



EXAMINATION II:

Fixed Income Valuation and Analysis

Derivatives Valuation and Analysis

Portfolio Management

Questions

Final Examination

March 2007



Question 1: Fixed Income Valuation and Analysis

(50 points)

You are an analyst of the Bond Investment Department of an Insurance Company, which is located in Country Z. You are preparing market analysis materials to be submitted to the regular Bond Investment Committee meeting.

- a) A long period of disinflation for the economy of Country Z is coming to an end and economists anticipate a rise in key short-term interest rates within the next 1 year. You want to find out how much of an interest rate hike market participants have discounted and investigate the price of 3-month interest rate futures for different maturities that are traded on the futures market (Table 1). At the current point in time (March 2007) 3-month interest rates are 2.00%.

Table 1: 3-Month Interest Rate Futures Prices

Maturity	June 2007	September 2007	December 2007	March 2008
Futures price	97.75	97.35	96.50	96.15

Based on the data in Table 1 and the pure expectations hypothesis, briefly discuss and quantify how much of a rise in the 3-month interest rates from the present point in time the interest-rate futures market has discounted for 6 months and 12 months respectively. How does your answer change if you assume the existence of a positive risk premium?

(6 points)

- b) You have created a government bond yield curve based on market yields for government bonds (Table 2). Fill in the par yield, the zero-coupon yield, the zero-coupon bond price, the forward 1-year rate and the modified duration missing from the table. Show your calculations (interest rates should be rounded to the third decimal place; the bond price rounded to the fourth decimal place; the modified duration rounded to the third decimal place.)

Table 2: Government Bond Market Yield Curve

Maturity	1 year	2 years	3 years	4 years	5 years	6 years	7 years
Par yield	2.500%	3.110%	(A)	4.003%	4.239%	4.380%	4.432%
Zero-coupon bond yield	2.500%	3.120%	3.620%	4.050%	(B)	4.450%	4.500%
Zero-coupon bond price	0.9756	(C)	0.8988	0.8532	0.8102	0.7701	0.7348
Forward 1 year interest-rate	2.500%	3.744%	4.627%	5.351%	5.306%	5.203%	(D)
Modified duration	0.976	(E)	2.797	3.630	4.422	5.178	5.907

Notes:

- The *par yield* is the yield to maturity for a par-priced bond with an annual coupon payment.
- *Forward 1 year interest-rates* are 1-year interest rates for a forward contract starting 1 year prior to corresponding maturities.
- Modified duration is for par bonds.

(15 points)

- c) Using the information in Table 2, find the maturity of the zero-coupon bond that will give the highest 1-year holding period return in each of the following cases:
 1) The yield curve 1 year from now is absolutely unchanged from the current yield curve. 2)



The yield curve 1 year from now is equal to the one implied by today's forward rates.

Explain your answers.

(12 points)

d) You have been assigned to analyze two portfolios with an equal modified duration:

- 1) a bullet portfolio of the 5-year par bond.
- 2) a barbell portfolio combining the 3-year par bond and the 7-year par bond.

Assuming that the market value of the portfolio is 100, calculate the market value of the barbell portfolio's 3-year par bond and 7-year par bond (round to the second decimal place). (5 points)

e) Which of the two portfolios described in d) would perform better in each of the following two scenarios:

- 1) the yield curve experiences a significant, parallel upward shift.
- 2) the 5-year interest rate remains unchanged and the yield curve completely flattens and becomes horizontal?

Explain your reasons for each case. For Case 2), use duration-based calculations to demonstrate your rationale. (7 points)

f) The Insurance company holds a portfolio of mortgage backed securities with an effective duration of 5 years. Underlying assets consist of home loans for which borrowers have prepayment options. You anticipate a higher volatility in market interest rates. Discuss the effect on the market price of the mortgage backed security portfolio when your expectation materializes. Describe the way in which the company could hedge against the impact on the portfolio from higher interest-rate volatility. Explain your answer. (5 points)



Question 2: Portfolio Management

(36 points)

Mr. Miyamoto is the director of the pension fund of Company ABC. He receives the information below regarding the pension fund.

Table 1 reports the results for the last 7 years (for the sake of simplicity, the investments are limited to domestic bonds and domestic equities).

Table 2 depicts the attribution analysis applied to analyse the pension fund performance.

Figure 1 graphs the relationship between benchmark returns and portfolio returns, and therefore gives the equity portfolio's sensitivity to the domestic equity benchmark.

For domestic bonds, Mr. Miyamoto calculated the duration for bond holdings A and B as shown in Table 3 and then estimated the impact of an expected rise in interest rates.

Table 1: Performance of Company ABC's Pension Fund (all figures in %)

Fiscal Year	Policy Asset Mix		Actual Weight		Benchmark Return		Actual Return	
	Domestic Bonds	Domestic Equities	Domestic Bonds	Domestic Equities	Domestic Bonds	Domestic Equities	Domestic Bonds	Domestic Equities
1999	50	50	60	40	2	30	4	36
2000	50	50	40	60	5	-25	5	-24
2001	50	50	40	60	0	-15	1	-12
2002	50	50	40	60	5	-25	6	-24
2003	50	50	40	60	-2	45	-3	42
2004	50	50	50	50	2	0	4	-18
2005	50	50	40	60	-2	50	-6	48

Note: Both the benchmark return and the actual return are excess returns over the risk-free interest rate.

Table 2: Illustration of performance attributions analysis by Brinson et al.

		Security Selection	
		Active [$R_{P,j}$]	Passive [$R_{I,j}$]
Asset Allocation	Active [$w_{P,j}$]	$IV = \sum w_{P,j} \cdot R_{P,j}$ <i>Active weights, Active returns</i>	$II = \sum w_{P,j} \cdot R_{I,j}$ <i>Active weights, Passive returns</i>
	Passive [$w_{I,j}$]	$III = \sum w_{I,j} \cdot R_{P,j}$ <i>Passive weights, Active returns</i>	$I = \sum w_{I,j} \cdot R_{I,j}$ <i>Passive weights, Passive returns</i>



Figure 1: Equity Portfolio Analysis

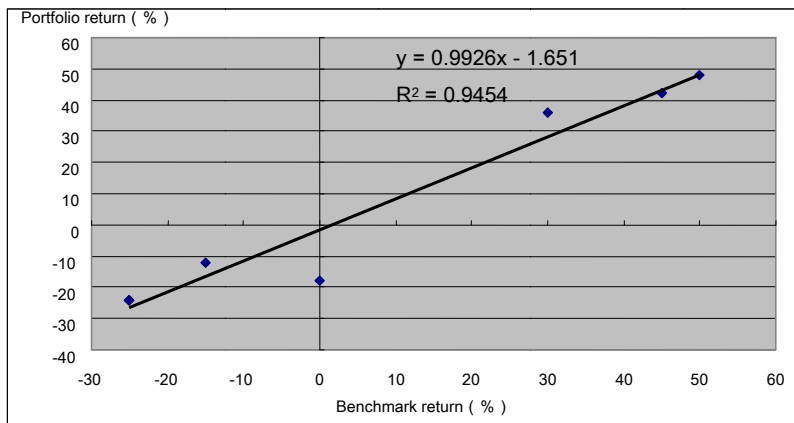


Table 3: Properties of Bond Holdings

	Issue A	Issue B
Type	Corporate Bond	Government Bond
Coupon	1.8%	2.5%
Weight	20%	80%
Duration	2.9	11.8

Note: The benchmark bond has a duration of 5 years.

- The fund's actual weight differs from the policy asset mix. The actual returns are also different from the benchmark returns. Using Table 2, explain the "asset allocation effects" and the "security selection effects" and show how they can be measured. (8 points)
- Complete the performance attribution analysis shown below for 2005 and comment on the performance of Company ABC's pension fund. (11 points)

Fiscal year	Security selection effects	Asset allocation effects	Cross effects	Total active effects
1999	4.0	-2.8	-0.4	0.8
2000	0.5	-3.0	0.1	-2.4
2001	2.0	-1.5	0.2	0.7
2002	1.0	-3.0	0.0	-2.0
2003	-2.0	4.7	-0.2	2.5
2004	-8.0	0.0	0.0	-8.0
2005				

Note: all figures in %.



- c) Using Figure 1, comment on the characteristics of the domestic equity portfolio. In particular assess the portfolio's beta, alpha and coefficient of determination. (6 points)
- d) The bond portfolio consists of Issue A and Issue B, as shown in Table 3. Discuss the important features and characteristics of this bond portfolio (focus your comment on the risk linked to holding these bonds). (6 points)
- e) Mr. Miyamoto is considering modifications to the asset allocation and the bond portfolio in order to avoid that rising interest rates will have an impact on the portfolio. You are required to provide advice to him on this matter. (5 points)



Question 3: Portfolio Management

(21 points)

Dr. K, currently aged 49, is a medical doctor who earns a relatively high income. He has financial assets of USD 400,000, mostly invested in bank deposits. As he has realized that the current interest rates earned are rather low, he would like to invest in stocks and bonds. Without additional contributions, he wants his current financial assets to grow to USD 1 million by his retirement at age 65, 16 years from now. Dr. K has steady income from his work until retirement, and will not have to withdraw his financial assets before retirement. He plans to support his post-retirement life by consuming out of the accumulated financial assets. With little investment experience, Dr. K shows some concerns about possible losses and poor performance in the 16 years to come, while he knows that stock markets are quite volatile. You are an investment counselor appointed to his account. Before making any specific recommendations, you have started asking him a few questions about his personal situation, while explaining the importance of a strategic asset allocation for long-term investments. You prepared six model portfolios as possible suggestions for him.

Suggested Model Portfolios

Portfolio number	1	2	3	4	5	6
Equity (in %)	0	20	40	60	80	100
Bond (in %)	100	80	60	40	20	0
Exp. Return (in %)	5.0	5.7	6.3	7.0	7.7	8.4
Std. Dev. (in %)	7.1	7.0	8.1	9.9	12.2	14.7

Note: Expected returns (continuously compounded) and standard deviations are expressed in annualized percentage terms. Returns are independently and identically distributed (i.i.d.).

- State five factors which should be taken into consideration for recommending an investment policy for individual investors and describe those for Dr. K's case. (5 points)
- What will be the required annualized rate of return for Dr. K to achieve his stated target value? (5 points)
- It is known that the standard deviation of average returns over many years is likely to be smaller than the one-year volatility. He would like to preserve his assets at a value of at least USD 800,000, even if the actual return for the coming 16 years turned out to be one standard deviation below the expected return of the portfolio he has selected. Indicate, with reasons, which portfolio you would recommend. (7 points)
- In addition to volatility risk, what is the primary risk factor to be taken into consideration to make his post-retirement life as he hoped? Explain. (4 points)



Question 4: Derivatives and Portfolio Management**(73 points)**

We are in March 2007 and your client, a small US company, has to pay 10 million EUR three month from now and wants to cover its foreign exchange risk exposure using derivatives. You have collected the following data on three-month EUR options from the Philadelphia Stock Exchange (PHLX), where options on foreign currencies are traded:

PHLX EUR Option	Strike (in USD per 1 EUR)	Option Price (in USD-cent per 1 EUR)	Delta	Implied Volatility in %
Call Jun 07	1.15	6.247	0.7823	12
Call Jun 07	1.20	2.113	0.5395	8
Call Jun 07	1.25	0.312	0.1464	7
Put Jun 07	1.15	0.416	-0.1197	9
Put Jun 07	1.20	1.693	-0.4538	8
Put Jun 07	1.25	4.833	-0.8469	7

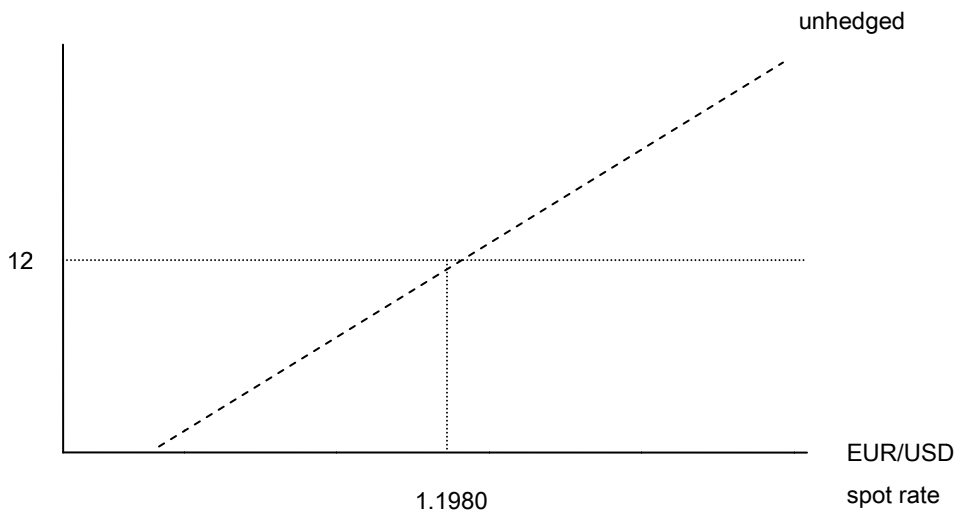
All options are of European type, and expire in exactly 3 months. The contract size is EUR 62,500. The current spot rate is EUR/USD 1.1980. The simple three-month risk-free interest rates are 4.8% for USD and 2.7% for EUR respectively (for the sake of simplicity, assume that they are used for both, deposits and loans). At the same time, the three-month Euro FX Futures contract at the Chicago Mercantile Exchange (CME) trades for EUR/USD 1.2022. The contract size for this futures contract is EUR 125,000; the last trading day is exactly 3 months from now. Day count is 30/360.

- The easiest way to eliminate the foreign exchange risk is to borrow USD, convert it into EUR at the spot rate immediately, and invest this amount for three months. What is the company's total amount paid for the 10 million Euros repayment in USD term using this first strategy? (6 points)
- Using strike 1.20 calls and puts instead, how many options do you purchase or sell in order to fix today the foreign exchange rate in three months? What is the company's total amount paid for the 10 million Euros repayment in USD term in this case? (6 points)
- As a third possibility you consider using the CME Euro FX Futures contract. How many contracts do you buy or sell? What does the company pay to meet its 10 million EUR obligation? Is this hedge cheaper than the hedge using options? Are there disadvantages compared with the options strategy? (7 points)



- d) You observe that the strike 1.15 options trade for a higher implied volatility than the rest. So you consider yet another strategy: sell strike 1.15 puts and buy 1.25 calls to “hedge” the 10 million EUR exposure over the three month period. Calculate the company’s total amount paid for two different outcomes, for a spot rate of EUR/USD 1.30 or 1.10 at the end of the three month period, respectively. Complete the following graph by drawing the total amount lines obtained by this strategy at maturity of the option contracts.

Total amounts
paid [Mio USD]



(16 points)

- e) Given a short position of 60 put contracts 1.15 and a long position of 60 call contracts 1.25, is it possible to dynamically replicate the payoff of this options strategy using the CME Euro FX futures contract instead? How many futures (long or short) do you need to start with?(8 points)
- f) What are the main problems in replicating an options strategy dynamically with futures? (6 points)
- g) Write down the put-call parity formula which applies here, clearly indicating the value of each parameter you use in the formula. (Note that there is a “dividend” on the underlying!) (5 points)

Hint: the general formula is $C_E - P_E - S \cdot e^{-y \cdot t} + K e^{-r \cdot t} = 0$,

where

- | | |
|---|--|
| t | time until expiry of the option |
| K | strike or exercise price of the option |
| r | continuously compounded risk-free rate of interest |
| y | continuously dividend yield |
| S | spot price of the underlying |



C_E value of European call option

P_E value of European put option

If you use simple interest rates for y and r , the formula becomes

$$C_E - P_E - \frac{S}{1+y \cdot t} + \frac{K}{1+r \cdot t} = 0$$

h)

h1) By looking at the volatility, chose the strike price where the arbitrage opportunity exists and give the reasons (no calculations are required). (4 points)

h2) Using the put-call-parity for the 1.15 and 1.25 strikes, check if there are arbitrage opportunities which can be exploited for the above price data. In case you find an arbitrage opportunity, describe the arbitrage and compute its profit. Also explain why this is indeed risk-free. (15 points)