Commerce 374
Winter 2007

# Homework 5 – Suggested Answers

**Problem 1: Multiple Choice**

1) A 1% decline in yield will have the least effect on the price of the bond with a
   - **A) 10-year maturity, selling at 80**
   - B) 10-year maturity, selling at 100
   - C) 20-year maturity, selling at 80
   - D) 20-year maturity, selling at 100

2) Yields on municipal bonds are typically _____ yields on corporate bonds of similar risk and time to maturity.
   - **A) lower than**
   - B) higher than
   - C) identical to
   - D) unrelated to

3) Consider two bonds, A and B. Both bonds presently are selling at their par value of $1,000. Each pays interest of $120 annually. Bond A will mature in 5 years while bond B will mature in 6 years. If the yields to maturity on the two bonds change from 12% to 14%, _____
   - A) both bonds will increase in value but bond A will increase more than bond B
   - B) both bonds will increase in value but bond B will increase more than bond A
   - C) both bonds will decrease in value but bond A will decrease more than bond B
   - **D) both bonds will decrease in value but bond B will decrease more than bond A**

4) A coupon bond which pays interest of $50 annually, has a par value of $1,000, matures in 5 years, and is selling today at $84.52 discount from par value. The current yield on this bond is _____
   - A) 5.00%
   - **B) 5.46%**
   - C) 5.94%
   - D) 6.00%

5) A coupon bond pays semi-annual interest is reported as having an ask price of 117% of its $1,000 par value in the WSJ. If the last interest payment was made 2 months ago and the coupon rate is 6%, the invoice price of the bond will be _____
   - A) $1,140
   - B) $1,170
   - **C) $1,180**
   - D) $1,200

6) You purchased a 5-year annual interest coupon bond one year ago. Its coupon interest rate was 6% and its par value was $1,000. At the time you purchased the bond, the YTM

was 4%. If you sold the bond after receiving the first interest payment and the bond's YTM had changed to 3%, your annual total rate of return on holding the bond for that year would have been _____

A) 5.00%
B) 5.51%
**C) 7.57%**
D) 8.95%

7) _____ is a true statement about convertible bonds.

A) The yield on a convertible will typically be lower than the yield on a similar non-convertible bond
B) A convertible bond will generally have a lower market value than a bond which is callable; but similar in every other respect
C) Convertible bonds are typically secured by specific assets of the issuing company
**D) A convertible bond can be valued as a straight bond with an attached option**

8) A bond will sell at a premium when _____

**A) its coupon rate is greater than its current yield and its current yield is greater than its yield to maturity**
B) its coupon rate is greater than its current yield and its current yield is less than its yield to maturity
C) its coupon rate is less than its current yield and its current yield is greater than its yield to maturity
D) its coupon rate is less than its current yield and its current yield is less than its yield to maturity

9) All other things equal, which of the following has the longest duration?

A) a 15 year bond with a 10% coupon
B) a 20 year bond with a 9% coupon
**C) a 20 year bond with a 7% coupon**
D) a 10 year zero coupon bond

10) An increase in a bond's yield to maturity results in a price decline that is _____ the price increase resulting from a decrease in yield of equal magnitude.

A) greater than
B) equivalent to
**C) smaller than**
D) The answer is indeterminate

11) Interest rate risk increases as a bond's _____

A) coupon rate increases
**B) coupon rate decreases**
C) maturity decreases
D) default risk increases

12) Which set of conditions will result in a bond with the greatest price volatility?

A) a high coupon and a short maturity
B) a high coupon and a long maturity
C) a low coupon and a short maturity
**D) a low coupon and a long maturity**

13) A bond presently has a price of $1,030. The present yield on the bond is 8.00%. If the yield changes from 8.00% to 8.10%, the price of the bond will go down to $1,020. The duration of this bond is _____

A) -10.5
B) -8.5
C) 9.7
**D) 10.5**

14) A bank has $50 million in assets, $47 million in liabilities and $3 million in shareholder's equity. If the duration of its liabilities is 1.3 and the bank wants to immunize its net worth against interest rate risk and thus set the duration of equity equal to zero, it should select assets with an average duration of _____.

**A) 1.22**
B) 1.50
C) 1.60
D) 2.00

15) A bond pays annual interest. Its coupon rate is 7%. Its value at maturity is $1,000. It matures in three years. Its yield to maturity is presently 8%. The duration of this bond is _____.

A) 2.60
B) 2.73
**C) 2.81**
D) 3.00

16) An 8%, 30-year bond has a yield to maturity of 10% and a modified duration of 8.0 years. If the market yield drops by 15 basis points, there will be a _____ in the bond's price.

A) 1.15% decrease
**B) 1.20% increase**
C) 1.53% increase
D) 2.43% decrease

17) To create a portfolio with a duration of 4 years, using a 5-year zero coupon bond and a 3-year 8% annual coupon bond with a yield to maturity of 10%, one would have to invest _____ of the portfolio value in the zero-coupon bond.

A) 50%
**B) 55%**
C) 60%
D) 75%

**Problem 2.**
*You own a $1,000 face value bond with three years to maturity. The bond makes annual coupon payments of $75, the first to be made one year from today. The bond is currently priced at $975.48. Given an appropriate discount rate of 10%, should you hold or sell the bond?*

To answer this question we have to understand that what you currently observe is a market price of the bond. Now, your job is to calculate the intrinsic value of this bond using the numbers provided. If it turns out that IV>Current price it probably means that the bond is underpriced and you should buy it. Otherwise, if IV<Market price the bond is overpriced and you should rush and sell the bond if you have it or not to buy at all if you have not done it so far.

To be more precise, doing calculations:
IV = $937.83 (In calculator: n = 3, i=10%, PMT=75; FV = 1,000 => IV=PV=?)
Clearly, it is less than $975.48, which means that the bond is overpriced and you should look for a better opportunity with some other fixed-income asset.

**Problem 3.**
*The term structure is flat at a rate of 6% (semi-annual). You are currently managing the portfolio of bonds listed below (all coupons paid semi-annually):*

*Long $500 worth of 6.5% coupon bonds t = 4 (maturity date, in years)*
*Long $1,000 worth of 7.0 % coupon bonds t = 3*
*Short $1,000 worth of 8.5% coupon bonds t = 5*

*a) If interest rates rise by .5%, what is the estimated effect of that change on the value of your portfolio (in percent)?*

Using semi-annual compounding:
MD (6.5% coupon bond) = 3.3368
MD (7% coupon bond) = 2.5831
MD (8.5% coupon bond) = 3.8739

Weight (6.5% coupon bond) = 500/(500+1000-1000) = 1
Weight (7% coupon bond) = 1000/(500+1000-1000) = 2
Weight (8.5% coupon bond) = -1000/(500+1000-1000) = -2

Hence, the modified duration of our portfolio is:
MD (portfolio) = 1*MD(6.5% coupon bond) + 2*MD(7% coupon bond) - 2*MD(8.5% coupon bond) = 0.7552

Finally, using the standard equation the change in the value of the portfolio will be:
$\Delta P/P$ = -MD(portfolio) *$\Delta y$ = -0.7552*.5% = -0.3776%

*b) You wish to reconfigure the relative positions in the 6.5% and 7.0% bonds to make your portfolio insensitive to small rate changes. How would you accomplish this goal? Assume that the weight of 8.5% coupon bond in the portfolio after rebalancing remains the same. Hint: Note, that in such a case there is no problem of cash flow matching; hence, the duration of the portfolio should be set to 0.*

To make your portfolio insensitive to the rate changes you have to find the portfolio with the duration equal to 0. Since, we know that the highest maturity bond will have the same weight in this portfolio the only two weights to be found are the weights on the shorter maturity bonds. If we denote the first weight by w1 and the other one by w2, then we would have the following two equations:
w1*3.3368 + w2*2.5831 -2*3.8739 = 0

Since the weights have to sum up to 1, we can also have the equation:
w1 + w2 -2 =1
Solving this system of two equations with two unknowns we get the solution:
w1 = 0.002 and w2= 2.998.

*c) One of these weights (8.5% bond) is negative. What problems might this cause in implementing your strategy?*

It means that we have to short the bond. In reality, this may be costly in some markets (liquidity reasons) or indeed may even be illegal.

**Problem 4.**
*Your client is concerned about the apparent inconsistency between the following two statements:*

- *Short-term interest rates are more volatile than long-term rates*
- *The rates of returns of long-term bonds are more volatile than returns on short-term securities*

*Discuss why these two statements are not necessarily inconsistent.*

While it is true that short-term rates are more volatile than long-term rates, the longer duration of the longer-term bonds makes their rates of return more volatile. The higher duration magnifies the sensitivity to interest-rate savings. Thus, it can be true that *rates* of short-term bonds are more volatile, but the *prices* of long-term bonds are more volatile.

**Problem 5.**
*Long-Term Capital Management was a prominent hedge fund of Greenwich, Conn, whose partners included two Nobel Prize winners. In September 1998, a cash infusion of $3.5 billion from a consortium of commercial banks and investment firms rescued this hedge fund with the support from the Federal Reserve Bank of New York.*

*Among the many strategies employed by the firm was one in which Treasury Bonds were short-sold and the proceeds of these sales were used to purchase higher yielding (and higher risk) mortgage-backed or corporate debt securities. The strategy – known as playing a credit spread – generates huge profits as long as bond yields remain stable. But since the stock market began plunging in July of 1998, investors fled for cover in the quality of liquid U.S. government securities and required higher risk premia on all risky assets. This question analyzes the risk of this investment strategy in a highly stylized example.*

*Suppose in September 1997, the fund was invested in the following two positions:*

- *A long position of 1,000,000 less liquid fixed-income securities (LLS) (such as off-the-run Treasury securities, mortgage-backed securities, corporate bonds, etc.) maturing in 5 years with an annual interest payment of 7.5% (each bond has a face value of $100,000).*
- *A short position of 950,000 Treasury securities (TS) maturing in 5 years with an annual interest payment of 6.5% (each bond has a face value of $100,000).*

*The table summarizes the yield curve of zero-coupon bonds in September 1997 and September 1998:*

| | *September 1997* | | *September 1998* | |
|---|---|---|---|---|
| *Maturity* | *TS* | *LLS* | *TS* | *LLS* |
| *1 Year* | *5.50%* | *6.50%* | *4.50%* | *7.50%* |
| *2 Years* | *5.75%* | *6.75%* | *4.75%* | *7.75%* |
| *3 Years* | *6.00%* | *7.00%* | *5.00%* | *8.00%* |
| *4 Years* | *6.25%* | *7.25%* | *5.25%* | *8.25%* |
| *5 Years* | *6.50%* | *7.50%* | *5.50%* | *8.50%* |

*a. What are the market values of the two bonds in September 1997? What is the equity value of the hedge fund?*

The two bonds are worth:

$$V^{TS} = \frac{6{,}500}{(1.055)} + \frac{6{,}500}{(1.0575)^2} + \cdots + \frac{106{,}500}{(1.065)^5} = 100{,}295$$

$$V^{LLS} = \frac{7{,}500}{(1.065)} + \frac{7{,}500}{(1.0675)^2} + \cdots + \frac{107{,}500}{(1.075)^5} = 100{,}264$$

The hedge fund owns a long position in 1 million low-liquidity bonds and a short position of high-liquidity bonds. Thus, the value of the hedge fund was 100.295-0.95*(100.264)=$5.045 billions.

Questions b and c look at the situation in September 1998 under two possible scenarios. In the first scenario the yield curve does not change and in the second scenario the yield spread increases. Assume that the hedge fund does not adjust its positions between September 1997 and September 1998. Thus, the fund still holds in 1998 the bonds it purchased or short-sold in 1997. Assume that the bonds just paid a

coupon payment in early September 1998 and that they have now a remaining maturity of 4 years.

b. *Suppose that the yield curve does not change and is the same in September 1998 as it was in September 1997. For example, in September 1998, a Treasury bond with a maturity of one year has a yield of 5.5%. What are the current market values of the two bonds? How high are the net interest receipts of the fund? What is the value of the fund?*

   The fund receives $7.5 billion coupon payments from its long bonds and it needs to pay $6.175 billion (=0.95*6.5) coupon payments from its short bonds. Thus, the net interest income is $1.325 billion.

   Moreover, the hedge fund owns a long position in 1 million low-liquidity bonds and a short position of high-liquidity bonds. The values of these two bonds are $V^{TS}$=100,998 and $V^{LLS}$=100,995. The value of the bond positions is 100,998-0.95*(100,995) =$5.047 billions.

   The total value of the hedge fund would be $6.372 billions (=1.325+5.047). The fund would have generated a return of 26.3% in this scenario.

c. *Actually, the yield curve changed considerably between September 1997 and 1998, as shown in the Table above. For example, in September 1998, a Treasury bond with a maturity of one year had a yield of 4.5%, while less-liquid securities yielded 7.5%. What are the current market values of the two bonds? How high are the net interest receipts of the fund? What is the value of the fund?*

   The fund still receives $7.5 billion coupon payments from its long bonds and it needs to pay $6.175 billion (=0.95*6.5) coupon payments from its short bonds. Thus, the net interest income is $1.325 billion.

   Under the actual scenario, the value of the Treasury bonds increases and the value of the illiquid bonds decreases because of the flight to quality. The values of these two bonds are $V^{TS}$=104,547 and $V^{LLS}$=97,679. The net value of the bond positions is now 97.679-0.95*(104.547)= -$1.641 billions.

   The total value of the hedge is now negative. It amounts to -$0.316 billion (=1.325-1.641). The fund actually lost 106.3% in this scenario.

d. *Discuss reasons for or against rescuing this hedge fund?*

   There are several reasons for or against bailing out the fund.

   For:

   - If the fund would not have been bailed out, then financial markets could have been destabilized further. The fund was just “too big to fail”.

- Traders could have taken advantage of the fact that the fund is forced to liquidate positions as it receives margin calls.

Against:

- Bailing out funds creates ‘moral hazard’ problems. That is, it motivates other funds to take more risks in the future because the funds know that if they perform poorly, then they will be bailed out. “Heads, I win, Tails, you lose!”
- Only very wealthy individuals and institutions can invest in hedge funds. Bailing out can be interpreted as a subsidy to the super-rich.