EXAMINATION II:

Fixed Income Valuation and Analysis

Derivatives Valuation and Analysis

Portfolio Management

Questions

Final Examination

September 2015

Question 1: Fixed Income Valuation and Analysis / Derivative Valuation and Analysis (64 points)

In your activity as a fixed income analyst, your company asks you to evaluate a series of different fixed income securities in order to manage an investment fund. The main focus of your analysis is on the corporate bond sector.

a) In the context of a generic valuation of different fixed income securities, you are asked first to examine two bonds, assuming that both bonds have the same issuer, the same seniority and currency, and they are both option-free (for the sake of simplicity both bonds have no accrued interest):

- Bond 1: expiry in 3 years, coupon of 3% paid annually, bullet redemption at par (100% of the nominal value);
- Bond 2: expiry in 3 years, coupon of 6% paid annually, bullet redemption at par (100% of the nominal value).

The euro interest rate swap curve (IRS) is the following:

Table 1:

Tenor	IRS Par curve	IRS Spot curve (Zero coupon rates)
1 year	0.20%	0.2000%
2 years	0.35%	0.3503%
3 years	0.55%	0.5514%

Note:
* Assumed yield convention: 30/360 daycount-convention, annual compounding.
**1 basis point = 0.01%.

a1) Using the data provided and knowing that the price of bond 2 is 116.212, calculate the price of bond 1 and verify if the yield to maturity (YTM) of the two bonds matches one of the following levels:

- Bond 1: 0.544% vs 0.559%
- Bond 2: 0.538% vs 0.556%

Show your calculations, considering that the credit spread employed is equal to zero. (8 points)

a2) Explain the relationship between coupon rate and yield to maturity, using as an example the analyzed bonds from question a1) [Note: take into account the shape of the IRS spot curve]. Explain the different meaning of the YTM curve as compared to the term structure of interest rates. (4 points)

a3) How could you answer question a1) without any calculations? (3 points)

a4) Explain the relationship between a bond coupon rate and its duration, comparing bond 1 with bond 2. No calculations are needed; only qualitative arguments. (3 points)

b) Because of the massive collapse of the risk-free (or quasi risk-free) interest rates, in particular in the euro area, you are asked to evaluate the investment in a new issue, the high yield corporate bond of company Beta, a leader in the renewable energies sector, whose shares are listed on the Italian stock exchange.

The main features of the issue are:

- Seniority: senior unsecured
- Issue date: March 1st 2015
- Expiry 5 years
- Bullet redemption
- Coupon 6.5% paid annually
- Issue price 99.25%
- Redemption price 100.00%
- Rating B+
- Nominal amount EUR 100 million

The EUR interest rate swap curve (IRS) is the following:

Table 2:

Tenor (years)	IRS Par Curve	IRS Spot Curve (Zero coupon rates)	Forward rates
1	0.2000%	0.2000%	
2	0.3500%	0.3503%	0.5008%
3	0.5500%	0.5514%	0.7276%
4	0.7000%	0.7029%	0.8711%
5	0.9500%	0.9580%	1.1484%

Notes:

* Assumed yield day count convention: 30/360 with annual compounding.

** "Forward rates" are the forward interest rates $F_{1,T}$ (expressed on an annual basis) for a forward contract starting 1 year from now and expiring in year T ($F_{1,2}$ = 0.5008%, $F_{1,3}$ = 0.7276%, $F_{1,4}$ = 0.8711%, …).

*** 1 basis point = 0.01%.

b1) Different dimensions affect the credit risk experienced by corporate bond investors. Explain what default risk is, and mention 3 factors involved in credit risk assessment. (6 points)

b2) Verify whether the credit spread at issue date is equal to 450.5 basis points or 577.7 basis points. [Hint: the credit spread is the spread over the IRS spot curve.] (6 points) b3) Let us now assume that this new issue has an additional feature: a call option by the issuer at the end of the 3rd year (March 1st 2018) at a price of 103.00.

Verify that the *Yield to call* at the call date of March 1st 2018 is 7.716%, considering an issue price of 99.25%. Show your calculations. Also explain the concept of the "negative convexity" of a callable bond. (5 points)

b4) Calculate the *Call option price* at issue date, considering the following information (show your calculations):

- Issue price 99.25%
- Call adjusted yield 5.85%

[Hint: the call adjusted yield is the yield that would be earned on a similar security but without the call feature.]

Also explain how an increase in interest rate volatility will affect the call option price. (7 points)

b5) Let us assume that the non-callable new issued corporate bond of question b) has a redemption of the principal amount based on an amortizing structure instead of a bullet structure.

The amortizing structure is as follows:

Table 3:

Dates	Principal Redemption
01/03/16	20.00%
01/03/17	20.00%
01/03/18	20.00%
01/03/19	20.00%
01/03/20	20.00%
Total	100.00%

Calculate (for the sake of simplicity use whole years for the calculations):

(i) The average life of the bond at the time of issue.
[Hint: The average life is the average time at which the bond redeems the principal]

(ii) The issue price using a credit spread of 590 basis points.
[Hint: the credit spread is the spread over the IRS spot curve.]

(iii) The price of the bond at the first principal amount redemption date (March 1st 2016) assuming that the credit spread is still 590bp and that the IRS curve on this date exactly reflects the expectations included in the implicit forward rates.

(12 points)

b6) Immediately after issuing the bond, due to better forecasts about the economic growth in the euro area, the IRS Spot curve goes through a parallel shift of +5bp. Explain which one of the two non-callable securities, bullet structure and amortizing structure, shows a higher interest rate sensitivity, assuming that both bonds are issued at the same credit spread of 590bp (no calculations are needed, only qualitative reasoning).

(3 points)

c) In the past, company Beta has issued a bond convertible into common stocks of the same company. At present, company Beta's stocks are quoted at EUR 77.50. The convertible bond has the following features:

- Seniority: senior unsecured
- Expiry 5 years
- Bullet redemption
- Coupon 3.5% paid annually
- Redemption price 100%
- Conversion ratio 10 to 1 (10 common stocks for 1 convertible bond)
- Nominal minimum amount EUR 1,000

Assuming that company Beta has also issued earlier a non-convertible 5-year bond (straight bond) at YTM of 6.00%, calculate the following:

(i) The conversion value.

(ii) The straight value of the convertible bond.

(iii) The minimum value of the convertible bond.

(7 points)

Question 2: Derivative Valuation and Analysis **(38 points)**

You are a young market maker on the German equity options market and you are about to trade “at the money” call options (European style) on the stock MUNICH RE, strike EUR 200, maturity 3 months. A colleague tells you that the theoretical probability of exercise at maturity is 49.80% for this call (this probability is actually the $N(d_2)$ parameter in the Black & Scholes formula).

The price of this call is EUR 8.86. The risk free rate is 2% (continuously compounded).

[Use 4 decimals for delta calculations.]

a) Calculate the delta of this call option. (4 points)

b) You sell 1000 of these call options. As a market maker, you immediately have to hedge your position. What do you trade on the underlying equity, to create a delta neutral position? [Note: assume 1 call option refers to 1 stock. In case you have not answered question a), use a delta of the call option of 0.5500.] (4 points)

c) The minute after you have sold the call options and traded the equities, the stock price of MUNICH RE moves to 202 EUR.

   c1) Calculate the new price of the call option using the Black-Scholes formula and the normal distribution table (all other parameters staying equal; use a volatility of 21%). (7 points)

   c2) Calculate the profit or loss on the position (options + stocks) traded in b). If a profit or loss is found, where can it come from? [Note: in case you have not answered c1), use a new price for the call option of EUR 10.] (6 points)

d) Now that MUNICH RE stock price is 202 EUR, you decide to use a delta-gamma neutral hedge.

   d1) Explain what delta-gamma neutral hedging is (i.e. usefulness, construction). (4 points)

   d2) The call option data is as below (ignore your earlier calculation of call delta):

   - Call strike: 200
   - Maturity: 3 months
   - Delta: +0.575
   - Gamma: 0.0369

   Another option on MUNICH RE is available on the market:

   - Put strike: 198
   - Maturity: 3 months
   - Delta: -0.3928
   - Gamma: 0.0341

Calculate the number of put options and MUNICH RE stocks needed to neutralize the original 1000 call option position in terms of both delta and gamma using the data only specified in this sub-section. (8 points)

e) An investor has bought 1000 call options, strike 200 on MUNICH RE, anticipating a surge in the stock price after the results publication. He paid 8.86 EUR for each option, and now thinks that it is a bit overpaid.

   What option position could he add to his long call position to reduce the price paid, without taking more risk if the MUNICH RE stock price falls, and still benefit up to a certain point from a rise (even if the participation to the upside is lower than with a long call position only)? Also use a chart to explain. (5 points)

Question 3: Derivatives / Derivatives in Portfolio Management (32 points)

You manage a diversified portfolio that has the same components as the Nikkei. At the current point in time, the value of this portfolio is 20 billion yen and the Nikkei is 20,000 yen. The economy has been unstable of late, and this is anticipated to have a variety of impacts on the market. Your objective is to control the return on the portfolio at appropriate levels for the next 3 months by adding trades in derivatives that have the Nikkei as underlying assets.

Answer the following questions (round your results to the 2nd decimal place). Assume that the simple risk-free rate is 4% per annum and that dividends can be ignored for the sake of simplicity. The maturity of all futures and options is currently 3 months out, and 1 trading unit is 1,000 times the Nikkei. (In other words, the cost of purchasing 1 trading unit of futures and options is 1,000 times the price of the futures or option.) Options are European-style. The strike prices of traded puts are 16,000, 18,000 and 20,000 yen; the strike prices of traded calls are 20,000, 22,000 and 24,000 yen. Individual prices and deltas are as shown in the table below.

Nikkei options:

	Strike price (yen)	Option price (yen)	Delta
Call	24,000	1,144	0.336
	22,000	1,700	0.447
	20,000	2,414	0.573
Put	20,000	2,274	-0.427
	18,000	1,328	-0.296
	16,000	664	-0.177

a) You are concerned about a drop in the Nikkei. You decide to purchase a put option with a strike price of 18,000 yen and hold it to maturity so as to create a floor. Doing so will allow the overall value of the portfolio (total of the stock portfolio, option and borrowings) to remain constant if the Nikkei is below the strike price at the end of 3 months. Calculate the number of trading units in the option that you should purchase and the value of the floor achieved. Assume that the cost of purchasing options is borrowed at the risk-free rate and returned upon maturity. (7 points)

b) Draw a graph illustrating the relationship between the overall value of the portfolio achieved at maturity and the value of the Nikkei as a result of the trade described in a), placing the former on the vertical axis and the latter on the horizontal axis. (4 points)

c) What kind of call option trade should you add to the trade described in a) in order to increase the value of the floor? How will adding that trade change the overall value of the portfolio at the end of 3 months (compared to the results achieved in b) above)? Discuss the costs and benefits of the call option trade. There is no need to perform calculations. (4 points)

d) Instead of buying put options, you decide to create the floor described in a) by a dynamic hedge that makes use of Nikkei futures. Assume that the current price of Nikkei futures is equivalent to the no-arbitrage price. Find the current price of Nikkei futures and calculate the futures positions and numbers of trading units you would need to trade to achieve the dynamic hedge. (5 points)

e) In actual practice, what are the pros and cons of replicating options by dynamic hedging as opposed to trading the options themselves? (4 points)

f) You have identified an arbitrage opportunity from the option prices in the table. Indicate the arbitrage opportunity and explain why it is an opportunity for arbitrage. Explain how you will set up the arbitrage trading and calculate the arbitrage profit that will be earned by the trading in 1 unit of the options. (8 points)

Question 4: Portfolio Management **(36 points)**

You are an active portfolio manager responsible for the tactical asset allocation (TAA) of a retirement fund. As a client restriction the ex-ante tracking error standard deviation (TESD) has to be lower than 4%. Over the last reporting season (1 year) your active strategy delivers a poor performance of -8% compared to the strategic asset allocation which works as a benchmark for your approach. The absolute performance of your portfolio over the last year is -6%.

a) The investor is confused about the substantial deviation from the benchmark performance given the agreed tracking error constraints. Give a short definition of ex-post and ex-ante tracking error. Under the assumption of normally distributed returns, what is the probability of achieving an annualized active performance between -8% and 8%?(6 points)

b) The investor asks for the ex-ante tracking error, based on the current portfolio. You have an active position of +20% equities (asset 1) against -20% bonds (asset 2). Use the following covariance matrix for your calculation of TESD and TEVar (Tracking error variance), where the row in the matrix corresponds to the asset number (i.e. row 1 relates to equities):

$$C = \begin{bmatrix} 0.20 & 0.03 \\ 0.03 & 0.05 \end{bmatrix}$$

With:
0.20 = Variance asset 1
0.05 = Variance asset 2
0.03 = Covariance between asset 1 and asset 2 (7 points)

c) In the long run you expect an information ratio of 0.8 for your management approach. Based on the strategic guidelines, what is your expectation for the active return on average? (5 points)

d) The so called "Fundamental Law of Active Management" expresses the information ratio (IR) in terms of the information coefficient (IC) of your bets and the square root of the number of independent bets (N) in your approach: $IR = IC \cdot \sqrt{N}$. Describe the meaning and implications of this formula assuming that N = 4.

Your allocation decisions are based on a fundamental market model. Based on the information in question c), what is your expected information coefficient and how realistic is this assumption? (7 points)

e) The investor is also concerned about the poor absolute performance last year and is questioning the overall asset allocation process critically. List the most significant characteristics of a TAA. (4 points)

f) One possible extension to the previous approach is the implementation of an overlay risk management. The client is thinking about a "Constant proportion portfolio insurance" (CPPI) strategy. Describe concisely the idea of CPPI. What is the problem of this strategy in the current low interest rate environment? (7 points)

Question 5: Portfolio Management (10 points)

NoLoss Investments manages a long-short portfolio with a zero beta. The portfolio is rebalanced each month, and you have been instructed to determine the long-short weights for the coming month. Your assistant has compiled the following data:

- P/E of long portfolio:	20/1
- P/E of short portfolio:	15/1
- Return on 10-year US Treasuries:	5%
- Beta of long portfolio:	1.5
- Beta of short portfolio:	1.2

a) Calculate the ratio of the long portfolio to the short portfolio that provides the desired zero beta. (5 points)

b) Comment on the reasoning behind the use of a long-short, zero-beta strategy. (5 points)