INSTRUCTIONS TO CANDIDATES

1. This 75-point examination consists of 41 essay questions. The number of points for each full question or part of a question is indicated at the beginning of the question or part. Answer these questions on the lined sheets provided in your Examination Envelope. Use dark pencil or ink. Do not use multiple colors.

Write your Candidate ID number and the examination number, 8, at the top of each answer sheet. Your name, or any other identifying mark, must not appear.

Do not answer more than one question on a single sheet of paper. Write on only the lined side of the paper, and be careful to give the number of the question you are answering on each sheet.

The answer should be concise and confined to the question as posed. When a list of a specific size is requested, do not offer more items in your list than the number requested. For example, if you are requested to list three items, only the first three responses will be graded.

If your response cannot be confined to one page, please use additional sheets of paper as necessary. Clearly mark the question number on each page of the response in addition to using a label such as Page 1 of 2 on the first sheet of paper and then Page 2 of 2 on the second sheet of paper.

In order to receive full credit or to maximize partial credit on mathematical and computational questions, you must clearly outline your approach in either verbal or mathematical form, showing calculations where necessary. Also, you must clearly specify any additional assumptions you have made to answer the question. For example, simply writing the answer as provided by a financial calculator will not merit full credit.

2. Attached to the examination, after question 41, is a table of the Normal Distribution.

3. Do all problems until you reach the last page of the examination where "END OF EXAMINATION" is marked.

4. Prior to the start of the exam you will have a fifteen-minute reading period in which you can silently read the questions and check the exam booklet for missing or defective pages. Writing will NOT be permitted during this time and you will not be permitted to hold pens or pencils. The supervisor has additional exams for those candidates who have defective exam booklets.

CONTINUE TO NEXT PAGE OF INSTRUCTIONS

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5. Your Examination Envelope is pre-labeled with your Candidate ID number, name, exam number, and test center. **Do not remove this label.** Keep a record of your Candidate ID number for future inquiries regarding this exam.

6. **Candidates must remain in the examination center until two hours after the start of the examination. You may leave the examination room to use the restroom with permission from the supervisor. To avoid excessive noise during the end of the examination, candidates may not leave the exam room during the last fifteen minutes of the examination.**

7. At the end of the examination, place all answer sheets in the Examination Envelope. Please insert your answer pages in your envelope in question number order. Insert a numbered page for each question, even if you have not attempted to answer that question. **BEFORE YOU TURN THE EXAMINATION ENVELOPE IN TO THE SUPERVISOR, BE SURE TO SIGN IT IN THE SPACE PROVIDED ABOVE THE CUT-OUT WINDOW.**

**Anything written in the examination booklet will not be graded. Only the answer sheets will be graded.**

8. If you have brought a self-addressed, stamped envelope, you may put the examination booklet and scrap paper inside and submit it separately to the supervisor. It will be mailed to you. **(Do not put the self-addressed stamped envelope inside the Examination Envelope.)**

If you do not have a self-addressed, stamped envelope, please place the examination booklet in the Examination Envelope and seal the envelope. **You may not take it with you. Do not put scrap paper in the Examination Envelope. The supervisor will collect your scrap paper.**

Candidates may obtain a **copy** of the examination by contacting the CAS Office.

All extra answer sheets, scrap paper, etc., must be returned to the supervisor for disposal.

9. **Candidates must not give or receive assistance of any kind during the examination. Any cheating, any attempt to cheat, assisting others to cheat, or participating therein, or other improper conduct will result in the Casualty Actuarial Society disqualifying the candidate’s paper, and such other disciplinary action as may be deemed appropriate within the guidelines of the CAS Policy on Examination Discipline.**

10. The exam survey is available on the CAS website in the “Admissions” section. **Please submit your survey by May 15, 2006.**

**END OF INSTRUCTIONS**
1. (1 point)

Identify and briefly describe two ways in which preferred stock is similar to a bond and two ways in which it is different from a bond.
2. (1.5 points)

Consider the following data about Stock X, Stock Y, and the price-weighted index based on Stocks X and Y:

<table>
<thead>
<tr>
<th>Stock</th>
<th>Initial Price ($)</th>
<th>Final Price ($)</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>200</td>
<td>180</td>
<td>-10.0 %</td>
</tr>
<tr>
<td>Y</td>
<td>100</td>
<td>110</td>
<td>10.0 %</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Price Weighted Index</th>
<th>Initial Value</th>
<th>Final Value</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>150</td>
<td>145</td>
<td>-3.3 %</td>
</tr>
</tbody>
</table>

The above information assumes that there are no stock splits or dividends.

Now suppose Stock X were to split two for one during this period.

a. (1 point)

Calculate the new percentage change (as defined in the tables above) in the price-weighted index.

SHOW ALL WORK.

b. (0.5 point)

Explain why the stock split causes the answer in part a. above to be different from the percentage change when there was no stock split.
3. (1 point)

Consider the following information:

- Expected annual inflation is 5.0%.
- Marginal tax rate is 35%.
- Annual investment yield is 10.0%.
- The portfolio consists of all fixed income securities.

Determine the after-tax real interest rate.

SHOW ALL WORK.
4. (2 points)

Consider the following information about a risky portfolio and a risk-free asset:

- The risk premium of the risky portfolio is 15%.
- The reward-to-variability ratio of the risky portfolio is 0.75.
- The expected return on the risk-free asset is 3.0%.

Assume you can invest in some combination of the risky portfolio and the risk-free asset.

Determine the equation for the Capital Allocation Line under these assumptions and graph the Capital Allocation Line. Label all items properly.

SHOW ALL WORK.
5. (1.5 points)

You are considering three portfolios in which to allocate your investment:

- A risk-free asset that yields 4.0%.
- A stock fund with an expected return of 22.0% and a standard deviation of 30.0%.
- A bond fund with an expected return of 8.0% and a standard deviation of 10.0%.

The correlation between the returns of this stock fund and this bond fund is -0.10.

a. (1 point)

Calculate the percentages of the optimal portfolio that would be allocated to the stock fund and to the bond fund.

b. (0.5 point)

Given the answer from part a. above, calculate the expected return of the optimal portfolio.

SHOW ALL WORK.
6. (2.5 points)

The following table gives a security analyst's opinion about expected returns on two stocks for two different market scenarios:

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Market Return</th>
<th>Stock A</th>
<th>Stock B</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>6.0%</td>
<td>2.0%</td>
<td>5.0%</td>
</tr>
<tr>
<td>#2</td>
<td>22.0%</td>
<td>34.0%</td>
<td>11.0%</td>
</tr>
</tbody>
</table>

The risk-free rate is 4.0% under both scenarios.

a. (0.5 point)

Calculate the beta for Stock A and for Stock B.

b. (0.5 point)

Calculate the alpha for each of Stock A and Stock B if Scenario #1 and Scenario #2 are equally likely.

c. (1 point)

Draw the Security Market Line (SML) for the given economy and plot the two securities on the SML graph. Label all items properly.

d. (0.5 point)

Briefly explain which stock, Stock A or Stock B, would be perceived by the analyst as a better buy.

SHOW ALL WORK.
7. (1.5 points)

The expected returns on Stocks A and B are defined by a multi-factor model with the following estimates:

<table>
<thead>
<tr>
<th>Stock</th>
<th>$E(r_i)$</th>
<th>$\beta_{i,GDP}$</th>
<th>$\beta_{i,IR}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5.0%</td>
<td>0.8</td>
<td>1.2</td>
</tr>
<tr>
<td>B</td>
<td>10.0%</td>
<td>1.2</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Assume the expected values for Gross Domestic Product (GDP) and Interest Rate (IR) are 7.5% and 2.5%, respectively, and that the actual Gross Domestic Product turns out to be 10.0%.

Calculate the actual Interest Rate needed such that Stock A and Stock B generate the same returns. Assume no firm-specific influences.

SHOW ALL WORK.
8. (2 points)

The analyses of easily accessible stock market data seem to predict risk-adjusted returns that are difficult to reconcile with the Efficient Market Hypothesis. These analyses have led to what are known as efficient market anomalies.

Identify and briefly describe two of these anomalies.
9. (1 point)

The Fama-French three-factor Model includes two additional factors not in the single-factor Capital Asset Pricing Model (CAPM).

Identify these two additional factors and explain the rationale for including each of them in the three-factor model.
10. (1 point)

Consider the following information about a U.S. Treasury bond:

- The quoted price is $92.75.
- The face value is $100,000.
- The coupon rate is 8.0%.
- The maturity date is October 15, 2010.
- The coupon dates are April 15 and October 15, with 183 days between coupon payments.

Calculate the cash price of this U.S. Treasury bond as of May 1, 2007.

SHOW ALL WORK.
11. (1 point)

Consider the following information for two zero-coupon bonds, Bond A and Bond B:

<table>
<thead>
<tr>
<th>Bond</th>
<th>Face Value</th>
<th>Price</th>
<th>Maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$1,000</td>
<td>$943.40</td>
<td>1 year</td>
</tr>
<tr>
<td>B</td>
<td>$1,000</td>
<td>$857.34</td>
<td>2 year</td>
</tr>
</tbody>
</table>

Calculate the forward rate for the second year.

SHOW ALL WORK.
12. (3 points)

Consider the following information on three U.S. Treasury bonds with coupons paid semi-annually:

<table>
<thead>
<tr>
<th>Bond</th>
<th>Bond Principal</th>
<th>Years to Maturity</th>
<th>Annual Coupon</th>
<th>Bond Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$100</td>
<td>0.50</td>
<td>$0</td>
<td>$95.00</td>
</tr>
<tr>
<td>B</td>
<td>$100</td>
<td>1.00</td>
<td>$9</td>
<td>$98.50</td>
</tr>
<tr>
<td>C</td>
<td>$100</td>
<td>1.50</td>
<td>$12</td>
<td>$101.50</td>
</tr>
</tbody>
</table>

Using the bootstrap method, calculate the continuously compounded 1.5-year zero rate.

SHOW ALL WORK.
13. (2 points)

You are given the following information for a zero-coupon bond:

- The face value is $1,000.
- There are 15 years until maturity.
- The current price (at time $t=0$) is $388.83.$
- The interest rate at time $t=1$ is 5.75%.
- The capital gains tax rate is 15.0%.
- The ordinary income tax rate is 34.0%.

a. (1 point)

Calculate the tax paid by an investor in this bond during the first year, assuming that the bond is held to maturity.

b. (1 point)

Calculate the after-tax rate of return for this bond, assuming an investor has sold the bond after one year.

SHOW ALL WORK.
14. (2 points)

Provide brief descriptions of each of the following covenant rights within a bond indenture and how they protect the rights of the bondholders:

a. (0.5 point)
   Sinking Funds

b. (0.5 point)
   Subordination of further debt

c. (0.5 point)
   Dividend restrictions

d. (0.5 point)
   Collateral

CONTINUED ON NEXT PAGE
14
15. (1 point)

Consider the following average cumulative default intensity rates for three bonds:

<table>
<thead>
<tr>
<th>Bond Rating</th>
<th>Term 1</th>
<th>Term 2</th>
<th>Term 3</th>
<th>Term 4</th>
<th>Term 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ba</td>
<td>1.26</td>
<td>3.48</td>
<td>6.00</td>
<td>8.59</td>
<td>11.17</td>
</tr>
<tr>
<td>B</td>
<td>6.21</td>
<td>13.76</td>
<td>20.65</td>
<td>26.66</td>
<td>31.99</td>
</tr>
<tr>
<td>Caa</td>
<td>23.65</td>
<td>37.20</td>
<td>48.02</td>
<td>55.56</td>
<td>60.83</td>
</tr>
</tbody>
</table>

Calculate the default intensity for the B rated bond in the third year.

SHOW ALL WORK.
16. (1 point)

In Altman’s article, “Measuring Corporate Bond Mortality and Performance,” he states that one of the possible explanations for relatively consistent positive return spreads across all rating categories of bonds is that the fixed-income market has persistently mispriced corporate debt issues, thereby implying an inefficient market.

Discuss one reason cited by Altman as to why this market inefficiency conclusion is difficult to reach and not easily corroborated in explaining the fact that return spreads have been so positive.
17. (1.5 points)

An investor enters into two short futures contracts on pork bellies, with each contract having the following characteristics:

- Each contract is for 40,000 pounds of pork bellies.
- The initial margin is $4,000 per contract.
- The maintenance margin is $3,000 per contract.

Assume the investor withdraws $1,500 at the earliest possible time.

Reconstruct the table below to display the withdrawals, any variation margins, and the remaining amount in the margin account at each point in time.

<table>
<thead>
<tr>
<th>Time</th>
<th>Price (cents per pound)</th>
<th>Margin Account before withdrawals or variation margins</th>
<th>Withdrawals</th>
<th>Margin Account after withdrawals or variation margins</th>
<th>Variation Margin</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>90</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>87</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>90</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>93</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SHOW ALL WORK.
18. (1 point)

A firm wants to hedge a portfolio with a beta of 0.75 and a value of $1,000,000 over the next three months using an S&P 500 index futures contract with four months to maturity.

The current level of the S&P 500 index is 1,000 and one futures contract is for delivery of 250 times the index.

Determine the hedge needed to increase the beta of the portfolio to 1.25.

SHOW ALL WORK.
19. (2 points)

A one-year long forward contract is entered into when the stock price is $100 and the annual risk-free rate of interest is 6%, with continuous compounding for all maturities.

The stock is expected to pay a dividend in three months and again in nine months.

Six months from now, the price of the stock is $105 and the risk-free rate of interest is still 6% per annum. The value of the long position at this time is $3.99.

Calculate the dividend per share, assuming that the dividend is the same at three and nine months.

SHOW ALL WORK.
20. (2 points)

A currency swap has a remaining life of 15 months. The swap involves exchanging annual euro interest for dollar interest. The principal amounts are also exchanged at the end of the life of the swap. You are given the following additional information:

- The swap involves exchanging interest at 11% on €25 million for interest at 8% on $30 million once a year.
- The term structure of interest rates in both Europe and the United States is currently flat.
- If the swap were negotiated today, the interest rates exchanged would be 8% in euros and 6% in dollars.
- All interest rates are quoted with annual compounding.
- The current exchange rate (dollars per euro) is 1.25.

Calculate the value of the swap to the party paying dollars.

SHOW ALL WORK.
21. (1.5 points)

You are given the following information:

- The 6-month interest rates in Japan and the United States are 3% and 6%, respectively, with continuous compounding.
- The spot price of the yen is $0.00856
- The futures price for a contract deliverable in 6 months is $0.00912.

Describe the arbitrage opportunity that exists, including the transactions needed to make a riskless profit.

SHOW ALL WORK.
22. (2 points)

Company X and Company Y both wish to borrow $50 million for 5 years. Company X has a AAA credit rating and Company Y has a BBB credit rating. They have been offered fixed and floating interest rates as shown in the table below:

<table>
<thead>
<tr>
<th>Company</th>
<th>Fixed rates</th>
<th>Floating rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>6.0%</td>
<td>6-month LIBOR + 0.5%</td>
</tr>
<tr>
<td>Y</td>
<td>8.0%</td>
<td>6-month LIBOR + 1.5%</td>
</tr>
</tbody>
</table>

Briefly explain how each company’s credit rating impacts its comparative advantage in fixed-rate markets and floating-rate markets.
23. (2 points)

Consider the following information about two option contracts on the same stock:

<table>
<thead>
<tr>
<th>Option</th>
<th>Expiration</th>
<th>Strike</th>
<th>Call Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2 months</td>
<td>$75</td>
<td>$20</td>
</tr>
<tr>
<td>B</td>
<td>3 months</td>
<td>$75</td>
<td>$18</td>
</tr>
</tbody>
</table>

Assume the call prices are correct (i.e., no arbitrage opportunity).

a. (1 point)

Identify and briefly describe one characteristic of the options that could result in this pricing structure.

b. (1 point)

Identify and briefly describe one characteristic of the underlying stock that could result in this pricing structure.
24. (3 points)

You own an American call option on Stock ABC with the following characteristics:

- Strike price of $45
- Expiration in one month
- Current price is $5.10

Consider the following additional information:

- Stock ABC currently trades at $50.
- The continuously compounded risk-free interest rate is 3% per year.
- There are no dividends or stock splits for stock ABC over the next month.
- You can borrow and lend at the risk-free rate.

You think the stock is currently over-priced and should drop in price over the next month.

One friend suggests exercising the option now and selling the stock. Another friend suggests selling the option. You, however, believe there is another transaction that can guarantee a higher profit than what either of your friends suggests.

Describe the transaction that will guarantee a higher profit, and demonstrate that the profit from your transaction is greater than your friends' suggestions.

SHOW ALL WORK.
25. (2 points)

Consider the following information about European options on stock ABC:

- Strike price is $95.
- Current stock price is $100.
- Time to expiration is 2 years.
- The stock pays no dividends.
- Price of a put is $0.75. This price is calculated using a 2-step Binominal Model where each step is one year in length.

The stock price tree is shown below:

```
          121
           /   \
         110    99
          /     /   \
        100   90    81
```

Calculate the price of the call on stock ABC with strike price $95 if the risk-free rate is 5%.

SHOW ALL WORK.
26. (2.75 points)

Consider the following information:

- An investor writes a top straddle consisting of a European call option and a European put option with strike prices of $50 and expiration in 6 months.
- The current stock price is $49.
- The price of the call option is $4.
- The price of the put option is $3.

a. (2 points)

Draw the profit diagram for the straddle and clearly label all key components and values.

b. (0.25 point)

Describe when a rational investor might enter into such a transaction.

c. (0.5 point)

Identify an alternative option trading strategy that could be used under the circumstances described in part b. above, but does not suffer from the drawback of writing a top straddle.
27. (1.5 points)

A bond has 2 years to maturity and the following relevant information:

- Annual coupon = 5.0%
- Par value = $100
- The bond is putable at par one year from now.
- Volatility of one-year rate = 30.0%
- $R_0 = 2.5%$
- $R_L = 3.0%$

a. (1 point)

Calculate the value of the putable bond.

b. (0.5 point)

Calculate the value of the embedded put option.

SHOW ALL WORK.
28. (1 point)

Black & Scholes made an unrealistic assumption of ignoring penalties regarding the short-selling of options and stocks.

a. (0.5 point)

Discuss two penalties associated with the short sale of stocks.

b. (0.5 point)

Describe how the penalties you identify in part a. above differ from the penalties for the short sale of options.
29. (2.5 points)

You are given the following information on a European option:

- The current exchange rate is 1.50 dollars per pound.
- The strike price is $1.45.
- The risk-free interest rate in the United States is 8% per annum.
- The risk-free interest rate in Britain is 10% per annum.
- Volatility is 15.0%.

Calculate the value of a one-year European call option on the British pound.

SHOW ALL WORK.
30. (1 point)

Consider the following information from one year ago:

- Futures exchange rate was 0.80 pounds per dollar.
- Initial exchange rate was 0.75 pounds per dollar.
- British risk-free rate was 9.0% per annum.

One year ago, a U.S. investor invested in a one-year risk-free British government bill. Also at that time, the investor hedged the exchange rate risk in the investment by using a futures contract.

Calculate the dollar-denominated risk-free rate that the investor locked into one year ago.

SHOW ALL WORK.
31. (2 points)

Consider a three-year bond with a par value of $1,000 that pays semi-annual coupons. This bond has two years to maturity.

The coupon rate on this bond is 6.5% and the yield to maturity is 5.5%.

The current market interest rate is 5.0%.

a. (1.5 points)

Calculate the Macaulay duration for this bond.

b. (0.5 point)

Calculate the modified duration for this bond.

SHOW ALL WORK.
32. (2 points)

An insurance company has a liability of $14,500 that will be paid at the end of three years.

The insurance company is considering funding this liability by purchasing a $10,000 bond that pays 10% annual coupons and matures in six years. All coupons are to be reinvested.

The current yield to maturity is 5.0% with annual compounding.

Determine if this bond is an appropriate choice to fund the obligation and immunize the insurer from small changes in interest rate levels and explain your answer (ignore taxes).

SHOW ALL WORK.
33. (2 points)

Consider the following information about a portfolio:

- This portfolio consists of options on Stock X and 2,000 shares of Stock Y.
- Delta on the options is 1,000.
- Stock X share price is $100.
- Stock Y share price is $200.
- Daily price volatility of Stock X is 2.0%.
- Daily price volatility of Stock Y is 1.0%.
- Correlation between daily price changes of Stock X and Stock Y is 0.20.

Calculate the 95% 10-day Value at Risk.

SHOW ALL WORK.
34. (2 points)

Hull discusses three different ways a financial institution can mitigate credit risk.

Identify and briefly discuss a limitation of two of these mitigation techniques.
35. (1.5 points)

Consider the following:

- Risk-free rate per annum, \( r = 4.0\% \)
- Current stock price, \( S = $50 \)
- Stock price volatility of 25.0% per annum
- \( d_1 = 0.810 \)
- \( N(d_1) = 0.791 \)
- \( N'(d_1) = 0.287 \)
- \( N(-d_1) = 0.209 \)
- \( N'(-d_1) = 0.287 \)

Consider a 4-month European put option on a non-dividend-paying stock.

Calculate the change in the delta of the option if the stock price increases from $50 to $51.

SHOW ALL WORK.
36. (1.5 points)

Value at Risk (VaR) may not always be an appropriate measure of risk for non-financial firms.

Briefly describe each of the following alternatives and explain its advantage over VaR:

a. (0.75 point)
   
   Cash Flow at Risk

b. (0.75 point)
   
   Shortfall Risk
37. (2 points)

Financial risk management can enhance the value of a firm by reducing its cash flow variability.

a. (1 point)

Identify two major costs associated with higher cash flow variability.

b. (1 point)

Briefly explain how reducing cash flow variability can lower each of the costs identified in part a. above.
38. (1 point)

Consider the following information for an insurance company that writes two lines of business:

<table>
<thead>
<tr>
<th>Line</th>
<th>Net Income</th>
<th>Allocated Capital</th>
<th>Cost of Capital</th>
<th>Risk-Free Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$1,100</td>
<td>$10,000</td>
<td>10.0%</td>
<td>5.0%</td>
</tr>
<tr>
<td>B</td>
<td>$400</td>
<td>$4,000</td>
<td>12.0%</td>
<td>5.0%</td>
</tr>
</tbody>
</table>

Using the Economic Value Added approach, calculate and explain whether each line creates value for the insurance company.

SHOW ALL WORK.
39. (4.25 points)

An insurance company is contemplating writing a new line of business. Assume the following probability distribution function of losses per risk:

<table>
<thead>
<tr>
<th>Incurred Loss</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>$5,000</td>
<td>0.70</td>
</tr>
<tr>
<td>$10,000</td>
<td>0.20</td>
</tr>
<tr>
<td>$60,000</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Assume that the risk-free interest rate is 0%.

a. (1 point)

Calculate the capital required per risk for an expected policyholder deficit (EPD) Ratio of 0.02.

b. (2.75 points)

The insurance company wants to reduce the capital required for writing this new line of business through reinsurance. The company decides to test the scenario of writing two independent risks, each having the above distribution function, with a 50% quota share reinsurance arrangement.

Calculate the reduction in total capital required compared to part a. above. Assume that the EPD Ratio target of 0.02 remains unchanged.

c. (0.5 point)

Briefly comment on the changes, if any, in expected losses and capital requirements between part a. and part b. above.

SHOW ALL WORK.
40. (1.5 points)

Consider the following information for Company X:

- \( E(D_{\text{year } 2}) = $25 \)
- \( E(D_{\text{year } 3}) = $30 \)
- Appropriate annual discount rate is 10.0%.
- Target Return on Equity is 20.0%.
- 30% of the company’s earnings are retained and reinvested each year.
- Dividends are paid at the end of the year and are expected to grow in perpetuity at a constant rate beginning in year 4.

Use the Dividend Discount Model to answer the following:

a. (0.75 point)

Calculate the present value of Company X’s terminal value.

b. (0.75 point)

Calculate the present value of Company X’s total future dividends.

SHOW ALL WORK.
41. (4.5 points)

Consider the following information and table of data for Company Z:

- Capital Asset Pricing Model equity beta is 0.84.
- Risk-free rate is 4.38%.
- Equity risk premium is 5.50%.
- Assumed growth rate beyond year 3 is 6.00%.

<table>
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<th>Year</th>
<th>GAAP Equity Beginning of the Year</th>
<th>Net Income</th>
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<tr>
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<td>$10,100</td>
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<tr>
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<td>$10,600</td>
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<td>3</td>
<td>$109,700</td>
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a. (2 points)

Calculate the Equity Value of Company Z based on the Abnormal Earnings Valuation Method, using the constant Abnormal Earnings in perpetuity assumption.

b. (2 points)

Calculate the Equity Value of Company Z based on the Abnormal Earnings Valuation Method, using a 3-year time horizon for Abnormal Earnings to fall to zero after the forecast horizon.

c. (0.5 point)

Based on economic theory, explain why assuming that the Abnormal Earnings fall to zero is a more reasonable assumption than assuming constant Abnormal Earnings in perpetuity.

SHOW ALL WORK.
# Tables of the Normal Distribution

## Probability Content from -oo to Z

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</table>
QUESTION 1

Similarities…

- Both receive a fixed stream of payments
- Holders of each have not voting rights

- A preferred stock is similar to a bond when a company goes bankrupt, preferred stock owners and bond holders are paid before common stockholders.
- They are also similar because preferred stocks and bonds can also be callable.

- In case the firm goes bankrupt, both preferred stock and bond holders have priority to claim the firm’s asset, over common stock holders.
- Both bond and preferred stock can be converted to firm’s shares.

- Both sensitive to changes in interest rates.
- Both tradable securities.

- Both have a prescribed cash flow to investor: preferred stock has dividend (still discretionary), bond has coupon payments.
- Both can have sinking fund provisions.

- Dividend amount is fixed which is like a fixed coupon amount on a bond.
- Preferred stock dividend must be paid before any dividend on common stocks and coupon on bond is also senior to a common stock dividend.
QUESTION 1

Differences…

- Company still has the right to defer the dividend distribution to the preferred stock holders, but company is obligated to pay the predetermined coupon payments to bond holders.
- Do not have the debentures as in bond in protecting them from default risk.

- It does not have a maturity date as a bond does.
- Interest payments made on bonds are tax deductible (for the issuer of the bond, not the holder), but the dividend payment made on preferred stock are not tax deductible (again I’m talking about the issuer, not the holder).

- Preferred stock dividends to corporate stockholders have a tax advantage. Only 30% of the dividend is taxable.
- Preferred stock is a stock. Its price moves with the market. It is tied into the systematic risk. Bond values do not depend on the systematic risk of the stock market.

- Bondholders have priority over preferred stockholders on payment if company goes bankrupt.
- Defaulted payments on preferred stocks accumulate rather than resulting in bankruptcy.

- Preferred stock is a perpetuity. Bonds have a maturation date.
- It is not required that firms pay dividend to preferred shareholders, just that they not pay ordinary dividends before preferred stockholders are paid. Not paying bonds triggers default.

- Preferred stockholders may have voting right but bond holders do not.
- Preferred stock price does not link to the yield to maturity while bond does.

- Bonds are debt while preferred stock is equity.
- Bonds will get priority of payment in case of bankruptcy. Preferred stock is equity and would get nothing.
QUESTION 2 – VERSION 1 OF 2

Part A

Initial \[ \frac{200 + 100}{2} = 150 \]

Calculate divisor

New price for stock x = 100 (after split)
\[ \frac{100 + 100}{d} = 150 \]
\[ d = 1.3333 \]

new final value
\[ \frac{90 + 110}{1.3333} = 150 \]

\% change = \[ \frac{150 - 150}{150} = 0\% \]

Part B

Price weighted index given more weight to stock with high price.

Before split, stock x has higher price, so its 10\% decrease has more weight than stock y’s 10\% increase. Therefore, overall change is a decrease.

After split, they are both at $100, therefore the index gives same weight to both. The 10\% decrease of x is cancelled by the 10\% increase of y. So overall change is 0\%. 
QUESTION 2 – VERSION 2 OF 2

Part A

\[(100 + 100) / x = 150\]
\[x = 1.33\]

\[(180 + 110) / 1.33 = 217.50\]

change = \[217.5 / 150 = 1.45 – 1 = 45%\]

Part B

When calculating a change for a price weighted index, the higher priced stock inherently has greater weight. Here the weight would be from \[200/2=100\] to 180 in the split versus 200 to 180 (-10%) in the no-split example.
QUESTION 3 – VERSION 1 OF 2

Assuming approximation on the syllabus

R = nominal rate
r = real after tax rate
t = tax rate
π = inflation

\[ r = R (1 - t) - \pi \]
\[ = 0.10 (1 - .35) - 0.05 \]
\[ = 0.15 \]
Real r after tax = 1.5%
QUESTION 3 – VERSION 2 OF 2

After tax real interest rate = \[1 + \text{nominal yield} \times (1 - \text{tax\%})\] / [1 + inflation] - 1
\[1 + 10\% \times (1 - 35\%)\] / [1 +5\%] - 1
= \frac{1.065}{1.05} - 1
=1.43\%
QUESTION 4 – VERSION 1 OF 2

\( E(r_p) - r_f = .15 \)

\( \frac{(E(r_p) - r_f)}{\sigma_p} = .75 \)

\( R_f = .03 \)

\( E(r_c) = E(r_p)y + (1 - y)r_f \)

\( = E(r_p)y + r_f - r_fy = [E(r_p) - r_f] y + r_f = (E(r_p) - r_f) \frac{\sigma_c}{\sigma_p} + r_f \)

\( \sigma_c = y \sigma_p \rightarrow y = \frac{\sigma_c}{\sigma_p} \)

Equation = \( E(r_c) = R_f + \sigma_c E(r_p - r_f) / \sigma_p \)

\( = .03 + .75 \sigma_c \)

Where \( E(r_c) \) is the expected return of the complete portfolio
\( \sigma_c \) is the standard deviation of the complete portfolio

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<th>( E(r_c) )</th>
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Capital Allocation Line
QUESTION 4 – VERSION 2 OF 2

S = .75
R_f = .03
E(r_p) - r_f = .15

E(r_p) = r_f + [E(r_p) - r_f] \sigma_c / \sigma_p

(E(r_p) - r_f) / \sigma_p = .75 \rightarrow .15 / \sigma_p = .75

\sigma_p = .2
E(r_p) - r_f = [E(r_p) - r_f] / \sigma_p \sigma_c

.15 = .75 \sigma_c
\sigma_c = .2

\sigma_c = y \sigma_p
.2 / .2 = 1 you will invest everything in the risky asset

E(r_p) = 0.03 + .15y in this case y = 1
E(r_p) = .03 + .15 = .18

***GRAPH THE SAME AS IN VERSION 1 OF 2 OF QUESTION 4***
QUESTION 5 – VERSION 1 OF 2

\( r_f = 4.0\% \)
E\((r_1) = 22.0\% \) and \( \sigma_1 = 30.0\% \) (stock)
E\((r_2) = 8.0\% \) and \( \sigma_2 = 10\% \) (bond)
\( \rho_{12} = 0.10 \)

Part A

\[
W_1 = \% \text{ in stock} = \frac{[E(r_1) - r_f] \sigma_2^2 - [E(r_2) - r_f] \sigma_{12}}{[E(r_1) - r_f] \sigma_2^2 + [E(r_2) - r_f] \sigma_1^2 - [E(r_1) - r_f + E(r_2) - r_f] \sigma_{12}}
\]

Where \( \sigma_{12} = \sigma_1 \sigma_2 \rho_{12} = (30\%)(10\%)(0.10) = 0.003 \)

Then \( W_1 = \frac{[22\% - 4\%](10\%)^2 - [8\% - 4\%](0.03)}{[22\% - 4\%](10\%)^2 + [8\% - 4\%](30\%)^2 - [22\% - 4\% + 8\% - 4\%](0.03)}\)

\[
W_1 = \frac{0.0018 - 0.00012}{0.0018 + 0.0036 - 0.00066}
\]

\[
= \frac{0.00168}{0.00474}
\]

= 35.44\% to stock

\( W_2 = 1 - W_1 = 64.56\% \) to bond

Part B

\[
E(r_p) = W_1 E(r_1) + W_2 E(r_2)
\]

= (35.44\%)(22.0\%) + (64.56\%)(8.0\%)

= 7.80\% + 5.16\%

= 12.96\%
QUESTION 5 – VERSION 2 OF 2

\[ \begin{align*}
E(r_s); \sigma_s \\
R_f &= 4; 0 \\
S &= 22; 30 \\
B &= 8; 10 \\
\rho &= -.10 \\
\end{align*} \]

Part A

Optimal portfolio

\[ W_s = \sigma_b^2 [E(r_s - r_f)] - [E(r_b - r_f) \rho \sigma_s \sigma_b] \]
\[ \sigma_b^2 [E(r_s - r_f)] + \sigma_s^2 [E(r_b - r_f)] - [E(r_b - r_f) + E(r_s - r_f)] \rho \sigma_s \sigma_b \]

\[ = 10^2(18) - (4)(-.10)(30)(10) \]
\[ = 1920 - 6060 \]

\[ = .3168 \]

\[ W_s = 31.68\% \]

\[ W_b = 68.32\% \]

Part B

\[ E(r_p) = W_s E(r_s) + W_b E(r_b) \]
\[ = (.3168)(22) + (.6832)(8) \]
\[ = 12.4352\% \]
QUESTION 6

\[ r = 0.4 \]
\[ E(r) = r_f + \beta \left[ E(r_m) - r_f \right] \]

**Part A**

Stock A:

\[ .02 = .04 + \beta \left[ .06 - .04 \right] \]
\[ = .04 + \beta (.02) \]

\[ .34 = .04 + \beta \left[ .22 - .04 \right] \]
\[ = .04 + \beta [.18] \]

\[ .32 = \beta (.16) \]

\[ \beta_a = 2 \]

Stock B:

\[ .05 = .04 + \beta \left[ 0.6 - .04 \right] \]
\[ = .04 + \beta (.02) \]

\[ .11 = .04 + \beta \left[ .22 - .04 \right] \]
\[ = .04 + \beta (.18) \]

\[ .06 = \beta (.16) \]

\[ \beta_b = .375 \]

**Part B**

\[ E(r_m) = .5(.06) + .5(.22) \]
\[ = .14 \]

\[ E(r_a) = .04 + 2[.14 - .04] = .24 \]
\[ E(r_a) = (.5)(.02) + (.5)(.34) = .18 \]

\[ \sigma_a = -.06 \]

\[ E(r_b) = .04 + .375 \left[ .14 - .04 \right] = .0775 \]
\[ E(r_b) = (.5)(.05) + (.5)(.11) = .08 \]

\[ \sigma_b = .0025 \]
Part C

Security Market Line

<table>
<thead>
<tr>
<th>Beta</th>
<th>Expected return</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.0%</td>
</tr>
<tr>
<td>0.5</td>
<td>0.5%</td>
</tr>
<tr>
<td>1.0</td>
<td>1.0%</td>
</tr>
<tr>
<td>1.5</td>
<td>1.5%</td>
</tr>
<tr>
<td>2.0</td>
<td>2.0%</td>
</tr>
<tr>
<td>2.5</td>
<td>2.5%</td>
</tr>
</tbody>
</table>

Part D

Stock A is at [2.0, 18%]
Stock B is at [0.38, 8%]

Stock B: It earns a higher return, based on its risk, than expected by CAPM.
QUESTION 7

<table>
<thead>
<tr>
<th></th>
<th>E(ri)</th>
<th>β_{iGDP}</th>
<th>β_{iIR}</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5</td>
<td>0.8</td>
<td>1.2</td>
</tr>
<tr>
<td>B</td>
<td>10</td>
<td>1.2</td>
<td>0.8</td>
</tr>
</tbody>
</table>

\[ E(r) = E(r_i) + \beta_{iGDP} R_{GDP} + \beta_{iIR} R_{IR} \]

A: \[ 5 + .8(10-7.5) + 1.2(IR-2.5) \]

B: \[ 10 + 1.2(10-7.5) + .8(IR-2.5) \]

\[ 5 + .8(10-7.5) + 1.2(IR-2.5) = 10 + 1.2(10-7.5) + .8(IR-2.5) \]

\[ 7 + 1.2IR - 3 = 13 + .8IR - 2 \]

\[ .4IR = 7 \]

\[ IR = 17.5\% \]
QUESTION 8 – MULTIPLE ANSWERS BASED ON WHAT ANOMOLIE WAS PRESENTED

Momentum effect – best and worst performing stocks to continue their performance from the recent past.

P/E Ratio – firms with lower P/E ratios earn higher risk adjusted returns than firms with higher P/E ratios.

Small firm in January – Small cap firms seem to earn a higher return than large cap firms in general, but especially in January, even after adjustments for risk are made. One explanation is that the small caps are sold in December to realize the loss for tax purposes, then repurchased in January temporarily driving up demand and price. This goes against EMH because if this were known, investors would buy the stock in December and eliminate the January profit.

Small Firm Effect – smaller cap companies seem to enjoy higher return than large companies even when risk adjusted.

January effect – small cap firms tend to have stock price rise in January. However, an efficient market would react to this and buy heavily in December in anticipation.

Neglected firm effect – Firms that are less studied have higher than expected returns. This might be because these firms are less liquid so investors demand a liquidity premium to hold stock in those firms.

Liquidity effect – The stock of companies that are illiquid in trading tend to do better than companies more highly traded. This may be partly due to higher cost in trading those companies.

Post-earning announcement drift – When new information on earnings are given the price of the stock, instead of changing instantly by a jump, changes in a slow way to adjust for the new information.

Book to Market Value – This is the anomaly that firms with high book to market perform better than those with lower book to market ratios. This info is also public and so it is inconsistent with EMH.

Long term reversion – Over a longer period, the best performing stocks tend to under perform and the worst performing stocks tend to overperform. Investors can simply invest in worst performing stocks to earn profit.
QUESTION 9 – VERSION 1 OF 2

This model considers firm size and firm book to market value. Both factors reflect additional risk factors apparently no captured by B.
1 – Firm size
2 – Book to market value ratio.

The rationale for including these was that it appeared to measure some of the systematic risk not captured by using only the market portfolio factor used in CAPM. It was not the case the F-F thought small firms or high BV to MV ratio firms had better returns but that by measuring returns of small firms compared to larger firms (and same for BV to MV ratios) that there were elements of systematic risk being captured by the model.
**QUESTION 10**

FV = $100K  
Coupon 8% annual  
Assume quoted price on 5/1/07 too

Price on 5/1/07?  
T bonds use actual/actual day counts  
Cash price = quoted price + accrued interest

Quoted price = 92.75 per $100 of FV  
Days of accrued int. is diff between 4/15/07 and 5/1/07 = 16 days  
Coupon = .08(.5)(100K) = 4000

Cash price = 92.75 X 100,000/100 +16/183 (4000)  

= $93,099.73
QUESTION 11

Assume annual compounding

\[ 943.4 = \frac{1000}{1+x_1} \]

\[ x_1 = 6\% \]

\[ 857.34 = \frac{1000}{(1 + x_2)^2} \]

\[ x_2 = 8\% \]

\[ \frac{(1.08)^2}{(1.06)} - 1 = 10.04\% \]
**QUESTION 12 – VERSION 1 OF 2**

<table>
<thead>
<tr>
<th>Bond</th>
<th>Principal</th>
<th>Maturity</th>
<th>AnnCoup</th>
<th>SemAnnCoup</th>
<th>Price</th>
<th>Spot</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>100</td>
<td>.5</td>
<td>0</td>
<td>0</td>
<td>95.00</td>
<td>$S_{.5}=10.26%$</td>
</tr>
<tr>
<td>B</td>
<td>100</td>
<td>1.0</td>
<td>9</td>
<td>4.5</td>
<td>98.50</td>
<td>$S_{1}=10.35%$</td>
</tr>
<tr>
<td>C</td>
<td>100</td>
<td>1.5</td>
<td>12</td>
<td>6</td>
<td>101.5</td>
<td>$S_{1.5}=10.62%$</td>
</tr>
</tbody>
</table>

$95 = 100e^{-0.5 \times S_{.5}} \rightarrow S_{.5}=10.26\%$ 
$98.50 = 4.5e^{-0.5 \times S_{.5}} + 104.5e^{-1 \times S_{1}} = 4.5e^{-0.5 \times 0.1026} + 104.5e^{-1 \times S_{1}} \rightarrow S_{1}=10.35\%$
$101.5 = 6e^{-0.5 \times S_{.5}} + 6e^{-1 \times S_{1}} + 106e^{-1.5 \times S_{1.5}} = 6e^{-0.5 \times 0.1026} + 6e^{-1 \times 0.1035} + 106e^{-1.5 \times S_{1.5}} \rightarrow S_{1.5}=10.62\%$

1.5 Year Zero Rate = 10.62\%
QUESTION 12 – VERSION 2 OF 2

95(1 + r_1) = 100
r_1 = 5.263%

98.5 = 4.5(1.05263) + 104.5/[(1.05263)(1 + r_2)]
r_2 = 5.360%

101.5 = 6/(1.05263) + 6/(1.05263)(1.0536) + 106/[(1.05263)(1.0536)(1 + r_3)]
r_3 = 5.739%

(1 + r_1)(1 + r_2)(1 + r_3) = e^{1.5}
ln(1.1727) = r(1.5)
1.5r = 15.93%
r = 10.62%
QUESTION 13

Part A

Current price = 388.83
Y = 6.4% Bond equivalent
Y = 6.5% Effective annual rate

Price at t = 1 if no change in interest rate
1000/(1 + 6.5%)^14 = 414.10

Taxable income (interest) = 414.10 - 388.83 = 25.27
Tax paid = 25.27 x 34.0% = $8.59

Part B

Price at t = 1 (interest rate = 5.75% effective annual rate)
1000/(1.0575)^14 = 457.17
Capital gain tax = (457.17 – 414.10) x 15% = $6.46

After-tax rate return = (457.17 – 388.33 – 8.59 – 6.46) / 388.83 = 13.7%
QUESTION 14

Part A

Company repurchases bonds at random based on a set schedule. Protects bondholders from default since principal is paid gradually (not in lump sum).

Part B

If the company issues new debt, the rights of the junior debt holders will be subordinated to the rights of the senior debt holders. This protects bondholder in the event of default, since the senior debt holders will have first right of recovering company assets before the junior bondholders can recover.

Part C

Restricts the amount of dividends the company can pay to shareholders. Protects bondholders because it makes sure the company retains more of its profits thus providing a protection against default.

Part D

Issuer posts assets as collateral until debt is paid off. Gives bondholders a protection since they will keep the collateral in the event of default.
QUESTION 15 – VERSION 1 OF 2

Default intensity = chance bond will default during year x / chance bond is still around at year x–1

\[
\frac{20.65 - 13.76}{100 - 13.76} = \frac{6.89}{86.24} = 7.99\%
\]
QUESTION 15 – VERSION 2 OF 2
Default intensity = prob of default in year 3 / prob of survival up to year 3

\[ (0.2065) - (0.1375) / (1 - 0.1376) = 7.989\% \]
Instead of being a market inefficiency, it could just be a liquidity premium because corporate bonds are a lot less liquid and require compensation for this.
Bonds are relatively illiquid and investors generally prefer liquidity. In order for investors to invest in bonds there must be an extra return to compensate for the illiquidity. This liquidity premium, as it is called, contributes to the excess returns described. So markets may still be efficient, but there is an additional liquidity premium in the returns.
**QUESTION 17 – VERSION 1 OF 2**

Initial margin = 4000(2) = 8000

Maintenance = 3000(2) = 6000

Short contract: if price drops, value increases

<table>
<thead>
<tr>
<th>T</th>
<th>Price</th>
<th>Margin</th>
<th>Withdrawals</th>
<th>Margin</th>
<th>Var</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>90</td>
<td>8000</td>
<td>0</td>
<td>8000</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>87</td>
<td>10400</td>
<td>1500</td>
<td>8900</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>90</td>
<td>6500</td>
<td>0</td>
<td>6500</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>93</td>
<td>4100</td>
<td>0</td>
<td>8000</td>
<td>3900</td>
</tr>
</tbody>
</table>

Price 90 – 87  value increase (0.03)(40000)(2) = 2400
Price 87 – 90  value decrease (0.03)(40000)(2) = -2400
Price 90 – 93  value decrease (0.03)(40000)(2) = -2400
**QUESTION 17 – VERSION 2 OF 2**

<table>
<thead>
<tr>
<th>Time</th>
<th>Price per lb</th>
<th>Margin acct before w/d or variation mgnsp</th>
<th>w/d</th>
<th>Margin acct after…</th>
<th>Variation margin</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>.90</td>
<td>8000</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1</td>
<td>.87</td>
<td>8000+2400=10400</td>
<td>1500</td>
<td>8900</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>.90</td>
<td>8900-2400=6500</td>
<td>-</td>
<td>6500</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>.93</td>
<td>6500-5400=4100</td>
<td>-</td>
<td>8000</td>
<td>3900</td>
</tr>
</tbody>
</table>

2 short futures contract (each 40000 pounds of pork bellies)
initial margin = 4000 x 2 = 8000
maint margin = 3000 x 2 = 6000

<table>
<thead>
<tr>
<th>Time</th>
<th>Price</th>
<th>Gain in margin account</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.87</td>
<td>(.03)(80000) = 2400</td>
</tr>
<tr>
<td>2</td>
<td>.90</td>
<td>-( .03)(80000) = -2400</td>
</tr>
<tr>
<td>3</td>
<td>.93</td>
<td>-( .03)(80000) = -2400</td>
</tr>
</tbody>
</table>
QUESTION 18

To change B (0.75) to B* (1.25) when B* > B you have to go long (B*-B) x (P/A) futures contracts.

\[(B^* - B) \times (P/A) = (1.25 - 0.75) \times \frac{1000000}{250000} = 2\]

To hedge the portfolio in order to increase B to 1.25 you need to buy 2 futures contracts.
QUESTION 19

- 1 year forward $S_0 = 100$
- $r = 6\%$ (continuously compounded)
- Dividends at 3 mo and 9 mo
- $S_0 = 100$
- $S = 105$

$$f = (F_0 - K)e^{-rt} = 3.99$$

$$f = \left\{ \left[ 105 - De^{-0.06(0.25)} \right] e^{0.06(0.5)} - \left[ (100 - De^{-0.06(0.25)} - De^{-0.06(0.75)}) e^{0.06} \right] \right\} e^{-0.06(0.5)} = 3.99$$

$$3.99e^{0.06(0.5)} = 108.198 - De^{0.015} - 106.184 + De^{0.045} + De^{0.015}$$

$$4.115 = 2.014 + De^{0.045}$$

$$2.0975 = De^{0.045}$$

$D = $2.005
**QUESTION 20**

Annual Compounding

<table>
<thead>
<tr>
<th>Time (months)</th>
<th>0</th>
<th>3</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euros</td>
<td>2.75 M€</td>
<td>27.75 M€</td>
<td>€ 25 million 11%</td>
</tr>
<tr>
<td>Dollars</td>
<td>2.4 M$</td>
<td>32.4M$</td>
<td>$ 30 million 8%</td>
</tr>
</tbody>
</table>

\[ S_0 = 1.25€ \]

\[ U_{swap} = B_e \times S_0 - B_d \text{ valuing it as bonds} \]

\[ B_e = \frac{2.75M€}{(1.08)^{3/12}} + \frac{27.75M€}{(1.08)^{15/12}} \]

\[ = 27,902,397€ \]

\[ B_d = \frac{2.4M$}{(1.06)^{3/12}} + \frac{32.4M$}{(1.06)^{5/12}} \]

\[ = 32,489,295 \]

\[ U_{swap} \text{ to party paying dollars} = 27,902,397(1.25) - 32,489,295 \]

\[ = 2,388,701 \]
QUESTION 21 – VERSION 1 of 3

- $r_f = .03$
- $r = .06$
- $S_0 = .00856$
- $T = .5$

$F_0 = S_0e^{(r-r_f)T}$

$= .00856e^{(.06-.03) .5}$

$= .00869 < .00912$

Therefore, arbitrage opportunity exists.

<table>
<thead>
<tr>
<th>Actions</th>
<th>Cash Flow Now</th>
<th>Cash Flow $T = .5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short future</td>
<td></td>
<td>+$.00912</td>
</tr>
<tr>
<td>Invest PV(¥1) = ¥.9851</td>
<td>-¥.9851</td>
<td>+1¥</td>
</tr>
<tr>
<td>Borrow $.00843</td>
<td>+$.00843</td>
<td>-$.00869</td>
</tr>
<tr>
<td>Convert $ to ¥</td>
<td>=$.00843</td>
<td>0</td>
</tr>
<tr>
<td>+¥.9851</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>$.00043</td>
<td></td>
</tr>
</tbody>
</table>

Riskless future profit of $.00043 @ time 0.5.
QUESTION 21 – VERSION 2 OF 3

- $r_f = 3\%$
- $r = 6\%$ (continuously compounded)
- $S_0 = 0.00856 \$/y$
- $F_0 = 0.00912$

Theoretical $F_0 = S_0 e^{(r-r_f)T} = 0.00856 e^{(0.06-0.03) \cdot 0.5} = 0.00869$
So $F_0$ is expensive in the market $\rightarrow$ short futures

<table>
<thead>
<tr>
<th>$T = 0$</th>
<th>$T = 6 \text{ mo}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter into short future contract</td>
<td>Long position pays you 0.00912 $/y$</td>
</tr>
</tbody>
</table>

Invest $e^{-rf(0.5)}$ yen

Borrow $e^{rf(0.5)} \times 0.00856$
+ convert to yen at $0.00856 \$/y (divide by this)

Pay off loan at $e^{(r-r_f)0.5} \times 0.00856$
+ $0.00912 - e^{(0.06-0.03)0.5} \times 0.00856$
$= 0.0043$ riskless profit
QUESTION 21 – VERSION 3 OF 3

Futures price should be = \( S_0 e^{(r-r_f)T} \)
= \( (\$0.00856 / 1 ¥) e^{(0.06-0.03)1/2} \)
=\$0.00869/¥

The actual futures price is too high. To construct a risk free profit, take a short position in the future and also:

Want to realize 1 yen in 6 months to meet delivery in the future. To get 1 yen in 6 months must invest \( e^{-0.03(1/2)} = 0.9851 \) yen now.

To get that, must borrow \( (0.9851¥)(\$0.00856/¥) = \$0.00843 \) now.

Borrow at US risk free rate we will owe \( \$0.00843e^{0.06(1/2)} = \$0.00869 \) in six months.

So transactions are:

1. short position in future
2. borrow \$0.00843 now
3. convert #2 into yen and invest at Japanese risk free rate.

At time \( t = 6 \), your Japanese investment grow to 1¥; sell it for \$0.00912 to close out futures contract. After borrowing \$0.00912 to pay off loan, left with \( .00912 - .00869 = .00043 \) riskless profit.
QUESTION 22

Company B will pay 2% more than A in fixed-rate markets and 1% more than Company A in floating rate markets. So B has a comparative advantage in the floating rate market while A has a comparative advantage in the fixed rate market.

This is true because in the floating rate markets, the lender has the right to review the default risk of each company at each time the interest rate is reset. And, in the short run, although Company B has lower credit rating, both companies have low default risk. So, the spread in floating rate market is small. However, as the time goes by, Company B will have larger default risk than A. And because lenders in fixed rate markets do not have the right to reset the interest rate, they will command a higher spread to compensate for this.
QUESTION 23

a) Option A could be an American option, while Option B could be a European option.

b) Large dividend could be expected to be paid after option A expires, but before Option B expires.
Exercising now + selling stock → profit = $5.013 at T = 1/12

Selling option → profit at T = 1/12 = $5.113

To guarantee a greater profit, short the stock and invest the proceeds.

50e^{0.03(1/12)} = 50.125

At T = 1, you hold 50.125, a call option with K=45 and you owe a share.

- If $S_t < 45$ then to repay the owed share option expires worthless and buy stock for $S_t$.
  - Cost = $S_t$. Profit = 50.125 - $S_T \geq 5.125$

- If $S_t > 45$ exercise the option and buy stock for 45.
  - Cost = 45. Profit = 5.125

This guarantees a profit of at least 5.125 and possibly a lot more if the price falls below 45.
Since it is an American option and there is not dividend or split, it is never optimal to early exercise. I’ll short sell the stock to get 50 and invest it in the risk free rate since I’m thinking the price will go down soon. Now, compare the strategies at the end of a month.

I’ll buy a stock at \( \min(45, S_t) \) to return it.

Friend 1  \( 5 \times e^{0.03/12} = 5.013 \)

Friend 2  \( 5.1 \times e^{0.03/12} = 5.113 \)

Myself  \( 50e^{0.03/12} - \min(45, S_t) \geq 50e^{0.03/12} - 45 = 5.125 \)

My strategy is better!
Profit from exercise now and sell the stock = 50 – 45 = 5$
Profit of selling the option =$5.10

You could sell the stock short instead

Payoff in one month. Let k = strike price and Sₜ be final stock price

If Sₜ > K : Sₜ – 45  -Sₜ = -45

If Sₜ < K  :  -Sₜ

Selling short will give $50 that can be invested to get $50e^{0.03(1/12)} = 50.125$ in one month.

Cash flow a t =1 month is either 50.125 – 45 = 5.125 or 50.125 – Sₜ (which is always greater than 5.125).

Value in one month of other options:

- From exercise = 5e^{0.03(1/12)} = 5.0125 < 5.125
- From selling = 5.1e^{0.03(1/12)} = 5.1128 < 5.125

So my strategy pays in all cases more than those of my friends.
QUESTION 24 – VERSION 4 OF 11

My strategy: short sale one share of stock ABC, invest the proceed in risk free asset.

1 – One month later, if stock price is greater than 45, then I exercise the option, use the stock to close out the short sale. The profit is \( (50e^{0.03(1/12)} - 45)e^{-0.03(1/12)} = 5.11 \)

2 – If stock price is less than 45, then I will not exercise the option. I just buy one share from the market to close out the short sale, the profit is greater than \( (50e^{0.03(1/12)} - 45)e^{0.03(1/12)} = 5.11 \)

Whatever the stock price at the end of the month, the profit \( \geq 5.11 \)

While the first friend’s profit = 50 - 45 = 5

The second friend’s profit = 5.1

My strategy will guarantee a higher profit.
QUESTION 24 – VERSION 5 OF 11

Option is currently in the money. Payoff from immediate exercise = 50 – 45 = 5$

Over a one-month horizon, we have:

1 – exercise, sell and invest at 3%
   end value = 5e^{0.03(1/12)} = $5.0125

2 – sell the option
   end value = 5.10e^{0.03(1/12)} = $5.113

3 – short sell the stock for $50 and invest at 3%. Keep the call option.

If stock price, at t = 1 month is below $45, you purchase it back with accumulated value of investment. 50e^{0.03(1/12)} – 44 (for example S_t=44) = 6.125

If stock price S_t \geq 45 you exercise the call to purchase the stock back. Payoff = 50e^{0.03(1/12)} – 45 = 5.125
If you exercise, you make \((50 - 45)e^{0.03/12}\) = $5.01 as of 3 months from now.

If you sell option, you make \(5.10e^{0.03/12}\) = $5.11

A third possibility: The option is under priced right now, relative to stock. So keep option and short stock.

<table>
<thead>
<tr>
<th>Transaction</th>
<th>CF Today</th>
<th>(If \ S_t &lt; 45)</th>
<th>(If \ S_t &gt; 45)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keep Option</td>
<td>0</td>
<td>0</td>
<td>(S_t - 45)</td>
</tr>
<tr>
<td>Short Stock</td>
<td>50</td>
<td>(-St)</td>
<td>(-St)</td>
</tr>
<tr>
<td>Invest Proceeds</td>
<td>-50</td>
<td>50.13</td>
<td>50.13</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td>50.13 - (S_t)</td>
<td>5.13</td>
</tr>
</tbody>
</table>

If \(S_t < 45\) then 50.13 - \(S_t\) > 50.13 - 45
= 5.13 > max \{5.01, 5.11\}

If \(S_t > 45\) then 5.13 > max \{5.01, 5.11\}

So third possibility always better.
QUESTION 24 – VERSION 7 OF 11

1 – Exercise the option now and invest
\[ 50 - 45 \times e^{0.03/12} = 5.013 \] – payoff in one month

2 – Sell the option and invest
\[ 5.10 \times e^{0.03/12} = 5.113 \]

3 – Short the stock invest $50 for one month

In 1 month, the payoff with be \[ 50 \times e^{0.03/12} \]

<table>
<thead>
<tr>
<th>Stock</th>
<th>Option</th>
<th>Total Payoff</th>
</tr>
</thead>
<tbody>
<tr>
<td>(-S_t)</td>
<td>(S_t - 45)</td>
<td>(S_t &lt; 45)</td>
</tr>
<tr>
<td>(-45)</td>
<td>0</td>
<td>(S_t = 45)</td>
</tr>
<tr>
<td>(-S_t)</td>
<td>0</td>
<td>(S_t &gt; 45)</td>
</tr>
</tbody>
</table>

The total payoff will be at least \[ 50e^{0.03/12} - 45 = 5.125 \], greater than strategies 1 and 2.
QUESTION 24 - VERSION 8 OF 11

Profit from Friend 1: exercise and sell = \(-45 + 50 = $5\)

Friend 2: sell option = 5.100

You can short the stock and invest in it if the price falls but is above the strike price, exercise the option then fulfill your shorting obligation. Otherwise purchase stock at \(S_t\) and sell it back.

<table>
<thead>
<tr>
<th></th>
<th>(T_0)</th>
<th>(S_t &gt; 45)</th>
<th>(S_t \leq 45)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Stock</td>
<td>50</td>
<td>(-S_t)</td>
<td>(-S_t)</td>
</tr>
<tr>
<td>Invest</td>
<td>-50</td>
<td>50e(^{0.03/12}) = 50.12515</td>
<td>50.12515</td>
</tr>
<tr>
<td>Call option</td>
<td>-45 + (S_t)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>5.12515</td>
<td>50.12515 - (S_t)</td>
</tr>
</tbody>
</table>

\(S_t < 45\) then at least \(50.12515 - 45 = 5.12515\)

PV of 5.12515 = 5.12515e\(^{0.03/12}\) = 5.1124

Which is greater than both friend 1 (5) and friend 2 (5.1)
QUESTION 24 – VERSION 9 OF 11

Assuming no transaction costs:

Exercise option and sell stock gives 50 – 45 = 5 \( 5e^{0.03/12} = 5.0125 \)

Sell option gives current price of 5.10 = 5.10 \( 5.10e^{0.03/12} = 5.1128 \)

Other option: short sell the stock and invest the proceeds for one month

- proceeds of $50 grows to 50e^{0.03/12} = 50.1252
- if the stock goes up in value or stays above $45, exercise the call for $45 and close out the short sale. Net proceeds = 50.13 – 45 = 5.13
- if the stock goes down in value below $45 the call expires unused. Buy the stock (to close the short sale) at \( S_t \) and make 50.13 – \( S_t \) > 5.13, since \( S_t > 45 \).
QUESTION 24 – VERSION 10 OF 11

\[ C = S_0 N(d_1) - K e^{-rt} N(d_2) \]

Option 1 – exercising the option and selling the stock
Profit = 50 – 45 = $5 at time 0

Option 2 – selling the option
Profit = $5.10

Option 3 – retain the option and sell the stock short

At time 1.

- If price of stock ≤ 45 (call expires unexercised, buy stock in market)
  - Profit at time 0 = \((50 - S_t) + 50(e^{0.03/12} - 1)e^{-rt} = (50.13 - S_t)e^{0.03/12} \)

- If price ≥ 45 (exercise call and give stock back)
  - Profit at t = 0 = \((S_t - 45) + (50 - S_t) + 50e^{0.03/12} - 1))e^{-0.03/12} = (5.1255)e^{0.03/12} = 5.11 > 5.10 \)

In both cases, profit is greater than under the previous two options.
With the put call parity
\[ C + Ke^{rt} = p + S_0 \]

1\(^{st}\) Friend suggestion: exercise option and sell stock
profit = \(-45 + 50 = 5\) (-strike price + stock price)

2\(^{nd}\) friend suggestion: sell the option
profit = 5.10 (price of the option)

More profitable solution
Short the share
Not needed since keep your call option and invest in risk free asset.

From put call parity, calculate the value of the put.
\[ 5.10 + 45e^{-0.03/12} = p + 50 \]
\[ p = 0 \] (put has no value)

If you short the stock, you obtain 50 which accumulates to \(50e^{0.03/12} = 50.125\)

If after 1 month the stock price is \(\leq 45\) you buy a share and close out the short position.
Profit \(\geq 50.125 - 45 = 5.125\) or PV(profit) \(\geq 5.125e^{-0.03/12} = 5.11\)

If stock price \(> 45\) you exercise the call and close out the short position
PV(profit) = \((50.125 - 45)e^{-0.03/12} = 5.11\)

Profit is at least 5.11, which is better than 5 or 5.103.
QUESTION 25 – VERSION 1 OF 3

- $K = 95$
- $S = 100$
- $t = 2$
- $p = 75$
- $r = .05$ assume continuous

$\mu = 110/100 = 1.1$

$d = 90/100 = 0.9$

$p = \{e^{rt} - d / \mu - d\} = (e^{.05(1)} - .9 )/ (1.1 -.9) = 0.151 / 0.2 = 0.756$

$1 - p = .244$ European no early exercise.

$f_\mu = e^{-0.05(1)} [26(.756) + 4(.244)] = 19.633$

$f_d = e^{-0.05(1)}[4(.756) + 0] = 2.878$

$f = e^{-0.05(1)} [19.633(.756) + 2.878(.244)] = 14.792$

Assuming didn’t need put info.

If wanted to determine real rate $r$ instead of risk neutral rate, could have solved for real rate and used in call calculation.
QUESTION 25 – VERSION 2 OF 3

Using put call parity

\[ C + Ke^{-rt} = S_0 + p \]

\[ C + 95e^{-0.05(2)} = 100 + .75 \]

\[ C = 14.79 \]

This can also be done by using the binomial tree method and the info given.
QUESTION 25 – VERSION 3 OF 3

Let $p =$ put stock increase (risk neutral)

$q = 1 – p =$ put stock decrease (risk neutral)

$0.75 = q^2 (95-81) e^{-0.05(2)}$

$q = .2433$

$p = 1 – q = .7567$

call = $[(121 – 95)(.7567)^2+(99-95)(.7577)(.2433)(2)]e^{-0.05(2)} = $14.80
QUESTION 26

Part A

x-axis is the final price and y-axis is profit

<table>
<thead>
<tr>
<th>Final Price</th>
<th>Price of call</th>
<th>Price of put</th>
<th>Call payout</th>
<th>Put payout</th>
<th>Profit (sum of previous four columns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>-10</td>
<td>-3</td>
</tr>
<tr>
<td>45</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>-5</td>
<td>2</td>
</tr>
<tr>
<td>50</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>55</td>
<td>4</td>
<td>3</td>
<td>-5</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>60</td>
<td>4</td>
<td>3</td>
<td>-10</td>
<td>0</td>
<td>-3</td>
</tr>
<tr>
<td>0</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>-50</td>
<td>-43</td>
</tr>
<tr>
<td>100</td>
<td>4</td>
<td>3</td>
<td>-50</td>
<td>0</td>
<td>-43</td>
</tr>
</tbody>
</table>

Assume that “profit” includes the income from writing the call and put, and that it wasn’t reinvested.

Part B

Only if they didn’t think that the underlying stock prices were going to change much.

Part C

A butterfly spread which would consist of the following positions:
1 – buy a call with strike price = 43
2 – buy a call with strike price = 57
3 – sell 2 calls with strike price = 50
All with same expiration date.
QUESTION 27

Part A

- \( t = 2 \)
- \( FV = 100 \)
- \( \sigma = .3 \)
- coupon = \( .05(100) = 5 \) putable at 100 at \( t = 1 \)
- \( r_0 = .025 \)
- \( r_1 = .03 \)
- \( r_h = .03e^{2(3)} = .0547 \)

Tree:

\[
\begin{array}{c}
\text{.025} \\
\text{.0547} \\
\text{.03}
\end{array}
\]

\( t = 0 \)

103.368 (derived later)

\( t = 1 \)

105/1.0547 = 99.558 < 100 putable

\[
\begin{align*}
&v = 100 \\
&c = 5 \\
&105/1.03 = 101.942 \text{ (this is } V_H) \\
\end{align*}
\]

\( t = 2 \)

\[
\begin{align*}
&v = 100 \\
&c = 5 \\
&v = 100 \text{ (this is } V_L) \\
\end{align*}
\]

\[
V_0 = (100 + 5)(.5) + (101.942+5)(.5) / 1.025 = 103.386
\]

Part B

If not putable...

\[
V_0 = (99.558 + 5)(.5) + (101.942 + 5)(.5) / 1.025 = 103.171
\]

Value = 103.386 – 103.171 = .2154
QUESTION 28

Part A

- Can only short sell stocks after uptick. (stock price rise)
- Must post collateral which may not earn interest or competitive interest.

Part B

Uptick rule doesn’t apply to options. No collateral necessary as you don’t need to have the option to sell it short.
**QUESTION 29**

\[ C = N(d_1)S_0e^{-rf} - Ke^{-rt}N(d_2) \]

- \( r = 8\% \)
- \( r_f = 10\% \)
- \( \sigma = 15\% \)
- \( T = 1 \)
- \( K = 1.45 \)
- \( S_0 = 1.50 \)

\[ d_1 = \ln(S/K) + (r - r_f + \sigma^2/2)T / \sigma \sqrt{T} \]

\[ d_1 = \ln(1.5/1.45) + (.08 - .1 + .15^2/2)1 / .15 \sqrt{1} = 0.1677 \]

\[ d_2 = d_1 - \sigma \sqrt{T} = 0.1677 - 0.15 \sqrt{1} = 0.0177 \]

\[ N(d_1) = .5636 + .77(.5675-.5636) = .5666 \]

\[ N(d_2) = .5040 + .77(.508-.504) = .5071 \]

\[ C = .5666(1.5)e^{-1(1)} - 1.45(1.5071)e^{-0.08(1)} = 0.0903 \]
0.8 pound/dollar = 1.25 dollars/pound

0.75 pound/dollar = 1.33 dollars/pound

\[ F = Se^{(r-rt)T} \]

\[ 1.25 = 1.33e^{(r-.09)} \]

\[ 0.9375 = e^{r-.09} \]

\[ -.06454 = r-.09 \]

\[ r = 2.55\% \]

The investor locked in at 2.55\%
One year ago

\[ F_0 = 0.80 \text{ pound/dollar} = 1.25 \text{ dollar/pound} \]

\[ E_0 = 0.75 \text{ pound/dollar} = 1.33 \text{ dollar/pound} \]

\[ r_f = 0.09 \]

\[ 1 + r_{us} = (1 + r_{uk}) \frac{F_0}{E_0} \]

\[ = (1.09) \frac{1.25}{1.33} = 1.021875 \]

\[ r_{us} = 2.1875\% \]
**QUESTION 31**

Part A

<table>
<thead>
<tr>
<th></th>
<th>32.5</th>
<th>32.5</th>
<th>32.5</th>
<th>1032.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.5</td>
<td>1</td>
<td>1.5</td>
<td>2</td>
</tr>
<tr>
<td>time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

yt人 = \(0.055\)

\(y/2 = 0.0275\)

\[D = \frac{\left(\frac{32.5}{1.0275} \times 0.5 + \frac{32.5}{1.0275^2} \times 1 + \frac{32.5}{1.0275^3} \times 1.5 + \frac{1032.5}{1.0275^4} \times 2\right)}{\left(\frac{32.5}{1.0275} + \frac{32.5}{1.0275^2} + \frac{32.5}{1.0275^3} + \frac{1032.5}{1.0275^4}\right)}\]

= \frac{1944.19}{31.63 + 30.78 + 29.95 + 926.32}

= 1.909

Part B

Mod dur \(D^* = \frac{D}{1 + y}\)

= \frac{1.909}{1.055}

= 1.809
**QUESTION 32**

Criterion 1: Present value of liability less or equal present value of assets.

A – PV (Liability) = \(14500/1.05^3 = 12525.64\)

B – PV (Assets) = Price of Bond = \(\sum CF_t/(1+y)^t = 12537.85\)

Criterion 1 is met.

Criterion 2: Duration of liability equals duration of assets.

A – Duration liability similar to zero coupon = 3

B – Duration of assets – \((1 + y)/y – [(1 + y) + t(c – y)]/[C[(1 + y)^t – 1] + y]\)
= \(1.05/.05 – [1.05 + 6(.1 - .05)]/[.1[(1.05)^6 – 1] + .05]\)
= 4.9 years

Since asset is longer than liability it is more sensitive to interest rate increase. Therefore the obligation is not perfectly immunized.
**QUESTION 33**

Portfolios…

X: options on stock X
- \( = 1000 \)
- \( P_x = 100 \)
- \( \sigma_{\text{Day}} = 2\% \)

Y: 2000 shares
- \( P_y = 200 \)
- \( \sigma_{\text{day}} = 1\% \)
- \( \rho_{xy} = .2 \)

95% from normal table = 1.645

\[
\sigma_p^2 = \alpha_x^2 \sigma_x^2 + \alpha_y^2 \sigma_y^2 + 2 \rho \alpha_x \alpha_y \sigma_x \sigma_y
\]

\[
\sigma_p = \sqrt{(s\Delta)^2 \sigma_x^2 + (S_y)^2 (P_y)^2 \sigma_y^2 + 2 \rho (S\Delta)(S_y P_y) \sigma_x \sigma_y}
\]

\[
= \sqrt{(1000)^2(100)^2(.02)^2 + (2000)^2(200)^2(.01)^2 + 2(.2)(1000)(100)(2000)(200)(.01)(.02))}
\]

\[
= \sqrt{4M + 16M + 3.2M} = \sqrt{23.2M}
\]

\[
= 4,816.64
\]

95% 10 day var = 1.645sq(10) (4816.64)

\[
= 25,055.89
\]
QUESTION 34

1 – *Downgrade Triggers*: Limitation is that these are only effective if not used that much. They provide that a contract can be closed out of a counter party’s credit rating balls below a certain level. But if the counterparty defaults and has several contracts that have downgrade triggers they may not be able to close out all of their contracts.

2 – *Collateralization*: Companies must post collateral to their counterparty once their debt exceeds a certain amt. A problem with this is that the amt is not protected and if a company defaults then the counterparty may not be able to collect.
Delta₀ = .791 – 1 = -.209

d₁ = .810 = \ln(50/K) + (.04 + .25²/2)(4/12)
\quad + .25 \times \sqrt{4/12}

.1169 = \ln(50/K) + (.04 + .25²/2)(4/12)

K = 45.5522

d₁’ = \frac{[\ln(51/45.5522) + (.04 + .25²/2)(4/12)]}{.25 \times \sqrt{4/12}}

= .9472

N(d₁’) = .828199 = Δ₁ + 1

Δ₁ = -.171801

Δ₁ – Δ₀ = 0.037199

(Δ₁ – Δ₀)/Δ₀ = -.177986
QUESTION 35 – VERSION 2 OF 2

Gamma(put) = \frac{N'(d_1)}{S_0 \sigma \sqrt{T}} = \frac{.287}{[(50)(.25)(\sqrt{4/12})]} = .03977

Change in Delta = Gamma \times \text{change in price}

= (.03977)(1) = .03977

because gamma represents the sensitivity of delta to a change in asset price.
QUESTION 36

Part A

Cash flow risk measures the risk attributable to cash flow streams over the course of the year. This generally requires the use of stimulation techniques and DFA. The advantage is the use of non-normal distributions and the ability to draw distributions regarding cash flows with more confidence in the long term.

Part B

Shortfall risk (SR) tells the probability of exceeding a target loss in the risk horizon. It has the following advantages over Var: 1) It takes account of severity of ruin; 2) the target loss is a real concern but the target level in Var (99%) is an arbitrage level.
QUESTION 37

Part A

1 – Bankruptcy (distress) costs – these can be either direct (legal fees, etc) or indirect (underinvestment problem)

2 – Taxation – volatile earnings reduce after tax net income due to the convexity of the taxation structure.

Part B

1 – When cash flow variability stabilizes, the firm will most likely be less susceptible to the risk of bankruptcy. If the firm is less distressed this should help them avoid the underinvestment problem of having difficulty issuing new debt.

2 – Reductions of cash flow variability should result in smoother earnings and thus increase after tax net income.
**QUESTION 38**

\[ EVA_i = \text{Net Income}_i - r_i \times C_i \]

\[ EVA_a = 1100 - .10(10000) = 100 \]

\[ EVA_b = 400 - .12(4000) = -80 \]

Want EVA to be \( \geq 0 \) so line A is creating value while line B is actually reducing firm value.
**QUESTION 39**

**Part A**

EPD ratio = 0.02 = EPD / E(L)

\[ E(L) = 5000(.7) + 10,000(.2) + 60,000(.1) = 11500 \]

EPD = 11,500 x .02 = 230

\[ 230 = .10(60,000 – A) \]

\[ A = 57,700 \]

\[ C = A – E(L) = 57700 – 11500 = 46,200 \]

**Part B**

<table>
<thead>
<tr>
<th>Incurred Loss</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>5K + 5K = 10K</td>
<td>.49</td>
</tr>
<tr>
<td>5K + 10K = 15K</td>
<td>.14 x 2 = .28</td>
</tr>
<tr>
<td>5K + 60K = 65K</td>
<td>.07 x 2 = .14</td>
</tr>
<tr>
<td>10K + 10K = 20K</td>
<td>.04</td>
</tr>
<tr>
<td>10K + 60K = 70K</td>
<td>.02 x 2 = .04</td>
</tr>
<tr>
<td>60K + 60K = 120K</td>
<td>.01</td>
</tr>
</tbody>
</table>

E(L) = 23K

50% quota share \( \Rightarrow \) \( E(L) = (23K)(.5) = 11,500 \)

EPD/E(L) = .02 \( \Rightarrow \) EPD = .02(11,500) = 230

\[ 230 = .01(60,000 – A) \]

\[ A = 37,000 \]

\[ C = A – E(L) = 37000 – 11500 = 25,500 \]

Reduction in capital = 46,200 – 25,500 = 20,700

**Part C**

Expected loss doesn’t change but since it is unlikely that both risks will have a worst-case loss, capital requirements are reduced. Essentially, the company is diversifying its risks (the insurance principle).
QUESTION 40 – VERSION 1 OF 2

- ROE = .2
- k = .1
- b = .3
- Present time t = 1

Part A

g = b x ROE - .3 x .2 = .06

D_4 = 30 x (1.06) = 31.8

Terminal value @ t = 3: 31.8 / (.1 - .06) = 795

PV of terminal value: 795(1.1)^-2 = 657 at t = 1

Part B

All total future dividends

PV @ t = 1

25(1.1)^1 + 30(1.1)^2 + 657

=704.52
QUESTION 40 – VERSION 2 OF 2

\[ g = b \cdot \text{ROE} = (.3)(.2) = .06 \]

\[(\text{DIV}_3)(1.06)/(k-g) = \text{Terminal value of dividends}\]

\[ k = \text{annual discount rate} \text{ give } = 10\% \]

\[ = 30(1.06)/(.10-.06) \]

\[ = 795 \]

\[ \text{PV at time 0 of terminal value} = 795/(1+k)^3 \]

\[ = 795(1.1)^3 \]

\[ = 597.30 \text{ (rounded)} \]

**Part B**

Assume we’re at time = 0. No dividend was given for year = 1

\[ \text{PV(expected dividends)} = 25/(1.1)^2 + 30/(1.1)^3 = 43.20 \]

So present value of future dividends = 597.30 + 43.20 = 640.50
QUESTION 41

Part A

\[ \text{value} = BV_0 + \sum AE_t/(1+k)^T \]

\[ k = 0.0438 + .84(.055) = .09 \]

Abnormal earnings

\[ AE_1 = 10,100 - 100,000 \times .09 = 1,100 \]
\[ AE_2 = 10,600 - 105,000 \times .09 = 1,150 \]
\[ AE_3 = 11,073 - 109,700 \times .09 = 1,200 \]

*Constant abnormal earning in perpetuity is assumed to mean that AE will grow at a rate of 0 and stay at 1,200 forever.

Value = 10,000 + \[ \frac{1,100}{1.09} + \frac{1,150}{(1.09)^2} + \frac{1,200}{(1.09)^3} \] + \[ \frac{1,200}{.09}/(1.09)^3 \]
= 113,199.51

Part B

They will decrease by \[ 1/4 = .25 \]

\[ AE_4 = 900 \]
\[ AE_5 = 600 \]
\[ AE_6 = 300 \]

Value = 100,000 + \[ \frac{1,100}{1.09} + \frac{1,150}{(1.09)^2} + \frac{1,200}{(1.09)^3} + \frac{900}{(1.09)^4} + \frac{600}{(1.09)^5} \]
+ \[ \frac{300}{(1.09)^6} \]
= 104,110.15

Part C

As competition arrives, it is more and more difficult to make consistent abnormal earning each year. This becomes truer as time passes, so it doesn’t make sense to assume that a firm will have perpetual abnormal earnings.