

# **EXAMINATION II:**

**Fixed Income Valuation and Analysis**

**Derivatives Valuation and Analysis**

**Portfolio Management**

**Questions**

**Final Examination**

**March 2017**

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**Question 1: Fixed Income Valuation and Analysis****(39 points)**

You are working in the Treasury department of an international bank and are asked to come up with an analysis for the potential issuance of so-called “Contingent Convertible” (“CoCo”)-bonds.

Such deeply subordinated bonds qualify as Additional Tier 1 Capital for regulatory purposes as their nominal value will be written down (or converted into shares) if the bank’s CET1-ratio (Core Equity Tier 1 Ratio) falls below the given trigger level (see below notes for CET1 definition). In addition, coupons will in that case not be paid.

Your peer group comprises the following “CoCo”-bonds:

Issuer	Volume (EUR billion)	Coupon	Structure	Maturity to Call Date	CET1-Trigger	Yield-to-Call	Theoretical Price-to-Call
Barclays	1.00	8.00%	Perpetual Non-Call 7 years	7 years	7.000%	6.65%	①
Santander	1.50	6.25%	Perpetual Non-Call 5 years	5 years	5.125%	5.98%	101.14%
Societe Generale	1.00	6.75%	Perpetual Non-Call 7 years	7 years	5.125%	5.85%	105.05%
Deutsche Bank	1.75	6.00%	Perpetual Non-Call 8 years	8 years	5.125%	5.92%	②

Notes: - **The Core Equity Tier 1 ratio** (CET1 ratio) is the Core Equity Tier 1 capital (CET1) divided by the Risk Weighted Asset (RWA). Or, simply, the ratio CET1 / RWA.

- **The CET1 trigger level** is the level of the CET1 ratio below which the CoCo bond is written down (i.e. when CET1 ratio < trigger level, which is usually fixed at 7% for a high trigger and 5.125% for a low trigger).
- Assume identical issuance dates, similar ratings, same CET1 definitions, annual coupon frequencies, same write-down structures (i.e. no share conversion) pertaining to all given “CoCo”-bonds above.

a) Firstly, you are asked to answer some basic questions.

a1) Calculate the 2 missing “Theoretical Price-to-Call” values ① and ② according to the data given in the table above. [Hint: The “Theoretical Price-to-Call” is the price of the bond if it were called at par at the given Call Date with the given Yield-to-Call.]

(6 points)

a2) Calculate the pro-forma Leverage-Ratio for Deutsche Bank before and after the issuance of a EUR 1.75 billion “CoCo”-bond. (Leverage-Ratio = Tier 1 capital / Leverage exposure; Tier 1 capital prior to issuance: EUR 46.85 billion; Leverage exposure prior & post to issuance: EUR 1,423 billion.)

(4 points)

- a3) Which of the above mentioned “CoCo”-bonds has the highest modified Duration and Convexity? For your answer, assume that the Coco’s mature at the call date. (provide a short reasoning – no calculation required) (5 points)
- b) Secondly, you are asked to further analyze the Yield-to-Calls of the given “CoCo”-bonds:
- b1) Barclays’ “CoCo”-bond offers the highest Yield-to-Call among the given bonds: What is the main reason for this fact? (short reasoning – no calculation – required) (5 points)
- b2) What are, in general, the main determinants of the Yield-to-Call of a newly issued “CoCo” bond? Give 4 determinants. (4 points)
- c) Finally, you are required to assess the risk/return exposure of “CoCo”-bonds:
- c1) What is the main reason for the strong demand for such “CoCo”-bonds from an investor perspective? Explain. (4 points)
- c2) What are, in general, the main risk factors of a “CoCo”-bond from an investor perspective other than interest rate risk? List 3 of them. (6 points)
- c3) Why do banks issue such comparatively expensive “CoCo”-bonds? (5 points)

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**Question 2: Fixed Income Valuation and Analysis****(10 points)**

You are the bond portfolio manager of a pension fund. You anticipate that the volatility risk of interest rates will increase in the future. The yield to maturity of your coupon-bearing bond portfolio is 5% and the Macaulay duration of the bond portfolio is 6.

- a) If you hold the bond portfolio until maturity and none of the bonds default, what must occur for you to earn a 5% return? (5 points)
- b) Your colleague wants you to create an immunization strategy for this bond portfolio. Explain briefly how you can create an immunization strategy and the benefits of this strategy. (5 points)

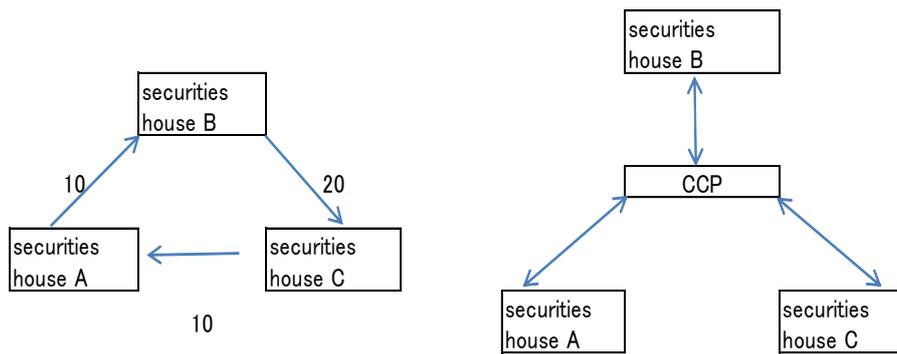
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**Question 3: Derivative Valuation and Analysis****(50 points)**

- a) Since the sub-prime crisis (i) a margin account system and (ii) a clearing system like those in exchange-traded derivative products have been introduced for over-the-counter derivative products as well. Below we discuss exchange-traded derivative products, beginning with the margin account system for futures between investors and financial institutions and the theoretical futures price.

At the start of trading on June 1<sup>st</sup>, 2016 a certain investor purchased two units of gold futures (a total of 200 ounces at 100 ounces per unit) with a delivery month of June 2017. The futures price was USD 1,285 per ounce. The amount of the initial margin was USD 2,000 per unit, for a total of USD 4,000. Furthermore, the amount of the maintenance margin was USD 1,500 per unit, for a total of USD 3,000. In addition, the spot price of gold at the start of trading on June 1<sup>st</sup>, 2016 was USD 1,250 per ounce. The risk-free rate was 2.3% per annum (thought of as a discrete interest rate), and the gold storage cost was USD 3 per ounce per annum in deferred payments.

- a1) The gold futures price fell from USD 1,285 to USD 1,282 at the close of trading on June 1<sup>st</sup>, 2016. Calculate the balance of the initial margin account. (3 points)
- a2) The price of gold futures declined from USD 1,282 to USD 1,279 at the close of trading on June 2<sup>nd</sup>, 2016. Calculate what the balance of the initial margin account is. Furthermore, find out whether a variation margin is necessary and the amount of the variation margin if it is necessary. (4 points)
- a3) At the start of trading on June 1<sup>st</sup>, 2016, there was an arbitrage opportunity between spot gold and gold futures. Explain the arbitrage transaction available at that time (i.e. June 1<sup>st</sup>, 2016) for 100 ounces of gold and calculate the amount that can be obtained from the arbitrage opportunity after one year (i.e. at May 31<sup>st</sup>, 2017). (6 points)
- b) Consider the clearing functions between financial institutions and clearing agencies. The figure below on the left shows a system in which there are no clearing agencies and three securities houses conduct transactions on a negotiation basis. Securities house A has an obligation to pay USD 10 million to securities house B, securities house B has an obligation to pay USD 20 million to securities house C, and securities house C has an obligation to pay USD 10 million to securities house A. Assuming that clearing agencies (central counterparty or CCP) mediating the transactions are introduced here as shown in the figure on the right, find the directions and amounts of the transactions among the respective securities houses and clearing agencies. For example, answer that the directions and amounts would be USD 50 million from securities house A to a clearing agency and USD 30 million from the clearing agency to securities house B. (5 points)



- c) Company X is a Japanese company that plans to make a payment of USD 10 million in 3 months and wants to manage the currency risk. The current USD/JPY currency rate is 100 [i.e. 1 USD = 100 JPY] and the 3-month risk free rate is 3% for USD and 1% for JPY (both annualized rates). The market only trades European-style foreign-exchange call options and put options with strike prices of JPY 100 and maturities of 3 months. [Note that foreign exchange call (put) options are the right to purchase (sell) USD by paying the strike price in JPY at maturity.]

For simplicity, assume that Company X is able to borrow and lend at the risk-free rates. The trading unit for forwards and options is USD 10,000. Answer the following questions.

- c1) Assuming the current USD/JPY currency rate to be  $S_0$ , the current USD riskless rate for the next 3 months  $r_A$ , the JPY riskless rate  $r_J$  (both annualized rates) and the USD/JPY 3-month maturity currency forward rate  $F_{01}$ , write the forward covered interest parity equation. Then calculate the current USD/JPY currency forward rate for a maturity of 3 months. (5 points)
- c2) The company decides to make a currency forward trade in which in 3 months it will receive USD 10 million. What amount of JPY is necessary today to fulfill its obligation in 3 months time? Show your calculations. (4 points)
- c3) Instead of a forward, the company decides to use at-the-money options to hedge the currency risk on the USD 10 million in 3 months time. What option does it have to trade (call or put)? Should the option be bought or sold? How many trading units? Also indicate what will be the cost in JPY for the USD 10 million, depending on the prevailing USD/JPY spot rate  $S_T$  in 3 months (do not consider the option premium). (7 points)
- c4) Assume that the current foreign currency is  $S_0$ , the price of a European-style currency call option with a 3-month maturity and strike price of  $K$  is  $C_0(K)$ , the price of a put option is  $P_0(K)$ , the USD risk free rate is  $r_A$ , and the JPY risk free rate is  $r_J$  (both annualized rates). The put/call parity equation that holds true for these variables at this time is:

$$C_0(K) - P_0(K) = \frac{S_0}{1 + (r_A / 4)} - \frac{K}{1 + (r_J / 4)}$$

Compare the put/call parity equation for foreign currency with the one that is valid for equities which pay no dividends. (5 points)

c5) Suppose that a call option and put option with a strike price of 90 maturing in 3 months are now traded. The price of a call option with a strike price of 90 maturing in 3 months is  $C_0(90) = 16.38$  JPY and the price of the put option is  $P_0(90) = 5.41$  JPY. Provide an example of an arbitrage transaction that could be executed at this time and find the return that would be obtained. (6 points)

c6) Discuss the limitations of the Black-Scholes model for pricing currency call options. (5 points)

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**Question 4: Derivatives in Portfolio Management****(33 points)**

You are portfolio manager at B&V Investment Management. Tomorrow morning you have an important meeting with the legal officer appointed by your best customer, a big European company, for analyzing their stock portfolio. Positive performance over the last semester aside, you expect that your customer will be particularly worried about, first, the effect of the global financial crisis in progress and, secondly, the high volatility in the EUR/USD exchange rate. Therefore, you are discussing with your staff the optimal financial strategies to suggest to your customer for the next year.

- a) During the technical meeting with your staff, you suggest hedging the stock portfolio against a potential negative trend in the financial markets due to the unresolved effect of the global financial crisis with stock index futures. Although 20% of stocks in portfolio are not listed in European markets, you propose the EURO STOXX 50 as benchmark.

Given that the stock portfolio market value is EUR 80 million and its beta with the EURO STOXX 50 index is equal to 1.10, calculate how many futures contracts are needed to fully hedge your managed position. The last quotation of the EURO STOXX 50 is 3,015, while the current value of the EURO STOXX 50 Futures with 1 year maturity is 2,960 and its contract size is EUR 10 per index point. (5 points)

- b) Now, you concentrate on the opportunity of hedging the 20% of the managed portfolio quoted in USD currency by trading at the CME Globex Electronic Market in EUR/USD futures contracts (for 1 EUR, x USD is received; the contract size of each EUR/USD futures contract is EUR 125,000).

b1) In order to protect the managed portfolio from a drop of the USD currency, do you need to buy or sell futures? Explain your answer. (3 points)

b2) After discussing with your staff, you decide to totally hedge the USD portfolio component for the next semester and then you decide to verify and update your strategy. By assuming that in the next semester the market performance of the 20% of the managed portfolio invested in US Companies is zero, while the euro exchange rate appreciates against the dollar from USD 1.1050 / EUR to USD 1.1505 / EUR, describe the profit/loss of the managed portfolio at the end of the semester with and without the hedging strategy (Assume that the futures contract entered into has a delivery price equal to the current spot price i.e. 1.1050). (12 points)

- c) As an alternative to hedging strategies, you evaluate a protective strategy using index put options. The target is to constitute a floor to protect the managed portfolio against a decline in capital value of more than 8% over the next year. The stock portfolio is effectively well-diversified and its dividend yield is 2% p.a. (continuously compounded), the same value of the dividend yield on the EURO STOXX 50 index. The risk-free interest rate is 1.0%.

c1) Calculate the decline in the market index (EURO STOXX 50) that corresponds to the 8% decline in the capital value of the portfolio (6 points)

- c2) Assuming that the insurance cost is to be borne externally from the managed funds, define which options with maturity exactly one year from now should have been considered and how many option contracts should have been purchased or sold. (7 points)

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**Question 5: Portfolio Management****(48 points)**

You are a financial advisor serving individual investors. Your clients consult you about various aspects of asset management:

- a) One of your clients, Mr. X (X) is a 35-year-old public employee and is considering installment-style investment of CU 1 million each year to prepare for his retirement. X heard somewhere that, in terms of lifecycle investment, individual investors have human capital in addition to financial assets, and he asks you what that means.

Explain briefly what "human capital" means. (4 points)

- b) X is considering a diversified investment in the global equity fund and domestic public bond fund shown below:

Fig. 1: Characteristics of funds under consideration

	Expected return (annualized)	Risk (standard deviation, annualized )
Global equity fund	7%	20%
Domestic public bond fund	2%	4%

- The correlation between the global equity fund returns and domestic public bond fund returns is -0.20.
- The risk-free interest rate is 1% (annualized).

- b1) Calculate the expected return and risk of a portfolio investing 60% in the global equity fund and 40% in the domestic public bond fund. Calculations should be presented as percentages rounded to the first decimal place. (5 points)

- b2) X is considering investing CU 1 million and he wants to limit the probability that the portfolio's market value becomes less than CU 800,000 after 1 year, to 5% or below. Calculate whether the portfolio described in b1) (global equity fund 60%; domestic public bond fund 40%) satisfies this condition, and justify your conclusion. Assume that returns follow a normal distribution. Note that according to the cumulative distribution function  $N$  of normal distribution,  $N(0.05) = -1.645$ . [Note: If you have not attempted b1), assume an expected return and risk of 0% and 12% respectively.] (4 points)

- c) X has learned that a hedge fund index has performed very well for the past 5 years, and is considering investing part of his funds in the hedge fund to further diversify his investments.

- c1) The calculation of returns of the hedge fund index can have a number of biases. Identify two typical biases and describe them. (4 points)

- c2) Identify two typical risks associated with hedge fund investments and describe them. (4 points)

- d) X invests CU 1 million in the portfolio studied in b1) and after 1 year makes an additional investment of CU 1.5 million in anticipation of a large market increase. Contrary to his expectations, however, the market decreases during the second year, and at the end of the

second year, the portfolio's market value, including the additional funds, is CU 2.57 million, as shown in the table below.

Fig. 2: Market value of investment portfolio

Time	Market Value at the end of the year: $V_t$ (CU million)	Additional funds at the beginning of next year: $NC_t$ (net cash flow) (CU million)	$V_t + NC_t$
Starting year ( $t = 0$ )	1.00		1.00
First year ( $t = 1$ )	1.30	+1.50	2.80
Second year ( $t = 2$ )	2.57		2.57

- d1) Calculate the money-weighted rate of return (annualized) over the 2 years in percentages terms rounded to the first decimal place. (4 points)
- d2) Calculate the time-weighted rate of return (annualized) over the 2 years in percentages terms rounded to the first decimal place. (4 points)
- d3) The additional investment of CU 1.5 million at the beginning of the second year was based upon X's view, anticipating a large market increase. In light of that, which is the better measure of 2-year performance, the money-weighted rate of return or the time-weighted rate of return? Explain briefly why. (4 points)

A few years later, you have become an asset management consultant for a pension fund.

- e) You want to explain to the client pension fund the importance of taking pension liabilities into account in asset allocation.
- e1) The passages underlined and marked ①~⑤ in the explanation of pension ALM (Asset Liability Management) may contain mistakes. Correct them if they contain mistakes. Otherwise, indicate that they are correct.

Pension ALM is an approach to asset management that takes account of pension liabilities. One form of pension ALM defines the difference between assets and liabilities as the "surplus" and attempts to manage it appropriately. To do this, it is important ① to increase the fluctuation of the surplus return.

You want to begin by explaining the distinctive features of asset classes when pension liabilities are taken into account. In defined benefit pensions (DB), employees are promised pension benefits for a long term into the future. The sponsoring company of the pension fund recognizes these as liabilities and can be deemed to have ② issued bonds corresponding to the average term to maturity (duration) of pension benefits. Given the liability side conditions on the pension fund, for asset side management ③ short-term bonds with short durations are better. On the other hand, stock reflects the long-term growth of the company, and for a DB in which pension benefits are proportional to final wages, stock can be expected to have a ④ negative correlation to wage increases. Alternative investments are ⑤ expected to have a high correlation with bonds and stocks, and should be considered for investment contributing to the

diversification effect. Alternative investments include real estate, private equity, and hedge funds. (10 points)

- e2) Discuss the problems when alternative investments are added to pension ALM in comparison to traditional assets (bonds and stocks), and identify the points that must be considered. (5 points)