42104

Technical University of Denmark
Introduction to Financial Engineering

Written Examination 2018

Date: December 20, 2018 **Duration:** 4 hours

INSTRUCTIONS

1. This exam consists of three sections
2. Section A consists of five questions
3. Section B consists of eight questions
4. Section C consists of eight Multiple Choice questions. Any ambiguity about the chosen answer will be awarded 0 marks.
5. All aids (excluding Internet use) are allowed
6. This final examination counts for 100% of the course grade

SECTION A: Numerical questions (40%)

There are five questions in this section. Attempt all questions.

1. A bond has a duration of 5 and a convexity of 75. Use this information to approximate the (percentage) change in value if the interest rate decreases by 1%.

2. Compute the following:
   a. If the average daily return of a stock over the past 5 years is 0.0008 (0.08%), what is the average return in annual terms?
   b. If the average monthly return of a stock is 0.015 (1.5%), what is the average return in annual terms?
   c. If the variance of daily returns is 0.0005, what is the standard deviation in annual terms?
   d. If the standard deviation of weekly returns is 0.05, what is the standard deviation in annual terms?

3. During the last year, Mastercard has experienced an annualized standard deviation of returns of 27% (0.27) and Netflix has experienced an annualized standard deviation of returns of 45% (0.45). The correlation of Mastercard's and Netflix's returns is 64% (0.64).
   a. Without using the information in Question 3.b, answer the following question: Will the Global Minimum Variance (GMV) portfolio make use of short-selling?
   b. During the last year, Mastercard has seen an average annual return of 31% and Netflix has seen an average annual return of 43%. Calculate the GMV-portfolio in terms of weights, standard deviation, and return.
   c. Assuming a risk free rate of return of 10% (in annual terms), calculate the tangent portfolio in terms of weights, standard deviation, and return.
   d. Calculate the Sharpe Ratio of the two assets, the GMV-portfolio, and the tangent portfolio.

4. Consider a hypothetical world with

   - one risk-free asset
   - two investors: Ronald and Santa
   - three stocks: McDonald's, Coca-Cola and Kraft Heinz. The number of shares of each stock and their corresponding prices are listed in Table 1:

   Assume that the assumptions of the Capital Asset Pricing Model (CAPM) hold and that the prices do not change.

Company	# of shares	Price per share
McDonald's	800,000	\$180
Coca-Cola	4,250,000	\$50
Kraft Heinz	1,200,000	\$40

Table 1: Hypothetical stock market

   a. What are the weights of the market portfolio?
   b. Ronald owns 100% percent of the shares of McDonald's, 20% of the shares of Coca-Cola and 50% of the shares of Kraft Heinz. Santa owns the remaining shares. Explain why this is not an optimal portfolio choice for either of them.
   c. Santa owns all the risk-free assets in the world: 1,000,000 T-bills issued at \$99 each. Suppose that Ronald wants to have 100,000 T-bills in his portfolio. Calculate Ronald's and Santa's optimal portfolio weights for the four assets.

5. Consider a portfolio of three stocks. Stock 1 has a beta of 0.8, stock 2 has a beta of 0.6, and stock 3 has a beta of 1.2.

   a. Show how the portfolio's beta (factor) can be expressed in terms of the stocks' betas and other relevant quantities.
   b. Compute a portfolio with a beta of 1. What is the expected return on this portfolio if the Capital Asset Pricing Model (CAPM) holds? Will the return be exactly equal to the market return?
   c. Is it possible to compute a portfolio with a beta of 0? If so, what is the expected return on this portfolio if the CAPM holds?

SECTION B: Verbal questions (40%)

There are eight questions in this section. Attempt all questions.

6. Explain how to calculate the dirty price from the clean price of a bond. Which of the two prices should be used for calculations of yield, duration and convexity?

7. What does it mean to short-sell a financial asset? When is it beneficial to short-sell?

8. Is the following statement true or false? Justify your answer.
   Any portfolio (with portfolio weights adding up to 1) constructed from two or more non-efficient portfolios is non-efficient

9. You have calculated historical returns and risk for a number of stocks and constructed a portfolio for an investor based on this information. The historical returns show that the portfolio should yield 10% return per year with an annualised standard deviation of returns equal to 23%. The investor has invested according to your recommendation, but has experienced a return of 6% and a standard deviation of 30%. He thinks your calculations must be wrong. Explain to him why this is not the case.

10. Answer the following questions
    a. What are the main assumptions for constructing the Efficient Frontier (or stated equivalently; what are the main assumptions of mean-variance analysis)?
    b. Which additional assumption is needed to derive the Capital Asset Pricing Model (CAPM)?
    c. Explain in words what the CAPM-relation (as found in e.g., CZ p87: (3.25) or GT p153: (5.5)) expresses.
    d. Empirical testing most often leads to a rejection of the CAPM-relation. Discuss why the CAPM-relation does not hold when using real financial data.

11. Define Value-at-Risk and discuss if this is a better way of measuring risk compared to using variance/standard deviation.

12. Consider Figure 1, where standard deviation is on the x-axis and return is on the y-axis. The hyperbola shows the risky-assets only Efficient Frontier. Which of the lines (A, B or C) is the correct Capital Market Line and why are the other two lines incorrect?

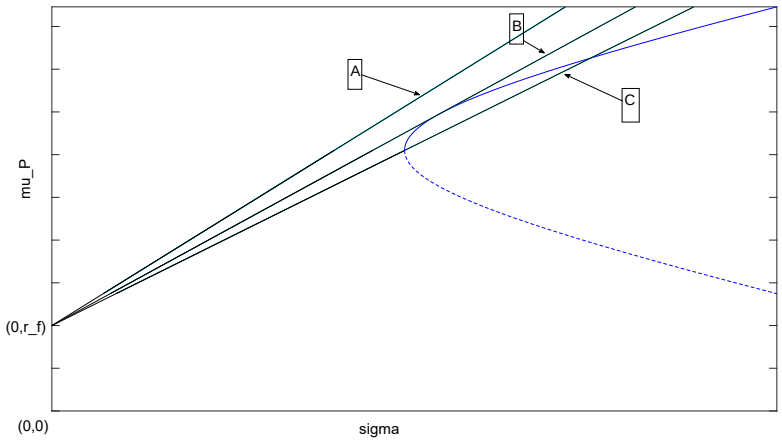

Figure 1: Efficient Frontier and possible Capital Market Lines.

13. Consider the figure in Figure 2, where standard deviation is on the x-axis and return is on the y-axis. The hyperbola shows the risky-assets only Efficient Frontier, and the dots show the seven individual assets making up the Efficient Frontier when there is no restriction on short-selling. Carefully illustrate or explain in words, where the Efficient Frontier would be located, if there is no short-selling allowed.

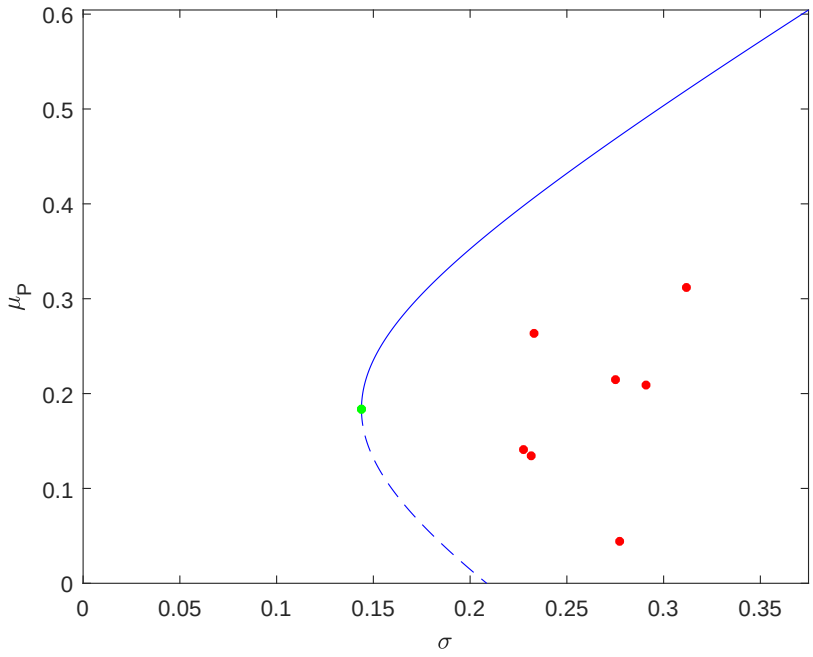

Figure 2: Efficient Frontier and assets

SECTION C: Multiple Choice questions (20%)

There are eight questions in this section. Attempt all questions and clearly state only one answer per question.

14. Assume positive interest rates. Which of the following statements is true?
    a. Having 100 kr today is worth the same as having 100 kr in one year from today
    b. Having 100 kr today is worth more than having 100 kr in one year from today
    c. Having 100 kr today is worth less than having 100 kr in one year from today

15. Which of the following is a part of the definition of the yield (to maturity) of a bond?
    a. The coupon / the cash flows
    b. The market interest rates
    c. The time to maturity
    d. The price
    e. All of the above
    f. Some, but not all of the above
    g. None of the above

16. The duration of a bond is a function of the bond's:
    a. Coupon rate
    b. Timing of cash flows
    c. Yield
    d. All of the above
    e. None of the above

17. If you buy a stock, which of the following is true?
    a. You know what the stock is worth in the future and which cash flows occurs
    b. There is no certainty about the future value/price of the stock and whether it pays any dividends
    c. There is no certainty about the future value/price of the stock, but you know that you will get dividends every year

18. If you buy a stock, what is the maximum percentage of your initial investment that you can lose?
    a. 100%
    b. More than a 100% – you might be required to pay creditors in case of bankruptcy
    c. It's not possible to say, but you will always get something in case of bankruptcy, so definitely less than 100%

19. What does it mean if you buy a call option on a stock?
    a. Buying a call option gives you the right, but not the obligation, to buy the stock at a pre-specified price at an expiration date
    b. Buying a call option gives you the right and the obligation to buy the stock at a pre-specified price at an expiration date
    c. Buying a call option gives you the right to buy the stock at market price at an expiration date
    d. None of the above

20. The seller of a call option on a stock
    a. has the right to buy the underlying stock at a pre-specified price at an expiration date
    b. has the right to sell the underlying stock at a pre-specified price at an expiration date
    c. may have the obligation to buy the stock at a pre-specified price at an expiration date
    d. may have the obligation to sell the stock at a pre-specified price at an expiration date

21. Consider the payments illustrated in Figure 3. Which type of bond has this cash flow?

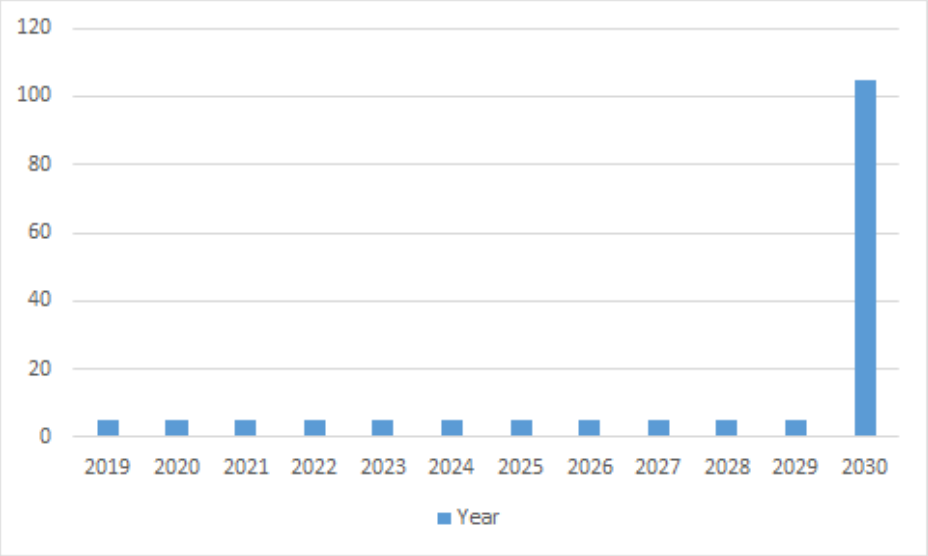

Figure 3: Cash flow for bond

a. Zero coupon bond
b. Bullet bond
c. Annuity
d. Serial bond

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