Certified International Investment Analyst

EXAMINATION II:

Fixed Income Valuation and Analysis

Derivatives Valuation and Analysis

Portfolio Management

Solutions

Final Examination

March 2017

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

[Note to the correctors:
The following answers do not represent the only calculation methods or explanations that could be applied. Please mark everything as correct as long as the definitions, calculations and relationships make sense (please note that the final digit may vary according to the calculation method).]

a)

a1)

The prices can be calculated as the present value of the coupons and the present value of the principal. Hence using the present value formulae:

$$P = \sum_{t=1}^{T} \frac{C}{\left(1+Y_C\right)^t} + \frac{100}{\left(1+Y_C\right)^T} = \frac{C}{Y_C} \cdot \left(1 - \frac{1}{\left(1+Y_C\right)^T}\right) + \frac{100}{\left(1+Y_C\right)^T}$$

$$① \; P_1 = \frac{8\%}{6.65\%} \cdot \left(1 - \frac{1}{(1+6.65\%)^7}\right) + \frac{100\%}{(1+6.65\%)^7} = 107.37\%$$ (3 points)

$$② \; P_4 = \frac{6\%}{5.92\%} \cdot \left(1 - \frac{1}{(1+5.92\%)^8}\right) + \frac{100\%}{(1+5.92\%)^8} = 100.50\%$$ (3 points)

a2)

Tier 1 capital prior to issuance: EUR 46.85 billion; Leverage exposure prior & post to issuance: EUR 1,423 billion.

Therefore,

$$\text{Leverage-Ratio prior to issuance} = \frac{\text{Tier 1 capital}}{\text{Leverage exposure}} = \frac{46.85}{1423} = 3.29\%$$ (2 points)

$$\text{Proforma Leverage-Ratio after issuance} = \frac{46.85+1.75}{1{,}423} = 3.42\%$$ (2 points)

a3)

We know that:

- The longer the maturity to call of the “CoCo”-bond, the higher will be its (modified) duration and convexity.
- The lower the Yield-to-Call of the “CoCo” -bond, the higher will be its (modified) duration and convexity.
- The lower the coupon of the “CoCo” -bond, the higher will be its (modified) duration and convexity.

Duration and convexity are directly linked to maturity, and inversely linked to coupon and yield to call. Since Deutsche Bank’s “CoCo”-bond has both the highest maturity and the lowest coupon (and a yield to call near to the lowest one), it is possibly the bond with the highest modified duration and convexity.

(5 points)

b)

b1)

Barclays' "CoCo"-bond offers the highest Yield-to-Call among the given 4 bonds because its nominal value as well as its coupons can be reduced already at a CET1-Ratio of 7% (whereas the other "CoCo"-bonds have a CET1-Trigger of only 5.125%).

This means that as soon as Barclays' CET1-Ratio falls below 7% (e.g. driven by losses reducing its CET1-Capital or increases of its risk-weighted-assets exposure) the respective investors will start losing money.

Such higher risk exposure of Barclays' "CoCo"-bond is offset by a higher Yield-to-Call (compared to the other 3 "CoCo"-bonds).

In summary, Barclays' "CoCo"-bond offers the highest Yield-to-Call because it has the highest CET1- Trigger (so it is riskier).

(5 points)

b2)

The main determinants of the Yield-to-Call of a newly issued "CoCo" bond are:

- Maturity of call date
- Coupon (and coupon frequency)
- New issuance premium
- CET1-Trigger (and buffer to trigger)
- Issuer rating (i.e. the credit quality of the bond)

(1 point per determinant, max 4 points)

c)

c1)

From an investor perspective:

- Investors, such as Insurance Companies or Pension Funds, are confronted with huge challenges to realize an appropriate return in light of a very low interest rate and credit spread environment.
- As a result they have a high interest in high-yield bonds in general and such "CoCo"-bonds, in particular, which offer yields higher than other less risky bonds.

So the main reason is "**yield enhancement**". (4 points)

c2)

The main risk factors of a "CoCo"-bond from an investor perspective other than interest rate risk are:

- Write-down risk (or higher 'credit risk' in general).
- Coupon payment risk.
- Liquidity risk in terms of low turnover in the secondary markets.
- Higher price volatility as a result of market events (e.g. crisis) compared to senior bonds.

(2 points for each risk factor, max. 6 points)

c3)
From the issuer perspective:

- Due to their regulatory Tier 1-Capital recognition these "CoCo"-bonds, **in case of conversion,** decrease the leverage [**Debt/Equity**] (and increase Tier 1 capital ratio) of the issuing bank, thus supporting the overall bond spreads of the bank in the debt markets. **In fact, in case the trigger event occurs, conversion of debt into equity drives down company's leverage** [**Debt/Equity**].
- In addition they support the general "Loss Absorbance Capacity" in the form of sub-ordinated instruments on the liability side (including shareholders' equity) and, hence, for instance, support the long-term rating of the issuing bank.
- In the exercise of increasing CET1, CoCo bonds are cheaper than issuing new equity with the cost of equity capital of about 10%.
- CoCo bonds are considered as debt by tax authorities and then CoCo bonds profit from the tax shield.

(5 points)

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

a)
The underlying assumption is that all interim cash flows (interest payments) can be reinvested at 5%. If all interest payments received from the bonds can be reinvested at 5%, then 5% will be the actual yield to maturity. Technically, 5% is a promised yield to maturity and is based on the underlying assumption that interest rates will remain unchanged and all interim cash flows are reinvested at that rate. In the real world this rarely occurs; thus investors face reinvestment risk, the risk that interim cash flows will be reinvested at a lower rate. If we anticipate that interest rates will decrease in the future, in order to earn a 5% return, capital gain (price increase) must offset the decrease of the reinvestment return of interest payments and vice versa.

(5 points)

b)
An investor can immunize the portfolio by matching the holding period and the duration. Accordingly, a holding period of 6 years would immunize this portfolio and lock in a return of 5%. In this scenario the price risk and reinvestment risk will offset each other. For example, if interest rates increase then the value of the bond would decrease. This loss would be offset by a higher return on the reinvestment of interim cash flows. It could be noted that the duration will change when interest rates change thus the portfolio duration may need to be adjusted over the six-year period. (5 points)

Question 3: Derivative Valuation and Analysis (50 points)

[Note to the correctors:
The following answers do not represent the only calculation methods or explanations that could be applied. Please mark everything as correct as long as the definitions, calculations and relationships make sense (please note that the final digit may vary according to the calculation method).]

a)

a1)

The change in price per ounce is USD 3 and therefore for 200 ounces the initial margin will be reduced by USD 600. Hence subtracting 600 from 4000 we get USD 3400:

$4000 - 200 \cdot (1285 - 1282) = 3400$ (3 points)

a2)

The change in price per ounce is USD 3 and therefore for 200 ounces the initial margin will be reduced by USD 600. Hence subtracting 600 from 3400 we get USD 2800:

$3400 - 200 \cdot (1282 - 1279) = 2800$ (2 points)

It is necessary to top up the margin account to the amount of the initial margin because the balance is below the maintenance margin (2800 < 3000), so pledge USD 1,200 (= 4,000 – 2,800).

(2 points)

a3)

Borrow 125,000 dollars at the risk-free rate and purchase 100 ounces of gold in the spot market.

One year later pay $125,000 \cdot (1+2.3\%) = 127,875$ and pay USD 300 as the storage cost. The amount received is 128,500 dollars (= 1,285 · 100). Hence the arbitrage profit is:

$128,500 - 127,875 - 300 = 325$ dollars.

(6 points)

b)

10 million dollars from securities house B to the clearing agency and 10 million dollars from the clearing agency to securities house C. (5 points)

c)

c1)

$$1 + \frac{r_J}{4} = \frac{1}{S_0} \cdot \left(1 + \frac{r_A}{4}\right) \cdot F_{01}$$

$$\therefore F_{01} = S_0 \cdot \frac{1 + (r_J / 4)}{1 + (r_A / 4)}$$

(2 points)

$$F_{01} = S_0 \cdot \frac{1 + (r_J / 4)}{1 + (r_A / 4)} = 100 \cdot \frac{1 + (1\% / 4)}{1 + (3\% / 4)} = 99.5037$$ (3 points)

[Using the theoretical price of futures, forward exchange rates:

$$F_{t,T} = S_t \cdot \left(\frac{1+R_{dom}}{1+R_{for}}\right)^{T-t} \Rightarrow F_{01} = S_0 \cdot \left(\frac{1+R_J}{1+R_A}\right)^{0.25} = 100 \cdot \left(\frac{1+1\%}{1+3\%}\right)^{0.25} = 99.5110]$$

c2)
From c1), in this currency forward, the company pays "forward price times USD 10 million" (i.e., rounded at JPY 995 million) in exchange for USD 10 million in 3-months time. Therefore, the amount to be provisioned at the current point in time for payment in 3 months is:

$$\frac{F_{01} \cdot 10{,}000{,}000}{1+(r_J/4)} = \frac{995{,}000{,}000}{1+(1\%/4)} = 992{,}518{,}703$$

i.e. JPY 992.52 million. (4 points)

[Using annual compounding:

$$\frac{F_{01} \cdot 10{,}000{,}000}{(1+R_J)^{0.25}} = \frac{995{,}000{,}000}{1.01^{0.25}} = 992{,}527{,}931]$$

c3)
He has to buy (**1 point**) 1,000 trading units (**1 point**) of call options with strike K = 100 yen (per dollar) (**1 point**).

At maturity:

- If $S_T < 100$, the option will not be exercised and the cost for the 10 million USD will be (10 million · S_T) JPY. (2 points)
- If, at the contrary, $S_T \geq 100$, the option will be exercised and the cost for the 10 million USD will be (1,000 million) JPY. (2 points)

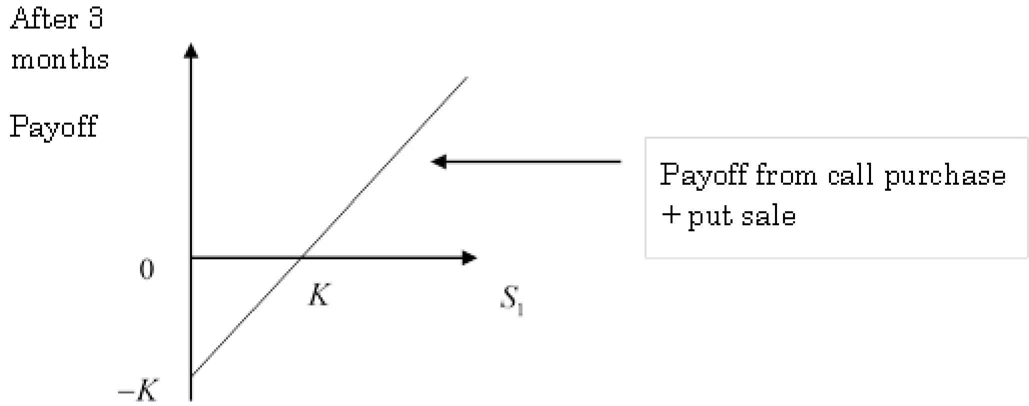
So:

- If $S_1 < 100$ in 3 months, the option value is zero and the company pays 10 million · S_1 in JPY.
- If $S_1 > 100$ in 3 months, option value is (S_1 - 100) and the company:
  - Pays 10 million · S_1 in JPY
  - Receives 10 million (S_1 - 100) in JPY
  - So in total: pays 10 million · 100 in JPY (or 10 million · K in JPY)

c4)
The put-call parity equation is derived by imposing no-arbitrage conditions on investment strategies across calls, puts and the underlying asset and it specifies a relationship between the prices of these assets under these conditions. The equation in this case differs from the more usual/familiar put-call parity relationships since with currency derivatives there will be two interest rates appearing in the equation. This arises from the fact that the interest rate in the foreign market is reflected in the equation as a form of income (or dividend in equity by analogy). The equation is derived from no-arbitrage arguments in frictionless markets employing discrete discounting/compounding and is subject to the normal limitations arising from this set of assumptions. (5 points)

[The following derivation is not required and is shown only for pedagogical reasons:

The relationship presented in the question is derived as:
The figure below shows the relationship between the payoff received in 3 months and the foreign exchange rate S_1 in 3 months from a position in which 1 unit of a European-style call option with a maturity of 3 months is purchased and 1 unit of a put option with the same strike price K is simultaneously sold.



In other words, the return in 3 months from a position in which 1 unit of calls is purchased and 1 unit of puts sold is $\left(S_1 - K\right)$.

However, by borrowing for 3 months $\dfrac{K}{1+(r_J/4)}$ JPY at interest rate r_J, and simultaneously purchasing $\dfrac{S_0}{1+(r_A/4)}$ JPY in USD for investment for 3 months at interest rate r_A, and then converting to JPY at currency rate S_1, the JPY converted return after 3 months will be $-K+S_1$

However, at the current point in time, this is equivalent to the return to be derived in 3 months from a position comprising the purchase of 1 unit calls and the sale of 1 unit puts (at strike price K).

If there are no arbitrage opportunities, the costs at the current time of creating both positions must be equal.]

c5)

$$P_0(90)+\frac{100}{1+(0.03/4)}-\frac{90}{1+(0.01/4)}=5.41+99.25-89.78=14.88<16.38=C_0(90)$$

Therefore, according to the put-call parity equation, the price of a call option with a strike price of 90 is too high (14.88 according to put-call parity vs. 16.38 in the market). The company therefore sells 1 trading unit of call options with strike price 90 and simultaneously purchases 1 trading unit of put options with strike price 90. In addition, it purchases $\dfrac{1{,}000{,}000}{1+\left(0.03/4\right)}$ JPY of USD, invests them for 3 months at the US interest rate of 3%, and then converts them to JPY at the currency rate S_1, while also borrowing $\dfrac{900{,}000}{1+\left(0.01/4\right)}$ in JPY at an interest rate of 1%, and making repayment in 3 months. The JPY-converted return after 3 months from this transaction is 0 JPY, and at the current point in time, $(16.38-14.88)\cdot 10,000=15,000$ JPY arbitrage profit is earned.

(6 points)

We can show the arbitrage with the following table:

	Today	**In 3 months**
Sell 1 unit of call	**16.38 JPY**	-max(ST-90;0) JPY
Buy 1 unit of put	**-5.41 JPY**	max (90-ST;0) JPY
Buy USD today to have 1 USD in 3 months and convert them in JPY with rate ST	-100/(1+0.03/4) = **-99.25 JPY** (= 0.9925 USD, because S0 = 100)	0.9925 USD x (1+03/4) x ST = 1 x ST = ST JPY
Borrow JPY to reimburse 90 JPY in 3 months	90/(1+0.01/4) = **89.78 JPY**	-90 JPY
TOTAL	**1.50 JPY**	**0 JPY**

Gain with trading unit of 10'000 USD	10'000 x 1.50 JPY **= 15'000 JPY**

c6)
Under the given conditions, using JPY risk free rate as the continuous compound risk free rate and the currency rate as the underlying asset in the Black-Scholes formula, the price of a currency call option found as a no-dividend European-style call option will be higher than the theoretical price of the same option.

When a foreign currency is used as the underlying asset, foreign interest rate is considered to be the dividend yield on the underlying asset, and the true price is the option price for the underlying asset with dividend. However, in the Black-Scholes formula, only the currency rate is considered for the underlying asset, and the "dividend" (r_A) is ignored. This results in the Black-Scholes price of a European-style foreign-exchange call option with no dividends being **higher** than the true price. (For example, if you buy a call option at the money, with dividend, you have fewer chances to be at the money at maturity than with no dividend; and therefore, with dividends, you obtain a lower theoretical price of call option.)

(5 points)

Question 4: Derivatives in Portfolio Management (33 points)

a)

$$N_F = -\beta_{r_S,r_F} \cdot \frac{N_S \cdot S_t}{k \cdot F_{t,T}} = -\beta_{r_S,r_F} \cdot \frac{\text{market value of spot position}}{\text{market value of futures contract}} == -1.1 \cdot \frac{80 \cdot 10^6}{10 \cdot 2{,}960} = -2{,}973$$

(5 points)

b)

b1)

To hedge the USD position you have to sell USD, buy EUR. Since the underlying of the future is 125,000 EUR, we need to buy futures. In fact, the futures quote is the price of 1 EUR in USD. If the dollar drops, the future quote rises, and since you have to gain from this you buy the future. (3 points)

b2)

Let's analyse the outcome of the managed portfolio under the two scenarios, with and without the proposed hedging strategy.

The value (in local currency, i.e. in EUR) of the 20% of the managed portfolio invested in US Companies is EUR 16 million (EUR 80 million · 20%). (1 point)

Case 1: final outcome without the hedging strategies.

– Market performance: 0% (1 point)

– Value of USD part in USD at the beginning: 16 million EUR · 1.1050 = 17.680 million USD (1 point)

– Value of USD part in EUR at the end: 17.680 million USD / 1.1505 = 15,367,232 EUR (1 point)

– Portfolio loss: EUR 16 million – EUR 15,367,232 = 632,768 EUR (or 3.95% of USD part) (1 point)

Case 2: final outcome with the hedging strategies.

– Market performance: 0%; (1 point)

– USD depreciation: 632,768 EUR / 16 million EUR = 3.95%. (1 point)

– Number of EUR/USD futures to totally hedge the stock position:
$\frac{16{,}000{,}000}{125{,}000} = 128$, so we buy 128 contracts. (2 points)

– Futures gain: (3 points)
  – At the beginning: 128 contracts · 125,000 EUR · 1.1050 = 17.680 million USD (I sell 17.680 million USD and receive 16 million EUR)

- At the end: 128 contracts · 125,000 EUR · 1.1505 = 18.408 million USD (I receive 18.408 million USD and pay 16 million EUR)
- Future gain in EUR at the end: (18.408 million – 17.680 million) / 1.1505 = 632,768 EUR (or 3.95%)

c)

c1)

First, we have to compute the change in the EURO STOXX 50 index over the next year, defined as r_{MC}, corresponding to a 8% decline in the capital value of the managed portfolio, that is $r_{PC} = -8\%$.

From the Security Market Line equation characterizing the CAPM model, we have:
$r_{PC} + r_{PD} = r_F + \beta \cdot (r_{MC} + r_{MD} - r_F)$, where r_{PC} is the capital return of the portfolio, r_{PD} is the dividend of the portfolio, r_F is the risk-free rate, r_{MC} is the capital return of the market, r_{MD} is the dividend of the market)

The target is to compute the capital index return r_{MC} over the next year:

$$r_{MC} = \frac{1}{\beta} \cdot (r_{PC} + r_{PD}) - \frac{1-\beta}{\beta} \cdot r_F - r_{MD}$$

$$r_{MC} = \frac{1}{1.1} \cdot (-8\% + 2\%) - \frac{1-1.1}{1.1} \cdot 1\% - 2\% = -7.36\%$$

Therefore, a 8% drop in the capital value corresponds to a 7.36% drop in the market index.

This result is consistent with the beta level and the dividend yield proportion. (6 points)

c2)

The target is now to insure the managed portfolio against a 7.36% decline of the DJ EURO STOXX 50 over the next year with respect to a present index value of 3015.

The strike price of the protective put option corresponds, theoretically, to the floor, say Φ, applied to the market index:

$$\Phi = 3015 \cdot e^{-7.36\%} = 2801$$

It can be remarked that in this particular case the theoretical strike price is very close to a real tradable level a round number like 2800, for a traded put option written on the EURO STOXX 50. Therefore, the implicit error due to the technical approximation is quite negligible.

The insurance portfolio strategy requires a long position in put options. Denoted N_{Put} the number of put option with strike price Φ to buy, we have.

$$N_{Put} = \beta \cdot \frac{\text{Portfolio value}}{\text{Index level} \cdot \text{Options contract size}} = 1.1 \cdot \frac{80 \cdot 10^6}{3,015 \cdot 10} = 2,919$$

Finally, we have to buy 2,919 put options with strike price 2,800.

(7 points)

Question 5: Portfolio Management (48 points)

a)
"Human capital" represents the investor's capacity to generate income by working and is a reflection of the investor's skill set. It can be seen as the sum of the present value of labour income that the investor will generate in future. (4 points)

b)
b1)
Expected return:
$$R_P = x_D \cdot R_D + x_E \cdot R_E = 0.4 \cdot 2\% + 0.6 \cdot 7\% = 5\%$$
(2 points)

Risk:
$$\sigma_P = \sqrt{x_D^2 \cdot \sigma_D^2 + x_E^2 \cdot \sigma_E^2 + 2 \cdot \rho_{DE} \cdot x_D \cdot x_E \cdot \sigma_D \cdot \sigma_E}$$
$$= \sqrt{0.4^2 \cdot 4\%^2 + 0.6^2 \cdot 20\%^2 + 2 \cdot (-0.2) \cdot 0.4 \cdot 0.6 \cdot 4\% \cdot 20\%}$$
(3 points)
$$=11.78 \approx 11.8\%$$

b2)
Considering the portfolio of b1), the expected return is 5% and the risk is 11.8%. The value at risk is given by:
$$\text{VaR}(1\text{year},95\%) = z_{95\%} \cdot \sigma(R) - \mu(R) = 1.645 \cdot 11.8\% - 5\% = 14.41\%$$
On a portfolio of CU 1 million, the VaR is therefore CU 144,100. (3 points)

Assuming a normal distribution, we can say as well:
-VaR (1year,95%) = -1.645 = (X - μ) / σ = (X - 5) / 11.8 → X = -14.41%

[Using the given values,
$$\text{VaR}(1\text{year},95\%) = z_{95\%} \cdot \sigma(R) - \mu(R) = 1.645 \cdot 12\% - 0\% = 19.74\%$$
On a portfolio of CU 1 million, the VaR is therefore CU 197,400]

Hence, with a probability of 95%, the portfolio will not fall below CU 800,000 in one year, and it satisfies X's condition. (1 point)

c)
c1)
- Survivorship Bias: Upward bias in performance because non-surviving funds etc. are excluded from index performance calculations.
- Backfill Bias: Upward bias in performance because of retrospective calculation of the returns of newly added funds whose past performance is excellent.
- Self-Selection Bias: Upwards or downwards bias because of the existence of funds that do not disclose returns.

(2 points per bias, max. 4 points)

c2)

- Leverage risk: The risk that over-leveraging of the fund will force positions to be unwound if the market moves above a certain threshold because the fund lacks the money for margin calls, which will trigger further declines in performance.
- Asymmetrical distribution of returns: The risk that downside risks are large in comparison to the upside potential of returns.
- Liquidity risk: The risk to suffer from losses beyond expectations because of the inability to sell the fund when desired, especially in down markets, due to limited withdrawal periods of the fund or due to low liquidity of the assets held in the fund.
- Operational risk: Most hedge funds are managed by small organizations, and there is a risk that their management structures are inadequate.

(2 points per risk, max. 4 points)

d)

d1)

The money weighted rate of return is the IRR:

$$CF_0 + \frac{CF_1}{1+IRR} = \frac{CF_2}{(1+IRR)^2}$$

$$\therefore CF_2 = CF_0 \cdot (1+IRR)^2 + CF_1 \cdot (1+IRR)$$

$$2.57 = 1 \cdot (1+IRR)^2 + 1.5_1 \cdot (1+IRR)$$

Solving we get IRR = 2.0%.

(4 points)

d2)

The time weighted rate of return is:

$$1+TWR_{Tot} = (1+TWR_1)\cdot(1+TWR_2) = \frac{MV_{End,1}}{MV_{Begin,1}} \cdot \frac{MV_{End,2}}{MV_{Begin,2}} = \frac{1.3}{1} \cdot \frac{2.57}{(1.3+1.5)} = 1.193$$

Therefore, the annualized TWR= $\sqrt{1.193} - 1 = 0.092 = 9.2\%$.

(4 points)

d3)

The additional funds were based on X's view that the market would experience a large increase, and therefore money-weighted performance is the preferred measure because it accounts for the impact of cash flow timing. (4 points)

e)

e1)

① Wrong. Should be: To decrease the fluctuation of the surplus return

② Correct (no change)

③ Wrong. Should be: Long-term bonds with long durations are better

④ Wrong. Should be: Positive correlation

⑤ Wrong. Should be: Expected to have a low correlation

(2 points each, max 10 points)

e2)

There is typically less long-term data available than for traditional assets (bonds and stocks), so one needs to consider how to measure expected returns (risk premiums) and risk. One must also consider how to set correlation against traditional assets and pension liabilities. In addition, the performance of alternative investments widely differs among management firms, and one must also give consideration to potentially low liquidity. (5 points)