

# **EXAMINATION II:**

**Fixed Income Valuation and Analysis**

**Derivatives Valuation and Analysis**

**Portfolio Management**

**Questions**

**Final Examination**

**March 2014**

**Question 1: Fixed Income Valuation and Analysis****(37 points)**

You are in charge of setting up a small fund of pension assets which should comprise the following 3 bonds:

**Table 1**

Security	Coupon	Tenor [years]	Yield	Price	Mod. Duration	Convexity
Corporate Bond	4%	7	3.50%	103.06%	6.04	36
“Covered” Bond	2%	10	2.50%	95.62%	8.92	73
Government Bond	0%	30	1.75%	①	②	③

Note: 1 bps: 0.01%; Yield Convention: 30/360; coupons are paid annually.

Mod. duration = modified duration.

Covered bonds: senior secured debt instruments typically issued by a bank with a preferential claim [i.e. backed] by cash flows from mortgages or public sector loans.

Your pension liabilities have a modified duration of 12 and a convexity of 200.

a) Before working on an asset/liability matching strategy you are asked to answer some basic questions.

a1) Calculate the 3 missing items ①, ② and ③ according to Table 1 above. (5 points)

a2) Approximate the absolute price change of the given government bond in the case where its yield increases by 125 bps by taking into account both its modified duration and convexity. [Note: in case you have not answered question a1), use the following values for the government bond's price / mod. duration / convexity: 60%, 29.5 and 900.] (4 points)

a3) Calculate the approximated government bond price after such 125 bps yield increase only based on the underlying modified duration, and compare it to the exact result and that from question a2). [Note: in case you have not answered question a2), use -18 for the absolute price change.] (4 points)

b) You have been charged to immunize your bond portfolio against interest rate movements by matching the duration and convexity of pension assets and liabilities.

b1) How much (in %) do you have to invest in the given 3 bonds to immunize your pension fund against parallel shifts in interest rates? [Hint: start with 3 equations for weights, duration and convexity for the 3 bond investments. In case you have not answered question a1) use the following values for the government bond's price / mod. duration / convexity: 60%, 29.5 and 900.] (12 points)

b2) What were the problems that arose when it came to developing an immunization strategy across the 3 bonds only based on duration? (short reasoning only – no calculation required) (4 points)

- c) Lastly, you are asked to assess the residual risk exposure after the portfolio immunization pursuant to question b).
- c1) What kind of risks do you see when comparing your immunized bond fund to the pension liability benchmark, which is comprised only of corporate bonds? (mention and briefly explain the key risk factors) (4 points)
- c2) What kind of instruments come to your mind with respect to hedging your pension exposure against the residual risks in question c1)? (short reasoning only – no calculation required) (4 points)

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**Question 2: Fixed Income Valuation and Analysis / Portfolio Management (24 points)**

Inflation-linked government bonds are securities that protect the purchasing power of the investment. The bond is provided with a fixed real coupon. The nominal coupons and the nominal face amount (and thus the repayment of the principal) are calculated by increasing/decreasing the real quantities based on the increase/decrease in the inflation rate measured by the Consumer Price Index [CPI] for the corresponding period (i.e. with this bond there are no leading/lagging effects with regards to inflation).

The prices of inflation-linked bonds are quoted in real terms. Settlement values and cashflows are then adjusted for accrued inflation. In other words, the trading price indicates the initial (face) coupon and principal discounted by the real interest rate to arrive at a real price. However, when the bonds are settled, the actual settlement price (nominal) is obtained by multiplying the real price by the index of the CPI (based on the time of issue) as at the time of the trade.

- a) On the market there is an inflation-indexed government bond with a fixed real coupon of 2% paid annually, principal of 100, and 3 years to maturity. The bond has just paid the coupon, and the index of the CPI has moved from 100 at the time of issue to 110 today.
- a1) If today you purchase this inflation-indexed government bond at a real yield of 1.0%, what would be the actual purchase price (nominal)? Show your calculations and round to the 2nd decimal place. (3 points)
- a2) One year after your purchase, the CPI index has risen by 1.5% and you sell the inflation-indexed government bond at a real yield of 1.0%. Calculate the (nominal) holding period return (in percentage terms) for the year. Your answer should be rounded to the 1st decimal place. (5 points)
- b) Currently, the real yield for an inflation-indexed government bond with 3 years to maturity is 1.0%, and the yield to maturity for a government bond (an ordinary government bond with nominal coupon and principal) with 3 years to maturity is 2.0%.
- b1) What is the CPI annual growth rate over the next 3 years (expressed as a percentage) implied by these yields to maturity? Your answer should be rounded to the 1st decimal place. (2 points)
- b2) What will have to happen to the CPI growth rate for the return on an inflation-indexed government bond to be higher than the return on a government bond? (2 points)
- b3) The CPI growth rate calculated in b1) may not match the CPI growth rate expected by the market. Identify two reasons why it could be so and explain whether these increase or decrease yields on inflation-indexed government bonds. (4 points)
- c) If prices are lower at redemption than at the time of issue, British inflation-indexed government bonds have redemption amounts less than the initial principal. By contrast, US inflation-indexed government bonds never see a reduction in nominal redemption amounts (that is, initial principal is guaranteed).

- c1) All else being equal, do US-style inflation-indexed government bonds have higher or lower values than UK-style inflation-indexed government bonds? Why? (2 points)
- c2) Identify two factors influencing the difference in prices between US-style and UK-style inflation-indexed government bonds, and describe the situations which may cause the price gaps to expand. (3 points)
- c3) Currently, the CPI growth rate in both US and UK is thought to be around 1%, but is forecasted to rise to 2-3% in the near future. Which will have higher returns, US-style or UK-style? Why? (3 points)

**Question 3: Derivatives Valuation and Analysis****(42 points)**

In March 2014 you are discussing option strategies with your colleague. The options are written on a stock which pays no dividends. They will expire one year from now in March 2015. The riskless interest rate is 1.0% (continuously compounded). The stock is currently trading at EUR 80. Options do not necessarily trade at their theoretical prices. The option contract size is 10. All options are European type. The following data is available:

Option	Strike	Price	Delta	Gamma	Theta	Vega
Call Mar 15	70	13.17	0.78	0.017	-3.079	23.77
Put Mar 15	70	2.47	-0.22	0.017	-2.386	23.77
Call Mar 15	80	7.31	0.56	0.023	-3.810	31.54
Put Mar 15	80	6.51	-0.44	0.023	-3.018	31.54
Call Mar 15	90	3.66	0.35	0.021	-3.469	29.63
Put Mar 15	90	14.76	-0.65	0.021	-2.578	29.63

- a) Looking at the data, are there any violations of put-call-parity? Explain your answer. (5 points)
- b) Given you have found an arbitrage opportunity in a), you want to trade 10 contracts of puts and calls, respectively, to exploit this opportunity.
- b1) Detail what the complete riskless arbitrage portfolio looks like, and calculate the immediate arbitrage profit. (5 points)
- b2) Verify that at maturity the arbitrage positions you have set up unwind leaving a riskless profit in any situation. (5 points)
- c) You are thinking of an outperformance strategy with a cap. That is, you buy 100 units of the underlying stock plus 10 contracts of the at-the-money Mar 15 calls with strike  $K_1 = 80$ . For the cap you sell 20 contracts of the out-of-the-money Mar 15 calls with strike  $K_2 = 90$ .
- c1) Calculate the initial investment, the profit and/or loss at maturity depending on the underlying price  $S_T$ , the maximum profit and/or loss as well as the break even points, if applicable. [Hint: ignore interest on the option premiums.] (8 points)
- c2) Draw a graph that shows the final profit/loss of your strategy at expiration as a function of the underlying price  $S_T$ . Mark all relevant levels. Compare the outcomes of this strategy with a direct investment in 100 underlying stocks. (5 points)
- d) What are the expectations of an investor buying this strategy with regard to the underlying? Discuss the prospects and risks of this strategy. (4 points)
- e) Calculate the Delta, Gamma, Theta and Vega of the strategy. (4 points)

- f) Your colleague is arguing that this strategy is not an outperformer but an underperformer, that is, it does not outperform the underlying in the short run.
- (i) Is he right?
  - (ii) What do the Delta, Gamma, Theta and Vega tell you about the short run behavior of the strategy?
  - (iii) Using the Vega from e), what is the approximated change in value of the strategy if the volatility increases suddenly by 20%?
- (6 points)

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**Question 4: Portfolio Management – miscellaneous****(57 points)**

- a) You predict that bond yields will decrease. For each of the following actions, indicate it is consistent with your prediction or not, and explain why.
- i) Decrease the maturity of your portfolio.
  - ii) Increase the yield to maturity of the bonds in the portfolio.
  - iii) Increase the duration of the portfolio.

(9 points)

- b) Choose the bond which will profit (in absolute terms) the most from a decrease of interest rates. Explain your reasoning.
- i) Maturity 20 years, 9% coupon, 9% yield.
  - ii) Maturity 30 years, 9% coupon, 8% yield.
  - iii) Maturity 30 years, 9% coupon, 9% yield.
  - iv) Maturity 30 years, 12% coupon, 11% yield.

(4 points)

- c) Draw the price-yield relationship graph for a bond which is callable, and for an identical bond which is not callable. Label the axes. Explain why the curves are different. (6 points)
- d) The changes in yield on a bond portfolio lead to two types of risk:
- Price risk.
  - Reinvestment risk.

Explain the relationship between these two types of risk, using the concepts of duration and portfolio immunization. (4 points)

- e) A midcap portfolio has a beta of 1.5, and a standard deviation of 20%. Over the past three years, it has produced an average “excess return” ( $R_p - R_f$ ) of 18% over the risk free rate  $R_f$ . The average “excess return” of the market over that same period was 13%, with a standard deviation of 12%.

e1) Calculate the Sharpe ratio. Explain and interpret the ratio, and analyze the portfolio performance according to this measure. (4 points)

e2) Calculate the Treynor ratio. Explain and interpret the ratio, and analyze the portfolio performance according to this measure. (4 points)

e3) Regressing the excess return of the portfolio against the excess return on the market gives the following result:

$$R_p - R_f = -0.06 + 1.5(R_M - R_f)$$

Identify the (Jensen's) “alpha” of the portfolio. Explain and interpret this number, and analyze the portfolio performance according to this measure (4 points)



- e4) You are asked to rate the performance of two portfolios. Portfolio A is composed of twenty stocks and is the sole holding of Mr. Adam, i.e it constitutes his only asset. On the other hand Portfolio B is one among twenty portfolios in the owner's pension fund all of which are held by the owner and where each portfolio is managed under a different strategy mandate. Portfolio B holds 75 assets and is managed under a growth mandate. Comment on the applicability of each of the performance measures in parts e1), e2) and e3) to each of the two portfolios, and justify your conclusions. (6 points)
- f) The Efficient Markets Hypothesis (EMH) arose as a suggested explanation of why stock price changes might follow a random walk.
- f1) Explain the meaning of "stock prices follow a random walk." (3 points)
- f2) Define what is meant more generally by an "efficient market." (3 points)
- f3) Explain why stock prices in an efficient market exhibit a random walk. (3 points)
- f4) Identify and explain the three "forms" of efficiency in the EMH. Then identify the form associated with each of the following sets of information:
- i) Articles in the financial press.
  - ii) Unannounced merger plans.
  - iii) Point and figure charts.
  - iv) Financial ratio analysis.
- (7 points)

**Question 5: Portfolio Management****(20 points)**

Growth and value styles are two distinctively different styles in equity investments. It is well known that the value style has a lower beta but has historically outperformed the growth style with a higher beta. While this fact seems to be an anomaly to the CAPM [Capital Asset Pricing Model], recent researchers have offered two plausible explanations; risk premium and behavioral bias.

Whatever the reasons, XYZ Asset Management plans to exploit this performance difference by forming a beta-neutral hedge fund strategy with long positions in value stocks and short positions in growth stocks in the world equity market index.

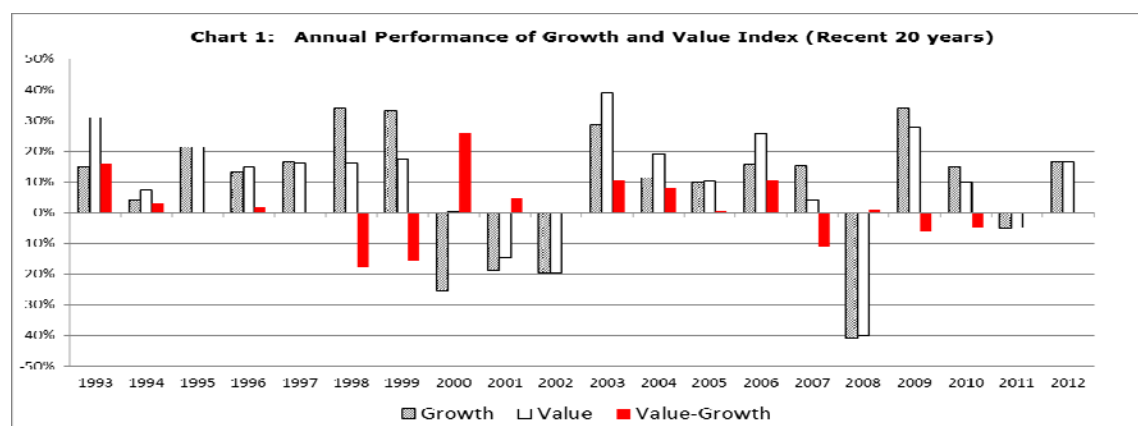
They analyzed the past monthly return data of global equity indexes (Growth, Value as well as Value minus Growth Hedge Strategy) by running regression analyses against the global total market index as the independent variable in the CAPM. Table 1 reports the performance statistics, obtained from data over a 38 year period from 1975 to 2012. They also measured more recent 20 year data from 1993 to 2012. Chart 1 shows year-by-year performance of growth index, value index and value minus growth index.

XYZ Asset Management has a few billion dollars under management, and has the capability of trading in any of major stock markets in the world. Trading costs are estimated as 1% for buying stocks and 2% for selling short.

**Table 1 Performance Statistics (January 1975 - December 2012)**

	Mean Return (p.a. %)	Standard Deviation (annual %)			Regression Statistics on Monthly Returns				
		Total Risk	Market Risk	Specific Risk	R <sup>2</sup>	$\alpha$	t-statistic for $\alpha$	$\beta$	t-statistic for $\beta$
Total Market Index	11.5	15	15	0					
Growth Index	10.4	16.3	15.5	5.1	0.96	-0.11	-2.43	1.03	99.44
Value Index	12.6	15			0.95	0.11	2.41	0.96	92.99
V-G Hedge Strategy	2.9	6.4	0	6.4	0	0.24	2.75	0	0

Note:  $\alpha$  is a monthly return  
(i.e. not annualized)



- a) Briefly explain why the risk premium and behavioral bias can be a reason for the fact that value stocks tend to outperform growth stocks. (4 points)
- b) The beta-neutral portfolio is a zero beta portfolio. If XYZ holds a USD 100 million long position in the value index, how much should they invest in the short-position in the growth index? Show your supporting calculations. (3 points)
- c) Both the growth index and the value index have systematic risk as well as specific risk. Total risk can be decomposed into those two types of risks as shown in Table 1 for the growth index. How much are those risks for the value index? Show your calculations. (4 points)
- d) How do you support the validity of the beta-neutral hedge fund strategy in generating alpha"? Briefly explain by referring to the numbers in Table 1. (3 points)
- e) Under what kind of market conditions does this market-neutral strategy perform better than the long-only strategies? Referring to Chart 1, describe its performance advantage under a specific historical event in the past 20 years. (3 points)
- f) No strategy is perfect all the time. This beta-neutral strategy performed poorly in two successive years from 1998 to 1999 during which both the growth and value indexes had positive performances. Describe what might have happened in this period. (3 points)