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Financial Markets and Investments

COMPLETE PROBLEM SET
QUESTIONS

INTRODUCTION

These problem sets are not representative of questions on the exams. They are designed to complement our classroom discussions. Since the lectures focus on conceptual matters, the exercises are primarily for numerical drill. Some of the questions are quite easy, while others are more difficult. *Do them all with equal care*. It will be helpful to practice with your calculator so that you come up with the correct number even for simple questions. It's better to work out the kinks now rather than on the job. Although you should discuss these problems in a study group, you should calculate *everything* yourself, and, of course, write it up by yourself. These five-finger exercises will make you a better person.

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PROBLEM SET I

1. You are among the NASDAQ marketmakers in the stock of BioEngineering Inc. and quote a bid and offer of 102 1/4-1/2.

(a) On Day 1 you receive buy orders from investors for 9,000 shares and sell orders from investors for 4,000 shares. How much do you earn during the day and what is the value of your inventory at the end of the day?

(b) Before trading begins on Day 2 the company announces trial testing of a cure for acne in mice. The quoted bid and offer jumps to 110 1/4-1/2. During Day 2 you receive sell orders from investors for 7,000 shares and buy orders for 2,000 shares. What is your total profit and loss over the two-day period? What is the value of your inventory at the end of Day 2?

(c) Is there anything you could have done at the end of Day 1, consistent with a pure marketmaker's objectives that would have improved your performance over the two-day period?

2. Here are some alternative investments you are considering for one year. (i) Bank A promises to pay 8% on your deposit compounded annually. (ii) Bank B promises to pay 8% on your deposit compounded daily. (iii) Bank C promises to pay 8% on your deposit compounded continuously. Compare the effective annual rate (EAR) on these investments.

3. Suppose you have 2 mutual funds whose annual returns are shown in the following table. Assume you invest $100 in each, and the proceeds from year 1 are reinvested in year 2 and so on. How much money do you accumulate in each fund after 5 years? What is the single rate that properly measures the average return for each fund over the five-year period?

Table		
Year	Fund A	Fund B
1	.16	.30
2	.10	-.10
3	.14	.28
4	.02	.17
5	.04	-.02

4. Suppose Mexico's one-year government bond rate is 35%, the U.S. one-year government bond rate is 5% and the exchange rate is currently 6 pesos per $1. Answer the following questions:

(a) If you expect the exchange rate to be 7 pesos per $1 in one year, show the transaction you would do and calculate the expected profit.

(b) How would you supplement the transaction in (a) if you could currently arrange to buy or sell pesos for dollars for delivery in one year (this is called the one year forward exchange rate) at an exchange rate of 7 pesos per $1. Does this make the transaction in (a)

more or less risky? (Note: Although you may never have heard of forward exchange rates before the idea is relatively straightforward. You may contract on January 1, 2015, to deliver on December 31, 2015, pesos for dollars at a fixed, currently agreed upon, rate. The example tells you to assume that the exchange rate for this contractual agreement is 7 pesos per dollar.)

(c) What are the consequences of the transaction in (b) for the excess demand for or excess supply of pesos for dollars for delivery in one year? What are the implications for the equilibrium one-year forward exchange rate? Will it be higher or lower than 7 pesos per $1?

(d) Calculate the forward exchange rate in (b) which will make the entire transaction break even in terms of profit (ignore transactions cost). In light of your answer in (c), why might this be the equilibrium one year forward exchange rate?

5. Suppose a hedge fund manager earns 1% per trading day. There are 250 trading days per year. Answer the following questions:

(a) What will be your annual yield on $100 invested in her fund if she allows you to reinvest in her fund the 1% you earn each day?

(b) What will be your annual yield assuming she puts all of your daily earnings into a zero-interest-bearing checking account and pays you everything earned at the end of the year?

(c) Can you summarize when it is proper to "annualize" using APR (annual percentage rate) versus EAR (effective annual rate)?

6.   Suppose you bought a five-year zero-coupon Treasury bond for $800 per $1000 face value. Answer the following questions:

(a) What is the yield to maturity (annual compounding) on the bond?

(b) Assume the yield to maturity on comparable zeros increases to 7% immediately after purchasing the bond and remains there. Calculate your annual return (holding period yield) if you sell the bond after one year.

(c) Assume yields to maturity on comparable bonds remain at 7%, calculate your annual return if you sell the bond after two years.

(d) Suppose after 3 years, the yield to maturity on similar zeros declines to 3%. Calculate the annual return if you sell the bond at that time.

(e) If yield remains at 3%, calculate your annual return after four years.

(f)   After five years.

(g) What explains the relationship between annual returns calculated in (b) through (f) and the yield to maturity in (a)?

7. Suppose you are given a choice of the following two annuities: (a) $10,000 payable at the end of each of the next 6 years and zero thereafter; or (b) $10,000 forever, but payments do not begin until 10 years from now (the first cash payment from the annuity is at the end of the 11th year). Which annuity do you choose if the annual interest rate is 5%? Does your answer change if the interest rate is 10%? Explain why or why not.

PROBLEM SET II

1. Here are some characteristics of two securities:

Security 1	R_1 = .10	$\sigma_1^2 = .0025$
Security 2	R_2 = .16	$\sigma_2^2 = .0064$

Answer the following questions:

(a) Which security should an investor choose if she wants to (i) maximize expected returns, (ii) minimize risk (assume the investor cannot form a portfolio)?

(b) Suppose the correlation coefficient of the returns on the two securities is +1.0, what is the optimal combination of securities 1 and 2 that should be held by the investor whose objective is to minimize risk (assume short sales are not allowed)?

(c) Suppose the correlation coefficient of returns is -1.0, what fraction of the investor's net worth should be held in security 1 and in security 2 in order to produce a zero risk portfolio (assume no short selling)?

(d) What is the expected return on the portfolio in (c)? Should the investor choose to invest in riskless U.S. Treasury bills yielding 10%?

2. The expected returns and standard deviation of returns for two securities are as follows:

	Security Z	Security Y
Expected Return	15%	35%
Standard Deviation	20%	40%

The correlation coefficient between the returns is + .25.

(a) Calculate the expected return and standard deviation for the following portfolios:

(i)	all in Z
(ii)	.75 in Z and .25 in Y
(iii)	.5 in Z and .5 in Y
(iv)	.25 in Z and .75 in Y

(v)	all in Y

(b) Are any of these portfolios efficient? Which one is optimal?

3. You are given the following information: A mutual fund of risky assets, M, has an expected return of 16% (R_m= 16%) per period and a standard deviation of 20% (σ_M= 20%); the risk free asset, F has a guaranteed return of 8% (R_F=8%) per period. Answer the following questions about the characteristics of the alternative portfolios described below:

(a) What is the expected return and standard deviation of a portfolio that is totally invested in the risk free asset?

(b) What is the expected return and standard deviation of a portfolio that has 50% of its wealth in the risk free asset and 50% in M?

(c) What is the expected return and standard deviation of a portfolio that has 100% of its wealth in M?

(d) What is the expected return and standard deviation of a portfolio that has 200% of its wealth in M, financed by borrowing 100% of its wealth at the risk free rate?

(e) Suppose you began the period with a net worth (wealth) of $1,000. What is your end of period net worth in part (c) above compared with part (d), assuming the risky mutual fund, M, earns its expected rate of return. For both (c) and (d), calculate the range in your end-of-period net worth, in dollars, if the return on M is one standard deviation higher than expected (.36 rather than .16) versus one standard deviation lower than expected (-.04 rather than .16).

(f) Is leverage good or bad? Have you ever put any money into a financial institution with leverage much greater than 100%?

4. Assume CAPM holds. If the expected return and standard deviation of the market portfolio are R_M= .12 and σ_M = .15, and if the risk free rate, R_F = .06, answer the following questions.

(a) What is the numerical value of the market price of risk?

(b) What is the equilibrium expected return on a risky asset with a β of 1.2? With a β of .6?

(c) What is the β of a security with an equilibrium expected return of .03?

(d) Is it possible in equilibrium for the expected return on a risky security to be less than the risk-free rate?

(e) Suppose a security with β = 1.5 had a return equal to .18. Can you tell according to CAPM, given R_F, R_M, and σ_M from above, whether the price of the security was too high or too low?

5. Consider the following data:

	Expected Return	Standard Deviation of Return
Russell Fund	16%	12%
Windsor Fund	14%	10%
S&P Fund	12%	8%

The correlation between the returns on the Russell Fund and the S&P Fund is 0.7. The rate on T-bills is 6%. You are risk-averse and care only about the mean and standard deviation of your portfolio's return. Which of the following portfolios would you prefer to hold in combination with T-bills and why?

   (a) Russell Fund

   (b) Windsor Fund

   (c) S&P Fund

   (d) A portfolio of 60% in the Russell Fund and 40% in the S&P Fund.

6. You are given the following two equations:

   (i) $R_i = R_F + (R_M - R_F)\beta_i$

   (ii) $R = R_F + (\dfrac{R_M - R_F}{\sigma_M})\sigma$

You also have the following information:

$$R_m = .15 \quad R_f = .06 \quad \sigma_M = .15$$

Answer the following questions, assuming that the capital asset pricing model is correct:

(a) Which equation would you use to determine the expected return on an individual security with a standard deviation of returns =.5 and a $\beta=2$? Given the parameters above, what is the expected return for that security?

(b) Which equation would you use to determine the expected return on a portfolio knowing that it is an efficient portfolio (consisting of the market portfolio M combined with the risk-free rate)? If you were told that the standard deviation of returns on that portfolio is equal to σ_M and you were given the above parameters, what is the expected return on that portfolio?

(c) Can you determine the β of the portfolio in (b)?

(d) Given your answer in (c), can you expand on what type of risky assets equation (i) can be used for? What about the risky assets equation (ii) can be used for?

7. Suppose research showed that the stock markets of the developing economies listed below had expected mean returns and standard deviations as follows:

Country	Mean	Standard Deviation
Poland	7.0%	12%
Indonesia	9.0	16
Nigeria	12.0	20
Argentina	13.8	22
Brazil	15.6	24

Answer the following questions about the composition of the optimal portfolio of these five risky investments based on the numerical answers you get from applying the Portfolio Optimizer to this data set. Note that the mean (expected) returns differ substantially among the countries but countries with higher expected returns also have significantly higher standard deviations. (You must explain your recommended allocations in words in addition to providing numerical answers.)

a) Assume, as a first approximation, that the correlation of returns among each of these stock markets is zero. If the risk free asset yields 4 percent, how should your clients divide their funds in forming the optimal combination of these risky assets. Convince them with words that your recommendation makes sense.

b) Suppose your research shows that your assumption about correlations is correct except for the two neighbors in South America, Brazil and Argentina, where the correlation of returns is .9 (90%). What is the nature of the allocation under this new set of assumptions and why?

Real Time Exercise: Equities

Question

Calculate the implied growth rates from the dividend growth model for IBM, Exxon and General Electric. Then explain why these calculated growth rates differ from the consensus 5-year growth forecasts of analysts who follow these companies.

Assumptions:

Use the simple dividend growth model [$P_0 = D_1/(k-g)$], solve for g (remember $D_1 = D_0(1+g)$), and assume that **$r_f = .04$ and $r_m = .10$** in your formula for each k_i.

Data

To get all of the data needed go to www.yahoo.com and click on finance. To begin the search enter the stock symbol (XOM= Exxon, GE=General Electric and IBM=IBM). When the company is displayed you will see the current price listed. You can then click on **Key Statistics** for access to company data. You should use the following estimates of beta provided by Standard and Poor's Corporation, rather than those reported by Yahoo (without any attribution): IBM = 1.64; XOM = .7; GE = .98. To get estimated earnings growth click on **Analyst Estimates** and scroll down to Growth Estimates. Record the number listed under 'Next 5 years.' This is an average of the 5-year growth forecasts of analysts who follow the company.

Answer Format

You should explain your answer in one or two paragraphs of text. Display your raw data, the date on which it was collected as well as your calculated growth rates, in a simple table. *Remember:* Only handwritten answers are acceptable.

PROBLEM SET III

1. Here are some data on bonds. Bond 1 is a zero coupon bond paying $100 one year from now. Bond 2 is also a zero coupon paying $100 two years from now. Bond 3 is a 10% coupon bond that pays $10 in year one and $10 plus the $100 principal in year two. The one-year spot interest rate is 10% and the price of bond 2 is $84.18. Assume annual compounding and answer the following questions.

      (a) What is the price of bond 1?

      (b) What is the yield to maturity on bond 2?

      (c) What is the implied forward rate based on bond 1 and bond 2?

      (d) What is the price of bond 3?

      (e) What is the duration of bond 2 and bond 3?

      (f) Based on your duration numbers in (e), calculate the new prices of bonds 2 and 3 assuming that the yield to maturity on each bond increases by one basis point (you must first calculate the yield to maturity on bond 3).

2. A zero coupon bond with 2.5 years to maturity has a yield to maturity of 25% per annum. A 3-year maturity 25% coupon annual pay bond also has a yield to maturity of 25%. Does the longer maturity bond have a larger percent price variability per one basis point change in rates? Calculate each percentage price change to prove your point.

3. Suppose the yield to maturity on a one-year pure discount bond is 8%. The yield to maturity on a two-year pure discount bond is 10%. Answer the following questions (use annual compounding):

      (a) According to the pure expectations theory, what is the *expected* one-year rate in the marketplace for year 2?

      (b) Suppose a potential "one-year investor starting in year two" expects the one-year rate next year to be 6%. Suppose the investor will have a cash inflow of $100 one year from today. What should that investor do today? *Exactly* how can the investor arrange his or her portfolio to accomplish the objective?

      (c) If all investors behave like the investor in (b), what will happen to the equilibrium term structure according to the pure expectations theory?

4. Suppose a dealer quotes a 180-day Treasury bill as 7.5% bid, offered at 7.4%. How much does an investor have to pay to buy $1 million in face value of such a bill? What is the investor's bond yield equivalent on this T-bill?

5. Assume the government issues a semi-annual pay bond that matures in 5 years with a face value of $1,000 and a coupon yield of 10 percent.

(a) What price would you be willing to pay for such a bond if the yield to maturity (semiannual compounding) on similar 5-year governments were 8%?

(b) What would be the price if the yield to maturity (semi-annual compounding) on similar governments were 12%?

(c) If the bid and offer on the bond were quoted as 103:17-19, calculate the yield to maturity (semiannual compounding) assuming you bought the bond at the offer price and held it to maturity?

(d) Suppose you held the bond in (c) for 6 months, at which time you received a coupon payment and then sold the bond for a price of 102, what would be your 6-month return?

6.   For each of the bonds and reinvestment rates listed below calculate the amount of money accumulated at the end from a $1000 initial investment:

(a) Invest $1000 in a 5-year zero coupon bond with a yield to maturity of 9 percent.

(b) Buy a 5-year 9% coupon annual pay bond at par ($1000) and reinvest the annual coupons at 9%.

(c) Same as (b) but reinvest the annual coupons at 12%.

(d) Same as (b) but reinvest the annual coupons at 6%.

(e) For (a) through (d) calculate the annual return (also called the realized compound yield for coupon-bearing bonds). What can you conclude about the relationship between yield to maturity and annual return?

7.   Suppose the following data for U.S. bonds, notes, and strips (zeros) were taken from the U.S. Treasury bond tables on February 15, 2017. Recall that Treasury notes pay coupon interest semi-annually. You may assume that all strips are paid on the 15th of the month in which they mature.

U.S. Government Bonds and Notes

Coupon Rate	Maturity	Price
12	Feb 18	?
4	Feb 19	96
6	Aug 20	97

U.S. Treasury Strips

Maturity	Price
Aug 17	98
Feb 18	94
Aug 19	90

Answer the following questions (Hint: Draw the time line of cash flows and pick out the proper discount rates from the tables):

(a) Based on the information above, what is the price per $100 face value of the 12% coupon note maturing on February 15, 2018?

(b) Calculate the yield to maturity on that note assuming you purchased it at the price you derived in answer (a)

(c) Suppose the notes were actually selling at a yield to maturity of 7%, what arbitrage could you do to produce an immediate profit? How much would you earn per $100 face value of the 12% note?

8. Suppose that the consensus forecast of security analysts of your favorite company is that earnings next year will be $5.00 per share. If the company plows back 50% of its earnings and if the Chief Financial Officer (CFO) estimates that the company's return on equity (ROE) is 16%, answer the following questions.

(a) If your estimate of the company's required rate of return on its stock is 10%, what is the equilibrium price of the stock?

(b) Suppose you observe that the stock is selling for $50.00 per share, and that this is the best estimate of its equilibrium price, what would you conclude about either your estimate of the stock's required rate of return or the CFO's estimate of the company's return on equity?

(c) Suppose you believe your own 10% estimate of the stock's required rate of return, what does the market price of $50.00 per share imply about the market's estimate of the company's expected return on equity?

9. Suppose you have the following two mutually exclusive projects that you can carry out on the corner of 6th Avenue and West 4th Street: Build a day care center or a health spa. Suppose the day care center has the following cash flows: An immediate cash outlay of $5,000 followed by inflows of $2500 in each of the next 3 years and zero thereafter. Suppose the health spa has the following cash flows: An immediate outlay of $5000 followed by inflows of nothing in year one, $1,000 in year 2 and $7,100 in year 3 and zero thereafter. Answer the following questions:

a) If you base your investment decision on whichever project has the highest IRR, which do you choose?

b) If you base your investment decision on whichever investment has the highest NPV, which do you choose when the cost of capital is 15% and which do you choose if the cost of capital is 5% ?

c) Suppose you could triple the size of the health spa project and triple its revenues but you can't change the size of the day care center. Would any of your answers in (a) or (b) change?

PROBLEM SET IV

1. Construct *profit tables on expiration* to show what position in IBM puts, calls and/or underlying stock *best expresses* the investor's objectives described below. Assume IBM currently sells for $150 so that profit tables between $100 and $200 in $10 increments are appropriate. Also assume that "at the money" puts and calls cost $15 each and puts and calls with strike prices 20% "out of the money" (if they are relevant) cost $5 each. (As always, the profit tables ignore dividends and interest.)

      (a) An investor wants to capture all of the upside potential if IBM goes up and is willing to accept losses if prices decline

      (b) An investor wants upside potential if IBM increases but wants guaranteed limited losses if prices decline

      (c) An investor wants to capture profits if IBM declines in price but wants a guaranteed limited loss if prices increase

      (d) An investor wants to capture all of the profit if IBM declines and is ready to accept losses if prices increase

      (e) An investor wants to profit if IBM's upcoming earnings announcement is either unexpectedly good or disappointingly bad.

      (f) An investor already owns IBM (at a price of $150) and wants to protect against price declines below $150 but wants to retain all of the upside if prices rise. Only one transaction is permitted here (to save on transaction costs).

      (g) How could the investor lower some of the cost of the downside protection in part F, assuming the investor were willing to give up all potential upside if the stock increased above $180.

      (h) Suppose the NYSE suspended trading in IBM pending a news announcement. You want to sell IBM before the announcement and options trading in IBM continues uninterrupted on the CBOE. How do you do it? Have you neutralized your exposure to the news announcement?

2. Suppose a call option has an exercise price of $100 and the underlying asset has a price of $100. Answer the following questions.

      (a) What is the intrinsic value of this option?

      (b) What will the option be worth on expiration?

      (c) What will the option be worth prior to expiration?

      (d) Will your answer in (c) be larger or smaller if the volatility of the underlying asset *is* higher than otherwise?

(e) Will your answer in (c) be larger or smaller if the option has 3 months rather than 6 *months* to expiration?

(f) Will your answer in (c) be larger or smaller if the interest rate is larger or smaller?

3. Suppose the CEO of your company owns 500,000 shares of stock in the company and is granted 10,000 non-transferable European options as a bonus. The expiration date of the options is two years, the strike price is $100 and the stock *is now selling* for $95 per share. Assume that the two year continuously compounded interest rate is 7%. Assume further that the company pays no dividends. You are called in to advise the CEO about how to value the options. She wants to know the following:

(a) What is the minimum value she should accept for these options if they were transferable?

(b) Assuming she is ready to buy or sell some assets other than the non-transferable options, how can she realize that minimum value with certainty?

(c) Why should you advise her not to sell the options for their minimum value, even if she could, and instead to follow the strategy outlined in (b)?

4. You plan to recommend the following options strategies to your clients. As part of your analysis calculate the stock price or prices on expiration above *which* or below *which* the strategies will be profitable. The options expire in 3 months and the current stock price is $68.00.

(a) Buy a straddle with an exercise price of 70, where each option costs $5.00.

(b) Sell a straddle with an exercise price of 70, where each option costs $5.00.

5. Use the option calculator made available at http://www.option-price.com/index.php to answer questions about valuing your executive stock options. Use the calculator page for the price of the option (assume the dividend is zero) and then go to the implied volatility tab for part c.

a) Assume S = 100, E = 100, vol = 30 percent, t = 3 years (1095 days), r = 6 percent, and dividends = 0. Show that the value of this 3 year call with a strike of 100 is $28.136 (the same as the classroom calculation).

b) Suppose the board of directors of your company decides that these options are too valuable to give away. They give you a choice between the following two inferior alternatives: (i) a one-year call with the same 100 strike; or (ii) a 3-year call with a 150 strike. Which of these two do you choose?

c) Suppose the company told you that their valuation experts (Stern MBAs, 2002) calculated that the proper price of the original option (under a) was $39.60. What volatility must those experts have used to come up with that price? Given that (higher) value for volatility, redo the calculations under (b) to determine which of the two alternatives you should choose.

d) Explain in words why the new volatility in part c gives a different preference for the two alternatives compared with your answer in part b. Will any increased value for volatility shift the ranking of the two?