1+0.04)^3] + [50 / (1+0.04)^4] + [(1000+50) / (1+0.04)^5] = 48.08 + 46.25 + 44.52 + 42.88 + 820.16 =$ **$1001.89**

This means that if the Apple bond is purchased at $1001.89 with other parameters mentioned above, the investor can expect to earn a yield to maturity of approximately 4%.

If the coupon rate of a bond is higher than the yield to maturity (YTM), it implies that the bond is offering a higher interest rate in the form of coupon payments compared to the prevailing market interest rate. This also is the reason that Bond if sold now into the secondary market could be trading at a Premium. Bonds with higher coupon rates relative to YTM are often in demand by income-seeking investors who prioritize current income over potential capital gains or who believe that interest rates will decrease, thereby increasing the bond's value.

Scenario 2: Consider an Apple Bond has below parameters with Coupon Rate > Yield to Maturity (YTM):

- Face Value of the Bond = $1,000
- Coupon Rate = 4% per annum
- Maturity = 5 years
- Coupon Payments = Annual
- Yield to Maturity (YTM) = 5%

Using the formulas mentioned above, firstly Cash Flow of the Bond is calculated

Cash Flow = (4/100) * 1000 = 40

So, Present Value of the Bond (P):-

$[40 / (1+0.05)^1] + [40 / (1+0.05)^2] + [40 / (1+0.05)^3] + [40 / (1+0.05)^4] + [(1000+40) / (1+0.05)^5] = 38.09 + 36.28 + 34.55 + 32.91 + 814.87 =$ **$956.70**

This means that if the Apple bond is purchased at $956.70 with other parameters mentioned above, the investor can expect to earn a yield to maturity of approximately 5%.

If the coupon rate of a bond is lower than the yield to maturity (YTM), it implies that the bond is offering a lower interest rate in the form of coupon payments compared to the prevailing market interest rate. This also is the reason that Bond if sold now into the secondary market could be trading at a Discount.

Scenario 3: Consider an Apple Bond has below parameters with Coupon Rate = Yield to Maturity (YTM):

- Face Value of the Bond = $1,000
- Coupon Rate = 5% per annum
- Maturity = 5 years
- Coupon Payments = Annual
- Yield to Maturity (YTM) = 5%

Using the formulas mentioned above, firstly Cash Flow of the Bond is calculated

Cash Flow = (5/100) * 1000 = 50

So, Present Value of the Bond (P):-

$[50 / (1+0.05)^1] + [50 / (1+0.05)^2] + [50 / (1+0.05)^3] + [50 / (1+0.05)^4] + [(1000+50) / (1+0.05)^5] = 47.62 + 45.36 + 43.19 + 41.13 + 822.70 =$ **$1000**

This means that if the Apple bond is purchased at $1000 with other parameters mentioned above, the investor can expect to earn a yield to maturity of approximately 5%, which is the same as the Coupon Rate.

If the coupon rate of a bond is equal to the yield to maturity (YTM), it implies that the bond is offering the same interest rate in the form of coupon payments compared to the prevailing market interest rate. This also is the reason that Bond, if sold now on the secondary market could be trading at a Fair Price or the Par value.

There could also be variations in coupon payments if a Bond is bought or sold midway through a coupon period, a certain amount of coupon interest would have accrued. Bond Price inclusive of Accrued Payment is known as Dirty Price of a Bond. Bond Price without the accrued payment is called Clean Price of a Bond.

Similarly, there are several scenarios that can be considered to calculate Bond Price depending on different change in parameters. Some of the scenarios could be changing Yield to Maturity and Coupon Rates, as we described in the above scenarios, considering zero coupon bonds which trade on Discount Margin, considering different coupon Payment options like Annual, Semi-Annual, Quarterly, considering market interest changes, credit quality, currency effects, embedded options like callable, putable bonds, etc. By testing these scenarios, investors and analysts can gain a comprehensive understanding of bond pricing dynamics, risk exposures, and investment implications under various market conditions.

4. Conclusion

In conclusion, Bond price calculation is essential for investors and financial analysts to understand the value of bond and potential return of bond investments. Bond prices provide valuable insights into market expectations, economic conditions, and investor sentiment. Changes in bond prices can signal shifts in interest rate expectations, credit conditions, and broader market trends. Understanding bond valuation in detail is crucial for investors seeking to build diversified portfolios, manage risk, and optimize returns in the bond market.

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