THE BOND MARKET

Bond – a fixed (nominal) income asset which has a:
-face value (stated value of the bond)
- coupon interest rate (stated interest rate)
- maturity date (length of time for fixed income payments)

Bonds are **debt** issued by either corporations, governments, or other entities,. They are obligated to pay the interest periodically until maturity date plus the value of the bond at the time it matures.

Ex: $1,000 bond, coupon rate of 5%, maturity of 5 years
- the fixed income from this bond is $50 per year (=.05*$1,000) for five years plus $1,000 when it is redeemed at maturity

Q: what is this stream of fixed income worth today?
A: It is necessary to consider the present discounted value of this fixed income stream

<u>PRESENT DISCOUNTED VALUE</u>
- think of this as the amount of money you would have to put into the bank today at whatever the interest rate is for the duration under consideration
- *discounting, is the exact <u>opposite</u> of compounding*

Compounding:

Sum of $ (PV) → interest rate (r), duration →future value (FV)

Present Value*(1 + interest rate) = Future Value

⇨ $PV(1+r) = FV_1$
⇨ Solving for PV: $\mathbf{PV = FV_1/(1+r)}$

To arrive at the present value of the future sum, we discount it (i.e., divide by (1+r))

This can be extended to many periods. For two periods:

⇨ Value after one year gets interest giving the future value after two years:
⇨ $[PV(1+r)]*(1+r) = FV_2$
⇨ $PV(1+r)^2 = FV_2$
⇨ Solving for PV: $\mathbf{PV= FV_2/(1+r)^2}$

Hopefully you see a pattern with the number of years for discounting and the exponent

Extending this to the fixed income stream from the bond discussed earlier, where there is interest income (I) each year and a face value (F) at maturity after 5 years:

$$\mathbf{PV = 50/(1+r) + 50/(1+r)^2 + \ldots + 50/(1+r)^5 + 1{,}000/(1+r)^5}$$

WE DO <u>NOT</u> USE THE STATED INTEREST RATE IN THE DENOMINATORS HERE (we will come back to this shortly)

Note that **PV = f(r, n)** where **n** is the number of years with discounting

For a given single payment in the future:
- the higher is r, the lower is the present value
- the farther in the future the sum is (larger is n), the lower is its present value
(explain each of these results)

Ex: Present value of $1,000 in the future

(1) **If r = 5% and n = 2 years, PV = $1,000/(1.05)^2 = <u>$907.03</u>**
(2) **If r = 10% and n = 2 years, PV = $1,000/(1.1)^2 = <u>$826.45</u>**
(3) **If r = 5% and n = 5 years, PV = $1,000/(1.05)^5 = <u>$783.53</u>**

#3 shows why investments whose "payoffs" occur far into the future are not as likely to occur as those paying off quicker, sometimes leading to the need for government to subsidize these

APPLICATIONS OF THESE PRINCIPLES

1) **<u>Net Present Value (NPV) and Internal Rate of Return (IRR)</u>**

Q: If an investment project is expected to generate a revenue stream in future years of R_1 in year 1, etc., what is the present value of that profit stream?

A: Its present value is: $R_1/(1+r) + R_2/(1+r)^2 + \dots + R_n/(1+r)^n$

What is the profitability of this investment project? Assuming costs occur up front (=C):

Profit = Revenue – Cost. In this context, however, it is necessary to discount the revenue stream, which leads to this project's Net Present Value:

$$\mathbf{NPV = R_1/(1+r) + R_2/(1+r)^2 + \dots + R_n/(1+r)^n - C}$$

So, ***Net Present Value*** *is the present discounted value of future revenues less the costs involved, which is the present discounted value of future profits.*

In this equation, we have not solved for the discount factor, r. Since we know the revenue stream (the R's, which are marginal revenue) and the costs (C, which is marginal cost), we can solve for the rate of discount, r, that maximizes profit (i.e., causes MR = MC).

- *The rate of discount that equates the present discounted value of future revenues with the cost of the project is the* ***Internal Rate of Return***.

Firms will often rank the desirability of various projects based on their internal rates of return.

Rule #1: Those projects with the highest IRR's get preference to those with lower IRR's.

Rule #2: Firms decide which projects to actually fund by comparing their IRR's to the cost of capital for their firms. If the IRR > cost of capital, undertake the project, since this implies a rise in (discounted) profits.

Q: Why is investment inversely related to r?

A: As r rises, the number of investment projects with positive NPV's falls, translating into fewer projects undertaken, and a lower aggregate value of investment

2) Yield To Maturity (YTM) of a Bond

While bonds have stated interest rates, those are not generally the yield that is followed in the bond market. Instead, an internal rate of return is used.

We saw that the present value of the fixed income stream from the bond we discussed earlier was:

$$\mathbf{PV = 50/(1+r) + 50/(1+r)^2 + \ldots + 50/(1+r)^5 + 1{,}000/(1+r)^5}$$

At any point in time, we know the price of the bond (P_b) from its value in the secondary bond market. If we equate this current bond price to the present discounted value of its fixed income stream:

$$\mathbf{P_b = 50/(1+r) + 50/(1+r)^2 + \ldots + 50/(1+r)^5 + 1{,}000/(1+r)^5}$$

the only unknown value is r. If we solve this equation for r (after substituting the value of current bond price), we arrive at its Yield to Maturity (YTM):

Yield to Maturity*: the rate of discount that equates the present discounted value of the fixed income stream from a bond with its current price.*

- This reflects the return from this bond if purchased now and held until maturity.

3) Bond prices and interest rates

Based on the Yield to Maturity formula, it should be apparent that ***bond prices and interest rates (in terms of YTM) are inversely related***.

- As interest rates rise, the present discounted value of future fixed income from this bond (given its stated r) falls, making it less attractive. As a result, the demand for this bond decreases, lowering its price.

RULE: ONLY BUY BONDS (OR BOND ETF's) WHEN INTEREST RATES ARE EXPECTED TO *FALL*. *This generally means expected economic weakness or lower inflation (bonds are recession hedges)*

4) Inflation and Bond Prices

Since bonds are fixed *nominal* income assets, the major threat to holding a bond is inflation, which lowers the *real* value of its fixed income stream.

- Using the earlier example, the real value of the $50 annual coupon payment will fall as inflation rises

Note that higher expected inflation raises the inflation premium in nominal interest rates, causing rates to rise. As discussed in #3 above, *this makes the stated yields on existing bonds less attractive than newer bonds, lowering their prices and yields to maturity.*

5) Deflation and Bonds

As bonds are fixed nominal income assets; anything that raises the purchasing power of their nominal income stream makes bonds more attractive, raising their demand.

- Deflation, a falling general price level, raises the real fixed income associated with a bond, causing bonds to rally.
- During deflation, stocks become less attractive, as goods prices fall, and nominal wages rise in real terms, *depressing stock prices*.
- **During periods of deflation, bonds rally while stocks fall.**

6) **Monetary Easing and Investment Spending**

When the Fed eases, it lowers interest rates (the fed funds rate) by raising the money supply. How does this affect investment spending?

a) As r falls, there will be a greater demand for goods, services, and housing, which raises the *value* of expected future profits, which is the numerator in the present value formula;

b) With a lower r, the present discounted value of expected profits rises, since (1+r) in the denominator falls, further raising the present value of future expected profit.

- Other things being equal, this should lead to greater investment spending

7) **Monetary Easing and Investment Spending 2**

Other things are not always (or seldom) equal. So, what if business believes the Fed is "behind the curve and a recession is coming?"

Then the *value* of expected profit falls, which counteracts *at least part* of the beneficial effect on NPV of the decline in r.

Q: Will this business pessimism offset the Fed's actions?

A: This depends on inflationary expectations. If the Fed continues to lower interest rates and this ignites inflationary fears, then the inflation premium in interest rates will rise, counteracting at least part of the Fed's easing attempts, making it difficult for the Fed to actually lower interest rates.

Treasury Prices and Yields, June 29, 2009

	COUPON	MATURITY DATE	CURRENT PRICE/YIELD	PRICE/YIELD CHANGE
3-Month	0.000	09/24/2009	0.18 / .18	0.008 / .008
6-Month	0.000	12/24/2009	0.33 / .34	0.04 / .041
12-Month	0.000	06/03/2010	0.44 / .45	0.043 / .044
2-Year	**1.125**	06/30/2011	**100-01½ / 1.10**	0-00+ / -.008
3-Year	1.875	06/15/2012	100-24½ / 1.61	0-01½ / -.016
5-Year	**2.625**	06/30/2014	**100-15 / 2.52**	0-05 / -.033
7-Year	**3.250**	06/30/2016	**100-15+ / 3.17**	0-06+ / -.033
10-Year	3.125	05/15/2019	96-31+ / 3.49	0-12+ / -.048
30-Year	4.250	05/15/2039	99-12 / 4.29	0-26 / -.049

(Source: Bloomberg.com)

Note that for the 2-year, 5-year, and 7-year US Bonds, *current price exceeds face value* (par) (stated in % as 100).

Q: Why would anyone pay a price that is higher than face value (par) for a bond?

A: That depends on the stated interest rate (or the desire for a flight to safety if sold at discount).

- If the stated interest rate is viewed as being "high," these bonds become attractive to potential purchasers, causing their demand to be bid up. This results in their prices rising, possibly moving beyond "par."

- This often occurs when the yields of newly issued bonds have higher interest rates than those in the secondary market. To induce persons to purchase the existing bonds, their price must fall, raising their yield-to-maturity.

RETURN AND BONDS

There are several measures of the return to bonds.

1) **Yield to Maturity**: the rate of return that equates the present value of the fixed nominal income stream to the current price of a bond.
2) **Current Yield**: the ratio of the bond's coupon value to its current price. This also reflects the inverse relationship between bond price and interest rates.
3) **Yield on a Discount Basis**: This adjusts current yield for the proportion of a year the bond (bill) will be held. For a treasury bill, there is no coupon, so the price discount replaces the coupon, then related to current bond price.
4) **Rate of Return**: the total return to a bond is the sum of its current yield and the percentage capital gain/loss for a period.

$$\mathbf{RET_t = (C/P_{t-1}) + (\Delta P_t/P_{t-1}),\ or}$$
$$\mathbf{RET_t = r_c + g}$$

where r_c is the current yield and g is the capital gain/loss.

- As market interest rates rise, bond prices fall, creating a capital loss to *existing* bond holders ($g < 0$)
- The longer is the time until maturity, the greater will be the price fluctuation in P.
- Bond prices and returns are more volatile for longer-term bonds
- **RET can be negative if interest rates rise**.

DEMAND AND SUPPLY FOR BONDS

Demand: inversely related to bond price ($\mathbf{P_b}$) since the lower the price of a bond, the higher is its yield to maturity, which raises the quantity of bonds demanded

- Bond Demand is downward sloping (other things being equal)
- Demand shifts for changes in expected return, wealth, risk, and liquidity

Examples:

- During an economic recovery, wealth rises, raising bond demand (given the other determinants)

- Expected returns: if interest rates are expected to *rise*, the expected return to bonds *falls*, lowering demand (since higher r translates into lower bond prices)
- If expected inflation rises, the real fixed income from bonds falls, lowering their expected return, causing demand to fall
- Greater riskiness of bonds, especially systemic risk, lowers their demand (for corporations, states, localities)

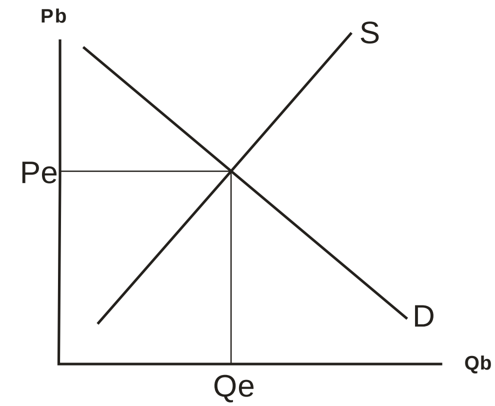
Supply: the supply of bonds is related to the borrowing needs of debtors along with the relative cost of raising funds for those entities

- Corporations can acquire money from banks, selling equity (if publicly traded), and the bond market
- The higher is bond price, the *lower* is the interest cost of acquiring funds for a debtor that sells bonds, causing a greater quantity of bonds supplied, so *bond supply is upward sloping relative to bond price*
- Another way to view this: the *higher* are bond prices, the *lower* is the relative cost of debt finance
- Bond supply shifts for changes in the expected profitability of investment, expected inflation, and government budget deficits (at any level)

Examples:

- A rise in the expected profitability of investment (in expansions) shifts bond supply to the right
- Higher expected inflation lowers the real cost of debt finance to debtors, *raising* bond supply
- Budget deficits raise the need for government to acquire funds, causing a higher supply of bonds

Bond Market Equilibrium



Bond Market Equilibrium: market clearing, where $\mathbf{Q^d = Q^s}$

- *Unlike "usual" markets (for goods), bond market equilibrium gives both price and the interest rate (*$\mathbf{r_e}$*)*
- The equilibrium price is sustainable, given the "other things" of bond demand and bond supply
- If $P > P_e$, there is an excess supply of bonds, as $B^s > B^d$, which will cause bond prices to fall, raising interest rates
- If $P < P_e$, there is an excess demand for bonds, as $B^d > B^s$, which will cause bond prices to rise, lowering interest rates

APPLICATIONS

1) Higher expected inflation

There is a positive correlation between expected inflation and (nominal) interest rates. This can be seen from the Fisher Equation:

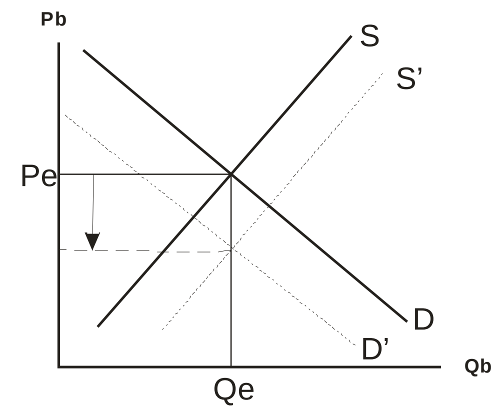
$$\mathbf{r_N = r_R + \pi^e}$$

Here: $\mathbf{r_n}$ is the nominal interest rate, $\mathbf{r_R}$ is the real interest rate, and $\boldsymbol{\pi^e}$ is expected inflation, which is called the **inflationary premium** in (nominal) interest rates.

- As expected inflation ($\boldsymbol{\pi^e}$) rises, the inflationary premium increases, causing nominal interest rates to rise (leading to the greater inflation proofing of returns)
- This is called the **Fisher Effect**

Using the bond demand and supply model:

- Higher expected inflation lowers the expected return to bonds relative to real assets (commodities), decreasing bond demand
- Higher expected inflation lowers the *real* cost of borrowing for debtors, making it more attractive, raising bond supply



The combination of a higher bond supply and lower bond demand causes bond prices to fall, resulting in higher interest rates

- This is what underlies the Fisher Equation

Q: How can we observe expected inflation?
A: There are two ways to do this (for our purposes)

#1: In StockCharts.com, using Treasury Inflation Protected Security prices (i.e., inflation proof bonds), **TIP**, and bond prices, specifically the 20+ year bond prices, **TLT**, we use the relative strength of TIP to TLT, or **TIP:TLT**

As this ratio represents expected inflation, when TIP:TLT is declining, expected inflation is falling, and vice versa

- Note how expected inflation fell dramatically during the economic turmoil after the summer of 2008, bottoming at the end of 2008
- With all the fiscal and monetary stimulus, along with declining energy and commodity prices, expected inflation jumped sharply, recovering almost half of its decline
- You can use technical analysis on this ratio to determine support, resistance, etc.

Note the strong positive correlation between this measure of expected inflation and the ten-year government bond rate, which is consistent with the Fisher Equation

#2: TIPS Spreads

- Using the Fisher Equation, we can solve for expected inflation:

$$\pi^e = r_N - r_R$$

To obtain values for this, we use the TIP interest rate as $\mathbf{r_R}$, and a government bond of the same maturity for $\mathbf{r_N}$.

Example: For April 10, 2009, using Bloomberg.com data:

10-year government bond yield ($\mathbf{r_N}$) = **2.92%**
10-year TIP (Inflation Indexed Security) interest rate ($\mathbf{r_R}$) = **1.57%**

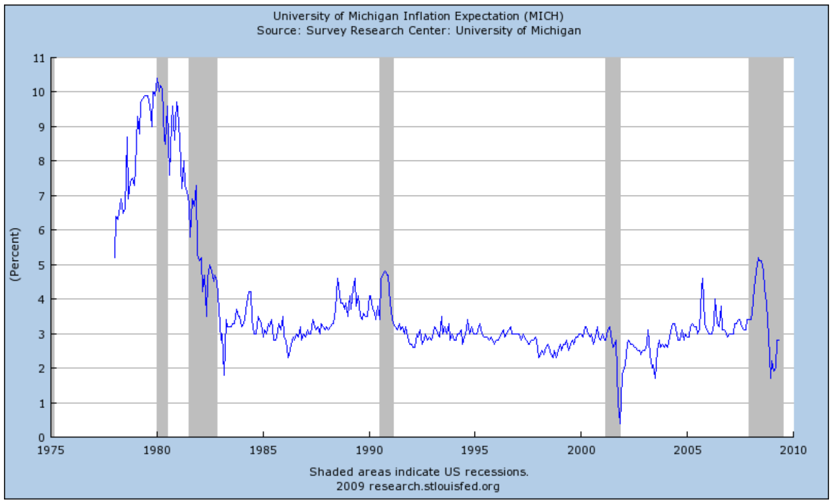
$$\pi^e = 2.92 - 1.57 = 1.35\%$$

Note how *we get specific values of expected inflation from this*. You can get time series data for both variables from FRED or Economy.com/freelunch.

#3: **Survey Data available from the Federal Reserve** (Federal Reserve Economic Data, or FRED)

On the FRED web site: http://research.stlouisfed.org/fred2/ , select **Business/Fiscal**, then **Other Economic Indicators**. Toward the very bottom (or at the bottom) is: **University of Michigan Inflation Expectation**. Select this (**MICH**). You will see a graph and other information (for example you can download historical data to a spreadsheet). Read the units for this series – *median price change expected over the next 12 months*.

- If you right click on the graph, you can either save it or copy it for use in a document. Doing this for July 1, 2009:



Note the sharp drop in inflationary expectations during the 2008 financial crisis. Through May of 2009, expected inflation moved from below 2% to around 2.8%.

2) Business Cycle Expansion

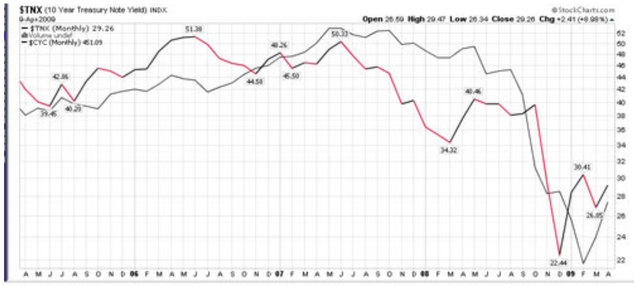
During expansions, income and wealth both rise, which increases bond demand, and the number of profitable investment opportunities also rises, causing a higher bond supply.

- **Higher bond demand: raises bond price**
- **Higher bond supply: lowers bond price**

As these two effects conflict, *technically* the impact of business expansion on bond prices (and interest rates) is indeterminate using this model

- We would need to know magnitudes of supply and demand shifts to resolve this indeterminacy.
- The strength of the expansion has a direct bearing on the magnitude of the rise in bond demand.
- While texts often omit this, expansions generally reduce federal/state/local funding needs, as their budgets tend toward surpluses, which reduces bond supply. So, the actual change in bond supply is likely to be less than what is normally considered.
- If public sector bond supply falls more than private sector supply rises, bond supply *in the aggregate* could actually fall, which would resolve the indeterminacy above.

In general, ***interest rates tend to be pro-cyclical***, so there is no indeterminacy in "the real world"



Using monthly data in StockCharts.com from 2005 – 2009, the relationship between cyclical performance (a proxy for income change) and the ten-year bond is generally positive (except for the first few months of 2009 with all the atypical events)

The relative strength of bonds (relative to the S&P 500) rose before the 2000 recession, continued after 9/11, and showed a double top in late 2002.

- Bonds underperformed stocks starting in 2003 through April of 2007 (due to economic growth)
- Bonds outperformed stocks starting in May 2007 (based on economic weakness)