

NPTEL ONLINE CERTIFICATION COURSES

Management of Fixed Income Securities

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Lecture 06: Bond Returns-I

CONCEPTS COVERED

- Current Yield
- Yield to Maturity
- Yield to Call
- Yield to Put

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KEYWORDS

- Average Rate to Maturity
- Bond Equivalent Yield
- Yield to Worst

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Current Yield and Nominal Yield

Current yield of a bond is the ratio of its annual coupon to its closing price.

Coupon rate, C^R, is the contractual rate the issuer agrees to pay each period. It is expressed as a proportion of the annual coupon payment to the bond's face value:

$$C^R = \frac{\text{Annual Coupon}}{F}$$

A coupon bond with no maturity or repayment of principal is known as perpetuity or consul

$V = C/R$

If the bond is priced in the market equal to V then the rate on the bond will be: $R = C/V$

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Example

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Yield to Maturity

- YTM is the rate that equates the price of the bond, P_0^B, to the PV of the bond's cash flow (CF); it is similar to the internal rate of return, IRR.
- In general, the yield on any investment is the interest rate that will make the present value of the cash flow from the investment equal to the price (or cost) of the investment.

$$P_0^B = \sum_{t=1}^{M} \frac{C}{(1+YTM)^t} + \frac{F}{(1+YTM)^M}$$

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Yield to Maturity

The YTM is the effective rate of return. As a rate measure, it includes:

1. **Return from coupons**
2. **Capital gains or losses**
3. **Reinvestment of coupons at the calculated YTM**

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Example

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Average Rate to Maturity

- Unless the CFs are constant, there is no algebraic solution to finding the YTM. The YTM is found through an iterative process (trial and error).
- The YTM can be estimated using the ARTM (also referred to as the yield approximation formula):

$$\text{ARTM} = \frac{C + [(F - P_o^B)/M]}{(F + P_0^b)/2}$$

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Example:

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Bond Equivalent Yield

- The rate on bonds are often quoted as a simple annual rate (with no compounding). For bonds with semi-annual coupon payments, this rate can be found by solving for the YTM on a bond using 6-month CFs and then multiplying that rate by 2. This rate is also known as the ***bond-equivalent yield***.
- Thus, the 10-year, 9% bond with semi-annual payments and trading at 937.69 would have a YTM for a 6-month period of 5% and a bond-equivalent yield of 10%. The effective rate is 10.25%.
- Bonds with different payment frequencies often have their rates expressed in terms of their bond-equivalent yield so that their rates can be compared to each other on a common basis.

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Yield to Call

- Many bonds have a call feature that allows the issuer to buy back the bond at a specific price known as the call price, CP.
- When the bond may be called and at what price are specified in the indenture.
- For some issues, the call price is the same.
- For other callable bonds, the call price depends on when the bond is called. In this case, there is a call schedule that specifies the call price for each call dates.

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Yield to Call Cont…

Given a bond with a call option, the ***yield to call***, YTC, is the rate obtained by assuming the bond is called on the identified call date, CD.

Like the YTM, the YTC is found by solving for the rate that equates the present value of the CFs to the market price.

$$P_0^B = \sum_{t=1}^{N} \frac{CF_t}{(1+YTC)^t} + \frac{CP}{(1+YTC)^N}$$

Where: N = number of periods to the identified call date

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Example

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Yield to Put

- An issue can be putable, allowing the bondholder the right to sell the bond back to the issuer at a specified price – put price, PP.
- As with callable bonds, putable bonds can have a constant put price or a put schedule.
- When a bond is putable, the convention is to calculate the yield to put, YTP.

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Yield to Put Cont…

- YTP is rate that equates the present value of the bond's CF to the assumed put date plus the present value PP at the put date equal to the bond's price.
- That is, like the YTM and YTC, the YTP is found by solving for the rate that equates the present value of the CF to the market price.

$$P_0^B = \sum_{t=1}^{N} \frac{CF_t}{(1+YTP)^t} + \frac{PP}{(1+YTP)^N}$$

Where: N = number of periods to the identified put date

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Example

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Yield to Worst

- The convention is for an investor to calculate the YTM , the yields to all possible call dates, and the yields to all possible put dates.

- The minimum of all the yields is called the ***yield to worst***.

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CONCLUSIONS

- Current yield of a bond is the ratio of its annual coupon to its closing price.
- YTM is the rate that equates the price of the bond to the PV of the bond's cash flow
- *yield to call* is the rate obtained by assuming the bond is called on the identified call date
- YTP is rate that equates the present value of the bond's CF to the assumed put date plus the present value PP at the put date equal to the bond's price

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REFERENCES

- Johnson, R.S. (2010), Bond Valuation, Selection, and Management, Second Edition, John Wiley & Sons, Inc., Hoboken, New Jersy.

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Lecture 07: Bond Returns-II

CONCEPTS COVERED

- Cash flow yield
- YTM on Zero coupon bond
- Bond Portfolio Yield
- Total Return

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KEYWORDS

- Amortized securities
- Spot rate
- Realized return

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Cash Flow Yield

- Fixed-income securities whose cash flows include schedule principal payments prior to maturity are ***amortized securities***
- Their cash flows include principal and interest payments
- Examples of amortized securities include many securitized securities, such as debt mortgage-backed securities, and other asset-backed securities.
- Many of these securities have prepayment options, which makes the cash flows consist of interest, scheduled principal, and prepaid principal.
- The CF for such securities are therefore not fixed over the life of the securities.

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Cash Flow Yield Cont…

- If the cash flows are constant, then the yields can determined by solving for the yield that equates the present value of the cash flows to the current price:

$$P_0^B = \sum_{t=1}^{N} \frac{CF}{(1+YTM)^t}$$

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Example

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YTM on Zero-Coupon Bond

The rate on a zero coupon bond is called the spot rate

Algebraic solution to the YTM on zero-coupon bond (or pure discount bond (PDB)):

$$P_0^B = \frac{F}{(1+YTM)^M}$$

$$(1+YTM)^M = \frac{F}{P_0^B}$$

$$YTM = \sqrt[M]{\frac{F}{P_0^B}} - 1$$

Or

$$YTM = \left[\frac{F}{P_0^B}\right]^{1/M} - 1$$

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Example

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Zero coupon bond yield with continuous compounding

Algebraic solution to the YTM on a zero-coupon bond with continuous compounding:

$$P_0^B e^{Rt} = F$$

$$e^{Rt} = \frac{F}{P_0^b}$$

$$\ln(e^{Rt}) = \ln\left[\frac{F}{P_0^b}\right]$$

$$Rt = \ln\left[\frac{F}{P_0^b}\right]$$

$$R = \frac{\ln[F / P_0^b]}{t}$$

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Example:

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Bond Portfolio Yield

- The yield for a portfolio of bonds is found by solving the rate that will make the present value of the portfolio's cash flow equal to the market value of the portfolio.
- The bond portfolio yield is not the weighted average of the YTM of the bonds comprising the portfolio.

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Example:

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Total Return

- The total return (also call the realized yield) is a measure of the yield obtained by assuming the cash flows are to be reinvested to the investor's horizon (HD) at an assumed reinvestment rate and at the horizon the bond is sold at an assumed rate given the horizon is not at maturity.
- The total return is determined by
  - Estimating the horizon value, total monetary return and bond price at the horizon
  - Given the current price or value and the horizon value, solving for the rate (similar to the way one solve for the rate on a zero-coupon bond)

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Example:

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CONCLUSIONS

- The cash flows for amortized securities are not fixed over the life of the securities.
- The rate on a zero coupon bond is called the spot rate
- The yield for a portfolio of bonds is found by solving the rate that will make the present value of the portfolio's cash flow equal to the market value of the portfolio
- The total return is equal to the calculated YTM if the CFs can be reinvested at the calculated YTM and the bond can be sold at the calculated YTM

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REFERENCES

- Johnson, R.S. (2010), Bond Valuation, Selection, and Management, Second Edition, John Wiley & Sons, Inc., Hoboken, New Jersy.

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Lecture 08: Bond Returns-III

CONCEPTS COVERED

- Market risk and total return
- Horizon analysis

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KEYWORDS

- **Price risk**
- **Reinvestment risk**

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Total Return with Different Reinvestment Rate

- The total return is equal to the calculated YTM if the CFs can be reinvested at the calculated YTM and the bond can be sold at the calculated YTM.

- Thus the total return illustrates that the YTM captures the return from coupons, capital gains, and the reinvestment of CFs at the calculated YTM.

- Since rates do change over time, the total return will usually not be equal the calculated YTM.

- If the coupons were expected to be reinvested at different rates or the bond sold at a different YTM, then a total return equal to the initial YTM would not have been realized.

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Example

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Example Cont…

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Market Risk and Total Return

- The uncertainty of the actual return on a bond deviating from the expected return because of a change in interest rates is known as ***market risk***.
- A change in interest rates has two effects on a bond's return – price risk and reinvestment risk

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Example Cont…

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Price Risk

- Interest rate changes affect the price of a bond and this is referred to as ***price risk***. If the investor's horizon is different from the bond's maturity date, then the investor will be uncertain about the price he will receive from selling the bond (if HD < M), or the price he will have to pay for a new bond (if HD > M).

- The price of a bond is inversely related to interest rates and is more price responsive to a change in interest rates if it has a longer term to maturity and its coupon rates are less.

- If interest rates change, the price effect on the total return will be negative (i.e., lower rates increase the horizon price and therefore the total return), with the effect being greater for bonds with greater terms to maturity and lower coupon rates.

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Reinvestment Risk

- Interest rate changes affect the return the investor expects from reinvesting the coupon is known as ***reinvestment risk***.

- If an investor buys a coupon bond, he automatically is subject to market risk.

- If interest rates change, the interest-on-interest effect on the total return will be direct (i.e., greater rates increase the reinvestment return and therefore the total return), with the effect being greater for bonds with greater coupon rates.

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Horizon Analysis

- One way to evaluate market risk for a bond is to estimate the bond's total returns given different interest rate scenarios- ***horizon analysis***

- By conducting horizon analysis on one or more bonds or bond portfolios, an investor or portfolio manager can project the performance of the bonds or portfolios and can compare different bonds or bond portfolios based on a planned investment horizon and expectations concerning the market.

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Example

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Analysis from Example

- Bond A has the smallest deviations in total returns, with the lowest rate being 7.23% and the highest being 7.77%. Bond A's total return also decreases when rates decrease and increases when rates increase, suggesting Bond A's interest-on-interest effect dominates its price effect.

- In contrast, longer term Bond D has the greatest market risk, with the range in total returns being 2.01% to 13.8%, and with its total return increasing when rates decrease and decreasing when rates increase, implying its price effect dominates its interest-on-interest effect.

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CONCLUSIONS

- If the coupons were expected to be reinvested at different rates or the bond sold at a different YTM, then a total return equal to the initial YTM would not have been realized
- A change in interest rates has two effects on a bond's return – price risk and reinvestment risk
- Change in the price of bond due to change in interest rate is referred as price risk
- Change in the value of reinvestment of coupons due to change in the market interest rate is called as reinvestment risk

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REFERENCES

- Johnson, R.S. (2010), Bond Valuation, Selection, and Management, Second Edition, John Wiley & Sons, Inc., Hoboken, New Jersy.

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Lecture 09: Bond Returns-IV

CONCEPTS COVERED

- **Equilibrium bond price using spot rate**

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KEYWORDS

- **Arbitrage**
- **Bootstrapping**

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Spot Rate, Equilibrium Price of Bond and Arbitrage

- ***Spot Rate:*** the rate on a zero-coupon bond. It is defined as the discount rate for a cash flow at specific maturity.

- The equilibrium price of a bond is the price obtained by discounting the bond's cash flow by spot rates

- If this price does not hold, then an arbitrage opportunity exist by buying the bond and stripping it into a series of zero coupon bonds and selling them, or by buying zeros, bundling them, and then selling the bundled bond

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Example

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Example cont…

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Analysis of Example

- In the first case given this risk-free opportunity, arbitrageurs would implement this strategy of buying and stripping the bond until the price of the coupon bond was bid up to equal its equilibrium price of Rs. 97.73. At that price, the arbitrage would disappear
- In the second case given this risk-free opportunity, arbitrageurs would implement this strategy of buying zeros, bundling the bonds, and selling 3-year coupon bonds until the price of the 3-year coupon bond was bid down to equal its equilibrium price of Rs. 97.73. At that price, the arbitrage would disappear.

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Bootstrapping: Estimating Spot Rates

- One problem in valuing bonds with spot rates or in creating stripped securities is that there are not enough longer term zero coupon bonds available to determine the spot rates on higher maturities. As a result, long-term spot rates have to be estimated.
- One estimation approach that can be used is a sequential process referred to as ***bootstrapping***
- The bootstrapping approach requires having at least one zero-coupon bond.
- Given this bond's rate, a coupon bond with the next highest maturity is used to obtain an implied spot rate
- Another coupon bond with the next highest maturity is then used to find the next spot rates, and so on.

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Example

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CONCLUSIONS

- The equilibrium price of a bond is the price obtained by discounting the bond's cash flow by spot rates
- Arbitrage opportunity is created when the equilibrium price is different from the price prevailed in the market
- Bootstrapping approach is used to estimate the spot rates

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REFERENCES

- Johnson, R.S. (2010), Bond Valuation, Selection, and Management, Second Edition, John Wiley & Sons, Inc., Hoboken, New Jersy.

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Lecture 10: Level of Interest Rate Determination-I

CONCEPTS COVERED

- Classical theory of interest rate determination
- Loanable fund theory of interest rate determination

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KEYWORDS

- Savings
- Investment
- Bond demand curve
- Bond supply curve

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Theories of Interest Rate Determination

- Classical Theory
- Loanable Funds Theory
- Keynesian Theory

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Classical Theory

- The rate of interest is a real phenomenon in the sense that it is determined by the real factors
- It is the supply of savings and the demand for investment that determine the equilibrium rate of interest.

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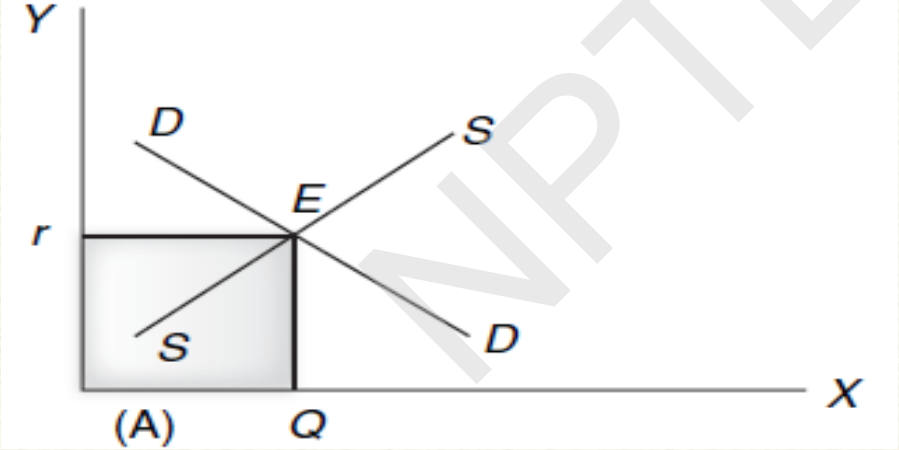
Supply of Savings and Demand for Investments

- The aggregate saving is the difference between the total national income and the total consumption expenditure.
- The savings may be effected by individuals, households, business, and the government.
- From savings point of view interest rate is a reward for sacrifice or abstinence or waiting involved in the act of supplying savings
- Firms and other economic units demand capital to make profits by producing goods
- The opportunities to produce more effectively by using roundabout methods of production determine investment demand.

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Interest Rate Determination

- While the saving schedule is upward sloping, the investment schedule is downward sloping.
- The equilibrium rate of interest is determined by the interaction of these saving and investment schedules in the economy



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Loanable Fund Theory

- According to this theory, rate of interest is determined by the demand for and supply of loanable funds.
- Interest-rate is determined by supply and demand in the bond market.
- In this regard this theory is more realistic and broader than the classical theory of interest
- The loanable funds theory discards the independence of the interest rate from the behaviour of money and banks.
- According to this theory, the real supply and demand curves determining interest rates should have added to them a component of the supply of saving which is associated with the creation of new money or credit

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Demand and Supply in the Bond Market

- The bond **demand Curve** shows the relationship between the quantity demanded and the price when all other economic variables are held constant
- Bond demand curve has the usual downward slope, indicating that at lower prices of the bond (everything else being equal), the quantity demanded is higher
- Bond **supply curve** shows the relationship between the quantity supplied and the price when all other economic variables are held constant.
- Supply curve has the usual upward slope found in supply curves, indicating that as the price increases (everything else being equal), the quantity supplied increases

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Market Equilibrium

- **Market equilibrium** occurs when the amount that people are willing to buy (*demand*) equals the amount that people are willing to sell (*supply*) at a given price.
- In the bond market, market equilibrium is achieved when the quantity of bonds demanded equals the quantity of bonds supplied
- The interest rate of that corresponds to this price is called the equilibrium or market clearing interest rate.

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Diagrammatic Representation

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Diagrammatic Representation Cont…

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Change in Equilibrium Interest Rate

- When quantity demanded (or supplied) changes as a result of a change in the price of the bond (or, equivalently, a change in the interest rate), we have a *movement along* the demand (or supply) curve.
- A *shift in* the demand (or supply) curve, by contrast, occurs when the quantity demanded (or supplied) changes *at each given price (or interest rate)* of the bond in response to a change in some other factors besides the bond's price or interest rate. When one of these factors changes, causing a shift in the demand or supply curve, there will be a new equilibrium value for the interest rate.

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Diagrammatic Representation

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CONCLUSIONS

- According to classical theory supply of savings and the demand for investment that determine the equilibrium rate of interest
- According to loanable fund theory, rate of interest is determined by the demand for and supply of loanable funds
- Bond **demand Curve** shows the relationship between the quantity demanded and the price when all other economic variables are held constant
- Bond **supply curve** shows the relationship between the quantity supplied and the price when all other economic variables are held constant

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