BUSN 233

chapter 6

Interest Rates & Inflation & BONDS (Debt)

Interest Rates

Real vs. Nominal Rates:

Real Rates

1. The percentage change in buying power.
2. Rates that have been adjusted downward for inflation.
3. Base rate that does not take inflation into consideration.
4. percentage change in how much more/less you can buy with your money

Nominal Rates

1. The percentage change in number of dollars that you have.
2. Rates that have NOT been adjusted downward for inflation.
3. Nominal Rates of interest include our desired real rate of return plus an adjustment for expected inflation

Example 1 →

Money

- Money is as money does
- It is better to define money by its function:
  - Buy stuff
  - get paid a wage
  - save

1. Money acts as a medium of exchange (without it, Barter)

2. A standard of value. money is the unit in which the prices of goods & services are measured. Gage of value, 20 units = sweater
10 units = toy, thus:
2 toys = 1 sweater

3. A store of value. A person can hold money & use it later.

Example 1

Jan 1, 2010 milk cost = $3.39

Jan 1, 2011 milk cost = $3.56

Milk Inflation = $\frac{3.56}{3.39} - 1 = 0.050147$

Jan 1 2010 Buy 100 cartons = 3.39*100
= $339.00

put in Bank & Earn 10%, n=1

APR (n=1) = Nominal = 10%

Jan 1 2011 FV = 339 * (1+.1) = $372.90

We earn 10%, But can we

Q: Buy 10% more cartons of milk?
can we buy 110 cartons of milk?

A: $\frac{\$372.90 \text{ \$ in bank}}{\$3.56 \text{ New Milk cost}} = 104.75$ } Number of cartons

change in buying power = $\frac{104.75}{100}$

= 0.0475

We earned a Nominal Rate of 10% but our buying power (for Milk) went up by only 4.75%

The Fisher Effect (Relationship between Real Rate, Nominal Rate, & Inflation)

$$1 + R = (1 + r) * (1 + h)$$ (P4)

R = Nominal Rate (Annual Rate with $n=1$)
h = Inflation Rate
r = Real Rate

Example 2

$R = 0.10$, $h = 0.050147$

$$1 + 0.10 = (1 + r) * (1 + 0.050147)$$

$$\frac{1.10}{1.050147} - 1 = r$$

$$0.047472 = r$$

(same as before $\frac{104.75}{100} - 1 = 0.0475$)

other formulas

$1+R=(1+r)*(1+h)$	$1+R=(1+r)*(1+h)$	$1+R=(1+r)*(1+h)$
$\frac{1+R}{1+h} = 1+r$	$\frac{1+R}{1+r} = 1+h$	$R=(1+r)*(1+h)-1$
$\frac{1+R}{1+h} - 1 = r$	$\frac{1+R}{1+r} - 1 = h$	

$$1 + R = (1+r)(1+h)$$

multiply out

$$1 + R = 1 + h + r + rh$$

$$R = 1 - 1 + h + r + rh$$

$$\boxed{R = h + r + rh}$$

compensation for decrease in value in original amount invested

real

compensation for decrease in value of interest earned

$$R \approx h + r$$

Example 1 (2nd time)

Jan 1, 2010 Milk cost = \$3.39

Jan 1, 2011 Milk Cost = \$3.56

Milk Inflation = $\frac{\text{End}}{\text{Beg}} - 1$ $\quad \frac{3.56}{3.39} - 1 = 0.050147$

Inflation went up, but what about the buying power of our money in the Bank?

Annual Rate $(n=1)$ = Nominal Rate = 10% = 0.10

$\$3.39 * (1+.1) = \$3.729$

we earn 10%, but did our buying power increase by 10%?

$$\frac{\$3.729}{3.56} - 1 = 0.0474191$$

or

$$\frac{1+.10}{1+.050147} - 1 = \frac{1+\text{Nominal}}{1+\text{inflation}} - 1 = 0.047$$

0.0474191 = change in buying power

The Fisher Effect (Relationship between Real, Nominal & Inflation)

$$\boxed{r = \frac{1+R}{1+h} - 1}$$

R = Nominal Rate (Annual Rate n = 1)

h = Inflation Rate

r = Real Rate = change in Buy power

$r =$ % change Buying power $= \dfrac{1+R}{1+h} - 1$

Amount you would earn in 1 year

What you could purchase give an inflation rate increase in Price of Goods/service

Example 3:

If nominal Rate is 12%
& Inflation is 6%,
What is change in Buying power?

$$r = \frac{1.12}{1.06} - 1 = 0.0566$$

Example 4:

If nominal Rate is 1%
and Inflation is 1.5%,
what is change in Buying power?

$$r = \frac{1.01}{1.015} - 1 = -0.004926$$

Example 5: in Excel workbook

Bonds

Loan contract = set of Future Cash Flows

Borrower

Bond Issuer = Bond Seller = Liability
= Corporation or Government Debt

How cash Flows Might look:

Interest ONLY Loan or Coupon Bond

* coupon = "interest"

PV = 975.02 ← Amount Received by Bond Issuer.

0	1	2	3	4	5	6 periods
PV = 975.02	PMT = -50	PMT = -50	PMT = -50	PMT = -50	PMT = -50	PMT = -50, FV = -1000

① periodic Interest PMT or Coupon PMT paid at end of each period.

② pay back principal at maturity.

Deep Discount Loan or Zero Coupon Bond

PV = 725.25 ← Amount Received by Bond Issuer.

0	1	2	3	4	5	6 periods
PV = 725.25						FV = -1000

① NO periodic Interest paid.

② All Interest & principal paid back at maturity.

Lender

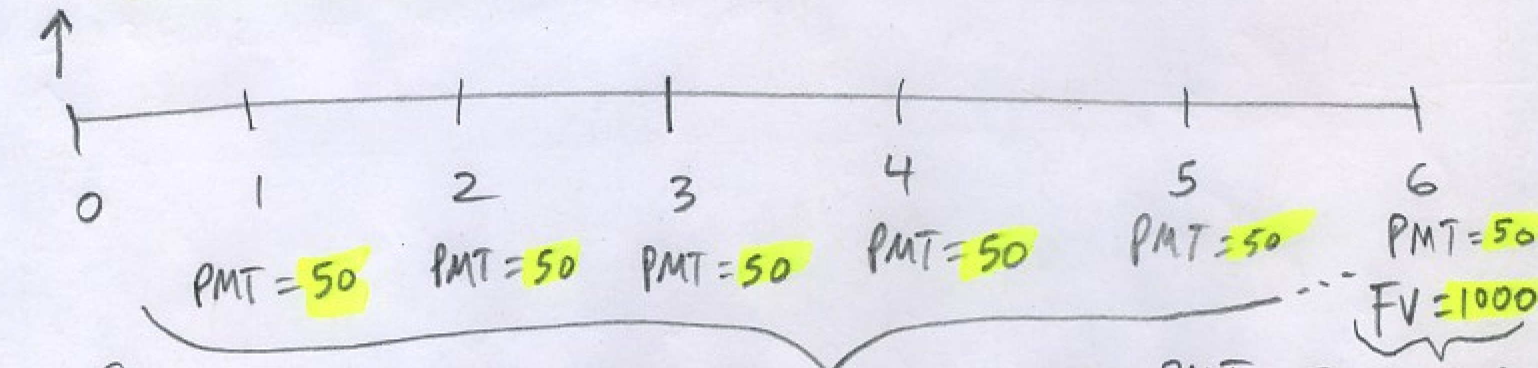
Bondholder = Bond Buyer = Asset

= Bondholder is buying **set of Future Cash Flows**

How Cash Flows might look:

Interest only or Coupon Bond * coupon = Interest

PV = -975.02 ← Amount Paid for Future set of Cash Flows

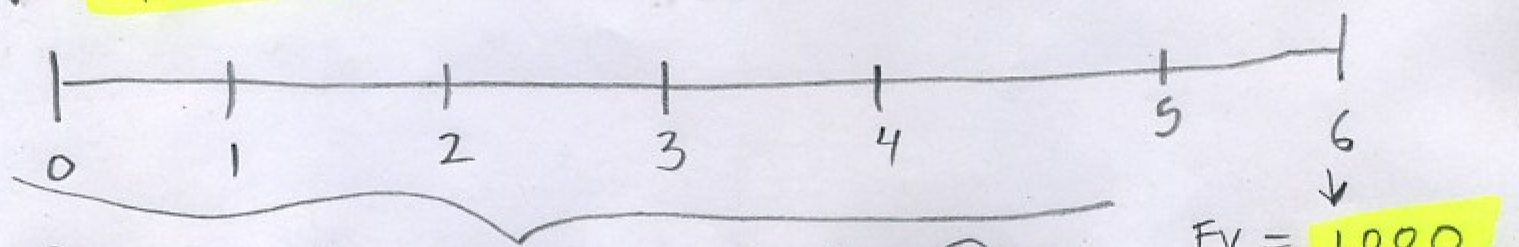


① periodic Interest PMT or Coupon PMT received at end of each period.

② Receive Principal Amount at Maturity

Deep Discount Loan or Zero Coupon Bond

PV = -725.25 ← Amount paid four Future set (1) of cash Flows.



① No periodic Interest Paid.

② All Interest & Principal paid back at Maturity.

Bond Terms:

1. Bond = Loan contract issued by corporation or Government that can be bought or sold in Financial markets.

2. YTM = Yield To Market = Discount Rate = Market Rate = Rate for similar securities.

Usually Different

3. Coupon Rate = contract interest rate for calculating Interest PMT.

4. Face value = Amount of loan to pay back at Maturity = "par value" = principal.

5. coupon payment = Interest payment.

6. Years until Maturity = years until pay back face value & last coupon payment.

7. Maturity = specific date when face value & last coupon payment is paid.

p 11.5

What Are Similar Securities?

- Similar securities are bonds or other investment vehicles issue by other corporations (different than the one being considered) that have similar business and financial risks

- The similarities could be:
  - Similar credit ratings
  - Similar business activities
  - Similar capital structure

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$$\text{Coupon Bond value} = PMT * \left[\frac{1-\left(1+\frac{YTM}{n}\right)^{-nx}}{\frac{YTM}{n}}\right] + \frac{FV}{\left(1+\frac{YTM}{n}\right)^{nx}}$$

Point of view of Bondholder $\rightarrow$ $= PV\,(rate, nper, PMT, FV) *$

$* = PV\left(\frac{YTM}{n}, n*x, \frac{\text{Coupon Rate} * \text{face}}{n}, FV\right)$

Math	Bond Terms	Excel
FV	face value	FV
PV	Bond Value	PV
i	YTM	
n	# compound periods per year usually 2	
X	years until Maturity	
$n*x$	Total number of periods	nper
$\frac{i}{n}$	$\frac{YTM}{n}$ = Discount Rate = Market Rate	rate
PMT	Periodic Interest PMT = $\frac{\text{Coupon Rate}}{n}$ * face value	PMT

Zero Coupon Bonds (Pure Discount Loan or "Zeroes"):

- A Bond that makes no coupon payments, and thus is initially priced at a deep discount
- From the Borrower's point of view: "Borrow an amount today, then pay back principal & all interest at the end of the loan period."
- From the Lender's (Bondholder's) point of view: "Lend (pay) an amount today, and receive all principal & interest at the end of the loan period."

$$\text{zero Bond value} = \frac{FV}{\left(1 + \frac{YTM}{n}\right)^{nx}}$$

$$= PV(rate, nper, , FV)$$

$$= PV\left(\frac{YTM}{n}, n*x, , FV\right)$$

point of view of Bondholder

Note: Interest on Zeroes is:

1. Deductable for income tax for Bond Issuer
2. Taxable for income tax for Bondholder

Why issue or buy zeroes?

1. Bond Issuer likes cash flow advantage of Deductable Non-cash Expense
2. Bondholder likes predictability of future Bond Income.

① To solve for the $\frac{YTM}{n}$ = {Discount Rate per period}

use:

Excel: =RATE(n*x, -PMT, PV, -FV, 0) ← Bond Issuer point of view

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② To solve for the Effective Annual Yield

use:

Excel: = EFFECT(YTM, n)

Math: $\left(1+\frac{YTM}{n}\right)^n - 1$

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③ To solve for Periodic Coupon PMT:

use:

Excel: $=PMT\left(\frac{YTM}{n}, n*x, -PV, FV, 0\right)$

Bondholders point of view

Q: For the Coupon Bond, How come Bond Issuer got only $975.02 instead of $1000?

A: (1) Because Corporate & Government Bonds are bought & sold in the Financial Markets, AND Market Rates change often. (Because of New information).

(2) This means the interest rate written in the Bond contract is usually different from the interest Rate in the Financial Markets.

Bond
Interest ONLY
face = 1000
coupon Rate = 10%
semiannual
years to Maturity = 3

Bond
Interest ONLY
face = 1000
coupon Rate = 10%
semi Annual
Years To Maturity = 3

Bond
Interest ONLY
Face = 1000
Coupon Rate = 10%
semiannual
Years To Maturity = 1

Corporation & Investment Bank write up Bond Contract & say they will pay 10%, n=2 coupon payments 4 months before they issue Bond.

But on the Day they sell the Bond contract the interest Rates have changed.
coupon Rate = 10%
YTM = 11%

Later, if someone Buys the Bond from the original Bondholder, the rates have changed again.

-4	-3	-2	-1	0	1	2	3	4	5	6	periods

Months (−4 to 0) semiannual periods (0 to 6)

Day they write up contract
Coupon Rate = 10%
YTM = 10%

"sold at Discount"
Day they issue Bond Contract
Coupon Rate = 10%
YTM = 11%

"sold at premium"
Day the Bond is bought by new person
coupon Rate = 10%
YTM = 9%

Why do rates change? In Financial Markets, each day New Information about the economy & business cause people to change their rates (RISK).

Example 6: Coupon Bond for Issuer

Bond Issuer = Corporation

Face = \$1000 (corp. usually issues many Bonds)

Coupon Rate = 10% Determines Interest Paid

n = 2

$\left\{\frac{\text{Coupon Rate}}{2}\right\} = \frac{10\%}{2} = 5\%$

YTM = 11% } Market Rate = Discount Rate for similar securities

$\frac{YTM}{n} = \frac{11\%}{2} = 5.5\%$

Years to Maturity = 3

Total periods = 3*2 = 6

Coupon PMT = 5% * 1000 = \$50

Coupon Bond

PV = SOLVE FOR THIS

0	1	2	3	4	5	6	semi annual periods
	PMT	PMT	PMT	PMT	PMT	PMT	
	-50	-50	-50	-50	-50	-50	
						-1000 = FV	

$$PV = \left\{\begin{array}{c}\text{cash}\\\text{coming}\\\text{into}\\\text{corporation}\end{array}\right\} = \left\{\begin{array}{c}\text{PV of}\\\text{future}\\\text{lump}\\\text{sum}\end{array}\right\} + \left\{\begin{array}{c}\text{PV of}\\\text{Annuity}\\\text{of}\\\text{coupon}\\\text{PMT}\end{array}\right\} = \frac{FV}{\left(1+\frac{YTM}{n}\right)^{nx}} + PMT * \left[\frac{1-\left(1+\frac{YTM}{n}\right)^{-nx}}{\frac{YTM}{n}}\right]$$

$$PV = \frac{1000}{(1+.055)^6} + 50 * \left[\frac{1-(1+.055)^{-6}}{.055}\right]$$

"sold at Discount"

$$PV = 725.245833 + 249.7765154$$

$$PV = \$975.02$$

= PV(rate, nper, -PMT-FV) = PV($\frac{YTM}{n}$, n*x, -PMT, -FV)

= PV(.055, 6, -50, -1000) = \$975.02 ← {corp receives \$}

Example 7: Zero coupon for Issuer

Bond Issuer = corporation

Face value = \$1000 (corp usually issues Many B.

Coupon Rate = 10% (Determines Interest Paid)

$n = 2$

$\left\{\dfrac{\text{coupon Rate}}{2}\right\} = \dfrac{10\%}{2} = 5\%$

$YTM = 11\%$

$\dfrac{YTM}{n} = \dfrac{11\%}{2} = 5.5\%$

Market Rate or Discount Rate for "Similar security"

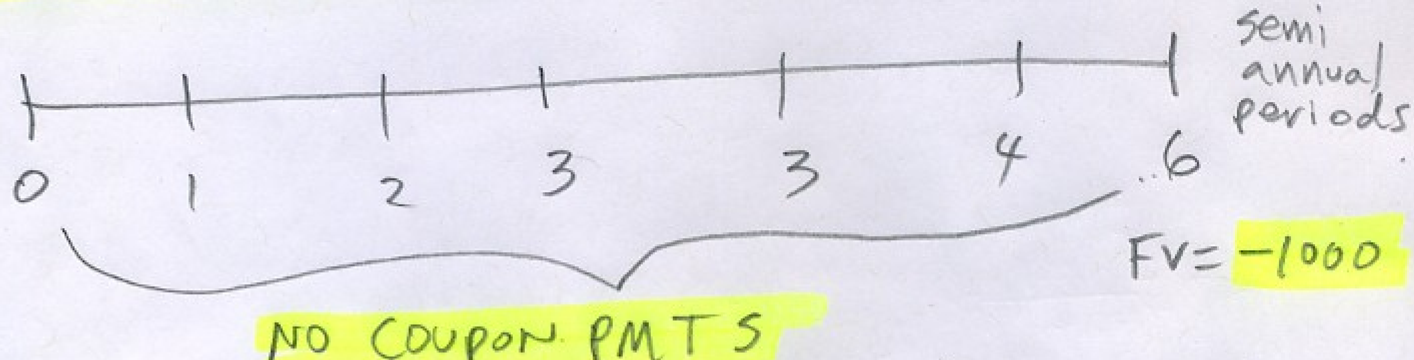
Years to Maturity = 3

Total periods = $3 * 2 = 6$

NO COUPON PMT !!

ZERO COUPON

PV = SOLVE FOR THIS



$$PV = \left\{\begin{matrix}\text{cash coming}\\ \text{into corporation}\end{matrix}\right\} = \left\{\begin{matrix}\text{PV of}\\ \text{Future}\\ \text{Lump}\\ \text{sum}\end{matrix}\right\} = \frac{FV}{\left(1 + \frac{YTM}{n}\right)^{nx}}$$

$$PV = \frac{1000}{(1 + .055)^6} = \$725.25$$

Corp. Receives \$

$= PV(\text{rate}, \text{nper}, , -FV) = PV\left(\frac{YTM}{n}, n*x, , -FV\right)$

Skip PMT

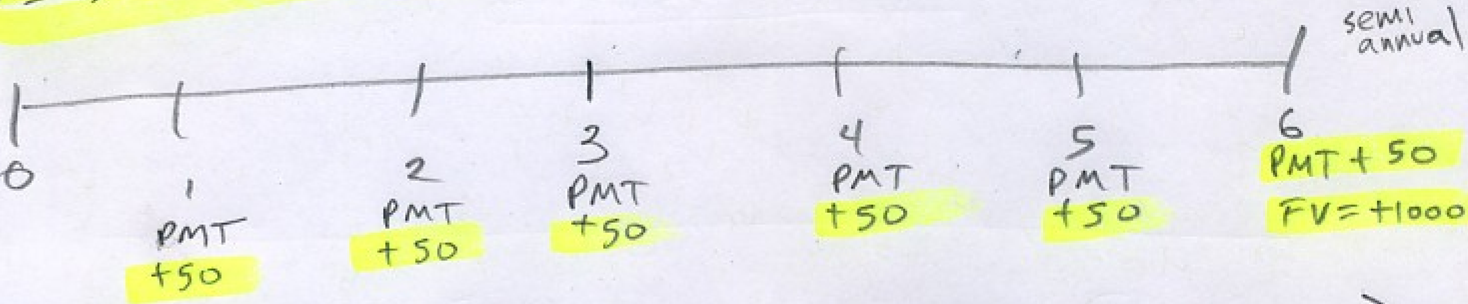
"sold at Discount"

$= PV(.055, 6, , -1000) = \$725.25$

Example 8: Coupon Bond for Bondholder #1

(A) Details same as example 6, but for Bondholder

PV = SOLVE FOR THIS



$= PV(rate, nper, PMT, FV) = PV\left(\frac{YTM}{n}, n*x, PMT, FV\right)$

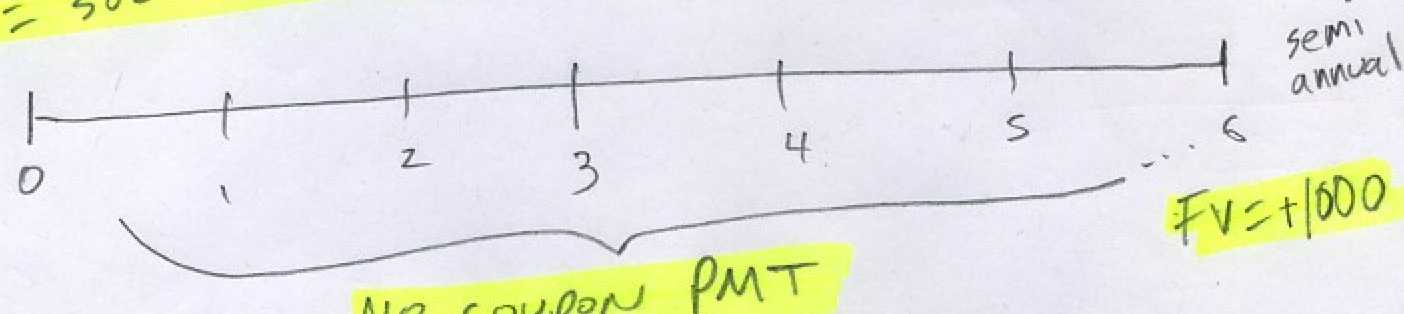
$= PV(.055, 6, 50, 1000) = -\$975.02$ ← "Bought at Discount"

Bondholder is willing to pay \$975.02 for set of Future Cash Flows!!!

Example 9: Zero coupon Bond for Bondholder #1

(*) Details same as example 7, but for Bondholder

PV = SOLVE FOR THIS



$PV = PV\left(\frac{YTM}{n}, n*x, , FV\right) = PV(.055, 6, , 1000) =$

"Bought at Discount" → $PV = -725.25$

Bondholder is willing to pay \$725.25 now in order to receive all the interest & principal (\$1000) later.

Example 10: Coupon Bond for Bondholder #2

Bondholder #1 sells Bond to Bondholder #2 at the end of year 2, and the rate in the market (YTM, or Rate on "similar security") is 9%

Bondholder #1 = sells Bond

Bondholder #2 = Buys Bond in secondary Market

Face value = \$1000 = FV

Coupon Rate = 10% (Determines Interest Paid)

$n = 2$

$\left\{\frac{\text{Coupon Rate}}{2}\right\} = \frac{10\%}{2} = 5\%$

YTM = 9% = Discount Rate = Market Rate

$\frac{YTM}{2} = \frac{9\%}{2} = 4.5\%$

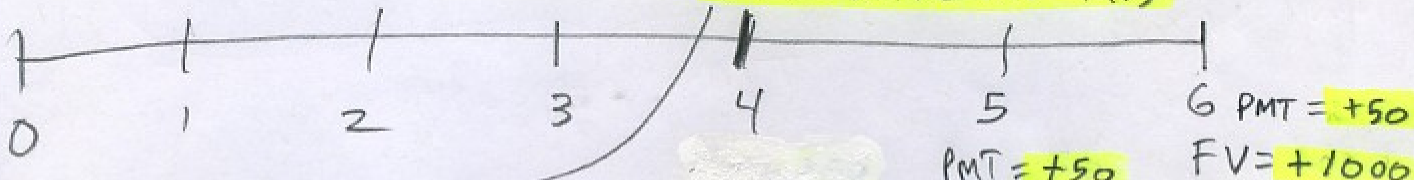
Years To Maturity = 1

total Periods = 1 * 2

coupon Payment = PMT = 1000 * .05 = \$50

Coupon Bond for Bondholder #2

PV = solve For This

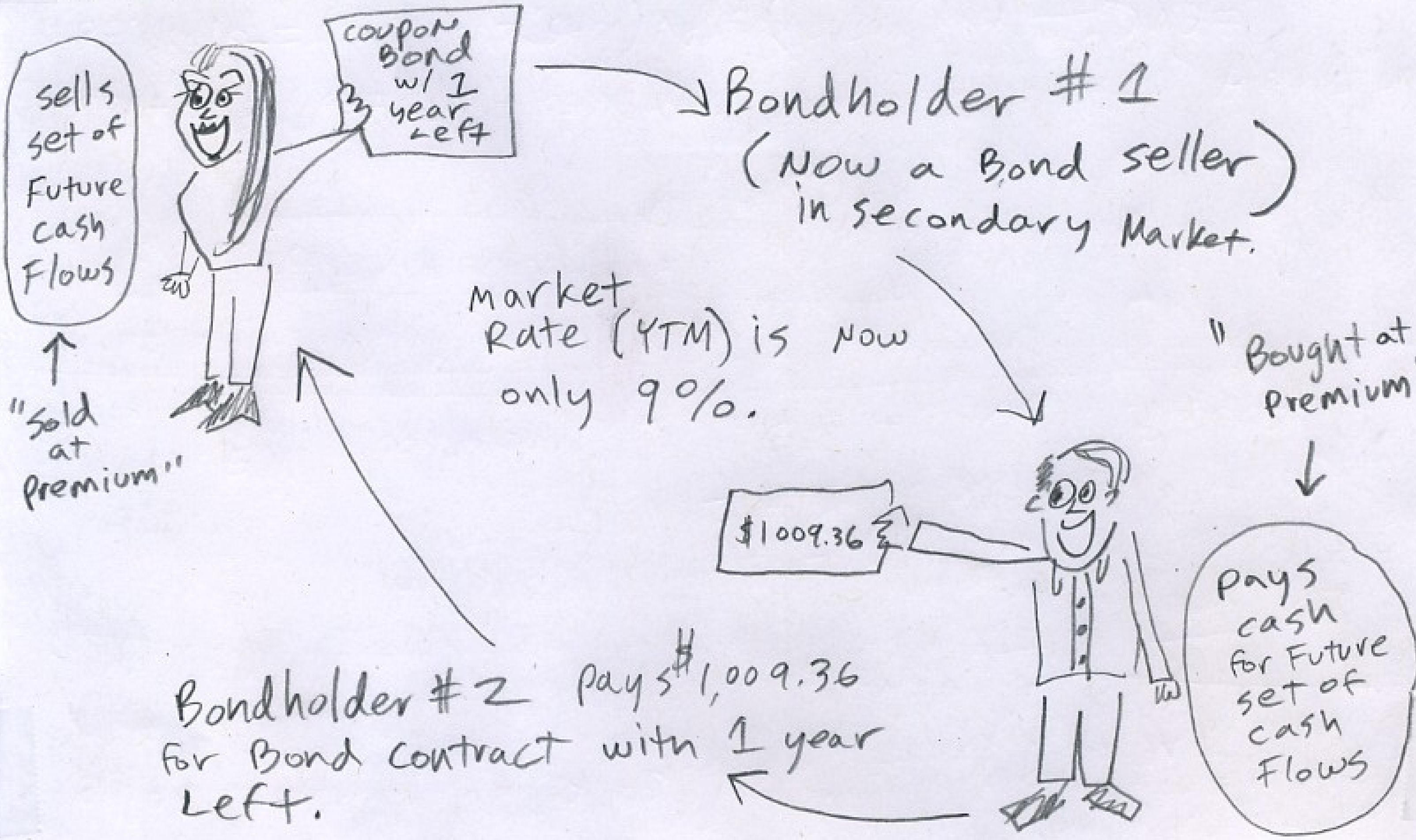


at Time 4

$= PV\left(\frac{YTM}{n}, n*x, PMT, FV\right) = PV(.045, 2, 50, 1000) = -\$1009.36$

Bondholder #2 pays Bondholder #1 \$1009.36 now in order to get future cash Flows from corporation "Bought at Premium"

Example 10 continued:



PV = 1,009.36

0	1	2	New periods
4	5	6	old periods
	PMT = +50	PMT = +50 FV = +1000	

① Present value of all future cash Flows at YTM of 9% is Bond Value.

② Bond with a 10% coupon is priced to yield 9% at $1,009.36.

Example 11:

But what if the buyer & the seller just had price = \$1,009.36 & not the YTM? Could we figure out YTM?

Sell price for Bond = \$-1,009.36 = PV

Face = \$1000 = FV

semi-annual Interest payment = \$50

Total number of periods left = 2

$\frac{YTM}{2} = ?$

= RATE(nper, PMT, -PV, FV) = $\frac{YTM}{2}$ =

= RATE(2, 50, -1009.36, 1000) ≈ 0.045

$\frac{YTM}{2} = 0.045 \Rightarrow YTM = 0.045 * 2 = 0.09 \Rightarrow 9\%$

<u>Effective Annual Yield</u> $= \left(1 + \frac{YTM}{n}\right)^n - 1 = 1.045^2 - 1$

$= 0.092025 \Rightarrow 9.2\%$

"1 Year Bond with a 10% Coupon is priced to yield 9% at \$1,009.36."

"Bond is Priced at a Premium."

"Bond's Effective Annual Yield is 9.2%."

Example 12:

sometimes you see Bond prices Quoted like this:

1.00936

or

100.936 %

or it is written like this:

"1 year 10% coupon Bond is priced at 100.936 %"

(assumed to be semiannual)

From statement we can get info. →

face = \$1000 = FV

semiannual coupon = \$50 = PMT

Price = 1000 * 1.00936 = \$1009.36 "PV"

Years to Maturity = 1

Total periods = 2 (assumed n = 2)

Point of view of Bondholder } YTM = RATE(nper, PMT, -PV, FV) * n

YTM = RATE(2, 50, -1009.36, 1000) * 2 =

YTM = 0.0900035

Three Principles in Bond Finance

Example 13:

① Rates are inversely related to Price

$\boxed{\text{YTM} \uparrow}$ then $\boxed{\text{Bond Price} \downarrow}$

Face value = 1000	FV = 1000	FV = 1000
Coupon Rate = 6%	Coupon Rate = 6%	Coupon Rate = 6%
YTM = 6%	YTM = 7%	YTM = 5%
years = 30	years = 30	years = 30
n = 2	n = 2	n = 2
price = $1,000	Price = $875.28	price = $1,154.54
sell at Par	sell at Discount	sell at Premium

Example 13.5

② Bonds sell at Par, Discount or Premium

Coupon Rate = 6%	Coupon Rate = 6%	Coupon Rate = 6%
YTM = 6%	YTM = 7%	YTM = 5%
face = price	face > price	face < par
1000 = 1000	1000 > 875.28	1000 < 1,154.54
C.R = YTM	C.R. < YTM	C.R. > YTM
6% = 6%	6% < 7%	6% > 5%
PAR	Discount	Premium

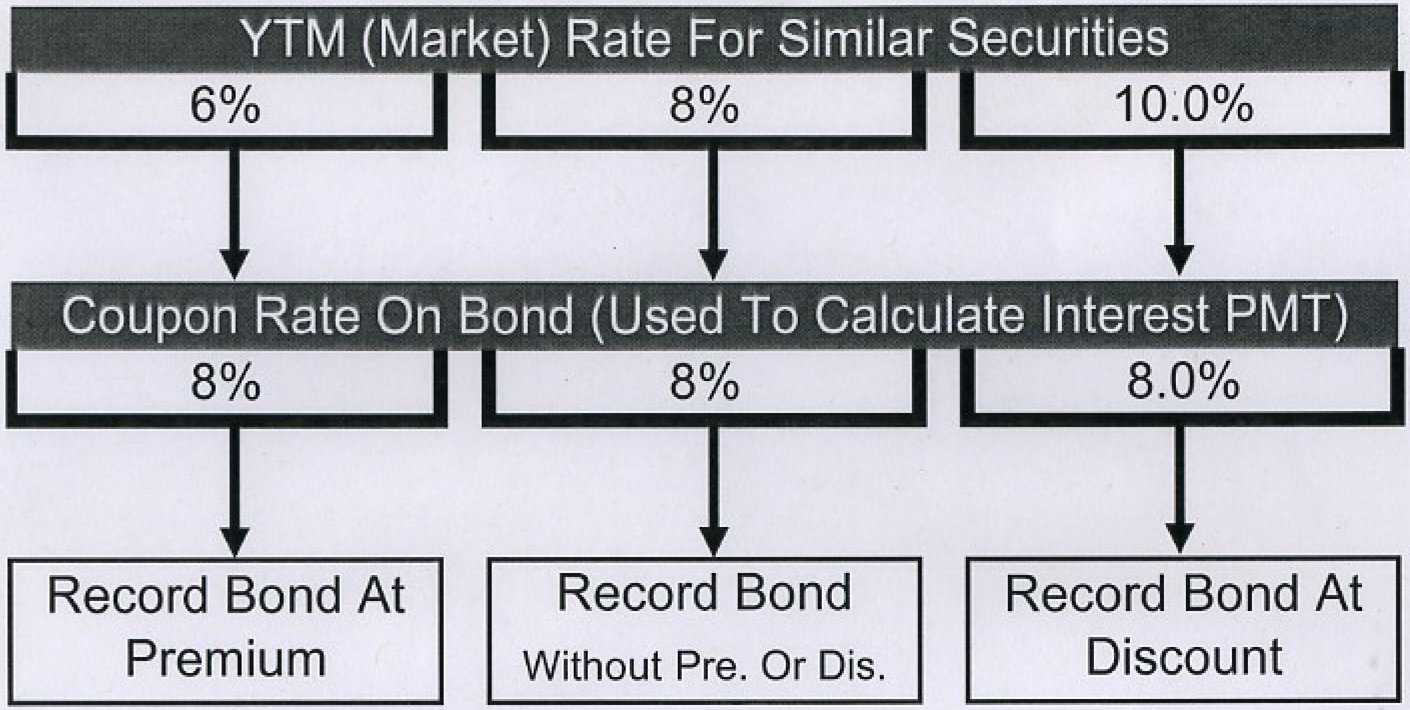
Example 14 & 14.5

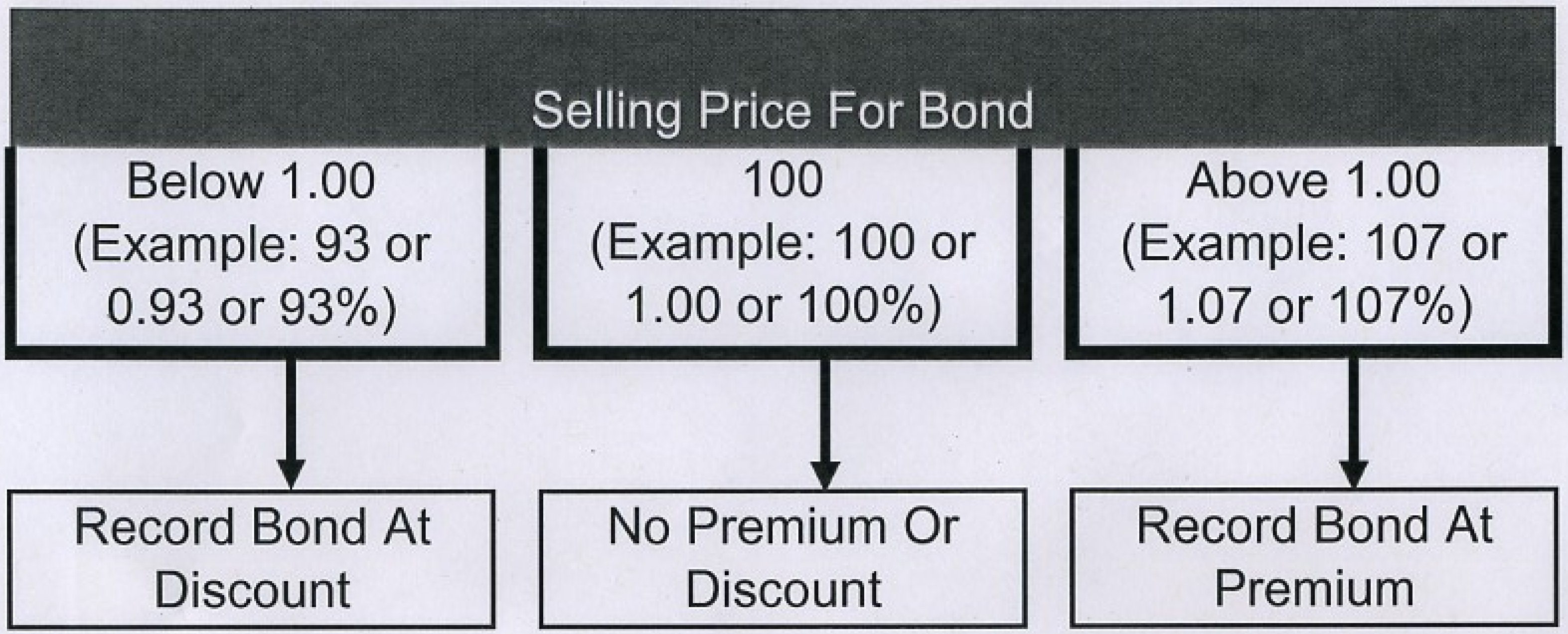
③ The More years to Maturity, the higher the Interest Rate Risk becomes.

① The longer to maturity, the more the YTM affects the Bond price.

② For long maturity (years = 30), a small increase in YTM can cause a large drop in Bond value.

③ Low coupon Rates have more risk than large coupon Rates because of pattern of cash Flows


YTM (Market) Rate For Similar Securities
6%
8%
10.0%
Coupon Rate On Bond (Used To Calculate Interest PMT)
8%
8%
8.0%
Record Bond At Premium
Record Bond Without Pre. Or Dis.
Record Bond At Discount


Selling Price For Bond
Below 1.00 (Example: 93 or 0.93 or 93%)
100 (Example: 100 or 1.00 or 100%)
Above 1.00 (Example: 107 or 1.07 or 107%)
Record Bond At Discount
No Premium Or Discount
Record Bond At Premium

Interest Rate Risk

- The risk that arises for bond owners from fluctuating interest rates
- How much interest rate risk a bond has depends on:
  - How sensitive its price is to interest rate change
    - The sensitivity depends on two things:
      - All things being equal, the longer the time to maturity, the greater the interest rate risk
      - All things being equal, the lower the coupon rate, the greater the interest rate risk

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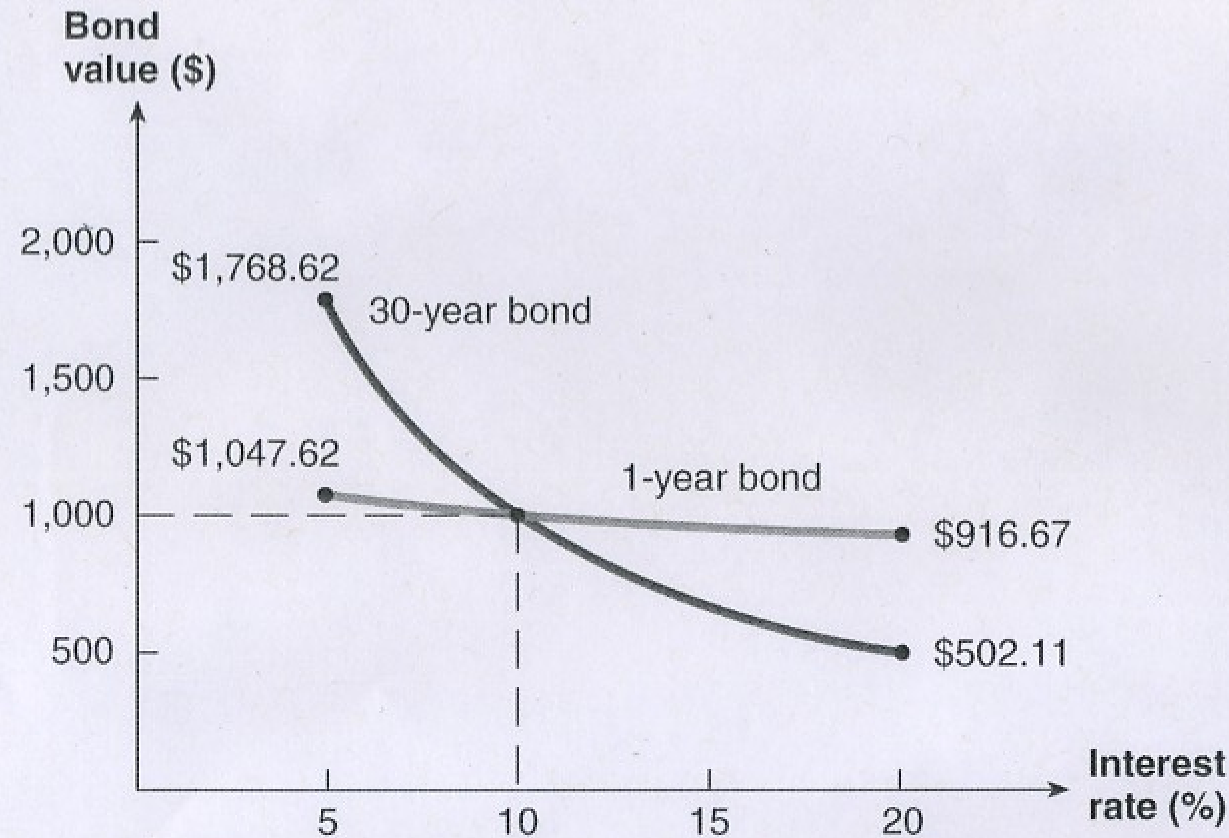
Interest Rate Risk And Time To Maturity



Value of a Bond with a 10 Percent Coupon Rate for Different Interest Rates and Maturities

	Time to Maturity	
Interest Rate	1 Year	30 Years
5%	$1,047.62	$1,768.62
10	1,000.00	1,000.00
15	956.52	671.70
20	916.67	502.11

Interest Rate Risk To Loss Of Principal (current price)

- Longer time to maturity
  1. Small changes in market rate have substantial affect on bond value
  2. Face value is discounted over many periods and thus compounding magnifies small interest rate changes
- Lower Coupon rate
  1. Bond with lower coupon rate is proportionally more dependent on the face value
     - (Bond with larger coupon rate has a larger cash flow early in life, so value less sensitive to discount rate)

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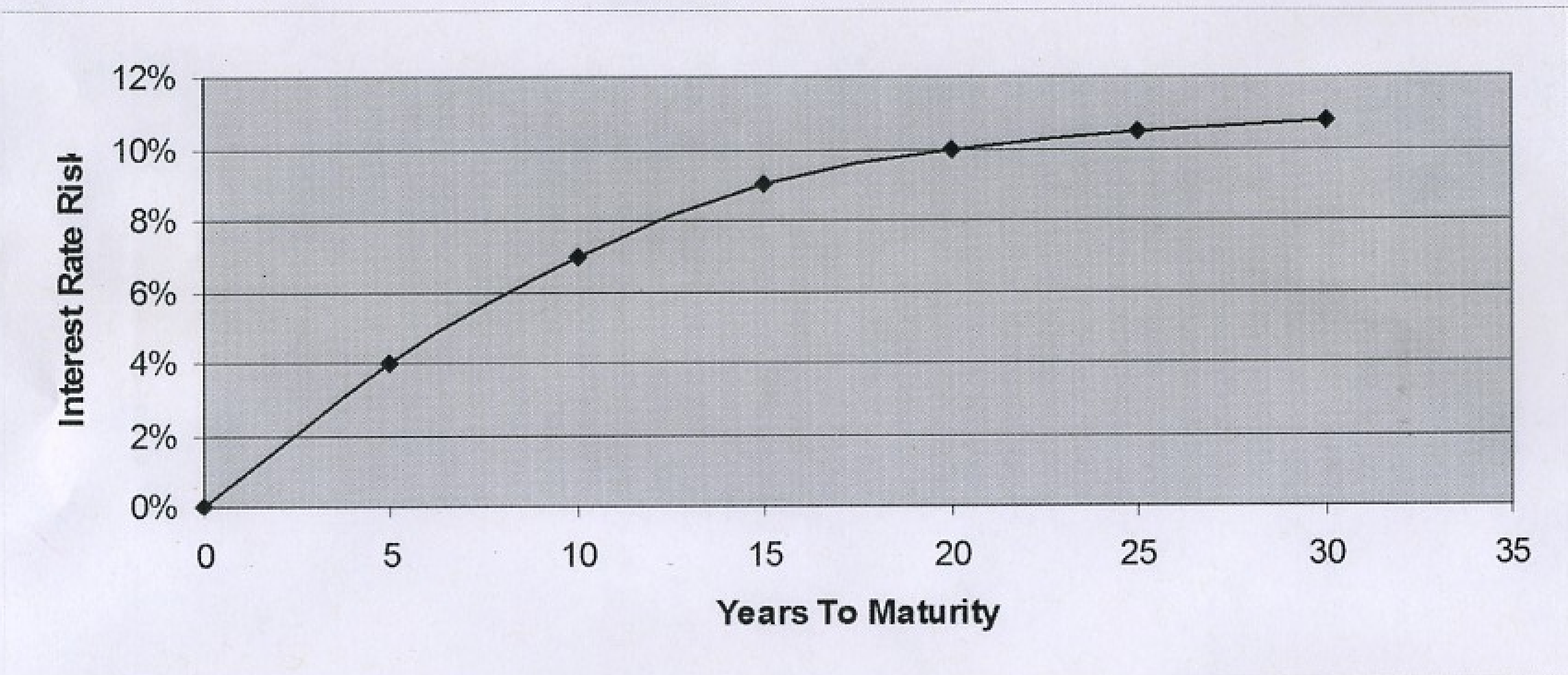
Interest Rate Risk Increases At A Decreasing Rate



Bonds	Stocks
1) Bring cash into Corp.	1) Bring cash into Corp.
2) Debt to Corp.	2) Equity to Corp.
3) Bondholders are creditors	3) Stockholders are owners
4) Interest must be paid (Fixed claim to cash flow)	4) Dividends are not a liability - they are paid only if Board of Directors Declare them (residual claim to cash flow)
5) Bondholders get paid interest & principal, but no more.	5) If corporation is very successful, owners may get paid a lot of Dividends (No upper limit)
6) Generally no voting rights	6) Generally, voting rights
7) Interest is tax deductable.	7) Dividends are not tax deductable
8) Bondholders have first claim in Bankruptcy.	8) Stockholders are in line behind creditors in Bankruptcy
9) Excess debt can lead to bankruptcy.	9) An all equity firm can not go bankrupt.

Government Bonds (USA biggest borrower in world) (P. 31)

Federal Level

Treasury Bill

Years < 1

Treasury Note

1 < Years ≤ 7

Treasury Bonds

other

Treasury Debt (Fed. Gov.)

1. considered default free
   * No default risk
2. Taxed at Federal Level only (Not State).
3. Highly Liquid to Bondholder.

State & Local Level

Municipal Bonds "Munis":

* Exempt from Federal Income Tax

Example 15:

Example: If your tax bracket is 25% for Federal Income tax, would you prefer 5% corporate Bond or 3.9% muni Bond?

$$.039 > .05 * (1 - .25) = .05 * .75 = .0375$$

$$.039 \text{ Muni} > .0375 \text{ corporate}$$