Lecture 7: Fixed Income

FE-312 Investments

NORTHWESTERN
UNIVERSITY

Bonds

- Bonds are the simplest (and possibly oldest) type of financial security
- The are essentially a promise to pay back
  - a pre-specified amount (the principal)
  - at some point in the future (the maturity date)
  - along with perhaps some intermittent payments (the coupons)
- Sometimes bonds are backed by other assets (collateralized), which the lender can claim in case the borrower defaults.

Bonds are not risk-free securities

Major risks in bond investing:

- interest rate risk
- default (credit risk)
- inflation
- prepayment risk
- (il)liquidity risk

To start, we will focus on Treasury bonds

- Risks: interest rates, inflation

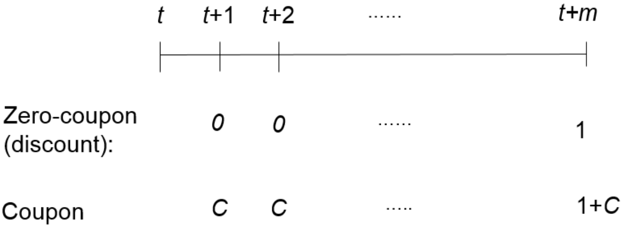
Treasury Bills, Notes, and Bonds

- Bills: issued with 1 year or less to maturity, zero coupon
- Notes: issued with 2-10 years to maturity, semi-annual coupon
- Bonds: issued with more than 10 years to maturity, semi-annual coupon

Treasury bonds

- US treasury bonds are a promise to pay a fixed principal on some date in the future plus biannual coupons
- We often study zero-coupon bonds
  - Single payment at maturity
- The treasury bond is often split into two parts – the coupons (strips) and the principal
  - Economically irrelevant – a coupon bond is just a portfolio of zeros

Fixed-income securities



A coupon bond is a portfolio of zero-coupon (discount) bonds

Bond pricing

- Pricing a bond is the same as any other asset:

$$P = \frac{c}{1+d} + \frac{c}{(1+d)^2} + ... + \frac{c+100}{(1+d)^n}$$

where

  - P is the price per \$100 of face value (a.k.a. par value or principal)
  - c is the coupon per period
  - d is the discount rate
  - n is the number of periods to maturity

- When auctioning bonds, the Treasury chooses the coupon so that P is as close as possible to 100. Bonds issued 'at par'
- *Bond prices and interest rates move in opposite directions*
  - "Treasury prices rose today" $\Longleftrightarrow$ "Treasury rates fell today"
  - Same as any other asset

Yield to maturity

- The yield to maturity on a bond is that discount rate which equates the present value of the bond's payments to its price.

- That is, it is the constant y that solves

$$P = \frac{c}{1+y} + \frac{c}{(1+y)^2} + \ldots + \frac{c+100}{(1+y)^n}$$

- The yield to maturity allows you to compare bonds of different maturity and coupon on an even basis. (It's like implied volatility for options.) It's just another more convenient way to rewrite the price.

- The yield curve or term structure of interest rates is the set of yields to maturity, at a given time, on bonds of different maturities

Standard yield curve shapes

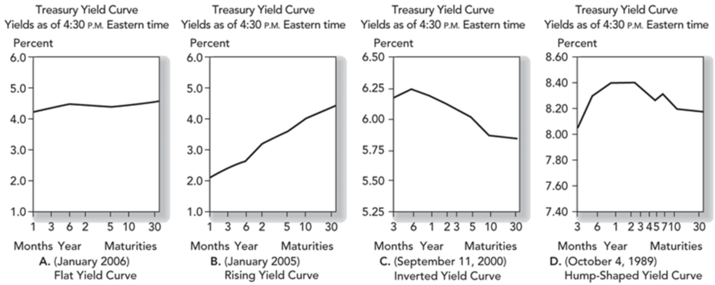


FIGURE 15.1 Treasury yield curves

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Yield to maturity vs returns

- The yield to maturity is NOT the same thing as the return to a bond.
- Even if the bond is held to maturity, this is not a riskless investment.
  - if you have a 10-year horizon, rolling over 30-day T-bills has interest rate risk
- Only a zero-coupon bond held to maturity is riskless!
- For a j-period zero-coupon bond, just a single payment

$$P_t = \frac{C_{t+j}}{(1+y)^j}$$

- What is the j-period return on this bond?

$$R_{t\to t+j} = \frac{C_{t+j}}{P_t} = (1+y)^j$$

- A j-period zero-coupon bond is the riskless asset for a j-period investor (ignoring inflation)

Prices, yields, and returns

- The **holding period return** is what you earn if you hold the bond for a single period (e.g. a month or a year)
- Returns will be determined by changes in yields (i.e. prices)
- Formula for the price of an n-period zero-coupon bond,

$$P_{n,t} = \frac{1}{(1+y_{n,t})^n}$$

The return is then

$$\begin{aligned} r_{n,t+1} &= \frac{P_{n-1,t+1}}{P_{n,t}} - 1 \\ &= \frac{(1+y_{n,t})^n}{\left(1+y_{n-1,t+1}\right)^{n-1}} - 1 \\ &\approx ny_{n,t} - (n-1)\, y_{n-1,t+1} \end{aligned}$$

Decomposing returns

$$
\begin{aligned}
r_{n,t+1} &= ny_{n,t} - (n-1)\, y_{n-1,t+1} \\
&= y_{n,t} + (n-1) \underbrace{\left(y_{n,t} - y_{n-1,t}\right)}_{\text{Slope of yield curve}} - (n-1) \underbrace{\left(y_{n-1,t+1} - y_{n-1,t}\right)}_{\text{Change in yields}}
\end{aligned}
$$

Return has three components

1. Current yield

2. Slope of yield curve (roll yield)
   - When the yield curve slopes up, your bond's yield falls over time and its price rises
3. Change in yields. This is where the risk comes from
   - The sensitivity of your return to changes in yields depend on the maturity (N) of the bond. More on this later.

Decomposing returns

$$\begin{aligned} r_{n,t+1} &= n y_{n,t} - (n-1)\, y_{n-1,t+1} \\ &= y_{n,t} + (n-1) \underbrace{\left(y_{n,t} - y_{n-1,t}\right)}_{\text{Slope of yield curve}} - (n-1) \underbrace{\left(y_{n-1,t+1} - y_{n-1,t}\right)}_{\text{Change in yields}} \end{aligned}$$

- If you see either high $y_{n,t}$ or high slope, long-term bonds look relatively attractive
- But the risk you face is that yields rise
- **Definition:** Forward rate is the rate you can lock in between two future periods, say $n-1$ and n. By the absence of arbitrage,

$$f_n = \frac{(1+y_n)^n}{(1+y_{n-1})^{n-1}} - 1 \approx y_n + (n-1)\,(y_n - y_{n-1})$$

Expectations Hypothesis

$$\begin{aligned} r_{n,t+1} - y_{1,t} &= y_{n,t} - y_{1,t} + (n-1)\left(y_{n,t} - y_{n-1,t}\right) - (n-1)\left(y_{n-1,t+1} - y_{n-1,t}\right) \\ &= f_{n,t} - y_{1,t} - (n-1)\left(y_{n-1,t+1} - y_{n-1,t}\right) \end{aligned}$$

- Expectations Hypothesis: Long yields are averages of expected short yields:

$$\begin{aligned} (1+y_{n,t})^n &= E_t\left[\left(1+y_{1,t}\right) \times \left(1+y_{1,t+1}\right) \times ... \times \left(1+y_{1,t+n-1}\right)\right] \\ y_{n,t} &\approx \frac{1}{n} E_t \sum_{j=0}^{n-1} y_{1,t+j} \end{aligned}$$

- Can then write:

$$E[r_{n,t+1} - y_{1,t}] = f_{n,t} - y_{1,t} - E_t\left[y_{1,t+n-1} - y_{1,t}\right]$$

- Expectations Hypothesis: Expected returns on all bonds should be the same (i.e. you should be indifferent to interest rate risk)
- If that is the case,

$$\begin{aligned} E[r_{n,t+1} - y_{1,t}] &= f_{n,t} - y_{1,t} - E_t\left[y_{1,t+n-1} - y_{1,t}\right] \\ 0 &= f_{n,t} - y_{1,t} - E_t\left[y_{1,t+n-1} - y_{1,t}\right] \\ f_{n,t} &= E_t\left[y_{1,t+n-1}\right] \end{aligned}$$

- Forward rates are expectations of future 1-yr yields.
- This can literally only be true of you are indifferent to interest rate risk!

The expectations hypothesis

Two ways to test it

- Do forward rates forecast future 1-yr yields?

$$y_{1,t+n-1} - y_{1,t} = a + b\left(f_{n,t} - y_{1,t}\right) + \varepsilon_{t+1}$$

Forecasting one-year rates, n years ahead. We should see $b = 1$

- Are expected returns on all bonds constant?

$$r_{n,t+1} - y_{1,t} = a + b\left(f_{n,t} - y_{1,t}\right) + \varepsilon_{t+1}$$

Forecasting one-year returns on n-period bonds. We should see $b = 0$

The expectations hypothesis

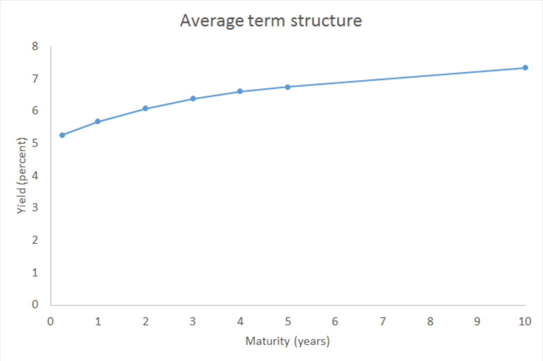
n	forecasting 1-yr returns on n-year bonds $r_{n,t+1} - y_{1,t}$			forecasting one year rates n years from now $y_{1,t+n-1} - y_{1,t}$		
	b	se	R^2	b	se	R^2
2	0.83	0.27	0.11	0.17	0.27	0.01
3	1.14	0.35	0.13	0.53	0.33	0.05
4	1.38	0.43	0.15	0.84	0.26	0.14
5	1.05	0.49	0.07	0.92	0.17	0.17

- High slope of the term structure forecasts high bond returns
- It **does not** forecast increases in future rates in the short end.
- Similar pattern as d/p and market returns...

The expectations hypothesis

Another way to see this is

- The term structure is upward sloping on average
- but people cannot always expect interest rates to rise!



Measuring price sensitivity to yields

- We saw that for zero-coupon bonds, their sensitivity to changes in yields is only a function of their maturity. What about coupon bonds?

- It turns out, the appropriate object to focus on is a *weighted* maturity

$$D = \frac{\sum_{j=1}^{n} j \times \frac{c_j}{(1+y)^j}}{\sum_{j=1}^{n} \frac{c_j}{(1+y)^j}}$$

  which is also called the bond's 'duration'

- To a first order approximation, duration measures the sensitivity of the price of a bond to changes in its yields: if its yield changes by Δr, your return will be

$$\frac{\Delta P}{P} \approx -\frac{D}{1+y} \times \Delta y$$

- For a zero-coupon bond with maturity T, $D = T$

Duration is an interest rate beta

- Duration measures the 'beta' of a bond with respect to changes in interest rates
- Which interest rate? Technically the yield to maturity
- It is a complete characterization of the risk of the bond only if all interest rates move in parallel.
- Empirically, that need not the case.
- One way to summarize the movements in the term structure is using a factor model.

A three-factor model for bond yields

- Litterman and Scheinkman (1991) show that a 3 factor model accounts for almost all of the risk in bond returns:

$$r_{n,t} = a_0 + b_{n,L} f_{L,t} + b_{n,S} f_{S,t} + b_{n,C} f_{C,t} + \varepsilon_{n,t}$$

- The three factors—level, slope, and curvature—explain over 97% of the variation in *realized* bond returns.

- How are the factors uncovered? By utilizing a statistical technique named 'principal components analysis' that seeks to approximate the correlation matrix of a set of variables using a small number of 'factors'

- The resulting factors are linear combinations of the underlying return series. You should think of PCA as a theory-free way of summarizing the correlations in the data.

A three-factor model for bonds

```
. use bonds, clear
. pca tmretadj*

Principal components/correlation                  Number of obs    =        888
                                                  Number of comp.  =          7
                                                  Trace            =          7
    Rotation: (unrotated = principal)             Rho              =     1.0000

    --------------------------------------------------------------------------
       Component |   Eigenvalue   Difference         Proportion   Cumulative
    -------------+------------------------------------------------------------
           Comp1 |      5.82878      5.00285             0.8327       0.8327
           Comp2 |      .825935      .646162             0.1180       0.9507
           Comp3 |      .179773      .110636             0.0257       0.9764
           Comp4 |     .0691366      .022832             0.0099       0.9862
           Comp5 |     .0463046      .018898             0.0066       0.9928
           Comp6 |     .0274067    .00474615             0.0039       0.9968
           Comp7 |     .0226605            .             0.0032       1.0000
    --------------------------------------------------------------------------

Principal components (eigenvectors)

    ------------------------------------------------------------------------------------------------
        Variable |    Comp1     Comp2     Comp3     Comp4     Comp5     Comp6     Comp7 | Unexplained
    -------------+----------------------------------------------------------------------+------------
     tmretadj112 |   0.3241    0.6377    0.4610    0.2527    0.4216    0.1743   -0.0618 |           0
     tmretadj212 |   0.3721    0.4468    0.0072   -0.2105   -0.6536   -0.4259    0.0949 |           0
     tmretadj512 |   0.4005    0.0982   -0.4458   -0.3184   -0.0585    0.7171    0.1103 |           0
     tmretadj712 |   0.4008   -0.0496   -0.4521   -0.1827    0.5654   -0.5142   -0.1224 |           0
    tmretadj1012 |   0.3926   -0.2248   -0.2365    0.8339   -0.1945    0.0069    0.0783 |           0
    tmretadj2012 |   0.3808   -0.3782    0.3466   -0.1505   -0.1533    0.0880   -0.7334 |           0
    tmretadj3012 |   0.3692   -0.4337    0.4564   -0.1974    0.1031   -0.0416    0.6450 |           0
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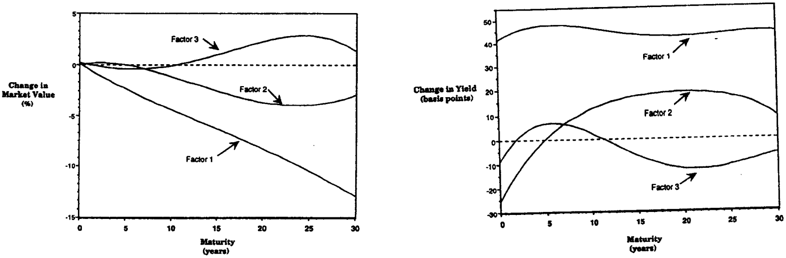
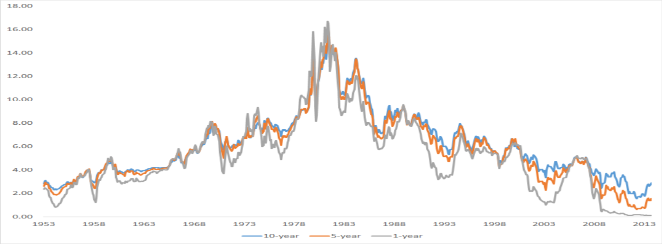
A three-factor model for bonds

FIGURE 1 ▪ Factor Loadings

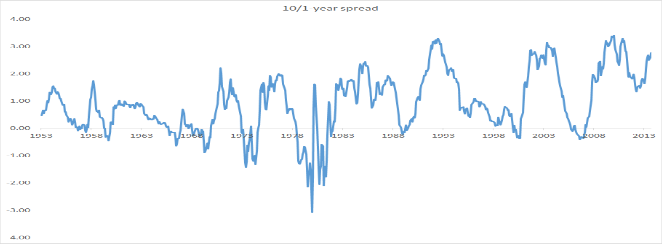


- The first factor is a 'level' factor, so factor betas are decreasing with maturity. It explains most of the variation in returns (83%)
- The second factor is a slope factor; hence long-term bonds have the largest exposure.
- The third factor is a curvature factor.

1-, 5-, and 10-year yields



10/1-year yield spread



What determines bond returns?

- The three factors (level, slope, curvature) are a statistical description of the data.
- What are the economic forces that determine bond returns?
  - inflation
  - economic growth
  - monetary policy

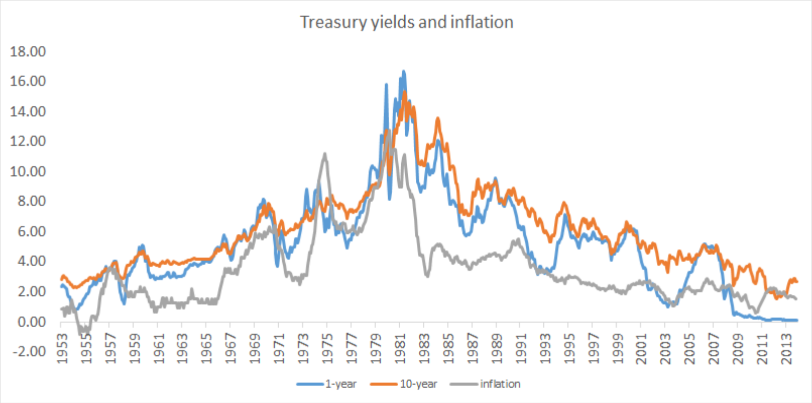
Real vs nominal rates

- Bonds are promises to pay in nominal amounts.
- This implies that their payments are risky in real terms!
- The nominal rate can be written as

$$i_t = E[\pi_{t+1}] + r_t$$

  where
  - r_t is the *real* interest rate
  - $E[\pi_{t+1}]$ is expected inflation
- This suggests that inflation should be a first-order determinant of all nominal yields

Treasury yields and inflation



- Inflation and yields are fairly persistent variables, but inflation seems to capture a lot of the level movements in yields

Treasury yields and economic growth

- The term spread is a counter-cyclical indicator of future economic activity: low (especially negative) term spreads forecast economic slowdowns
- Recessions since 1965 (see www.nber.org/cycles.html)
  - Dec 1969 – Nov 1970
  - Nov 1973 – Mar 1975
  - Jul 1981 – Nov 1982
  - Jul 1990 – Mar 1991
  - Mar 2001 – Nov 2001
  - Dec 2007 – Jun 2009
- All preceded by an inverted yield curve

Treasury yields and economic growth

- One way to understand this is to go back to the consumption CAPM
- Recall, it implies that:

$$E_t\left[\beta^j \frac{u'(C_{t+n})}{u'(C_t)}(1+y_{t,n})^n\right] = 1$$

- Using CRRA $u'(C) = c^{-\gamma}$, we can derive an approximate relation:

$$y_{n,t} \approx -\ln\beta + \gamma E_t[c_{t+n} - c_t]$$

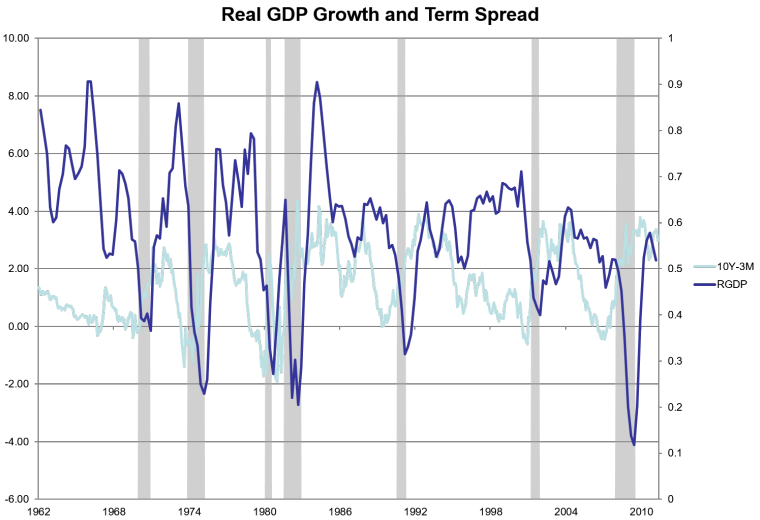
- The n-period zero coupon yield depends among other things, expected economic (consumption) growth
- This is because of consumption smoothing: if households anticipate high consumption growth in the future, they would like to borrow against the future to enjoy higher consumption today.
- We can't all borrow (bonds are in zero net supply) so rates have to increase.

- This becomes more powerful in terms of differences in yields

$$y_{n,t} \approx -\ln\beta + \gamma E_t[c_{t+n} - c_t]$$
$$y_{n,t} - y_{3m,t} \approx \gamma E_t[c_{t+n} - c_t] - \underbrace{\gamma E_t[c_{t+3m} - c_t]}_{\approx 0}$$

- If long yields are high relative to the short rate, this suggests that investors anticipate higher future growth

Treasury yields and economic growth



The central bank and the term structure

- Monetary policy also plays an important role
- The Fed conducts policy by managing very short-term interest rates (the Fed Funds rate on an overnight loan)
- However, the Fed's actions can affect the entire yield curve:
- Monetary policy has an effect on
  - inflation
  - economic growth
  - future interest rates (beliefs about future monetary policy)

The Fed's goal

- The Federal reserve is a quasi-governmental entity created by an act of congress (technically: a Federal instrumentality)
- Congress requires that the Fed manage the money supply to *maintain stable prices and maximum employment*
  - Stable prices is interpreted as low and stable inflation (∼2%)
  - Maximum employment is unemployment as low as possible without raising inflation (4-6%)
- The Fed controls lending to banks, the money supply, and may buy and sell government securities
  - Also regulates certain banks (macroprudential regulation)

The Fed's tool

- The Fed controls short-term interest rates
- Much of macroeconomics studies how interest rates affect the economy
- **In general, raising interest rates will:**
  1. Lower output and employment
     - Firms invest less, therefore employ fewer people and produce less
  2. Lower inflation
     - Slack labor markets mean there is no price pressure

The Fed's policy function

- In the US, monetary policy is well explained by the **Taylor Rule**. That is, the Fed sets interest rates depending on inflation and output:

$$i = i^* + 1.5 \times \left(\pi - \pi^*\right) + 0.2 \times \left(q - q^*\right)$$

  where
  - i is the interest rate
  - π is inflation,
  - π^* is the inflation target,
  - $q - q^*$ is the deviation of aggregate output from its trend (output gap)
  - i^* is the steady-state interest rate

- The Taylor rule implies
  - If output is below trend, the Fed cuts interest rates
  - If inflation is above target, the Fed raises interest rates
  - If output is low and inflation is high (the late 1970's), we're in trouble

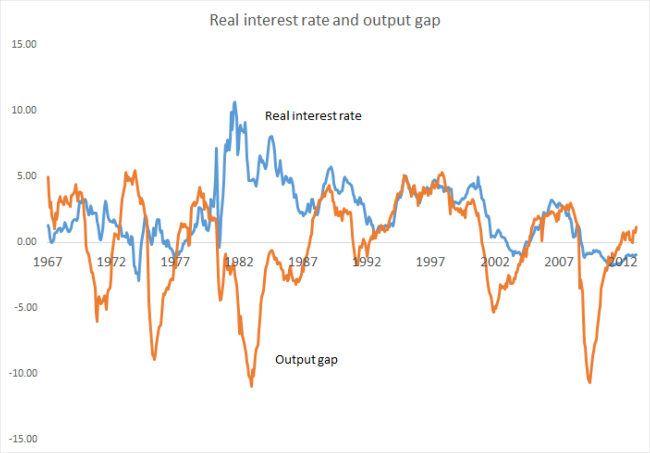
- Given the Taylor rule, the real interest rate is

$$\begin{aligned} i_{real} &= i - \pi \\ &= i^*_{real} + 0.5 \times \left(\pi - \pi^*\right) + 0.2 \times \hat{q} \end{aligned}$$

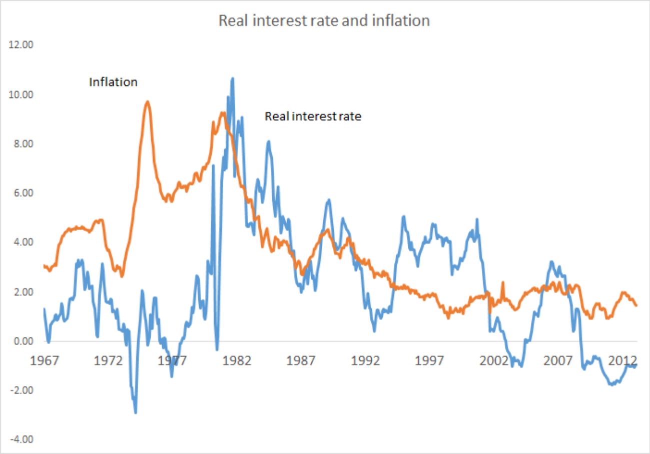
- Real interest rate varies positively with inflation and the output gap

- The nominal interest rate should be strongly related to inflation

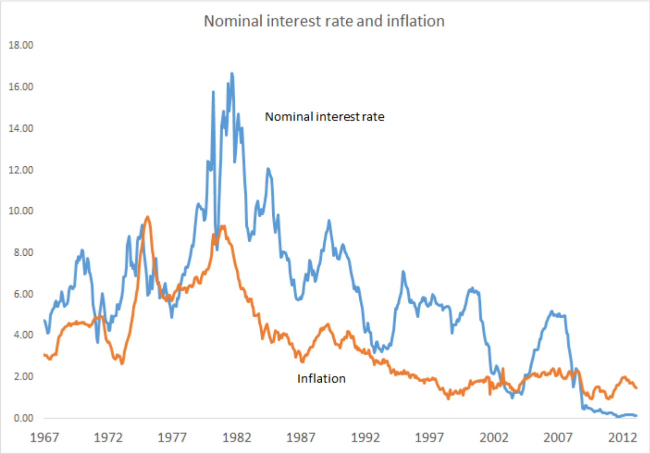
Real interest rate and output gap



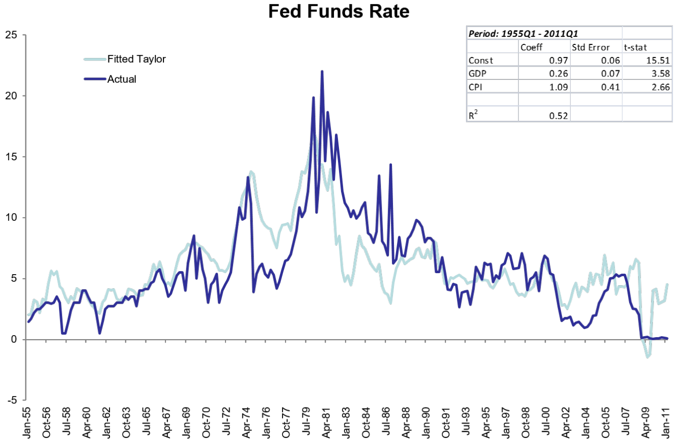
Real interest rate and inflation



Nominal interest rate and inflation



Taylor rule



Period: 1955Q1 - 2011Q1			
	Coeff	Std Error	t-stat
Const	0.97	0.06	15.51
GDP	0.26	0.07	3.58
CPI	1.09	0.41	2.66
R^2	0.52		

Factors driving bond yields: Summary

- Variation in bond yields reflects market's beliefs about inflation, economic growth and monetary policy
- In addition, bond prices contain risk premia compensating investors for the above factors
- A large term structure literature beginning with Ang and Piazzesi (2003) finds:
  - Inflation and output account for 85% of the variation of short-term interest rates, but only 40% of long-term bond yields
  - The term spread is very sensitive to expected inflation and inflation risk premiums
  - Bond prices contain valuable information for forecasting future GDP
  - Monetary policy risk is priced in long-term bonds
- But, macro factors (and the Fed) do not account for all yield curve movements. Liquidity?

Default risk

- So far, we have assumed away the possibility of default risk, that is the probability that the loan is not repaid.

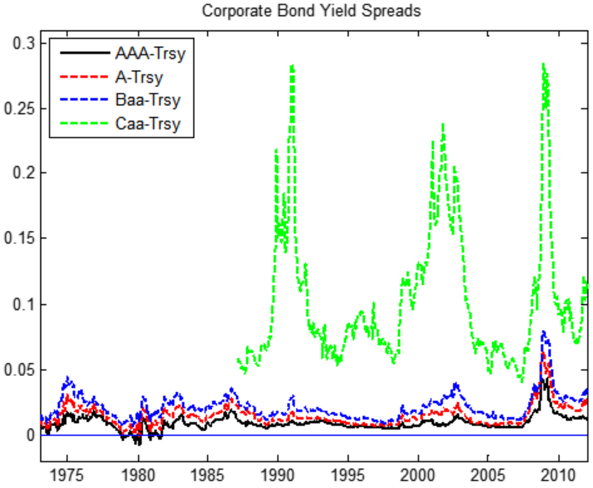
- Consider a bond issued by XYZ corporation, that promises to pay \$100 in one year. It's price P and yield y still satisfy

$$P = \frac{100}{1+y}$$

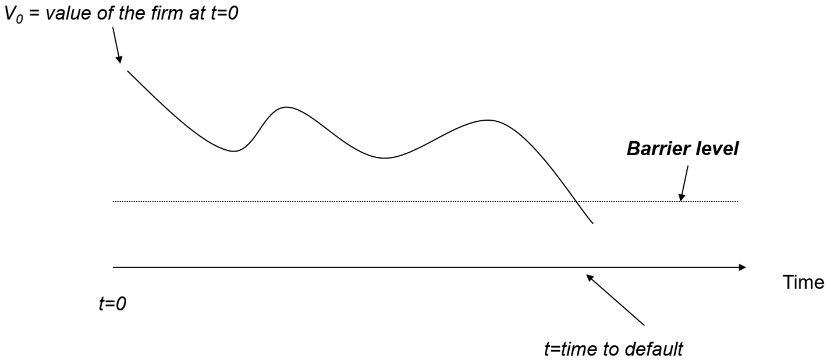
  except now the yield to maturity can no longer interpreted as the return to maturity.

- Rather, it is the return to maturity *conditional on no default.*

Credit spreads are quite volatile

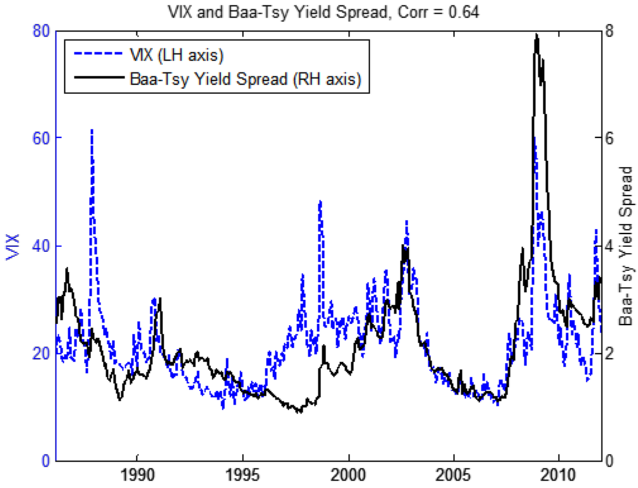


Structural models of default

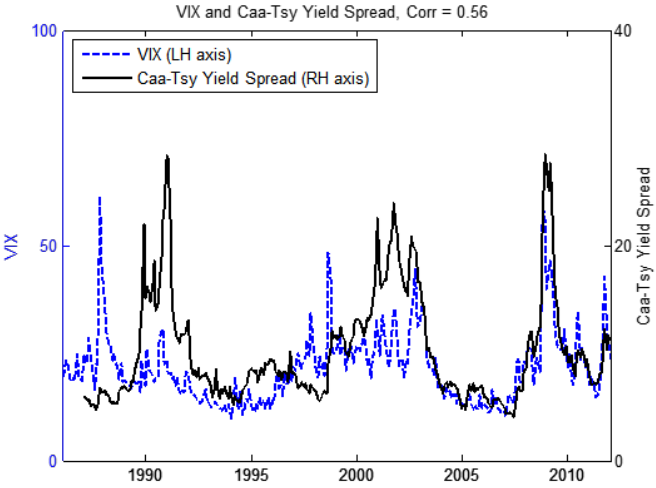


- In structural models of default (originally due to Merton (1974)), the firm enters bankruptcy when the firm's value crosses a default boundary (originally exogenous but in later models this is endogenous).
- The bond is a put option on the firm's assets. Hence its price falls with volatility.

Credit spreads comove with Volatility



Credit spreads comove with Volatility



Default Risk

- Suppose that if the bond defaults, you can recover a fraction f of the principal. Recalling our discussion in Lecture 5, we can write the price of the bond today in terms of risk-neutral expectations

$$\begin{aligned} P &= E[mX] \\ &= E^Q\left[\frac{X}{1+r_f}\right] \\ &= \underbrace{\left(\frac{1-q}{1+r_f}+\frac{qf}{1+r_f}\right)}_{\frac{1}{1+y}}\times 100 \end{aligned}$$

- If the recovery rate is zero ($f=0$) then

$$1+y=\frac{1+r_f}{1-q}\approx 1+r_f+q$$

- The yield to maturity is equal to the risk-free rate for the same period, plus the **risk-neutral** probability of default.

Recovery Rates

(Moody's: 1982 to 2006)

Class	Mean (%)
Senior Secured	54.44
Senior Unsecured	38.39
Senior Subordinated	32.85
Subordinated	31.61
Junior Subordinated	24.47

Cumulative Average Default Rates (%)

(1970-2006, Moody's)

	1	2	3	4	5	7	10
Aaa	0.000	0.000	0.000	0.026	0.099	0.251	0.521
Aa	0.008	0.019	0.042	0.106	0.177	0.343	0.522
A	0.021	0.095	0.220	0.344	0.472	0.759	1.287
Baa	0.181	0.506	0.930	1.434	1.938	2.959	4.637
Ba	1.205	3.219	5.568	7.958	10.215	14.005	19.118
B	5.236	11.296	17.043	22.054	26.794	34.771	43.343
Caa-C	19.476	30.494	39.717	46.904	52.622	59.938	69.178

- The table shows the *actual* probability of default for companies starting with a particular credit rating
- A company with an initial credit rating of Baa has a probability of 0.181% of defaulting by the end of the first year, a cumulative probability of 0.506% by the end of the second year, and so on

CDOs simplified

- During the financial crisis of 2008/09, collateralized debt obligations (CDOs) played an important role.
- Consider a 'firm' whose assets are a portfolio of risky debt, e.g.,
  - Corporate bonds
  - Mortgages
  - Student loans
  - Credit card debt
- CDOs are claims (resembling debt and equity) on the realized return of the portfolio.
- This was a highly profitable (for the banks) exercise. What was the value added? The banks claimed to be exploiting the benefits of diversification.

CDOs simplified

- Assume $f = 0$. We can write the realized return on a bond as:

$$R = \frac{100}{P} \times (1 - D) = (1 + y) \times (1 - D)$$

where $D = 1$ in the event of default and zero otherwise

- Now suppose you invest in a diversified portfolio of bonds with the same yield

$$\frac{1}{N}\sum_{i=1}^{N} R_i = (1 + y) \times \left(1 - \frac{1}{N}\sum_{i=1}^{N} D_i\right)$$

- A common assumption was the *default was uncorrelated across firms*.
- If that is the case, the *Law of Large Numbers impies* $\frac{1}{N}\sum_{i=1}^{N} D_i \to p$ as $N \to \infty$, where p is the *actual* probability of default.

CDOs simplified

- If default was truly an idiosyncratic event, the return to the portfolio can be written as

$$\frac{1}{N}\sum_{i=1}^{N} R_i = (1+y)\times(1-p) = (1+r_f)\frac{1-p}{1-q}$$

- In this case, the portfolio return is riskless when N is large.
- It will also be higher than the risk-free rate if $q > p$.
- 'Ratings arbitrage': Banks would select bonds with high yields (i.e. q) relative to their credit rating (i.e. p)

CDOs simplified

- The above description is a simplified version of what happened. In reality, banks did understand that default events were correlated.
- But evidence suggests that they did underestimate the extent of these correlations.
- Why? One possibility was that the overly relied on historical data.
  - Correlations tend to rise in bad times
  - Are historical default rates on mortgages originated in the 1990's and early 2000's representative of subprime mortgages?
- Banks would issue different claims on these portfolios; these claims were then rated by Moody's and S&P based on the likelihood that they would deliver less than the promised yield.

Default risk is not idiosyncratic

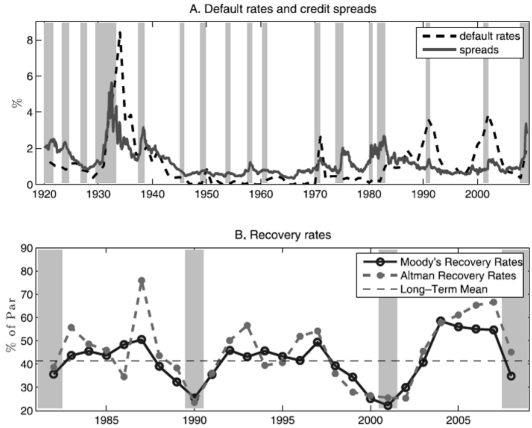
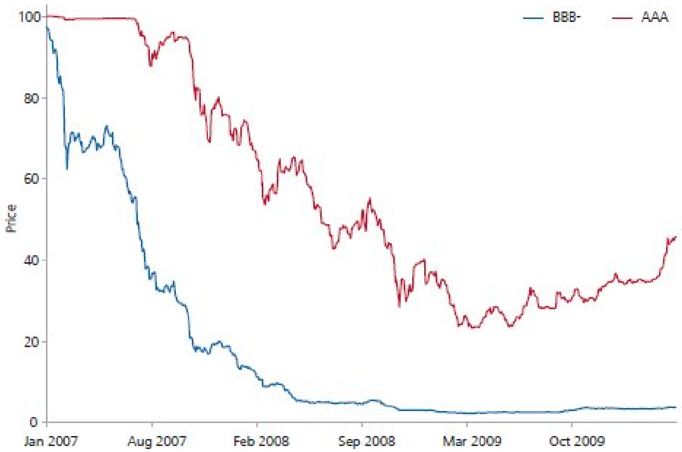


Figure 1. Default rates, credit spreads, and recovery rates over the business cycle. Panel A plots the Moody's annual corporate default rates during 1920 to 2008 and the monthly Baa-Aaa credit spreads during 1920/01 to 2009/02. Panel B plots the average recovery rates during 1982 to 2008. The "Long-Term Mean" recovery rate is 41.4%, based on Moody's data. Shaded areas are NBER-dated recessions. For annual data, any calendar year with at least 5 months being in a recession as defined by NBER is treated as a recession year.

CDOs were not riskless

Figure 2. **ABX-HE 06-01 AAA and BBB- index prices**



Source: Markit.

Adverse selection was an issue...

Table 2: S&P Downgrade Severity by Rating at the Start of the Performance Observation Period
This table shows the mean number of fine rating notches that a security was downgraded by S&P. Each row corresponds to the security rating at the end of 207H1.

Downgrade as of Jul 1 2008

Rating at end of 2007H1	Not in a CDO	Collateral in a non-synth CDO	Reference asset in a synth CDO	Both collateral and a reference asset
AAA	0.16	0.28	0.39	0.52
AA	1.42	3.03	3.11	3.86
A	2.10	4.79	5.40	5.83
BBB	2.94	3.75	5.74	5.13
BB and below	2.30	2.88	5.80	5.14

Downgrade as of Jul 1 2009

Rating at end of 2007H1	Not in a CDO	Collateral in a non-synth CDO	Reference asset in a synth CDO	Both collateral and a reference asset
AAA	2.41	5.36	4.21	5.36
AA	4.08	7.62	8.85	8.90
A	4.37	8.47	9.44	9.86
BBB	5.13	7.14	8.86	8.99
BB and below	4.64	5.75	7.36	7.30

Downgrade as of Jun 1 2010

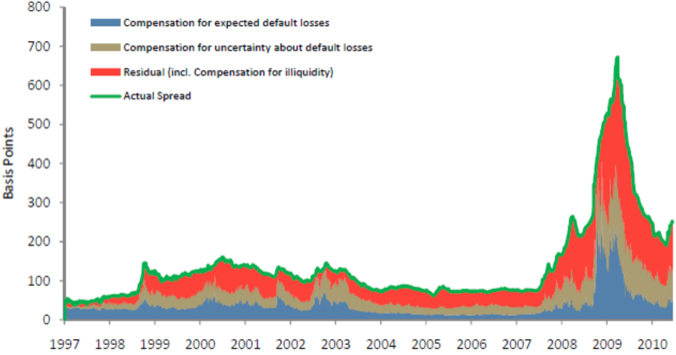
Rating at end of 2007H1	Not in a CDO	Collateral in a non-synth CDO	Reference asset in a synth CDO	Both collateral and a reference asset
AAA	6.00	12.36	8.88	9.89
AA	8.07	12.65	14.01	13.67
A	8.07	12.49	12.45	13.06
BBB	7.85	10.70	11.14	11.44
BB and below	6.31	8.13	8.97	8.76

Source: Faltin-Traeger and Mayer, 2011

Credit Risk: Summary

- Credit spreads are quite volatile. This reflects the fact that default is not an idiosyncratic event: firms default more in bad times.
  - Long-run average defaults are 1.5%, but there are pronounced waves. Default rates are over 15% during the 1870s (railroad boom and crash), over 6% during the 1930s (Great Depression), and 3% during 2001-2002 (Dot-com bust).
  - Average credit spreads are 1.53%. Combined with a 50% loss rate, the average 1.5% default rate represents average credit losses of 0.75%. Thus, there is an average premium of around 80bp for default risk.
- But spreads are also too volatile: Variables that should measure changes in default and recovery rates explain only a minority (25%) of movements of credit spreads (see Collin-Dufresne, Goldstein and Martin (2001)). These variables include leverage, term spread and curvature, VIX, stock returns, and option smirks.

Credit Spread Puzzle



- Credit spreads not only move too much, but they are also 'too high'

Summary

- Bonds are promises to repay a pre-specified amount.
- Hence, their prices are sensitive to changes in interest rates and the likelihood of default.
- Yields of different maturities move together, but the yield curve often changes slope.
- Movements in the curve reflect expectations of inflation, economic growth, monetary policy, and risk premia.
- But these factors do not capture all the variation in yields. Perhaps role for liquidity and demand/supply effects.