



School of Business and Economics

Exam: Investments

Code: E\_EBE3\_INVES

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Date: 31 May 2018

Time: 12:00

Duration: 2 hours and 45 minutes

Calculator allowed: Yes

Graphical calculator allowed: Yes

Number of questions: 20 multiple choice ones and 3 open-ended ones

Type of questions: Open/ multiple choice

Answer in: English

Remarks: Be concise and complete in your answers (including calculations). Always explain the answers to the open questions, even if not explicitly called for. Use your time efficiently, using the maximum number of points per question as a guideline.

Credit score: 3 points for the multiple-choice part and 4 points for the open-ended part

Grades: The grades will be made public on: June 14

Inspection: Friday, June 15 at 9.00. Room: TBA

Number of pages: 13 (including front page)

**Good luck!**

**PART 1 (MULTIPLE CHOICE QUESTIONS; 20 questions providing 3 points at maximum)**

**Read the questions carefully and write down the answers on your answer sheet. Your final score is determined as (number of correct answers - 3)\*3/17. Negative scores for this part of the exam are set to zero.**

1. Which of the following is not among the stylized facts of asset returns?

- A. The risk premium on the average stock is zero
- B. Serial correlation of daily returns is close to zero
- C. The distribution of daily returns typically exhibits fat tails
- D. Variance of returns has positive autocorrelation for small horizons
- E. Distributions of daily returns are typically asymmetric

The risk premium on the average stock is positive

2. Which of the following measures of risk best does NOT highlight the potential loss from extreme negative returns?

- A. Value at Risk (VaR)
- B. Conditional Tail Expectation
- C. Expected Shortfall
- D. Sharpe Ratio
- E. None of the above is related to downside risk

Sharpe Ratio does not highlight the risk from extreme losses.

3. Given an optimal risky portfolio with expected return of 18% and standard deviation of 21% and a risk free rate of 5%, what is the slope of the best feasible Capital Allocation Line?

- A. 0.64
- B. 0.14
- C. 0.62
- D. 0.33
- E. 0.36

Slope =  $(18 - 5)/21 = .6190$

4. An investor allocates capital between a risk-free investment and the market portfolio. The amount that the investor allocates to the market portfolio is negatively related to

- I) The expected return on the market portfolio.
- II) The investor's risk aversion coefficient.
- III) The risk-free rate of return.
- IV) The variance of the market portfolio

- A. I and II
- B. II and III
- C. II and IV
- D. II, III, and IV**
- E. I, III, and IV

The optimal proportion is given by  $y = (E(R_M) - r_f) / (.01 \times A \sigma_M^2)$ . This amount will decrease as  $r_f$ ,  $A$ , and  $\sigma_M^2$  decrease.

5. Which of the following is not an essential property of the Intertemporal Capital Asset Pricing Model?

- A. Investors' demand for risky assets is at least partially determined by changes in the investment opportunity set
- B. Investors face more than one systemic source of risk
- C. There are restrictions on borrowing**
- D. Correlations of assets with changes in time-varying factors, such as the risk-free rate, give rise to hedging demands to protect against that risk.
- E. Any risk factor should be related to subsequent market returns.

The ICAPM is not concerned with restrictions on lending or borrowing.

6. Portfolio A has expected return of 10% and a beta of 1. Portfolio B has expected return of 12% and a beta of 0.9. Rational investors will

- A. Borrow at the risk free rate and buy A.
- B. Sell A short and buy B.**
- C. Sell B short and buy A.
- D. Borrow at the risk free rate and buy B.
- E. Lend at the risk free rate and buy B.

Rational investors will arbitrage by selling A and buying B. Portfolio B can be scaled to have the same beta as Portfolio A.

7. Which of the following is (are) true regarding the Arbitrage Pricing Theory (APT)?

- I) All individual securities satisfy the APT relationship.
- II) More than one factor can be important in determining returns.
- III) All portfolios satisfy the APT relationship.
- IV) The market portfolio need not be among the priced factors.

- A. II, III, and IV
- B. II and IV
- C. II and III
- D. I, II, and IV
- E. I, II, III, and IV

All except the first item are true. APT need not apply to all individual securities.

8. A security has an expected rate of return of 10% and a beta of 1.1. The market expected rate of return is 8% and the risk-free rate is 5%. The alpha of the stock is

- A. 1.7%.
- B. -1.7%.
- C. 8.3%.
- D. 5.5%.
- E. -5.5%.

$10\% - [5\% + 1.1(8\% - 5\%)] = 1.7\%$ .

9. Which of the following would be supporting evidence for the validity of the CAPM?

- A. The market beta is equal to 0.
- B. Non-systematic risk has significant statistical power in explaining security returns.
- C. The average grade of students taking Investments 3.5 is higher than 5.5.
- D. The intercept in tests of the returns-beta relationship is exactly 1.
- E. Professional investors do not generally out-perform market indexes, demonstrating that the market is efficient.

The CAPM is qualitatively supported by findings that the market portfolio is efficient.

10. Which of the following findings is consistent with a behavioral explanation for the book-to-market (BTM) effect?

- A. The difference in returns between high and low BTM stocks predicts GDP growth.
- B. High prices of low book-to-market stocks reflect excessive optimism plus overreaction and extrapolation of good news.
- C. Value stocks are riskier than growth stocks during market downturns.
- D. High prices of low book-to-market stocks reflect underreaction to bad news.
- E. None of the above.

B is the only one consistent with a behavioral explanation.

11. You have just purchased a 10-year zero-coupon bond with a yield to maturity of 10% and a par value of €1,000. What would your rate of return at the end of the year be if you sell the bond? Assume the yield to maturity on the bond is 11% at the time you sell.

- A. 10.00%
- B. 20.42%
- C. 13.8%
- D. 1.4%
- E. None of these is correct.

$$€1,000/(1.10)^{10} = €385.54; €1,000/(1.11)^9 = €390.92; (€390.92 - €385.54)/€385.54 = 1.4\%$$

12. In normal times, a typical yield curve is:

- A. upward sloping.
- B. humped.
- C. inverted.
- D. flat.
- E. None of these is correct.

The typical shape is upward-sloping

13. An 8%, 15-year bond has a yield to maturity of 10% and duration of 8.05 years. If the market yield changes by 25 basis points, how much change will there be in the bond's price?

- A. 1.85%
- B. 2.01%
- C. 3.27%
- D. 6.44%
- E. 3.19%

$$\Delta P/P = (-8.05 \times 0.0025)/1.1 = 1.85\%$$

14. The curvature of the price-yield curve for a given bond is referred to as the bond's

- A. modified duration.
- B. immunization.
- C. sensitivity.
- D. convexity.
- E. tangency.

Convexity measures the rate of change of the slope of the price-yield curve, expressed as a fraction of the bond's price.

15. The intrinsic value of an in-the-money put option is equal to

- A. the stock price minus the exercise price.
- B. the put premium.
- C. zero.
- D.** the exercise price minus the stock price.
- E. None of these is correct.

The intrinsic value of an in-the-money put option contract is the strike price less the stock price, since the holder can buy the stock at the market price and sell it for the strike.

16. A portfolio consists of 400 shares of stock and 200 calls on that stock. If the hedge ratio for the call is 0.6, what would be the euro change in the value of the portfolio in response to a one euro decline in the stock price?

- A. +€700
- B. +€500
- C. -€580
- D.** -€520
- E. None of these is correct

$-\text{€}400 + [-\text{€}200(0.6)] = -\text{€}520.$

17. The price of a call option on a stock is \_\_\_\_\_ correlated with the stock price and \_\_\_\_\_ correlated with the striking price.

- A. positively, positively
- B. negatively, positively
- C. negatively, negatively
- D.** positively, negatively
- E. not, not

The higher the stock price, the more valuable the call option. The lower the striking price, the more valuable the call option.

18. **Vega** is defined as

- A. the change in the value of an option for a dollar change in the price of the underlying asset.
- B. the change in the value of the underlying asset for a dollar change in the call price.
- C. the percentage change in the value of an option for a one percent change in the value of the underlying asset.
- D. the change in the volatility of the underlying stock price.
- E.** the sensitivity of an option's price to changes in volatility.

An option's hedge ratio (delta) is the change in the price of an option for \$1 increase in the stock price.

19. A trader who has a \_\_\_\_\_ position in gold futures wants the price of gold to \_\_\_\_\_ in the future.

- A. long; decrease
- B. short; decrease**
- C. short; stay the same
- D. short; increase
- E. long; stay the same

Profit to short position = Original futures price - Spot price at maturity. Thus, the person in the short position profits if the price of the commodity declines in the future.

20. Who guarantees that a futures contract will be fulfilled?

- A. the buyer
- B. the seller
- C. the Central Bank
- D. the clearinghouse**
- E. nobody

Once two parties have agreed to enter the transaction, the clearinghouse becomes the buyer and seller of the contract and guarantees its completion.

## PART 2 (OPEN QUESTIONS; 3 questions providing 4 points at maximum)

Read the questions carefully and write down the answers on your answer sheet.

### Question 1: Portfolio Construction and Asset Pricing (1.2 points)

#### Part a. (0.4 points)

What are the main reasons why the Markowitz Portfolio Selection Model might be challenging to implement empirically? How is an index model helping to solve those challenges?

There are two main issues. One, the large number of parameters, and two, errors in estimating covariances/correlations. An index model accounts in a tractable way for sources of risk and decomposes uncertainty into systematic and idiosyncratic risk. The procedure drastically decreases the number of estimates needed for portfolio construction.

#### Part b. (0.4 points)

Define the semi-strong form of the efficient market hypothesis. How can you test whether markets are efficient in the semi-strong form using an event study?

Semi strong form: stock prices reflect all publicly available information regarding past performance and prospects of the firm. The idea behind an event study is to obtain the abnormal return due to the event as the difference between the actual return at/around the event date and its proxy in the absence of the event.

#### Part c. (0.4 points)

You want to evaluate three mutual funds. The market return is 5% and the risk free rate is 1%. Below is the data for the three funds.

Fund	Average Return	Standard Deviation	Beta
A	7%	5%	1.2
B	5%	4%	1
C	3%	3%	0.5

- i) Provide the formula for Sharpe Ratio, Jensen's alpha, and Treynor's measure

Sharpe ratio =  $(\text{return of the portfolio} - \text{risk free rate}) / \text{std. deviation}$

Treynor's measure =  $(\text{return of the portfolio} - \text{risk free rate}) / \text{beta}$

Jensen's alpha =  $\text{return of the portfolio} - (\text{risk free rate} + \text{beta} * (\text{return of the market} - \text{risk free rate}))$

- ii) Why do many investors and academics prefer to use Jensen's alpha?

Both Treynor's measure and Sharpe's ratio are increasing in alpha

- iii) Calculate Jensen's alpha and Treynor's measure for the funds. Is the relative ranking of the three funds different? Based on your analysis, which fund performs the worst?

	Jensen's Alpha	Treynor
A	1.20%	0.05
B	0.00%	0.04
C	0.00%	0.04

Relative ranking is the same. Funds B and C have the same scores and perform the worst

- iv) Which fund is most likely to be an index fund?

Fund B. It has an alpha of 0 and a beta of 1

## Question 2: Fixed Income Securities (1.4 points)

### Part a. (0.4 points)

You want to invest your hard-earned money in fixed income securities. You consider the following 4 bonds. However, you are worried about the impact of changes in future interest rates on the value of your investment. Assume the bonds are default risk free, coupons are expressed in percentages and paid semi-annually and maturities are expressed in years. The face value of each bond is €1000.

Bond	Coupon	Maturity
A	4	7
B	2	3
C	3	3
D	3	7

- i. Which of the four bonds is most sensitive to interest rate changes? Why?

Bond D. It has the highest duration as it has cash flows that are in the aggregate furthest away from today.

- ii. In the event of a change in interest rates, which bond has the smallest percentage change in price? Why?

Bond C. It has the lowest duration as it has cash flows that are in the aggregate closest to today (it has a higher coupon payment relative to bonds A).

- iii. Explain why duration can be a useful measure for quantifying the sensitivity of fixed income securities to changes in interest rates.

Duration is a measure of the effective maturity of bonds. It gives a higher weight to large payments scheduled further in the future, which are more sensitive to changes in interest rates than smaller payments closer to today. The weighting allows for direct comparison of interest rate sensitivity across bonds with different characteristics.

### Part b. (0.5 points)

You are currently at time zero. Consider the following forward rates, for the subsequent three years:  $f_1 = 2\%$ ,  $f_2 = 2.4\%$ , and  $f_3 = 2.8\%$ . All bonds in your universe have a face value of €1000.

- iv. What is current spot rate in the market?

The spot rate equals  $f_1$  and is therefore 2%

- v. What are the prices of zero-coupon bonds with maturities of 1, 2, and 3 years? Report numbers to two decimal places.

$P_1 = 1000/(1+f_1) = 980.39$ ,  $P_2 = 1000/((1+f_1)*(1+f_2)) = 957.41$ ,  $P_3 = 1000/((1+f_1)*(1+f_2)*(1+f_3)) = 931.34$ .

- vi. Calculate the zero-yield curve, using the forward rates. Report numbers in percentages to two decimal places.

$z_1 = f_1 = 2.00\%$

$(1+z_2)^2 = (1+f_1)*(1+f_2) = 2.20\%$

$(1+z_3)^3 = (1+f_1)*(1+f_2)*(1+f_3) = 2.40\%$

- vii. Comment on the shape of the derived yield curve. If there is no uncertainty about future interest rates, do you expect an increase in future spot rates? Why?

The yield curve is upward sloping. In a world with no uncertainty, buying a one year zero and rolling over with one year zero one from now would generate the same return as buying a two year zero now. Thus, future spot rates must equal current forward rates and therefore we expect an increase in future spot rates.

### Part c. (0.5 points)

Continue with the data from Question 2, part b. You think the market is too conservative in their expectations of future interest rates. That is, you think interest rates in the future are going to be higher than what the market currently expects. At the same time, your company will need to borrow €1mln exactly two years from now in order to invest in a new bitterballen production facility. You decide to incorporate your interest rate expectations in your company's investment plan. Specifically, you want to construct a synthetic forward loan that allows you to borrow €1mln in exactly two years at the currently favourable interest rate environment. The loan you consider has a maturity of 1 year.

- i. How can you engineer such a synthetic forward loan using zero coupon bonds? How many bonds of different maturities do you need to buy/sell today?

You buy 1000 zero-coupon bonds with maturity 2 years and sell 1028 zero-coupon bonds with maturity of three years.

- ii. What are the cash flows of this contract at years 0, 2, and 3?

At time zero:

$$-P_0(2) * 1000 + (1 + f_3) * 1000 * P_0(3) = 0$$

At time 2, the two year zeros mature and you receive  $1000 * 1000 = 1\text{mln}$

At time 3, the three year zeros mature and you have to pay  $1028 * 1000 = 1028000$

- iii. What is the interest rate on your loan?

The interest rate equals  $f_3 = 2.8\%$

### Question 3: Derivatives (1.4 points)

#### Part a. (0.4 points)

In the context of the pricing of futures, what is meant by the cost-of-carry? How is the cost of carry derived?

The cost of carry asserts that the futures price is determined by the relative cost of buying the underlying with deferred delivery in futures markets versus buying it in the spot market with immediate delivery. By buying the underlying now, you tie up your funds and incur a time-value loss of  $r_f$ . On the other hand, you (may) receive dividend payments.

The relationship is derived by observing that the return of portfolio long in the underlying and short in a future is perfectly hedged. Thus, its return needs to be the  $r_f$  rate.

More formally,

$$F_0 = S_0(1 + rf) - D = S_0(1 + rf - d)$$

Where  $rf-d$  represents the cost of carry.

**Part b. (0.5 points)**

Consider a stock with a current price of 95 euro. Further, consider a binomial tree for the evolution of the price of the stock over the period of 1 year, assuming two steps ( $t=0$ ,  $t=1$ ,  $t=2$ ). The stock does not pay any dividends. At each nod, the price can go up by a factor of 1.1, or go down by a factor of 0.95. The **annual** risk free rate is 2%.

- i. You consider buying a European call option on the stock with a strike price of 90. Report the risk-neutral probabilities necessary to construct the value of the call today. Further calculate the price of the call.

$Q=0.4$

			114.95
		104.50	
			99.28
95.00			
			99.28
		90.25	
			85.74

			24.950
		15.391	
			9.275
8.278			
			9.275
		3.673	
			0.000

- ii. Suppose that instead you have to calculate the price of an otherwise identical American call option. Do you need to make any adjustments to your binomial tree and would the price of the American call be different from the price of the European call?

With American options, you typically have to check at each nod whether early exercise is possible and if so, attach this value to the nod. However, this is an American call on a non-dividend paying stock so early exercise is never optimal. Thus, the binomial tree looks the same and the value of the call is the same (8.278)

### Part c. (0.5 points)

Your company has just borrowed €1mln from a famous bank. The loan matures in 2 years and in addition, you have yearly payments to the bank that are equal to the EURIOBOR rate. Note that this is identical to issuing a variable-rate coupon paying bond with a face value of 1mln and yearly coupons equal to the EURIBOR rate. The yield curve of the EURIBOR rates implies a one year forward rate of 1% and a 2 year rate of 3%. You are worried about a potential increase in interest rates and therefore decide to enter a variable-rate receiving, fixed-rate paying SWAP with another bank.

- i. What is the fair fixed rate of the SWAP? Explain how you reached your conclusion.

$$\frac{F_1}{(1+y_1)^1} + \frac{F_2}{(1+y_2)^2} = \frac{F_*}{(1+y_1)^1} + \frac{F_*}{(1+y_2)^2}$$

Where  $F_1=1\%$ ,  $F_2=3\%$ ,  $y_1=1\%$ , and  $y_2=3\%$ .  $F_*$  is the fixed rate and is therefore equal to 1.98%

- ii. An alternative to the SWAP would be to buy back the current debt and issue new one at a fixed rate. Why would your company prefer the SWAP agreement?

It is just much cheaper – you only swap cash flow payments on the notional and you don't have to go through the very costly procedure of buying back your own debt and issuing new one. This is one of the reasons why SWAPs are such popular contracts.