vrije Universiteit amsterdam

Faculty of Economics and Business Administration

Exam:	Investments 3.4
Code:	E_BE3_INV
Examinator:	Dr. Teodor Dyakov
Co-reader:	Dr. Vincent van Kervel
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Time:	8.30
Duration:	2 hours and 45 minutes
Calculator allowed:	Yes
Graphical calculator allowed:	Yes
Number of questions:	20 multiple choice and 4 open-ended
Type of questions:	Open/ multiple choice
Answer in:	English

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

Credit score:	The maximum possible scores for each part and question are indicated. In total, you can earn 100 points. Your final exam grade is determined by dividing the number of points by 10.
Grades:	The grades will be made public on: April 6, 2015
Inspection:	Tuesday, April 7 2015 at 13.00. Room – to be announced on blackboard.
Number of pages:	17 (including front page)

Good luck!

PART 1 (MULTIPLE CHOICE; 40 points at maximum)

Read the questions and answers carefully and write down your answer on your answer sheet. Your final score is determined as (# correct answers - 2) * 40/18. Negative scores for this part of the exam are set to zero.

1. The holding-period return (HPR) for a stock is equal to
A. the real yield minus the inflation rate.
B. the nominal yield minus the real yield.
C. the capital gains yield minus the tax rate.
D. the capital gains yield minus the dividend yield.
E. the dividend yield plus the capital gains yield.

HPR consists of an income component and a price change component. The income component on a stock is the dividend yield. The price change component is the capital gains yield.

2. Steve is more risk-averse than Edie. On a graph that shows Steve and Edie's indifference curves, which of the following is true? Assume that the graph shows expected return on the vertical axis and standard deviation on the horizontal axis.
I) Steve and Edie's indifference curves might intersect.
II) Steve's indifference curves will have flatter slopes than Edie's.
III) Steve's indifference curves will have steeper slopes than Edie's.
IV) Steve and Edie's indifference curves will not intersect.
V) Steve's indifference curves will be downward sloping and Edie's will be upward sloping.
A. I and V
B. I and III
C. III and IV
D. I and II
E. II and IV

3. Given an optimal risky portfolio with expected return of 16% and standard deviation of 20% and a risk free rate of 4%, what is the slope of the best feasible CAL?
A. 0.60
B. 0.14
C. 0.08
D. 0.36
E. 0.31

Slope = (16 - 4)/20 = .6

4. Suppose you held a well-diversified portfolio with a very large number of securities, and that the single index model holds. If the σ of your portfolio was 0.25 and σ_M was 0.21, the β of the portfolio would be approximately ________.

A. 0.64

B. 1.19

C. 1.25

D. 1.56

E. 0.87

$s^2p/s^2m = b^2$; $(0.25)^2/(0.21)^2 = 1.417$; $b = 1.19$.

5. The CAPM applies to

A. portfolios of securities only.

B. individual securities only.

C. efficient portfolios of securities only.

D. efficient portfolios and efficient individual securities only.

E. all portfolios and individual securities.

The CAPM is an equilibrium model for all assets. Each asset's risk premium is a function of its beta coefficient and the risk premium on the market portfolio.

6. Assume the CAPM holds. The risk-free rate is 5 percent. The expected market rate of return is 11 percent. If you expect stock X with a beta of 2.1 to offer a rate of return of 15 percent, you should

A. buy stock X because it is overpriced.

B. sell short stock X because it is overpriced.

C. sell short stock X because it is underpriced.

D. buy stock X because it is underpriced.

E. hold the stock because it is fairly priced.

15% < 5% + 2.1(11% - 5%) = 17.6%; therefore, stock is overpriced and should be shorted.

7. In terms of the risk/return relationship in the APT

A. only factor risk commands a risk premium in market equilibrium.

B. only systematic risk is related to expected returns.

C. only nonsystematic risk is related to expected returns.

D. only factor risk commands a risk premium in market equilibrium and only systematic risk is related to expected returns.

E. only factor risk commands a risk premium in market equilibrium and only nonsystematic risk is related to expected returns.

Nonfactor risk may be diversified away; thus, only factor risk commands a risk premium in market equilibrium. Nonsystematic risk across firms cancels out in well-diversified portfolios; thus, only systematic risk is related to expected returns.

8. Consider the regression equation: $r_i - r_f = g_0 + g_1 b_i + g_2 s^2(ei) + e_{it}$ where: $r_i - r_t$= the average difference between the monthly return on stock **i** and the monthly risk-free rate b_i= the beta of stock **i** $s^2(ei)$ = a measure of the nonsystematic variance of the stock **i** If you estimated this regression equation and the CAPM was valid, you would expect the estimated coefficient, g_1 to be

A. 0

B. 1

C. equal to the risk-free rate of return.

D. equal to the average difference between the monthly return on the market portfolio and the monthly risk-free rate.

E. equal to the average monthly return on the market portfolio.

The variable measured by the coefficient g^1 in this model is the market risk premium.

9. A company whose stock is selling at a P/E ratio greater than the P/E ratio of a market index most likely has ________.

A. an anticipated earnings growth rate which is less than that of the average firm

B. a dividend yield which is less than that of the average firm

C. less predictable earnings growth than that of the average firm

D. greater cyclicality of earnings growth than that of the average firm

E. None of these is correct.

Firms with lower than average dividend yields are usually growth firms, which have a higher P/E ratio than average.

10. Low Fly Airline is expected to pay a dividend of $7 in the coming year. Dividends are expected to grow at the rate of 15% per year. The risk-free rate of return is 6% and the expected return on the market portfolio is 14%. The stock of Low Fly Airline has a beta of 3.00. The intrinsic value of the stock is _____.

A. $46.67

B. $50.00

C. $56.00

D. $62.50

E. None of these is correct

6% + 3(14% - 6%) = 30%; P = 7/(.30 - .15) = $46.67.

The following data are available relating to the performance of Sooner Stock Fund and the market portfolio:

	Sooner	Market Portfolio
Average Return	20%	11%
Standard Deviation of Returns	44%	19%
Beta	1.8	1.0
Residual standard deviation	2.0%	0.0%

The risk-free return during the sample period was 3%.

11. Calculate the information ratio for Sooner Stock Fund.

A. 1.53

B. 1.30

C. 8.67

D. 31.43

E. 37.14

α_P = 20% - [3% + 1.8(11% - 3%)] = 2.6%, 2.6%/2.00% = 1.3.

12. A coupon bond that pays interest of $90 annually has a par value of $1,000, matures in 9 years, and is selling today at a $66 discount from par value. The yield to maturity on this bond is __________.

A. 9.00%

B. 10.15%

C. 11.25%

D. 12.32%

E. None of these is correct.

FV = 1000, PMT = 90, n = 9, PV = -934, i = 10.15%

13. A bond will sell at a discount when __________.

A. the coupon rate is greater than the current yield and the current yield is greater than yield to maturity

B. the coupon rate is greater than yield to maturity

C. the coupon rate is less than the current yield and the current yield is greater than the yield to maturity

D. the coupon rate is less than the current yield and the current yield is less than yield to maturity

E. None of these is correct.

In order for the investor to earn more than the current yield the bond must be selling for a discount. Yield to maturity will be greater than current yield as investor will have purchased the bond at discount and will be receiving the coupon payments over the life of the bond.

14. Given the yield on a 3 year zero-coupon bond is 7.2% and forward rates of 6.1% in year 1 and 6.9% in year 2, what must be the forward rate in year 3?
A. 8.4%
B. 8.6%
C. 8.1%
D. 8.9%
E. None of these is correct.

$f3 = (1.072)^3/[(1.061)(1.069)] - 1 = 8.6\%$

15. According to the expectations hypothesis, an upward sloping yield curve implies that
A. interest rates are expected to remain stable in the future.
B. interest rates are expected to decline in the future.
C. interest rates are expected to increase in the future.
D. interest rates are expected to decline first, then increase.
E. interest rates are expected to increase first, then decrease.

An upward sloping yield curve is based on the expectation that short-term interest rates will increase.

16. Which of the following bonds has the longest duration?
A. A 12-year maturity, 0% coupon bond.
B. A 12-year maturity, 8% coupon bond.
C. A 4-year maturity, 8% coupon bond.
D. A 4-year maturity, 0% coupon bond.
E. Cannot tell from the information given.

The longer the maturity and the lower the coupon, the greater the duration.

17. Which of the following factors affect the price of a stock option
A. the risk-free rate.
B. the beta of the stock.
C. the time to expiration.
D. the expected rate of return on the stock.
E. the risk-free rate, the riskiness of the stock, and the time to expiration.

The risk-free rate, the riskiness of the stock, and the time to expiration are directly related to the price of the option; the expected rate of return on the stock does not affect the price of the option.

18. The intrinsic value of an at-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 plus the stock price.
E. None of these is correct.

The intrinsic value of an at-the-money put option contract is zero.

19. To hedge a short position in Treasury bonds, an investor most likely would
A. ignore interest rate futures.
B. buy S&P futures.
C. buy interest rate futures.
D. sell Treasury bonds in the spot market.
E. None of these is correct.

By taking the long position, the hedger is obligated to accept delivery of T-bonds at the contract maturity date for the current futures price, which locks in the sales price for the bonds and guarantees that the total value of the bond-plus-futures position at the maturity date is the futures price.

20. Suppose that the risk-free rates in the United States and in Japan are 5.25% and 4.5%, respectively. The spot exchange rate between the dollar and the yen is $0.008828/yen. What should the futures price of the yen for a one-year contract be to prevent arbitrage opportunities, ignoring transactions costs?
A. $0.009999/yen
B. $0.009981/yen
C. $0.008981/yen
D. $0.008891/yen
E. None of these is correct

$0.008828 (1.0525/1.045) = $0.008891/yen.

PART 2 (OPEN QUESTIONS; 60 points at maximum)

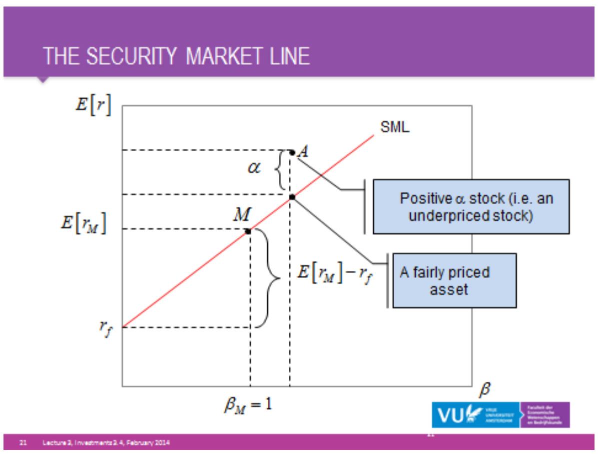
Question 1: Equilibrium Pricing Models (15 points)

Part a. (4 points)

Give the expression for the expected return – beta relationship of the CAPM. Plot a graphical interpretation. On the plot, also indicate the market portfolio and the risk-free rate. Where does a fairly priced security lie? Plot an example of an underpriced security and explain why it is underpriced. What would be the mechanism that corrects for this mispricing, under the CAPM?

$$E[r_i] = r_f + \beta_{i(E[r_m]-r_f)}$$

You need to plot the SML, which plots E[r] vs . beta. It looks like that:



The market portfolio has a beta of 1. A fairly priced security lies on the SML. An underpriced security lies above the SML (it has a higher expected return that the one implied by the CAPM). The equilibrium effect, under the CAPM, would be that all investors slightly tilt their portfolios and assign a higher weight on the underpriced stock, which means a higher price and expected return down and return it to equilibrium.

Part b. (4 points)

Assume that the CAPM holds. The risk free-rate is 3% and the return on the market is 6%. Consider the following three stocks:

Stocks	beta	ROE	b
A	1.25	0.1	0.1
B	1	0.15	0.1
C	0.75	0.2	0.1

i. What is the required rate of return for the three stocks?

k=rf + beta x (rm – rf)

Stocks	**k**
A	0.0675
B	0.0600
C	0.0525

ii. What is the P/E ratio for the three stocks, assuming a constant growth model with endogenous earnings growth?

P/E=(1-b)/(k-b x ROE)

Stocks	**k**	**PE**
A	0.0675	15.65
B	0.0600	20.00
C	0.0525	27.69

iii. Assume now that the retention ratio increase from 0.1 to 0.2 for all stocks. What are the new P/E ratios? Which stock experiences the largest change and why?

Stocks	**k**	**PE**	**PE new**	**Difference**
A	0.0675	15.65	16.84	1.19
B	0.0600	20.00	26.67	6.67
C	0.0525	27.69	64.00	36.31

For all three stocks, ROE>k so the higher the retention ratio, the higher the PE ratio. Stock C experiences the largest increase in the PE ratio since it has both the lowest k (beta) and the highest ROE.

Part c. (7 points)

Motivated by Merton's ICAPM and the observation that value stocks typically have higher returns than growth stocks, you apply an extended version of the CAPM where you consider HML (the return of value minus growth stocks) as an additional source of risk that describes investors' investment opportunity set. You therefore consider the following asset pricing model:

$$r_i = \alpha_i + \beta_i * r_m + \gamma_i * HML + \epsilon_i$$

Where r_i is the excess return of stock i, r_m is the excess return on the market. The variances of the two factors are σ_m and σ_{hml}. The variance of the idiosyncratic risk is σ_ϵ for all stocks i (i.e. it is the same). Assume that the idiosyncratic risks are uncorrelated, and that the two factors are uncorrelated as well. Now consider two stocks $i = \{1,2\}$.

i. Give an expression for the systematic risk of each of the two stocks

$$\sigma_i = \beta_i^2 * \sigma_m^2 + \gamma_i^2 * \sigma_{hml}^2$$

ii. Construct an equally-weighted portfolio of the two stocks. What is the non-systematic risk component? Compare it to the non-systematic component of each stock.

$$\sigma_p^2 = 0.5 * \sigma_\epsilon^2$$

iii. What would the non-systematic risk component of the equally-weighted portfolio in (ii) have been, had the idiosyncratic risk components of the two stocks been positively correlated? Higher, or lower than in (ii)? Why do you observe this effect?

$$\sigma_p^2 = w_1^2 * \sigma_{\epsilon,1} + w_2^2 * \sigma_{\epsilon,2} + w_1 * w_2 * cov(\sigma_{\epsilon,1}; \sigma_{\epsilon,2})$$

$$\Rightarrow \sigma_p^2 = 0.5 * \sigma_\epsilon^2 + w_1 * w_2 * cov(\sigma_{\epsilon,1}; \sigma_{\epsilon,2}) > 0.5 * \sigma_\epsilon^2$$

In (iii), the idiosyncratic components are positively correlated which has a negative effect on the diversification benefits, which leads to higher total non-systematic risk component than in (ii).

iv. Construct a portfolio out of the two stocks that has exposure of 1 to the HML factor. Give an analytical expression of its weights.

$$w_1 + w_2 = 1$$

$$\gamma_1 * w_1 + \gamma_2 * w_2 = 1$$

$$\Rightarrow w_1 = \frac{\gamma_2 - 1}{\gamma_2 - \gamma\_1}; w_2 = \frac{1 - \gamma_1}{\gamma_2 - \gamma\_1}$$

Question 2: Portfolio Construction and Performance Measurement (15 points)

Part a. (3 points)

Discuss, in general, the performance attribution procedures.

The portfolio management decision process typically involves three choices: (1) allocation of funds across broad asset categories, such as stocks, bonds, and the money market; (2) industry (sector) choice within each category; and (3) security selection within each sector. The returns resulting from each of these decisions are measured against a benchmark return resulting from a passive, index-investment approach. The excess returns (if any) resulting from these decisions over and above those earned from a passive indexing strategy are attributed to the success of the portfolio manager.

Part b. (4 points)

Consider the following probability distribution for stocks A and B:

State	Probability	Return on stock A	Return on stock B
1	0.2	3	-5
2	0.5	4	6
3	0.3	-2	10

i. Calculate the expected return for each stock

$$ER_i = P^1 * R_i^1 + P^2 * R_i^2 + P^3 * R_i^3$$

	A	**B**
ER	2	5

i. Calculate the standard deviation of the two stocks

$$\sigma_i = (P^1 * \left(R_i^1 - ER_i\right)^2 + P^2 * \left(R_i^2 - ER_i\right)^2 + P^3 * \left(R_i^3 - ER_i\right)^2)^{0.5}$$

	A	**B**
ER	2	5
STD	2.65	5.29

ii. Calculate the correlation coefficient between the two stocks

$$Cov_{\{i,j\}} =$$
$$= P^1 * \left(R_i^1 - ER_i\right) * \left(R_j^1 - ER_j\right) + P^2 * \left(R_i^2 - ER_i\right) * \left(R_j^2 - ER_j\right) + P^3 * \left(R_i^3 - ER_i\right) * \left(R_j^3 - ER_j\right)$$

$$Corr_{\{i,j\}} = cov_{\{i,j\}}/(\sigma_i * \sigma_j)$$

cov	-7.00
corr	-0.50

iii. If you invest 35% in stock A, and 65% in stock B, what would be your portfolio's expected rate of return and standard deviation?

$$ER_p = w_i * ER_i + w_j * ER_j$$
$$\sigma_p = \left(w_i^2 * \sigma_i^2 + w_j^2 * \sigma_j^2 + 2 * w_i * w_j * \sigma_i * \sigma_j * corr_{\{i,j\}}\right)^{0.5}$$

ER	3.95
Stdev	3.08

Part c. (4 points)

You want to evaluate 3 mutual funds. The risk-free rate during the sample period is 6%. The average returns, standard deviations, and betas for the three funds are provided in the table below and are stated in percentages.

Fund	Average Return	Standard Deviation	Beta
A	10	10	0.7
B	14	20	1
C	16	25	1.2

i. Define the Sharpe Ratio. Compute the Sharpe Ratios of the three funds and rank your funds according to it

$SR_i = (AR_i - rf)/\sigma_i$

	SR
A	0.40
B	0.40
C	0.40

All funds rank the same.

ii. Define the Treynor measure and compute it for each mutual fund. How does the Treynor measure differ from the Sharpe Ratio? Rank the three funds according to the Treynor measure.

The Treynor measure gives the excess return per unit of systematic risk, while the Sharpe Ratio is the excess return per unit of risk

$$TR = (AR_i - rf)/\beta_i$$

	SR	**Treynor**
A	0.40	5.71
B	0.40	8.00
C	0.40	8.33

Fund C has the highest score, while fund A the lowest.

iii. Based on your analysis, which fund would you like to hold and why?

All three funds have the same Sharpe Ratios. However, fund C has the highest Treynor ratio, which indicates that it has the best risk/return tradeoff. It is on par with the rest of the funds when we compare returns to total risk, but it provides a better compensation for taking systematic risk than the rest of the funds.

Part d. (4 points)

Discuss the differences in risk-taking behavior between investors who are risk averse, risk neutral, and risk loving.

The investor who is risk averse will take additional risk only if that risk-taking is likely to be rewarded with a risk premium. This investor examines the potential risk-return trade-offs of investment alternatives. The investor who is risk neutral looks only at the expected returns of the investment alternative and does not consider risk; this investor will select the investment alternative with the highest expected rate of return. The risk lover will engage in fair games and gambles; this investor adjusts the expected return upward to take into account the "fun" of confronting risk.

Question 3: Fixed Income (15 points)

Part a. (5 points)

Discuss duration. Include in your discussion what duration measures, how duration relates to maturity, what variables affect duration, and how duration is used as a portfolio management tool (include some of the problems associated with the use of duration as a portfolio management tool).

Duration is a measure of the time it takes to recoup one's investment in a bond, assuming that one purchased the bond for, say, 1000 euro. Duration is shorter than term to maturity on coupon bonds as cash flows are received prior to maturity. Duration equals term to maturity for zero-coupon bonds, as no cash flows are received prior to maturity. Duration measures the price sensitivity of a bond with respect to interest rate changes. The longer the maturity of the bond, the lower the coupon rate of the bond, and the lower the yield to maturity of the bond, the greater the duration. Interest-rate risk consists of two components: price risk and reinvestment risk. These two risk components move in opposite direction; if duration equals horizon date, the two types of risk exactly offset each other, resulting in zero net interest-rate risk. This portfolio management strategy is immunization. Some of the problems associated with this strategy are: the portfolio is protected against one interest rate change only; thus, once interest rates change, the portfolio must be rebalanced to maintain immunization; duration assumes a horizontal yield curve (not the shape most commonly observed); duration also assumes that any shifts in the yield curve are parallel (resulting in a continued horizontal yield curve); in addition, the portfolio manager may have trouble locating acceptable bonds that produce immunized portfolios; finally, both duration and horizon dates change with the mere passage of time, but not in a lockstep fashion, thus rebalancing is required. Although immunization is considered a passive bond portfolio management strategy, considerable rebalancing must occur, as indicated above. The portfolio manager must consider the tradeoffs between the transaction costs and not being perfectly immunized at all times.

Part b. (4 points)

You are given the following three coupon bonds with annual coupon payments and face value of 100.

Bond	Maturity	Coupon (in %)	Price	Yield to Maturity (in %)	Notional
A	2	3	102.9531	1.4904	100
B	2	6	108.8314	1.4857	100
C	3	4	106.7183	1.6847	100

Compute the zero rates z_1, z_2, and z_3 (up to two decimal places) for maturities of 1, 2, and 3 years.

The prices of bond A and B can expressed as $P_A = \frac{3}{1+z_1} + \frac{103}{(1+z_2)^2}$ and $P_B = \frac{6}{1+z_1} + \frac{106}{(1+z_2)^2}$. Note then that a portfolio of a long position in 2 type A bonds and a short position in 1 type B bond is a zero coupon bond, such that $2 * P_A - P_B = \frac{100}{(1+z_2)\hat{}2}$. Solving for z_2, we obtain:

z_2=1.50 (1.4955)

We plug back z_2 in the price of either bond A or B and obtain a value of z_1

z_1=1.14 (1.144)

We can now express the price of bond C as $P_C = \frac{4}{1+z_1} + \frac{4}{(1+z_2)^2} + \frac{104}{(1+z_3)^3}$. We solve for z_3 and obtain:

z_3=1.68 (1.6797)

Part c. (6 points)

Use the same data provided in Part a. above.

i. Compute the modified duration of the three bonds

For bond A,

$$D_A = \left(\frac{C_A}{(1+y_A)} * 1 + \frac{C_A + F_A}{(1+y_A)^2} * 2\right) / P_A$$

$$MD_A = \frac{D_A}{(1+y_A)}$$

The formulas are analogous for bonds B and C

Bond	**Duration**	**Modified Duration**
A	1.97	1.94

B	1.95	1.95
C	2.89	2.86

ii. Construct a portfolio that consists of a long position in 10 type A bonds, a short position in 20 type B bonds, and a long position in 60 type C bonds. Obtain the value of the portfolio and the weights of each bond

The value of the portfolio is calculated as $V_P = 10 * P_A - 20 * P_B + 60 * P_C = 5256.001$
The weights are calculated as the position*price/the portfolio value

	weight
A	0.20
B	-0.41
C	1.22

iii. Compute the modified duration of this portfolio

$$MD_P = w_A * MD_A + w_B * MD_B + w_c * MD_C = 3.056$$

iv. Using duration approximation, what percentage change in the value of your portfolio you would expect if there is an upward shift in the term structure (i.e. an increase of all interest rates) by 50 basis points? What if instead of an increase of 50 basis points, there is a decrease of 100 basis points? Comment on the quality of the approximation in both cases.

For a shift of +50bp: -3.056*0.5%=-1.53%
For a shift of -200bp: -3.056*(-2%)=6.11%
The approximation error should be smaller for the 50bp shift

Question 4: Option Pricing (15 points)

Part a. (3 points)

Describe the protective put. What are the advantages of such a strategy?

A protective put consists of investing in stock and simultaneously purchasing a put option on the stock. Regardless of what happens to the price of the stock, you are guaranteed a payoff equal to the put option exercise price.

Part b. (2 points)

You are pricing a European call option using a binomial tree and the Black-Scholes formula. What is the relationship between the two valuations when you increase/decrease the number of steps in the binomial tree?

The Black-Scholes formula can be thought of the limiting case of a binomial tree. Increasing the number of nods in the binomial tree brings the value of the option closer to that of the Black-Scholes formula.

I would further give 2 bonus points to students who mention that the price approximation using binomial tree does not monotonically approach the Black-Scholes value when you increase the number of steps, but rather oscillates around it (I did give you a hint that I will ask this question in class, but since it is a very difficult one I would only award bonus points for it and not penalize you if you do not mention this relationship).

Part c. (6 points)

Consider the binomial tree for the evolution of the €/$ exchange rate over the period of 6 months, assuming two steps (t=0, t=1, t=2). The current exchange rate at t=0 is 0.9 €/$. The **annual** risk free rate is 3%, and the exchange rate can increase by 5% or decrease by 2.5% each period.

i. Draw the binomial tree for (t=0, t=1, t=2)

The tree looks in the following way:

		0.992
	0.945	
		0.921
0.900		
		0.921
	0.878	
		0.856

ii. Calculate the risk-neutral probabilities of an upward movement and that of a downward movement. Do they differ at each nod of the tree and why?

The risk-neutral probability of an upward move is calculated as $Q = \frac{S_0*(1+r_f)-S_1^d}{S_1^u-S_1^d} = 0.43.$ Pay attention to that the period risk free in this case is 0.75%. Consequently, the risk neutral probability of a downward movement is 1-0.43=0.57

The risk neutral probabilities are the same at each nod of the three, because they use the exact same discounting at each point in time.

iii. Suppose you own a business in the Eurozone at time 0 and need to make a payment 6 months from now in dollars. You want to hedge against an unfavorable foreign exchange rate in 1 year, but also like to gain from a potential depreciation of the US dollar. Thus, you consider buying plain vanilla **at the money** call options that expire in 6 months. Compute the price of such an option.

You are calculating the value of an at the money call, hence its strike price X is 0.9. At time t=2 the option payoffs at each end of the three are calculated as

$$C_i = \max(0, S_i - 0.9)$$

We then use the calculated risk-neutral probabilities to save recursively:

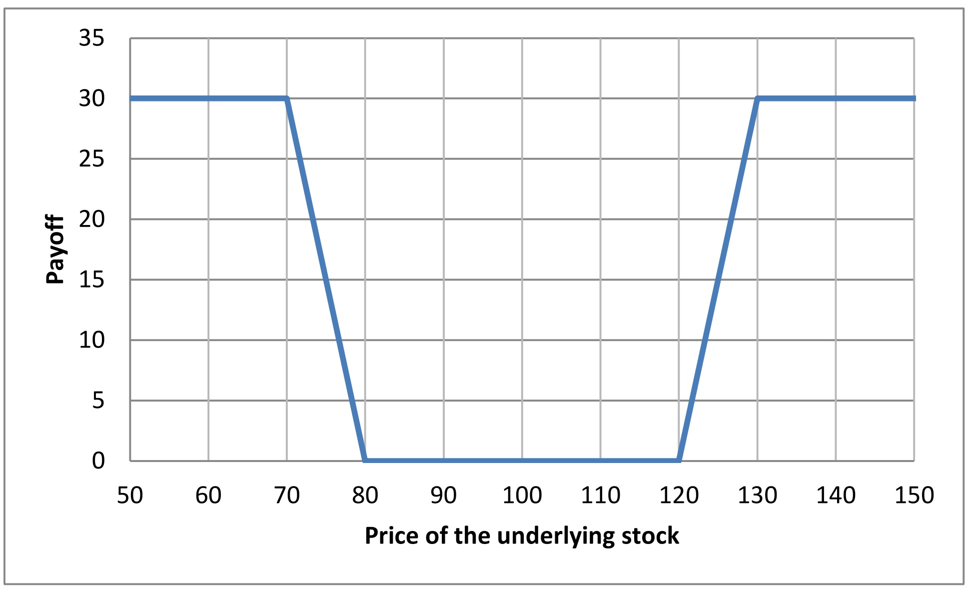
$$C_0 = Q\frac{C_1^u}{1+rf} + (1-Q)\frac{C_1^d}{1+rf}$$

		0.092
	0.052	
		0.021
0.027		
		0.021
	0.009	
		0.000

Thus, the value of the call is 0.027

Part d. (4 points)

Replicate the payoff structure below, known as “short iron condor” using call and put options. On the horizontal axis you have the price of the underlying stock, and on the vertical axis – the payoff at maturity. Pay attention to the values on the horizontal and vertical axes. Briefly explain what might motivate traders to pursue this payoff structure.



Solution: long 3 calls at 120, long 3 puts at 80, short 3 calls at 130, short 3 puts at 70

Motivation: The short iron condor is a limited risk, limited profit trading strategy that is designed to earn a profit when the underlying stock price makes a (sharp) move in either direction.