Bond Market Development in Emerging East Asia

Fixed Income Valuation

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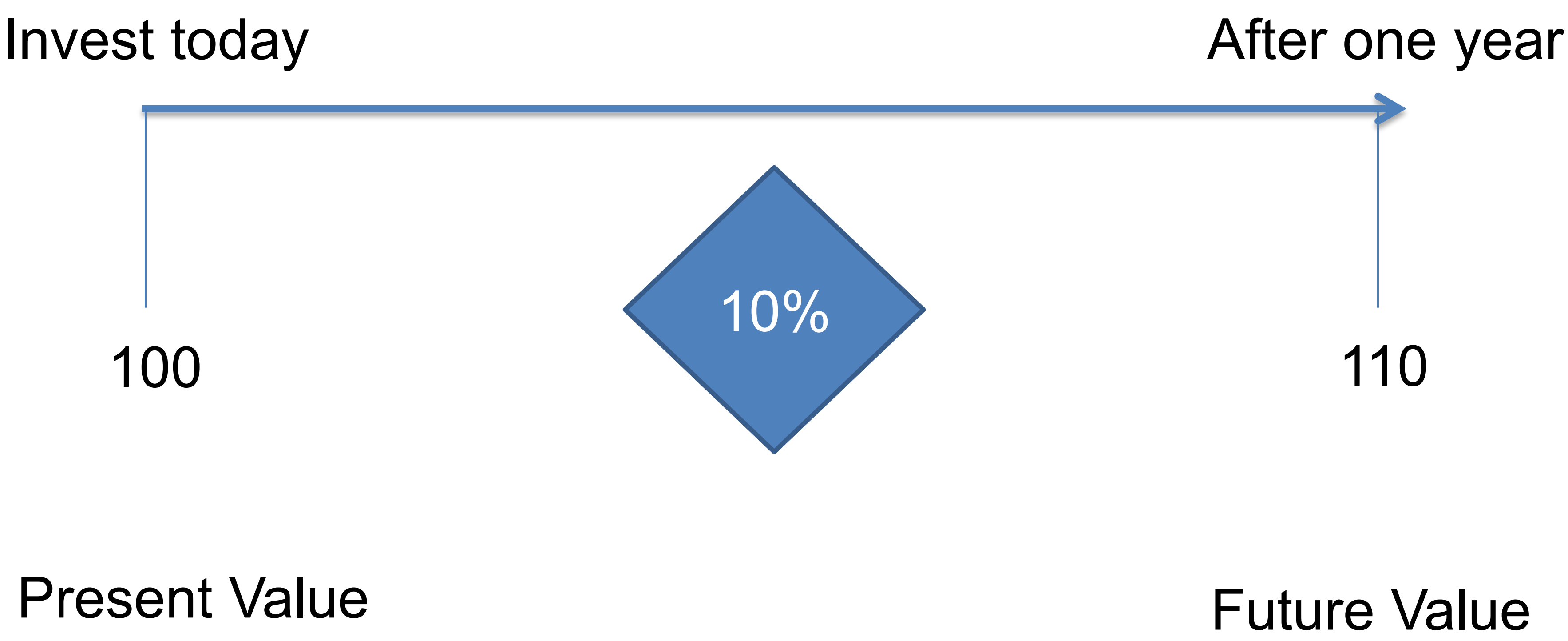
Valuation of an Asset

- There are many different ways of valuing an asset.
- In finance, the “gold standard” in valuation is the use of discounted cash flow valuation (DCF).
- In DCF valuation, the value of any asset is the present value of its expected cash flows.

Time Value of Money



Basic DCF Valuation Formula

$$PV = \frac{CF}{\left(1 + \frac{y}{m}\right)^{Nm}}$$

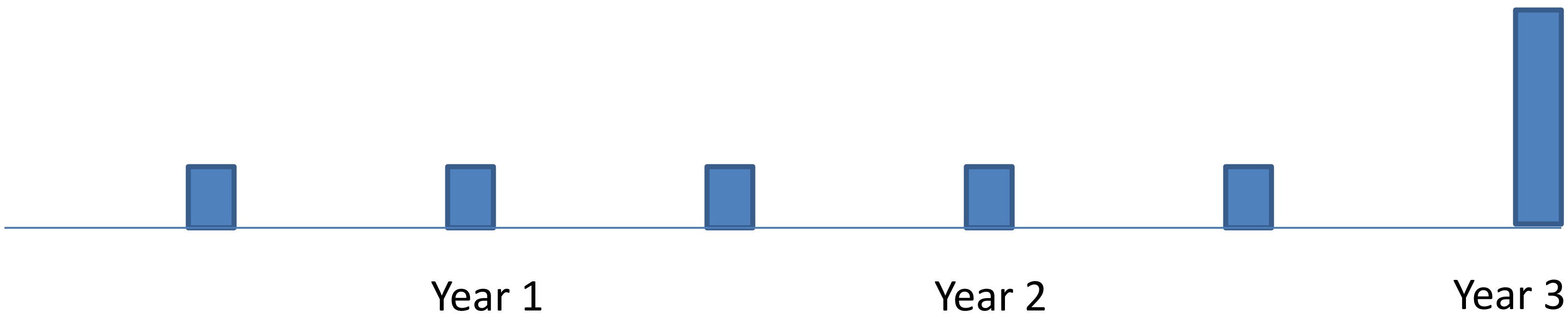
CF = Cash flow
y = interest rate
N = years
m = interest compounding

Steps in DCF Valuation

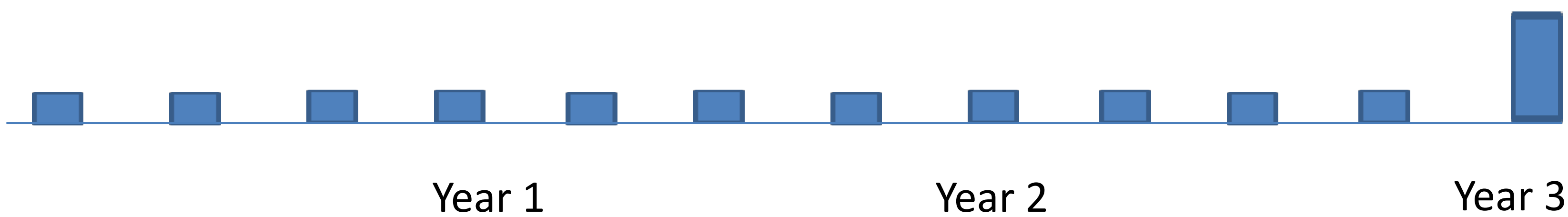
1. Estimate life of the asset and expected cash flows.
2. Assess risk of the cash flows.
3. Select or identify the appropriate required rate of return.
4. Calculate present value of the expected cash flows using required rate of return.

Estimating Expected Cash Flows

Coupon Bond (Semi-annual Coupon Payments)



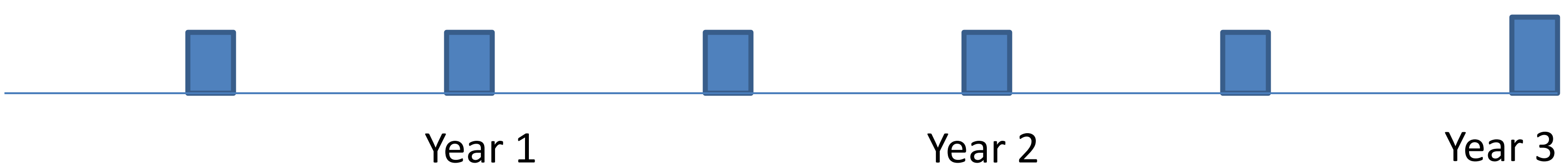
Coupon Bond (Quarterly Coupon Payments)



Estimating Expected Cash Flows

Zero Coupon (Lump Sum Payment)

Perpetual Bond (Infinite Coupon Payments)

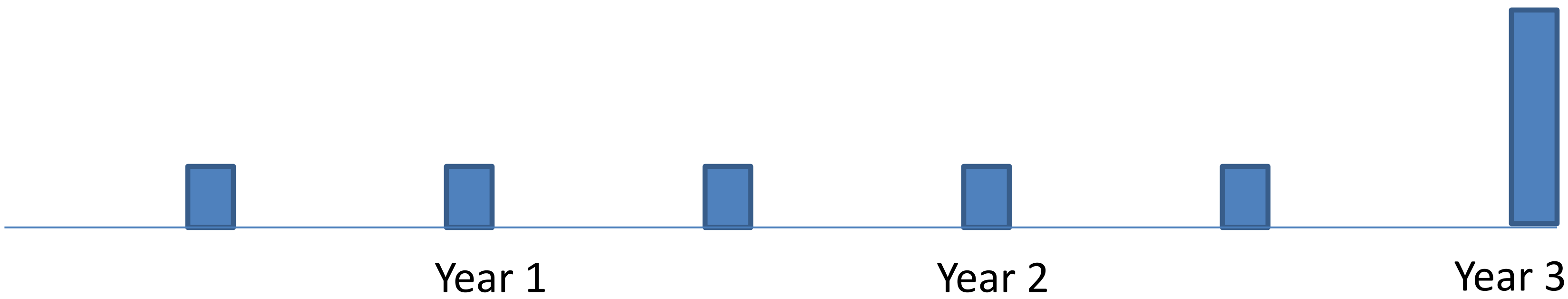


A more specific DCF formula for bonds

$$PV = \left(\sum_{t=1}^{Nm} \frac{(Coupon\ Rate * FV)/m}{\left(1+\frac{y}{m}\right)^{Nm}}\right) + \frac{FV}{\left(1+\frac{y}{m}\right)^{Nm}}$$

Examples

Coupon Bond (Semi-annual Coupon Payments)

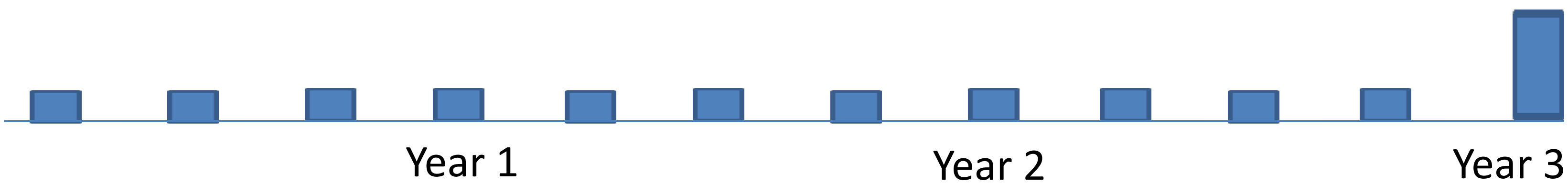


$$PV = \frac{\frac{(Coupon\ Rate * FV)}{2}}{(1+\frac{y}{2})^1} + \frac{\frac{(Coupon\ Rate * FV)}{2}}{(1+\frac{y}{2})^2} + \frac{\frac{(Coupon\ Rate * FV)}{2}}{(1+\frac{y}{2})^3} + \frac{\frac{(Coupon\ Rate * FV)}{2}}{(1+\frac{y}{2})^4}$$

$$+ \frac{\frac{(Coupon\ Rate * FV)}{2}}{(1+\frac{y}{2})^5} + \frac{\frac{(Coupon\ Rate * FV)}{2}}{(1+\frac{y}{2})^6} + \frac{FV}{\left(1+\frac{y}{2}\right)^6}$$

Examples

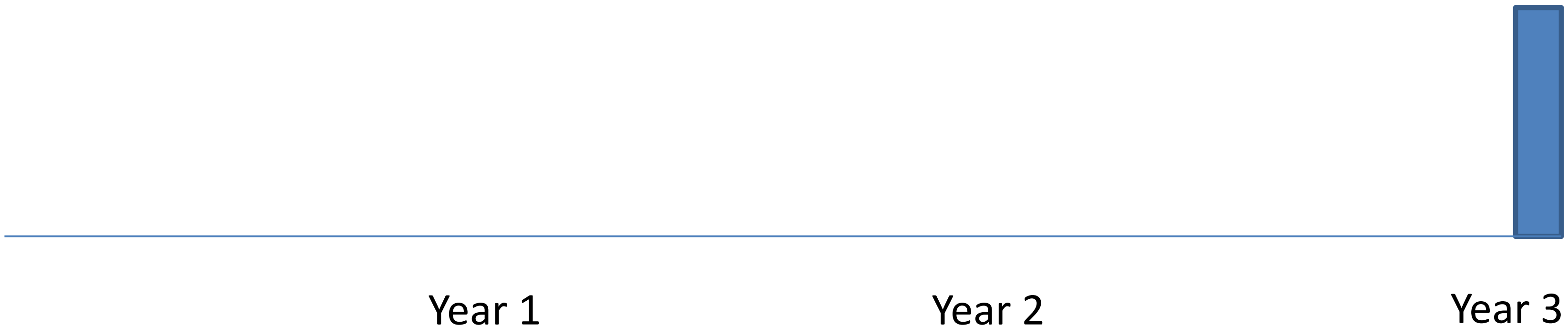
Coupon Bond (Quarterly Coupon Payments)



$$PV = \frac{\frac{(Coupon\ Rate * FV)}{4}}{(1+\frac{y}{4})^1} + \frac{\frac{(Coupon\ Rate * FV)}{4}}{(1+\frac{y}{4})^2} + \frac{\frac{(Coupon\ Rate * FV)}{4}}{(1+\frac{y}{4})^3} + \frac{\frac{(Coupon\ Rate * FV)}{4}}{(1+\frac{y}{4})^4}$$
$$+ \frac{\frac{(Coupon\ Rate * FV)}{4}}{(1+\frac{y}{4})^5} + \frac{\frac{(Coupon\ Rate * FV)}{4}}{(1+\frac{y}{4})^6} + \frac{\frac{(Coupon\ Rate * FV)}{4}}{(1+\frac{y}{4})^7} + \frac{\frac{(Coupon\ Rate * FV)}{4}}{(1+\frac{y}{4})^8}$$
$$+ \frac{\frac{(Coupon\ Rate * FV)}{4}}{9} + \frac{\frac{(Coupon\ Rate * FV)}{4}}{(1+\frac{y}{4})^{10}} + \frac{\frac{(Coupon\ Rate * FV)}{4}}{(1+\frac{y}{4})^{11}} + \frac{\frac{(Coupon\ Rate * FV)}{4}}{(1+\frac{y}{4})^{12}} + \frac{FV}{\left(1+\frac{y}{4}\right)^{12}}$$

Estimating Expected Cash Flows

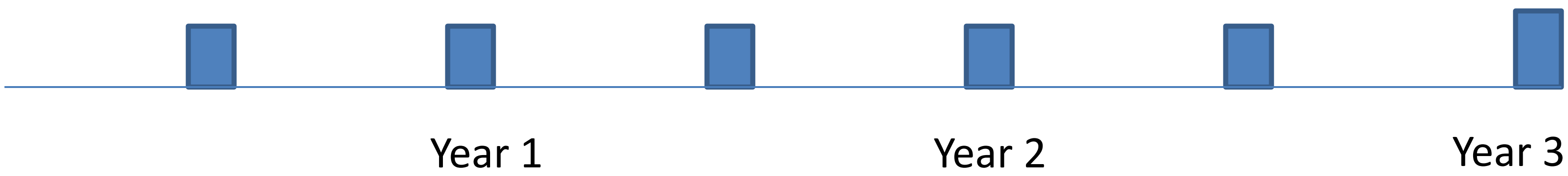
Zero Coupon (Lump Sum Payment)



$$PV = \frac{FV}{\left(1 + \frac{y}{2}\right)^{6}}$$

Estimating Expected Cash Flows

Perpetual Bond (Infinite Coupon Payments)



$$PV = \frac{\frac{(Coupon\ Rate * FV)}{2}}{(\frac{y}{2})}$$

Determining the Appropriate Discount Rate

- The appropriate discount rate is the market/investors required rate of return given the riskiness of the asset's cash flows.
- The discount rate is derived as:

$$Y = Real\ Risk\ Free\ Rate + Risk\ Premiums$$

Determining the Risk Free Interest Rate

- The risk free interest rate is generally derived based on current market prices and yields on government bonds traded on the secondary market.
- Term premium is added if the life of the asset is longer than the maturity of the reference government bond being used.
- Generally, inflation is not added, as yields on government bonds are already on a nominal basis.

Examples

Face Value: 1,000,000
Coupon Rate: 0%
Coupon Frequency: 2
Maturity: 1 year
Type: Government

The prior 1-year interest is at 6%, but inflation for the year is expected to rise, raising interest rates to 8%. What is the market value of the bond?

Examples

$$PV = \frac{1,000,000}{\left(1+\frac{.08}{2}\right)^2}$$

$$PV = \frac{1,000,000}{(1.04)^2}$$

$$PV = \frac{1,000,000}{1.0816}$$

$$PV = \frac{1,000,000}{1.0816}$$

$$PV = 924,556.21$$

Examples

Face Value: 1,000,000
Coupon Rate: 7%
Coupon Frequency: 2
Maturity: 3 years
Type: Government

The current 3-year interest is at 9%, what is the market value of the bond?

Examples

$$PV = \frac{\frac{(.07 * 1{,}000{,}000)}{2}}{(1+\frac{.09}{2})^1} + \frac{\frac{(.07 * 1{,}000{,}000)}{2}}{(1+\frac{.09}{2})^2} + \frac{\frac{(.07 * 1{,}000{,}000)}{2}}{(1+\frac{.09}{2})^3} + \frac{\frac{(.07 * 1{,}000{,}000)}{2}}{(1+\frac{.09}{2})^4} + \frac{\frac{(.07 * 1{,}000{,}000)}{2}}{(1+\frac{.09}{2})^5} + \frac{\frac{(.07 * 1{,}000{,}000)}{2}}{(1+\frac{.09}{2})^6} + \frac{1{,}000{,}000}{\left(1+\frac{.09}{2}\right)^6}$$

$$PV = 33{,}492.82 + 32{,}050.55 + 30{,}670.38 + 29{,}349.65 + 28.085.79 + 794{,}772.09$$

$$PV = 948{,}421.28$$

Examples

Face Value: 1,000,000
Coupon Rate: 7%
Coupon Frequency: 2
Maturity: 3 years
Type: Corporate

The current 3-year interest is at 9%, the bond was first issued at a premium of 100 bps (1%) over a comparable government bond, what is the market value of the bond, assuming credit risk has not changed?

Examples

$$PV = \frac{\frac{(.07 * 1{,}000{,}000)}{2}}{(1+\frac{.10}{2})^1} + \frac{\frac{(.07 * 1{,}000{,}000)}{2}}{(1+\frac{.10}{2})^2} + \frac{\frac{(.07 * 1{,}000{,}000)}{2}}{(1+\frac{.10}{2})^3} + \frac{\frac{(.07 * 1{,}000{,}000)}{2}}{(1+\frac{.10}{2})^4} + \frac{\frac{(.07 * 1{,}000{,}000)}{2}}{(1+\frac{.10}{2})^5} + \frac{\frac{(.07 * 1{,}000{,}000)}{2}}{(1+\frac{.10}{2})^6} + \frac{1{,}000{,}000}{\left(1+\frac{.10}{2}\right)^6}$$

$$PV = 33{,}333.33 + 31{,}746.03 + 30{,}234.32 + 28{,}794.59 + 27{,}423.42 + 772{,}332.93$$

$$PV = 923{,}864.62$$

Clean Price Versus Dirty Price

- In secondary market trading of bonds, quotations are either given based on yield or price per hundred.
- For quotations on price, quotes are based on clean pricing.
- Dirty price = Clean Price + Accrued Interest

Example

- A semi-annual coupon bond that matures on January 1, 2020 with a coupon rate of 10% is being quoted at a price of a 99.50.
- An investor wishes to buy 50M worth (Face Value) of bonds.
- The total amount that the investor will pay is:

Example

- The investor buys the bond on January 1, 2015 (on coupon payment day). The amount paid is: 50,000,000 * 99.50/100 or 49,750,000.
- The investor buys the bond on January 2, 2015 (1 day of accrued interest), the amount paid is: 49,750,000 + $.10 * \frac{1}{360} * 50{,}000{,}000$ or 49,763,888.89.

Sample List of Day Count Conventions

Convention	Rule
Actual/360	
Actual/365F	365 days in the period
Actual/365A	366 days on leap years
30E/360, European	If DAY1=31, set to D1=30, else set to D1=DAY1. If DAY2=31,set D2=30.
30/360, Bond Basis, American	If DAY1=31, set to D1=30, else set to D1=DAY1. If DAY2=31 and DAY1= 30 or 31, set D2=30, else set D2=DAY2.

Example

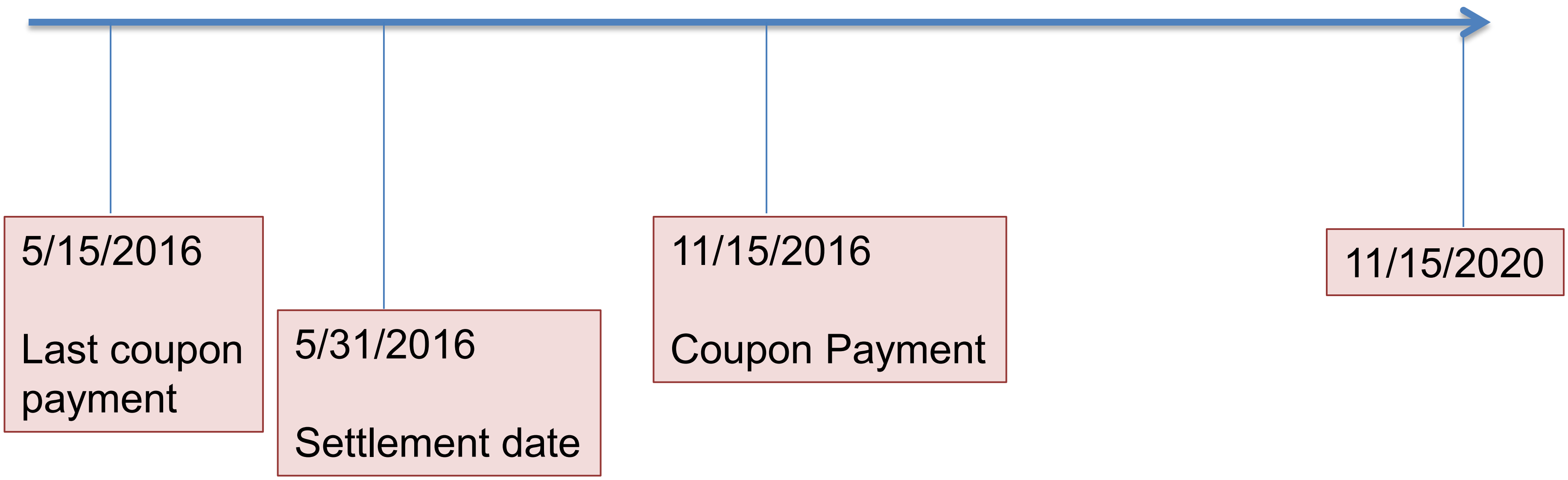
Sunday	Monday	Tuesday	Wednesda y	Thursday	Friday	Saturday
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31	1	2	3

Example

Face Value: 1,000,000
Coupon Rate: 7%
Coupon Frequency: 2
Maturity Date: 11/15/2019
Settlement Date: 5/31/2016

The current interest is at 9%, what is the market value of the bond?

Example



Number of Days between Coupon Payment Dates: 180
Number of Days of Accrued Interest
30E/360: 15
30/360: 16

Example

30E/360

$$PV = \frac{\frac{(.07 * 1{,}000{,}000)}{2}}{(1+\frac{.09}{2})^{(\frac{165}{180})}} + \frac{\frac{(.07 * 1{,}000{,}000)}{2}}{(1+\frac{.09}{2})^{(1+\frac{165}{180})}} + \frac{\frac{(.07 * 1{,}000{,}000)}{2}}{(+\frac{.09}{2})^{(2+\frac{165}{180})}}$$

$$+ \frac{\frac{(.07 * 1{,}000{,}000)}{2}}{(1+\frac{.09}{2})^{(3+\frac{165}{180})}} + \frac{\frac{(.07 * 1{,}000{,}000)}{2}}{(1+\frac{.09}{2})^{(4+\frac{165}{180})}} + \frac{\frac{(.07 * 1{,}000{,}000)}{2}}{(1+\frac{.09}{2})^{(5+\frac{165}{180})}}$$

$$+ \frac{\frac{(.07 * 1{,}000{,}000)}{2}}{(1+\frac{.09}{2})^{(6+\frac{165}{180})}} + \frac{1{,}000{,}000}{\left(1+\frac{.09}{2}\right)^{(6+\frac{165}{180})}}$$

Example

30E/360

$PV =$ 33,615.90 + 32,168.33 + 30,783.09+29,457.50+28,189.00+26,975.12+763,342.32

$PV =$944,762.26

Dirty Price = 944,762.26/1,000,000*100 = 94.48

Clean Price = 94.48 – 3.5*15/180 = 94.43

Example

30E/360

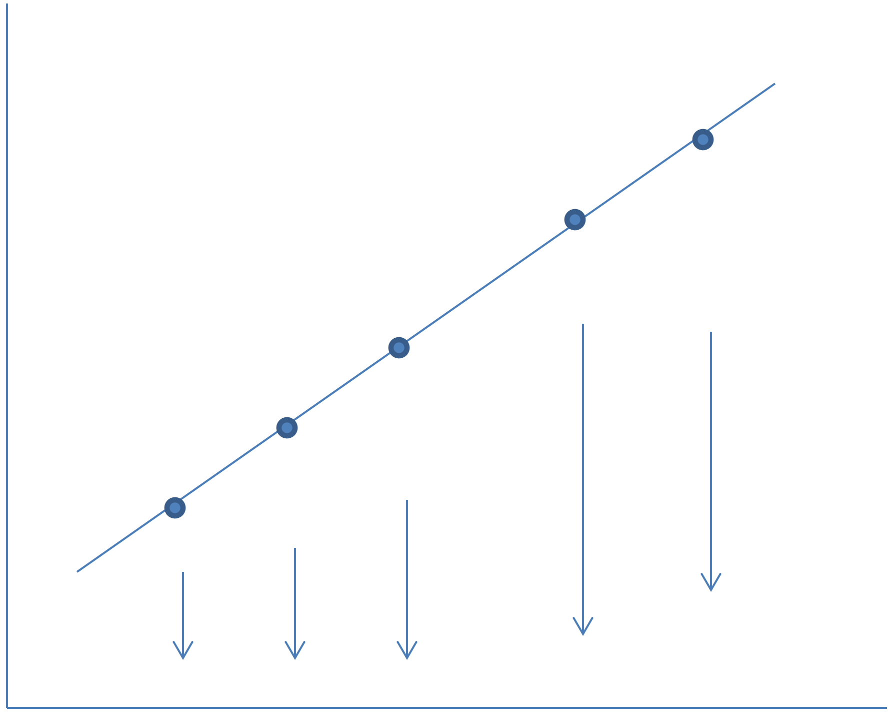
$PV =$ 33,615.90 + 32,168.33 + 30,783.09+29,457.50+28,189.00+26,975.12+763,342.32

$PV =$944,762.26

Dirty Price = 944,762.26/1,000,000*100 = 94.48

Clean Price = 94.48 – 3.5*15/180 = 94.43

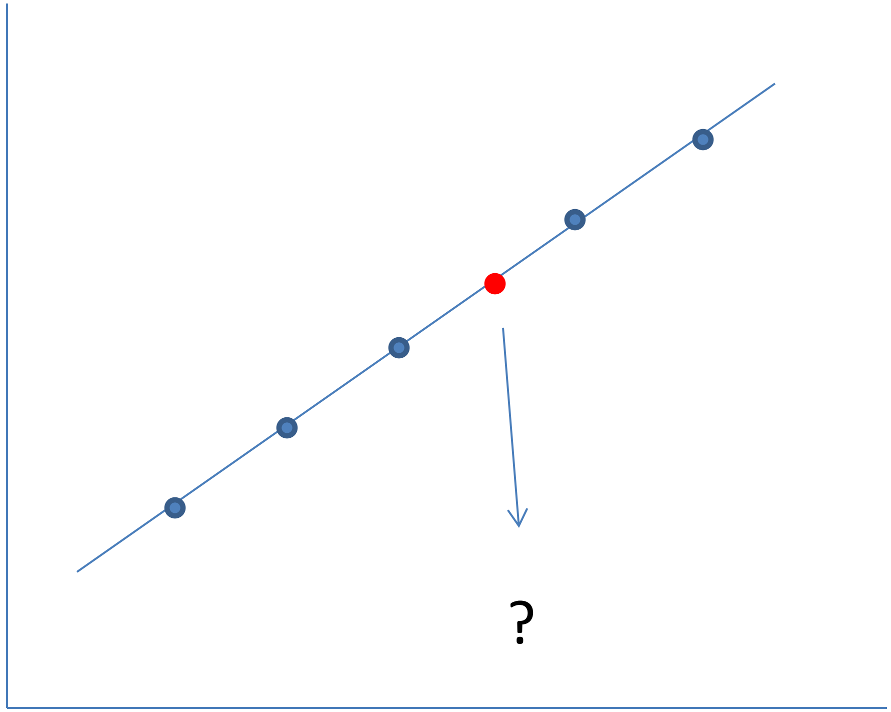
Building a Benchmark Risk Free Yield Curve



Methods

- Creating or designating benchmark bonds or tenors
- Establishment of market makers to provide liquidity
- Creating/releasing “fixing” rates
- Using an exchange or bond pricing agency

Interpolation



Linear Interpolation

$$\frac{Yield_b - Yield_a}{Tenor_b - Tenor_a} = \frac{Yield_c - Yield_a}{Tenor_c - Tenor_a}$$

$$Yieldb \ = Yielda + \frac{(Yieldc - Yielda) * (Tenorb - Tenora)}{Tenorc - Tenora}$$

$Yield_b$ = *target rate to be interpolated*
$Yield_a$ = *available rate with shorter maturity*
$Yield_c$ = *available rate with longer maturity*
$Tenor_b$ = *maturity of* $Yield_b$
$Tenor_a$ = *maturity of* $Yield_a$
$Tenor_c$ = *maturity of* $Yield_c$

Example

Tenor	Yield
1	4.9%
2	
3	6.33%
4	7.25%

4.90% + ((2 - 1) / (3 - 1)) x (6.33% – 4.90%) = 5.615%

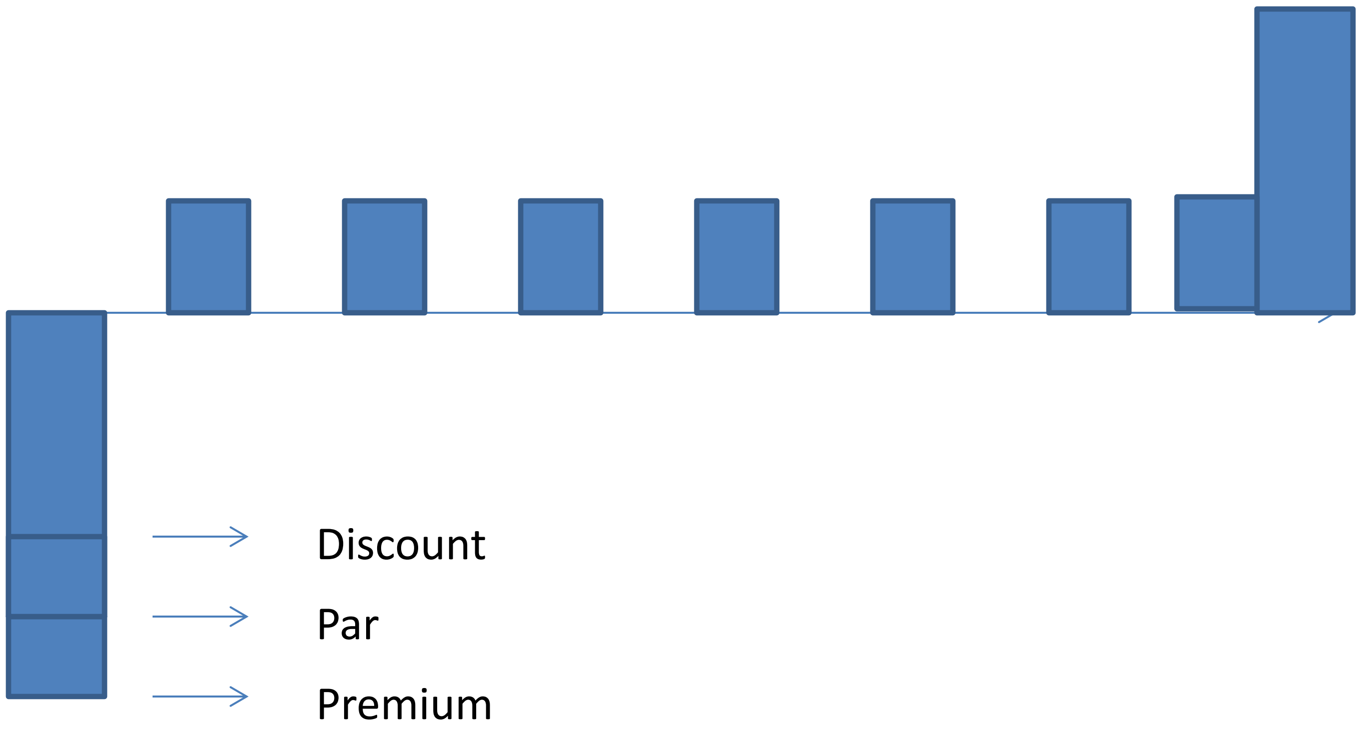
Sources of Bond Returns

- Coupon income and return of principal
- Reinvestment of coupon payments
- Capital gains on sale of bond before maturity

2 Common Types of Bond Risk

- Interest rate risk
  - Risk that interest rates will rise
- Reinvestment risk
  - Risk that interest rates will fall

Interest Rate Risk



Measures of Interest Rate Risk

- Price Value of a Basis Point (PVBP)
  - Risk that interest rates will rise
- Macaulay Duration
  - Term-weighted average of the discounted cash flows of the bond
- Modified Duration
  - Similar to Macaulay duration, but allows for estimation of price changes due to yield.

Price Value of a Basis Point

- Consider a 1-year bond paying 6% coupon semi-annually on a par value of 100 and with yield-to-maturity of 5%.

$$P' = \frac{3}{\left(1+\frac{0.2495}{2}\right)} + \frac{103}{\left(1+\frac{0.02495}{2}\right)^2} = 100.9734$$

$$P'' = \frac{3}{\left(1+\frac{0.02505}{2}\right)} + \frac{103}{\left(1+\frac{0.02505}{2}\right)^2} = 100.954$$

$$PVBP = \frac{P' - P^{ii}}{2} = \frac{100.9734 - 100.954}{2} = \mathbf{0.0097}$$

Macaulay Duration

- Consider a 1-year bond paying 6% coupon semi-annually on a par value of 100 and with yield-to-maturity of 5%.

$$D = \frac{\sum_{i=1}^{N} \frac{iCF_i}{(1+y)^i}}{P}$$

$$D = \frac{(1)\left(\frac{3}{1.025}\right) + (2)\left(\frac{3}{(1.025)^2}\right)}{100.9637} = \mathbf{1.971911}$$

$$D = \mathbf{1.971911/2 = .99855}$$

Modified Duration

- Consider a 1-year bond paying 6% coupon semi-annually on a par value of 100 and with yield-to-maturity of 5%.

$$D = \frac{PVBP * 10{,}000}{Price}$$

$$D = \frac{Macaulay\ Duration}{(1 + \frac{Yield}{C})}$$

$$D = \frac{\mathbf{.99855}}{(1 + .025)} = \mathbf{.9615}$$

Convexity