<u>Exam Risk Management June 24, 2016</u>

1. A portfolio manager has maintained an actively managed portfolio with a beta of 0.4. During the last year, the risk-free rate was 4% and the return from the market portfolio 20%. The portfolio manager produced a return of 10%. How did the manager perform? **1 point**
   a) The manager performed good.
   b) The manager performed badly.

   $\alpha = 10 - 4 - 0.4(20 - 4) = -0.4 \rightarrow$ negative alpha, so the manager performed badly

2. Suppose the risk-free rate is 6%, the expected return on the market is 15%, and the standard deviation of the return on the market is 21%. An investor creates a portfolio on the efficient frontier with an expected return of 12%. What is the systematic risk of this investment? **2 points**

$$\beta = \frac{12 - 6}{15 - 6} = \frac{2}{3}, \qquad \beta R_m = \frac{2}{3} \cdot 15 = 10$$

3. In which market are options traded? **1 point**
   a) Exchange-traded market
   b) Over-the-counter market
   c) <u>Both</u>
   d) None

4. Forward contracts… **1 point**
   a) Are standardized.
   b) Give you the right to buy/sell an asset in the future for a certain price.
   c) Are traded on the exchange-market.
   d) <u>Are usually settled at the end of the contract.</u>

5. A company knows that in six months it will receive a certain amount of a foreign currency. What type of option contract can be used to hedge? **1 point**
   a) A long position in a six-month call option
   b) A short position in a six-month call option
   c) <u>A long position in a six-month put option</u>
   d) A short position in a six-month put option

6. Suppose that an October put option with a strike price of €46 costs €2.40. What is the minimum stock price for which the seller of the put option will make a profit? **1 point**

   The minimum stock price for which the seller will make a profit equals $46 - 2.40 = €43.60$.

7. The current price of a stock is €45 and 6-month European call options with a strike price of €47.50 currently sell for €2.25. An investor who feels that the price of the stock will increase is trying to decide between buying 100 shares and buying 2,000 call options. How high does the stock price have to rise for the option strategy to be more profitable? **2 points**

The option strategy is more profitable when

$$(S - 47.50) \cdot 2000 - 2000 \cdot 2.25 > S \cdot 100 - 45 \cdot 100$$
$$\Leftrightarrow 2000S - 99500 > 100S - 4500$$
$$\Leftrightarrow 1900S > 95000$$
$$\Leftrightarrow S > 50$$

8. The Greek theta is equal to: **1 point**
   a) $\frac{\delta P}{\delta \sigma}$
   b) $\frac{\delta^2 P}{\delta S^2}$
   c) $\boldsymbol{\frac{\delta P}{\delta t}}$ ←
   d) $\frac{\delta P}{\delta S}$

9. Estimate the change in the value of a gamma-neutral portfolio with delta equal to 20 per € and vega equal to 10 per % when suddenly the underlying asset prices increases by €6 and its volatility decreases by 2%. **1 point**

$$\Delta P \approx \frac{\delta P}{\delta S}\Delta S + \frac{\delta P}{\delta \sigma}\Delta\sigma + \frac{\delta P}{\delta t}\Delta t + \frac{1}{2}\frac{\delta^2 P}{\delta S^2}\Delta S^2 = 20 \cdot 6 + 10 \cdot -2 = 120 - 20 = 100$$

10. Consider the following portfolio and traded options:

	Delta	Gamma	Vega
Portfolio	100	-3,000	-2,000
Option 1	0.3	2.0	1.5
Option 2	0.8	0.7	0.4

What position in the traded options and underlying asset would make the portfolio delta, gamma and vega neutral? **3 points**

The following set of equations should be solved to determine how many of the traded options should be bought to make the portfolio both gamma and vega neutral:

$$-3000 + 2w_1 + 0.7w_2 = 0$$
$$-2000 + 1.5w_1 + 0.4w_2 = 0$$

This can be solved as follows:

$$-3000 + 2w_1 + 0.7w_2 = 0 \rightarrow w_1 = 1500 - 0.35w_2$$

$$-2000 + 1.5w_1 + 0.4w_2 = 0 \rightarrow -2000 + 1.5(1500 - 0.35w_2) + 0.4w_2$$
$$= 250 - 0.125w_2 = 0 \rightarrow w_2 = \frac{250}{0.125} = 2000$$

$$w_1 = 1500 - 0.35 \cdot 2000 = 1500 - 700 = 800$$

This means that 800 of the first traded option should be bought and 2000 of the second traded option. The new delta of the portfolio equals

$$100 + 800 \cdot 0.3 + 2000 \cdot 0.8 = 100 + 240 + 1600 = 1940.$$

Thus, the portfolio including 800 of the first traded option and 2000 of the second traded option can be made delta neutral by selling 1940 of the underlying asset.

11. Suppose that each of two investments have a 5% chance of losing €15 million, a 3% chance of losing €5 million and a 92% chance of gaining €1 million in one year. What is the 1-year 95% VaR (Value at Risk) and the 1-year 95% ES (Expected shortfall) of a portfolio consisting of the two investments? Round to one decimal place. **2 points**

Probability	*Loss*
0.0025	*30*
0.003	*20*
0.092	*14*
0.0009	*10*
0.0552	*4*
0.8464	*-2*

1-year 95% VaR $= €14.0$ *million*

1-year 95% ES $= \frac{(0.05-0.003-0.0025)}{0.05} \cdot 14 + \frac{0.003}{0.05} \cdot 20 + \frac{0.0025}{0.05} \cdot 30 \approx €15.2$ *million*

12. Suppose that the change in the value of a portfolio over a 1-day time period is normally distributed with mean zero and standard deviation €5 million. **2 points**
    a) Give an approximation of the 3-day 97% VaR (Value at Risk) in million euros. Round to one decimal place.
    b) Provide a more accurate value for the 3-day 97% VaR in million euros by including a first-order daily autocorrelation of 0.2. Round to one decimal place.

    a) $\sqrt{3} \cdot 5 \cdot N^{-1}(0.97) \approx €16.3$ million
    b) $5\sqrt{3 + 2 \cdot 2 \cdot 0.2 + 2 \cdot 1 \cdot 0.2^2} N^{-1}(0.97) \approx €18.5$ million

13. The probability that the loss from a portfolio will be greater than €7.5 million in 4 months is estimated to be 5%. What is the 4-month 99% VaR assuming that the change in the portfolio value is normally distributed with mean zero? Round to one decimal place. **1 point**

$VaR(99) = VaR(95) * \frac{N^{-1}(0.99)}{N^{-1}(0.95)} = 7.5 * \frac{2.326}{1.645} = €10.6$ million

14. Consider the following investment portfolio on June 24, 2016:

Index	Portfolio value (€ million)
AEX	2
AMX	5
ASCX	4

The following historical data of the previous week is available:

Day	AEX	AMX	ASCX
0	453.770	648.060	756.730
1	442.690	655.645	748.957
2	432.890	663.856	740.485
3	439.075	658.384	735.385
4	445.089	643.897	730.445
5	458.145	648.384	738.395
6	443.820	653.586	742.349

What is the value in €million of the portfolio on June 25, 2016 under Scenario 3? Round to one decimal place. **2 points**

$$2 \cdot \frac{439.075}{432.890} + 5 \cdot \frac{658.384}{663.856} + 4 \cdot \frac{735.385}{740.485} \approx €11.0 \textit{ million}$$

15. The following table provides the losses ranked from highest to lowest for 500 scenarios with an assigned weight obtained from historical simulation.

Scenario number	Loss (€ million)	Weight
234	5.2	0.0034
385	5.1	0.002
143	4.8	0.01
443	4.6	0.002
142	4.2	0.003
67	4.1	0.001
…	…	…

What is the 1-day 98% VaR? What is the 1-day 98% ES? Round to one decimal place. **2 points**

1-day 98% VaR $= €4.2$ *million*

$$\textit{1-day 98\% ES} = \frac{0.0034}{0.02} \cdot 5.2 + \frac{0.002}{0.02} \cdot 5.1 + \frac{0.01}{0.02} \cdot 4.8 + \frac{0.002}{0.02} \cdot 4.6 + \frac{0.02-0.0034-0.002-0.01-0.002}{0.02} \cdot 4.2$$

$$= €\ 4.8 \textit{ million}$$

16. What is the correct definition of stressed VaR (Value at Risk)? **1 point**
    a) 100% VaR
    b) 95% VaR
    c) <u>VaR over the historical period where VaR is the greatest</u>
    d) VaR over the most recent year

17. Consider a portfolio consisting of a €1 million investment in asset A and a €500,000 investment in asset B. Assume that the daily volatility of asset A equals 3%, the daily volatility of asset B equals 1% and the coefficient of correlation between their returns equals 0.2. In addition, assume that the expected change in the investments over 3 days is zero. Use the model building approach to determine the 3-day 95% VaR for this portfolio in million euros. **1 point**

    3-day 95% VaR $= N^{-1}(0.95) \cdot \sqrt{1^2 \cdot 0.03^2 + 0.5^2 \cdot 0.01^2 + 2 \cdot 0.2 \cdot 1 \cdot 0.5 \cdot 0.03 \cdot 0.01} \cdot \sqrt{3} =$ € 0.9 *million*

18. What is the correct relation between Expected Loss (EL), Exposure at Default (EAD), Loss Given Default (LGD) and Probability Default (PD)? **1 point**
    a) EAD = PD x EL + LGD
    b) EL = PD x LGD + EAD
    c) <u>EL = EAD x PD x LGD</u>
    d) LGD = PD x EAD x EL

19. What is the required capital for a bank to stay healthy according to Basel I? **1 point**
    a) 97% Value at Risk
    b) <u>8% x Risk Weighted Assets</u>
    c) 95% Expected Shortfall
    d) Unexpected Loss