Exam 8
Investments and Financial Analysis

May 5, 2005

INSTRUCTIONS TO CANDIDATES

1. This 80 point examination consists of 45 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.

2. Attached to the examination, after question 45, 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. 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.

CONTINUE TO NEXT PAGE OF INSTRUCTIONS

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5. At the beginning of the examination, check through the exam booklet for any missing or defective pages. The supervisor has additional exams for those candidates who have defective exam booklets.

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 to the CAS Office by May 31, 2005.

END OF INSTRUCTIONS
1. (1 point)

   a. (0.5 point)
      
      Describe, in words, the Fisher equation.

   b. (0.5 point)
      
      Describe why Fisher’s hypothesis is difficult to validate.

2. (1.5 points)

   You are given the following information regarding stocks included in a market index.

<table>
<thead>
<tr>
<th>Stock</th>
<th>Initial Price</th>
<th>Final Price</th>
<th>Shares</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$50</td>
<td>$75</td>
<td>30</td>
</tr>
<tr>
<td>B</td>
<td>$26</td>
<td>$13</td>
<td>150</td>
</tr>
<tr>
<td>C</td>
<td>$80</td>
<td>$80</td>
<td>75</td>
</tr>
</tbody>
</table>

   There are no dividends or stock splits.

   a. (0.5 point)
      
      Based on the price-weighted average, calculate the percentage change in the value of the index.

   b. (0.5 point)
      
      Based on the value-weighted average, calculate the percentage change in the value of the index.

   c. (0.5 point)
      
      Explain the reason for the difference between your answers in parts a. and b. above.

SHOW ALL WORK.

CONTINUED ON NEXT PAGE
3. (1 point)

A U.S. investor purchased British stocks for £1,000 one year ago when the British pound cost U.S. $1.70. The value of the stocks is now £1,080 and the pound is worth $1.85.

No dividends were paid during this period.

a. (0.5 point)

Calculate the total rate of return (based on U.S. dollars).

b. (0.25 point)

Calculate the number of pounds the investor could have sold forward one year ago to fully hedge exchange rate risk.

c. (0.25 point)

Briefly explain why you could not set up a perfect hedge in this case.

SHOW ALL WORK.
4. (1.75 points)

You are given the following information.

<table>
<thead>
<tr>
<th>Investment</th>
<th>Expected Return</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12%</td>
<td>20%</td>
</tr>
<tr>
<td>2</td>
<td>15%</td>
<td>30%</td>
</tr>
<tr>
<td>3</td>
<td>20%</td>
<td>40%</td>
</tr>
</tbody>
</table>

Your utility formula is represented by $U = E(r) - 0.003A\sigma^2$.

a. (0.5 point)

Briefly explain which of the three investments a risk-neutral investor would select.

b. (0.5 point)

Identify which investment an investor with the utility function shown above and $A=2$ would select.

c. (0.75 point)

Calculate the certainty equivalent of the investment selected in part b. above.

SHOW ALL WORK.
5. (3 points)

You are given the following information about two risky assets and a risk-free asset.

<table>
<thead>
<tr>
<th>Asset</th>
<th>Expected Return</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>15%</td>
<td>20%</td>
</tr>
<tr>
<td>B</td>
<td>20%</td>
<td>15%</td>
</tr>
<tr>
<td>Risk-free</td>
<td>5%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Short sales are not allowed.

a. (2 points)

Calculate the standard deviation of the optimal risky portfolio if the correlation coefficient is 0.1.

SHOW ALL WORK.

b. (0.5 point)

What is the standard deviation of the optimal risky portfolio if the correlation coefficient is -1?

c. (0.5 point)

What is the standard deviation of the optimal risky portfolio if the correlation coefficient is 1?
6. (1 point)

You are given the following information about stocks and gold.

<table>
<thead>
<tr>
<th>Asset</th>
<th>Expected Return</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stocks</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>Gold</td>
<td>10%</td>
<td>30%</td>
</tr>
</tbody>
</table>

Demonstrate graphically why an investor would choose to hold gold, in light of the apparent inferiority of gold with respect to expected return and volatility.

Be sure to completely and clearly label all information on the graph.

7. (1 point)

Evaluate whether the following situations are possible and explain your response.

Assume the simple Capital Asset Pricing Model is valid in both situations.

Consider parts a. and b. below independently.

a. (0.5 point)

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>Expected Return</th>
<th>Beta</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>18%</td>
<td>1.4</td>
</tr>
<tr>
<td>Y</td>
<td>20%</td>
<td>1.2</td>
</tr>
</tbody>
</table>

b. (0.5 point)

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>Expected Return</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>20%</td>
<td>40</td>
</tr>
<tr>
<td>Y</td>
<td>30%</td>
<td>30</td>
</tr>
</tbody>
</table>
8. (2 points)

You are given the following information about quarterly returns.

<table>
<thead>
<tr>
<th>Quarter Ending</th>
<th>Quarterly Stock X Return</th>
<th>Quarterly Market Return</th>
<th>Quarterly T-Bill Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td>-6.0%</td>
<td>0.0%</td>
<td>1.0%</td>
</tr>
<tr>
<td>June</td>
<td>1.0%</td>
<td>2.0%</td>
<td>1.0%</td>
</tr>
<tr>
<td>September</td>
<td>-4.0%</td>
<td>-1.0%</td>
<td>1.0%</td>
</tr>
<tr>
<td>December</td>
<td>5.0%</td>
<td>3.0%</td>
<td>1.0%</td>
</tr>
</tbody>
</table>

Using the single-index model, calculate the estimated beta for Stock X.

SHOW ALL WORK.

9. (1 point)

a. (0.5 point)

Define illiquidity premium.

b. (0.5 point)

Calculate the illiquidity premium for Stock A based on the information below.

- Risk-free rate of return \( (r_f) = 3.0\% \)
- Expected return on market portfolio, \( E(r_m) = 6.0\% \)
- \( E(r_A) = 10.0\% \)
- \( \beta_A = 1.5 \)

SHOW ALL WORK.
10. (2 points)

Briefly discuss four elements of Roll's critique of the Capital Asset Pricing Model.

11. (1.5 points)

a. (0.5 point)

Briefly describe the equity premium puzzle.

b. (1 point)

Briefly discuss two possible explanations for the equity premium puzzle.

12. (1 point)

You are given the following information.

<table>
<thead>
<tr>
<th>Stock</th>
<th>Expected Return</th>
<th>Covariance of Stock with Market</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5%</td>
<td>25.00</td>
</tr>
<tr>
<td>B</td>
<td>14%</td>
<td>156.25</td>
</tr>
</tbody>
</table>

- Risk-free rate of return \( (r_f) = 3\% \)
- Expected return on market portfolio, \( E(r_M) = 6\% \)

Calculate the change in the expected return on Stock B that would bring Stock B into equilibrium with Stock A. Assume the information above with respect to Stock A does not vary with changes in the expected return on Stock B.

SHOW ALL WORK.
13. (2.5 points)

You are given the following information about a collateralized mortgage obligation.

<table>
<thead>
<tr>
<th>Bond Class</th>
<th>Outstanding Par Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class A</td>
<td>$600,000</td>
</tr>
<tr>
<td>Class B</td>
<td>$900,000</td>
</tr>
<tr>
<td>Class C</td>
<td>$750,000</td>
</tr>
</tbody>
</table>

During a given month, the pool of mortgages had:

- Interest payments of $150,000
- Scheduled principal payments of $350,000
- Prepayments of $400,000

Calculate the total cash flows during the month for each of the three classes of bonds for this collateralized mortgage obligation.

SHOW ALL WORK.

14. (1 point)

Briefly explain the liquidity preference theory and its effect on the term structure of interest rates.
15. (1 point)

You are given the following corporate bond information from the *Wall Street Journal*.

<table>
<thead>
<tr>
<th>COMPANY</th>
<th>COUPON</th>
<th>MATURITY</th>
<th>LAST PRICE</th>
<th>LAST YIELD</th>
<th>EST SPREAD</th>
<th>UST</th>
<th>EST $ VOL (000's)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM</td>
<td>8.375</td>
<td>July 15, 2033</td>
<td>94.229</td>
<td>8.929</td>
<td>368</td>
<td>30</td>
<td>138,007</td>
</tr>
<tr>
<td>B</td>
<td>5.700</td>
<td>May 15, 2013</td>
<td>95.615</td>
<td>6.306</td>
<td>199</td>
<td>10</td>
<td>131,245</td>
</tr>
<tr>
<td>DES</td>
<td>2.125</td>
<td>Apr 15, 2023</td>
<td>104.590</td>
<td>1.117</td>
<td>n.a.</td>
<td>n.a</td>
<td>95,518</td>
</tr>
<tr>
<td>GWBC</td>
<td>8.000</td>
<td>Aug 01, 2031</td>
<td>92.866</td>
<td>8.679</td>
<td>342</td>
<td>30</td>
<td>50,355</td>
</tr>
</tbody>
</table>

- Assume the par value on all bonds is $1,000 and coupons are paid semi-annually.
- All prices are quoted as of August 5, 2005.

a. (0.5 point)

Calculate what would be paid for a GWBC bond on August 5, 2005.

b. (0.5 point)

Explain what the column labeled “Est Spread” measures.

SHOW ALL WORK.

16. (1 point)

Assume that the ratio of Current Assets over Current Liabilities is added as a new variable to Altman’s Z equation.

Briefly explain whether this variable should receive a positive or negative coefficient in Altman’s Z equation.
17. (2 points)

You are given the following information for yields on three different bonds of varying maturity.

<table>
<thead>
<tr>
<th>Maturity Year</th>
<th>Risk-free Zero Rates</th>
<th>Corporate Bond Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6%</td>
<td>6.3%</td>
</tr>
<tr>
<td>2</td>
<td>6%</td>
<td>6.6%</td>
</tr>
<tr>
<td>3</td>
<td>6%</td>
<td>6.8%</td>
</tr>
</tbody>
</table>

Assume no recovery on default.

a. (1.5 points)

Calculate the default probability in year 2.

b. (0.5 point)

Calculate the hazard rate for year 2.

SHOW ALL WORK.

18. (1 point)

Assume there are three bonds that have identical times to maturity, par values, and coupon rates. Bond A is callable at 102, Bond B is callable at 106, and Bond C is not callable.

List the three bonds in order of yield-to-maturity (from highest to lowest), and briefly explain the reason for the order.
19. (2 points)

In general terms, explain how Merton's model, in conjunction with Ito's Lemma and the Black-Scholes formula, can be used to determine the value of a company's assets, the volatility of a company's assets, and the probability of default for the company.

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20. (1.5 points)

At the beginning of the year, an investor buys a zero-coupon bond for $400 with a par value of $1,000 and 10 years until maturity.

This investor's tax rate on interest income is 35% and on capital gains is 20%.

During the year, while the investor holds the bond, the yield-to-maturity changes to 8.0%.

a. (1 point)

Determine the investor's after-tax return on the bond if sold at the end of the year.

b. (0.5 point)

Calculate how much tax the investor owes at the end of the year if the bond is not sold.

SHOW ALL WORK.
21. (2.5 points)

Consider a one-year long forward contract on a bond. This bond matures in 5 years and has a 7% coupon rate, with coupons paid semi-annually. The current price of the bond is $850.

Assume the six-month and one-year continuously compounded risk-free interest rates are equal to 10%.

a. (1 point)

Calculate the arbitrage-free price of this contract.

b. (1.5 points)

Assume the current forward price on this bond is $875. Describe the actions an investor would take to make an arbitrage profit.

SHOW ALL WORK.

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22. (1.5 points)

An investor contacts her broker to enter into five long futures contracts on bushels of corn.

- Each contract is for the delivery of 5,000 bushels.
- The current futures price is $2.40 per bushel.
- The initial margin is $2,000 per contract.
- The maintenance margin is $1,500 per contract.

a. (0.5 point)

Describe the purpose of a margin associated with futures transactions.

b. (0.5 point)

Calculate the price change that would lead to a margin call.

c. (0.5 point)

Calculate the futures price of corn at which the investor could withdraw $2,000 from the margin account.

SHOW ALL WORK.
23. (2 points)

A bank offers a corporate client a choice between borrowing cash at 10% per annum and borrowing platinum at 2.5% per annum. If platinum is borrowed, interest must be repaid in platinum. Thus 100 ounces borrowed today would require 102.5 ounces to be repaid in one year.

The risk-free interest rate is 7% per annum, and storage costs for platinum are 0.4% per annum.

Assume the following:

- The interest rates on the two loans are expressed with annual compounding.
- The risk-free interest rate and storage costs are expressed with continuous compounding.
- There is no income earned on platinum.
- There are no transaction costs for trading.
- The market participants can borrow money at the same risk-free rate of interest at which they can lend money.

Determine whether the rate of interest on the platinum loan is too high or too low in relation to the rate of interest on the cash loan. Round all calculations to 3 decimal places (x.xxx).

SHOW ALL WORK.

24. (2 points)

Consider an 8% coupon bond with 18 years and five months to maturity and the following information.

- The face value of the bond is $100 and coupon payments are made semi-annually.
- The discount rate is 6% per annum with semi-annual compounding.

\[ \sum_{i=1}^{36} \frac{1}{1.03^i} = 21.83 \]

Calculate the conversion factor.

SHOW ALL WORK.
25. (2 points)

ABC Insurance Company has entered into a 10-year currency swap with XYZ Insurance Company.

Under the terms of the swap, ABC receives interest at 4% per annum in Swiss francs and pays interest at 8% per annum in U.S. dollars. Interest payments are exchanged once per year. The principal amounts are 10 million dollars and 13 million francs.

Suppose that XYZ declares bankruptcy at the end of year 7, right before the swap payment is to be made. The exchange rate at the end of year 7 is $0.80 per franc.

Assume that forward rates are realized and, at the end of year 7, the interest rate is 4% per annum in Swiss francs and 9% per annum in U.S. dollars for all maturities.

All interest rates are quoted with annual compounding.

Calculate the cost to ABC at the end of year 7 due to XYZ’s bankruptcy.

SHOW ALL WORK.

26. (3 points)

A stock price is governed by a geometric Brownian motion model with the following parameters:

- Current stock price = $54.60
- Volatility = 70.71% per annum
- Expected return = 15.00% per annum

The stock pays no dividends, and there are no transaction costs when it is bought or sold.

Calculate the probability that a two-year European call option purchased today with a strike price of $75.00 will be exercised.

SHOW ALL WORK.
27. (2 points)

A two-year bond is putable at 100% of par at the end of year one. The bond has a face value of $100.00 and pays a 6.00% coupon at the end of each year.

The current one-year spot rate is 5.95%, compounded annually. One year from now, the one-year spot rate will be either 4.87% or 7.27%, with equal probability.

Calculate the value of the bond.

SHOW ALL WORK.

28. (1 point)

Consider a stock whose current value is $S_0$. At the end of a period $T$, the stock will either move up to a value of $S_{0u}$ or down to a value of $S_{0d}$.

Let $p$ be the probability of the upward movement in the stock price, and let $r$ be the risk-free rate with continuous compounding.

Using the principle of risk-neutral valuation, derive the formula for $p$.

SHOW ALL WORK.
29. (1.5 points)

You own one share of stock and conduct the following transactions.

- You buy one put with strike price of $20, that costs $2.50.
- You sell one call with strike price of $40, that sells for $1.50.

Draw the payoff diagram that results from these transactions. Be sure to completely and clearly label all information on the graph.

30. (2 points)

Explain how the following two methods are used to calculate the volatility of a stock.

a. (1 point)

   Estimating volatility from historical data

b. (1 point)

   Calculating implied volatilities
31. (4.5 points)

An investor is very bullish about the stock market but does not want to take too much risk.

He decides to buy four American call options on one particular stock. Each option is for 100 shares with exercise price at $65 per share and maturity of 8 months.

He is told that the expected return from the stock is 20% per annum and the volatility of the stock is about 30% per annum. The current stock price is $61. The risk-free interest rate is 6% per annum.

a. (2 points)

Calculate the price of one call option. Assume the stock does not pay dividends before maturity of the option.

b. (2.5 points)

He is told that the stock pays a quarterly dividend of $1 in 3 months and 6 months. Determine whether it would be more profitable to exercise the options early.

SHOW ALL WORK.

32. (1 point)

Briefly explain why the solution to the Black-Scholes-Merton differential equation obtained in a risk-neutral world is also valid in a risk-averse world.
33. (1.5 points)

Briefly discuss how the following methods diminish the accounting effect of restructuring an asset portfolio.

a. (0.5 point)
   Interest rate swaps

b. (0.5 point)
   Issuing puts

c. (0.5 point)
   Swaps of assets

34. (2.5 points)

Consider a $1,000 bond with a 6.0% coupon that matures in two years. Coupon payments are made semi-annually. The current yield-to-maturity is 5.0%.

a. (1 point)
   Calculate the modified duration of the bond.

b. (1 point)
   Calculate the convexity of the bond.

c. (0.5 point)
   Calculate the approximate percentage change in the price of the bond (using duration and convexity) if the yield-to-maturity decreases to 4.0%.

SHOW ALL WORK.
35. (2 points)
   
   a. (1 point)
   
   Identify the two elements of insurance securitization identified by Gorvett.
   
   b. (1 point)
   
   Explain whether or not reinsurance satisfies the requirements for each element identified in part a. above.
36. (4 points)

Assume you have purchased European put options for 100,000 shares of a non-dividend paying stock and you are given the following information.

- Price of stock = $49.16
- Strike price = $50.00
- Continuously compounded risk-free interest rate = 5% per annum
- Volatility = 20% per annum
- There are 20 weeks remaining until maturity.

a. (1.5 points)

Determine the initial position you should take in the underlying stock to implement a delta hedging strategy.

b. (2.5 points)

You now have the following information.

<table>
<thead>
<tr>
<th>T (weeks)</th>
<th>Stock Price</th>
<th>$d_1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$49.33</td>
<td>0.10</td>
</tr>
<tr>
<td>2</td>
<td>$49.09</td>
<td>0.05</td>
</tr>
</tbody>
</table>

You decide to readjust the delta hedging strategy on a weekly basis.

Calculate the cumulative cost, including interest, of the hedge at the end of week 2.

SHOW ALL WORK.
37. (2.25 points)

Consider an investment portfolio consisting of the following.

<table>
<thead>
<tr>
<th>Asset</th>
<th>Market Value</th>
<th>Daily Volatilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>$100,000</td>
<td>0.7%</td>
</tr>
<tr>
<td>Zinc</td>
<td>$400,000</td>
<td>0.2%</td>
</tr>
</tbody>
</table>

- The coefficient of correlation is 0.80.
- The 99% one-tailed Z-value is 2.33.

a. (1 point)

Calculate the 15-day, 99% value at risk (VaR) of the portfolio. Assume the change in portfolio value is normally distributed.

b. (1 point)

Calculate the impact of diversification on the portfolio VaR.

c. (0.25 point)

Suppose this portfolio also includes options and the gamma of this portfolio is 10. Without doing any calculations, state an alternative method one could use to estimate VaR.

SHOW ALL WORK.
38. (1 point)

Miller, Culp, and Neves, in the article "Value at Risk: Uses and Abuses," compare various methods of measuring financial risk.

a. (0.5 point)

Based on the article, describe the difference between VaR and shortfall risk.

b. (0.5 point)

Based on the article, briefly describe one advantage of shortfall risk over VaR.

39. (1 point)

Stulz argues that companies already in financial distress would receive the least benefit from implementing a financial risk management strategy.

Explain this argument.

40. (1.5 points)

Briefly explain how each of the following friction costs impacts a firm’s rate of return.

a. (0.5 point)

Agency and informational costs

b. (0.5 point)

Double taxation

c. (0.5 point)

Regulation
41. (1 point)

Two bases used to allocate capital are Risk-Based Capital (RBC) and Value at Risk (VaR).

Briefly discuss one advantage and one disadvantage of each of these two bases used to allocate capital.

42. (3 points)

You are given the following information for an insurance company.

- In present value terms, the company expects to earn $3,900 in premiums and to incur, in addition to losses, $1,170 in expenses in the next year.
- During the next year, the company expects to earn $179 investment income on the capital it holds.
- The company holds statutory surplus of $2,000 and carries $3,000 in reserves on an undiscounted basis.
- The company has $250 of unrealized capital gains on bonds.
- The company’s corporate tax rate is 34%.
- The company has a one-year target solvency standard of 95%.

Assume the company has losses uniformly distributed over the values $0 to $5,000 (in present value terms) and that this is the only risk that the company faces.

a. (1 point)

Calculate the company’s after-tax expected risk-adjusted return on capital (RAROC) and briefly explain whether the company should expect to add shareholder value through its activities given a 15% hurdle rate for the company.

b. (1 point)

Calculate the available equity capital and comment on its adequacy.

c. (1 point)

Nakada’s study of the U.S. property-casualty industry suggests that catastrophe risk is more of an issue for RAROC than it is for solvency. Briefly explain this statement in reference to catastrophe-prone lines of business such as commercial multi-peril and homeowners/farmowners.

SHOW ALL WORK.
43. (1.5 points)

You are given the following information for two companies in the same industry.

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a. (0.5 point)

Identify and briefly explain which company the market feels has more profitable growth opportunities.

b. (0.5 point)

Identify and briefly explain in which company a risk-taker would prefer to invest.

c. (0.5 point)

You recently learned that some accounting decisions have led to manipulations of the financial statements for these two companies. Identify and briefly explain what measure other than the price/earnings ratio you might use to compare these companies.
44. (3 points)

Company XYZ is an established firm with several profitable existing products as well as some promising new products in development.

- The company earned $2 per share in 2003, and paid out a dividend of $0.80 per share on December 31, 2003.

- The company plans to maintain its dividend payout ratio at 40%.

- ROE is 18% and this is expected to persist indefinitely.

- The required market rate of return is 15%.

a. (0.5 point)

Calculate the price of Company XYZ's stock as of January 1, 2004.

b. (2 points)

Suppose a competitor has developed a product that will eliminate Company XYZ's competitive market advantage. This new product will come to market on January 1, 2006, and will force Company XYZ to decrease ROE to 15% at that time to be competitive. As a result, Company XYZ will also reduce its plowback ratio to 40% at the end of 2005.

Calculate Company XYZ's intrinsic value per share. Assume no impact on the required market rate of return.

c. (0.5 point)

Suppose investors become aware of the competitor's plans for the new product in 2005. Briefly explain how this would affect the market price of Company XYZ's stock at that time.

SHOW ALL WORK.
45. (1 point)

As an actuary, you are conducting a going-concern valuation on a monoline carrier that writes homeowners property. The following information has been brought to your attention.

- The company uses total insured value as its exposure base, but its systems have not been accurately capturing changes in property values upon renewal.

- The claim department has gone through a fundamental change in its reserving practices, and the current management believes that in the past twelve months claim reserves have been brought to a level consistent with the rest of the industry.

- The investment philosophy of the company has shifted to a position of taking on significantly less risk and matching the maturities of its investments to its loss payment obligations.

The experience of the company is insufficient to use in this valuation.

As guided by the Casualty Actuarial Society, “Statement of Principles Regarding Property and Casualty Valuations,” provide an example of external data that may be used to supplement the company’s experience and briefly explain how it would be used.
# Tables of the Normal Distribution

## Probability Content from \(-\infty\) to \(Z\)

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Question 1:

1a. Fisher equation

The nominal interest rate equals the real interest rate plus expected inflation rate.

Fisher argues that holding the real rate constant, the nominal rate would increase 1 unit for each unit that expected inflation rate is increased.

1b. It is because the real interest rate is neither constant nor observable in time.
Question 2:

2a. Price weighted average\(_1\) = 50 + 26 + 80

Price weighted avg\(_2\) = 75 + 13 + 80

\[
\text{% change} = \frac{75 + 13 + 80}{50 + 26 + 80} - 1 = .0769
\]

2b. Value wtd avg\(_1\) = 50(30) + 26(150) + 80(75) = 11,400

Value wtd avg\(_2\) = 75(30) + 13(150) + 80(75) = 10,200

\[
\text{%Change} = \frac{10200}{11400} - 1 = -.1053
\]

2c. The price weighted average is influenced more heavily by the stocks w/ higher share prices and their rates of return are positive or zero. So overall is positive.

The value-weighted average is influenced by the market value holding each stock – have the most of the stock w/ lowest price, and it also had a negative rate of return. So overall is negative.
Question 3:

3a. £1,000 = $1,700 @ $1.70/£
    £1,080 = $1,998 @ $1.85/£
    \[
    \frac{1998}{1700} = 1.1753 \rightarrow 17.53\%
    \]

3b. £1,000

3c. The investor cannot hedge the price of the stocks using currency forwards.

Alternatively,

3a. Total RoR = \( \frac{(1,080)(1.85) - 1}{(1,000)(1.70)} \)
    \[\text{RoR} = 17.5\%\]

3b. 1,080, final value of pounds.

3c. Would require that you know exactly how many pounds to sell forward at the beginning of the year. This amount is not known until the end of the year.

Alternatively,

3a. Paid $1700  Got Stocks  £1000
    Now has stocks £1080
    Is worth  1,080 \times 1.85 = $1,998
    Return = \( \frac{1998}{1700} - 1 = 17.5\% \)

3b. If he knew the stock’s return, he would have sold forward £1080. If he didn’t, he could have sold forward the amount invested plus the return = 1000e^{rT}

3c. In order to set up a perfect hedge, you must know the amount to be returned – i.e., if you knew the stock would return 1080, you could hedge exactly the right amount.
Question 4:

4a. A risk neutral investor would select investment 3 because it has the highest expected return of 20%. Since investor is risk neutral he only cares about maximizing expected return and his investment decision is not impacted by level of risk (i.e. standard deviation) of investment.

4b. \[ u = E(r) - 0.003A\sigma^2 \] where \( A=2 \)
\[ u_1 = 12 - 0.003(2)(20)^2 = 9.6 \]
\[ u_2 = 15 - 0.003(2)(30)^2 = 9.6 \]
\[ u_3 = 20 - 0.003(2)(40)^2 = 10.4 \]

Investor would select investment 3 because it has the highest utility of 10.4 based on investors utility function where \( A=2 \).

4c. Certainty equivalent would be 10.4 because certainty equivalent is expected return on risk free investment with same utility as investment 3. Since certainty equivalent is risk free, it has standard deviation of 0 and its expected return equals its utility value, which is 10.4.
Question 5:

5a. X = amount in A, Y = amount in B.

Investor solves

$$\text{Min } \sigma^2_p \text{ such that } 0.15X + 0.2Y + 0.05(1-X-Y) = \mu$$
$$\text{subject to } x,y$$

$$\text{Min } X^2 \sigma^2_A + Y^2 \sigma^2_B + 2XY \text{cov}(A,B) \text{ such that } 0.15X + 0.2Y + 0.05(1-X-Y) = \mu$$
$$\text{subject to } x,y$$

La Grange: $L = .04x^2 + .0225y^2 + 2xy(.1)(.2)(.15)$
$$+ \lambda (\mu - .15x - .2y - .05 + .05x + .05y)$$
$$= .04x^2 + .0225y^2 + .006xy + \lambda (\mu - .10x - .15y - .05)$$

FOC:

$$\begin{bmatrix}
.08x + .06y &= .10\lambda \\
.045y + .06x &= .15\lambda \\
.08x + .06y &= .10\lambda \\
.08x + .6y &= 2\lambda
\end{bmatrix}$$

$.594y = 1.7\lambda \Rightarrow y = 3.20\lambda$

$.006x = .006\lambda$

$$x = \lambda$$

$$\frac{x}{x+y} = \frac{1}{4.2} = .238 \quad \frac{y}{x+y} = \frac{3.2}{4.2} = .762$$

So 23.8% in X, 76.2% in Y

This has variance

$$\sigma^2_p = .04(.238)^2 + .0225(.762)^2 + .006(.238)(.762)$$
$$= .0164$$

$$\sigma_p = 12.8\%$$

Alternatively, For optimal risky portfolio, weight in A.

$$W_a = \frac{(E(r_a) - r_f) \sigma_a \lambda - 2 - (E(r_b) - r_f) \sigma_b \lambda \rho}{(E(r_a) - r_f) \sigma_a \lambda + (E(r_b) - r_f) \sigma_b \lambda - 2 - (E(r_a) - r_f) \sigma_a + E(r_b) - r_f) \sigma_b \lambda \rho}$$

$$= \frac{(0.15 - 0.05) \times (0.15^2) - (0.2 - 0.05) \times .15 \times .2 \times .1}{(0.15 - 0.05) \times (.15^2) + (0.2 - 0.05) \times (.2^2) - (0.15 - 0.05 + 0.2 - 0.05) \times 0.1}$$
$$= .24$$

Weight in B $W_B = 1 - .024 = .76$
\[ \sigma_p^2 = W_A^2 \sigma_A^2 + W_B^2 \sigma_B^2 + 2W_AW_B \sigma_A \sigma_B \rho \]

\[ = 0.24^2 \times 0.2^2 + 0.76^2 \times 0.15^2 + 2 \times 0.24 \times 0.76 \times 0.2 \times 0.15 \times 1 \]

\[ = 0.01639 \]

\[ \sigma_p = 0.1280 \]

5b. If short sell is allowed and A and B are perfectly negatively correlated. There is arbitrage opportunity of creating a zero standard deviation portfolio with return higher than the risk free rate so that investors would like to take unlimited portfolio in it by borrowing at the risk free rate. That is optimal portfolio. Therefore, standard deviation of optimal risky portfolio is 0.

5c. Since the two assets are perfectly correlated, asset b dominates asset a, and short sales are not allowed then all will be invested in asset b. Thus the standard deviation will be 15.
As shown in the graph, gold is apparently inferior to stock, however, it may provide diversification benefits if it is independent of (or negatively correlated with) the stock performance. A risky portfolio including gold maybe preferable when considering the complete portfolio.
Question 7:

7a. \[ E(r) = r_f + \beta[E(r_m) - r_f] \]
where \( r_f \): risk free rate
\( \beta \): beta
\( E(r_m) - r_f \): market risk premium

The situation is not possible because the higher beta of portfolio x would result in a higher expected return unless the market risk premium is negative which is not possible.

7b. \[ \beta = \frac{\text{Cov}(r, r_m)}{\sigma_m^2} \]
where \( r_m \): return on market
\( \sigma_m^2 \): variance associated with the market return
\( \text{Cov}(r, r_m) \): Covariance between the return Associated with the asset and the Market portfolio.

If the situation is possible than as stated in (a), beta is higher for portfolio y. This implies that \( \text{Cov}(r_y, r_m) \) is higher than \( \text{Cov}(r_x, r_m) \). This is independent from the S.D. of the return.

It is possible.
Question 8:

8. 

\[(r_x - r_f) \quad (r_m - r_f)\]

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<td>.01</td>
<td>-.07</td>
<td>-.01</td>
<td>.0001 \quad .0005 \quad .0001 \quad .0002</td>
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<tr>
<td>2</td>
<td>.01</td>
<td>.02</td>
<td>.01</td>
<td>.00</td>
<td>.01</td>
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<td>3</td>
<td>-.04</td>
<td>-.01</td>
<td>.01</td>
<td>-.05</td>
<td>-.02</td>
<td>.0004 \quad .0006 \quad .0004 \quad .0012</td>
</tr>
<tr>
<td>4</td>
<td>.05</td>
<td>.03</td>
<td>.01</td>
<td>.04</td>
<td>.02</td>
<td>.0004 \quad .0012 \quad .0004 \quad .0006</td>
</tr>
</tbody>
</table>

\[
E[R_x] = \frac{-.07 + 0 - .05 + .04}{4} = -.02
\]

\[
E[R_m] = \frac{-.01 + .01 - .02 + .02}{4} = 0.00
\]

\[
\beta_x = \frac{\text{Cor}(X, M)}{	ext{Var}(M)} = \frac{.000625}{.00025} = 2.5
\]
Question 9:

9a. Investor prefer liquidity so they must receive some extra expected return to compensate for illiquidity.

9b. \[ 10 = r_f + \beta(r_m - r_f) + \text{illiquidity prem} \]
\[ 10 = 3 + 1.5(6 - 3) + \text{illiquidity prem} \]

illiquidity prem = 2.5%
Question 10:

Roll’s Critique

10a. Single testable hypothesis of CAPM: The market portfolio is mean-variance efficient

10b. CAPM not testable unless the exact composition of the market portfolio is known and used in the test.

10c. A proxy such as the S+P 500 may be inefficient or subject to benchmark errors.

10d. Linear relationship between expected return and beta is not independently testable.
Question 11:

11a. Historical equity risk premiums in the U.S. seem too high given their associated risk.

11b. 1. The equity premium puzzle is largely related to the 2nd half of the 20th century. During this period, there were large capital gains above what would have been expected. These capital gains are not expected to persist into future periods.

2. The puzzle arose in the US market, which has long been one of the most successful in the world. Thus, the higher equity risk premiums may indicate survivorship bias, since the analysis does not include poorer performing markets or markets that have failed. This would lead to upward bias by not including such markets.
Question 12:

12. 5% = 3% + \beta_A(6\% - 3\%) \Rightarrow \beta_A = 2/3

\[
\frac{156.25}{25} = 6.25 \Rightarrow \beta_B = (2/3) \times 6.25 = 4.167
\]

E(r_B) = 3\% + 4.167(6\%-3\%) = 15.5\%

The expected return for stock B should increase 1.5\% to 15.5\%. 
Question 13:

13. Interest: I assume same % rate for each mortgage

\[
\begin{align*}
A &= \frac{600k}{600k+900k+750k} \cdot (150,000) = 40,000 \\
B &= \frac{900k}{600k+900k+750k} \cdot (150,000) = 60,000 \\
C &= \frac{750k}{600k+900k+750k} \cdot (150,000) = 50,000 \\
\end{align*}
\]

Total Principal payments = $350,000 + 400,000 = $750,000

A gets the first 600,000 because its outstanding principal is 600,000

B gets the remaining 150,000 which is less than 900,000 outstanding

C gets 0 principal

Totals:
\[
\begin{align*}
A &= 40,000 + 600,000 = 640,000 \text{ total} \\
B &= 60,000 + 150,000 = 210,000 \text{ total} \\
C &= 50,000 + 0 = 50,000 \text{ total} \\
\end{align*}
\]

I assumed A got principal first, then B, then C because they are labeled A-B-C.
Question 14:

14a. Liquidity preference theory implies that forward rate must be higher than the expected short rate in the future i.e. $f_n > E(r_n)$

This is due to the assumption that bond investors are dominantly short-term; to attract them to hold long-term bonds, the yield rate must be higher as the maturity date becomes later. Therefore, $f_n > E(r_n)$. 
Question 15:

15a. \[ \text{Invoice Price} = \text{Flat Price} + \text{Accrued Interest} \]

\[ \text{Flat Price} = 92.866 \times \frac{1000}{100} = 928.66 \]

\[ \text{Accrued Interest} = \frac{0.08 \times 1000}{2} \cdot \frac{4 \text{ days}}{180 \text{ days}} (08/01 - 08/05) \]

\[ = 0.89 \]

\[ \text{Invoice Price} = 928.66 + 0.89 = 929.55 \]

*Corp Bonds Use 30/360 day counts*

15b. “Est. Spread” is the basis point spread of the bond YTM over T’s.
Question 16:

16. Higher current ratio (CA/CL) is good for a company’s solvency. High current ratio leads to lower bankruptcy probability.

In Altman’s Discriminant Analysis model, High Z score means good solvency. So the added ratio should receive a positive coefficient.
Question 17:

17a. \( Q(T) = 1 - e^{-[y(T) - y(T^*)]T} \)

\( Q(1) = 1 - e^{- (0.063 - 0.06)(1)} \)

= 0.003

\( Q(2) = 1 - e^{- (0.066 - 0.06)(2)} \)

= 0.0119

Prob. default in year 2 = 0.0119 - 0.003

= 0.0089

17b. hazard rate in year 2 = \( \frac{\text{Prob(default in year 2)}}{\text{Prob(survival to year 2)}} \)

= 0.0089/(1 - 0.003)

= 0.0089 (there is rounding here)
Question 18:

18. Callable bonds must have higher yield to maturity to compensate investor for the possibility that the bond be called. Under callable bonds the capital gains are limited due to the call provision.

Also the higher the call price, the lower the probability that the bond will be called and also the lower the yield-to-maturity required.

Therefore, the yield-to-maturity will be

\[ A > B > C \]
Question 19:

19a.  
\[ V_t = \text{value of company's asset at time } t \]
\[ E_t = \text{value of company's asset at time } T \]
\[ D = \text{value of debt at maturity of the debt agreement} \]
\[ T = \text{maturity time of debt agreement} \]

Firms Equity Position at time T:

1. if \( V_t > D \) \( \Rightarrow \) Equity = \( E_t = V_t - D \)
2. if \( V_t < D \) \( \Rightarrow \) Equity = 0 (default)

Equity position is like a call option on asset \( V_t \) with strike price \( D \)

Value of Equity at time 0 by BS formula

\[ E_o = V_o N(d_1) - D e^{-rT} N(d_2) - (*) \]

Where \( d_2 = \frac{\ln(V_o/D) + (r - (\sigma^2 V^2)/2)T}{\sigma \sqrt{T}} \) (*)&

\( r = \text{risk free rate} \)
\( \sigma = \text{volatility of } V_t \)

also by Black-Scholes-Merton Differential Equation = \( \sigma_E E_o = N(d_1) \sigma_v V_o \) - (**)

where \( \sigma_E E = \text{volatility of } S_T \)

\( \Rightarrow \) solve for \( \sigma_v \) and of \( V_o \) from (*) and (**) (Since \( E_o \) and \( \sigma_E \) observable)
\( \Rightarrow \) calculate risk-neutral default probability = \( N(-d_2) \)

Alternatively:

Merton proposed a model where a company’s equity is an option on the assets of the company.

\[ E_T = \max(V_T - D, 0) \]

Since this can be seen as an option, then we can use option pricing (Black-Scholes and Ito’s Lemma) to price it.

The Black-Scholes formula and Ito’s Lemma provide two equations that can be solved simultaneously to obtain the current value of the company’s assets and the volatility of those assets. (All other variables in these formulas are observable or are estimatable.) Once these parameters are found, then the probability of default is determined by the Black-Scholes model \([N(-d2)]\). However, the default probabilities show significant difference from observed default probabilities. Fortunately, these default probabilities can be useful for estimating actual default probabilities.
Question 20:

20a. Assume yields are annual
Value of zero at Beginning of year = 400.
Yield = \((1000/400)^{\frac{1}{10}}\) = 9.59582%  
This will be used for imputing interest

Expected value at end of year = 400\((1.0959582)\) = 438.38
The actual value = \((1000)(1.08)^{-9}\) = 500.25

There is 38.38 of imputed interest and 500.25 - 438.38 = 61.87 of capital gain

After Tax Income = (38.38(1-.35)) + (61.87(1-.2)) = 74.44

After tax return = 74.44/400 = 18.61%

20b. If not sold, the investor only pays tax on the imputed interest
(.35)(38.38) = 13.43 in taxes
Question 21:

21a. \( f = (S-I)e^{rt} \)  \( S-I = \text{current price} - \text{PV(Coupons)} \)
\[
S-I = 850 - 35e^{-1(.5)} - 35e^{-1(1)} = 785.0377
\]
\[
f = 785.0377e^{1(1)} = 867.60
\]

21b. The current price is higher than the theoretical price so we want to be short the forward contract (sell high) and long the bond. To make an arbitrage profit, we would sell the forward, borrow 850 and buy the bond. Net cash flow today = 0. In one year we deliver the bond to the person who bought the forward from us, collect 875, and pay back borrowed money of 850e^{1(1)} = 939.40 with money from forward and coupons of 35e^{1(.5)} + 35 = 71.79
\[
875 + 71.79 = 946.79
\]
riskless arbitrage profit = 946.79 – 939.40 = 7.39.
Question 22:

22a. Margin is required to ensure parties to position (exchange, brokers, investor) against default losses.

22b. 5,000 bushels * 5 contracts = 25,000 bushels

Margin required = 2,000 * 5 = 10,000

Maintenance margin = 1,500 * 5 = 7,500

price change greater than

value: 25,000 * $2.40 = 60,000

-2,500

25,000 * X = 57,500

x = $2.30 per bushel

2.3/2.4 = -4.17% change in price

22c. value: 25,000 * 2.40 = $60,000

+ 2,000

25,000 * X = 62,000

x = $2.48 per bushel
Question 23:

23a. For platinum, let $S_0 = 100$, then one year forward price is

$$F_0 = S_0 e^{(r+u)T}$$
$$= 100 e^{(0.07+.004)*1.0}$$
$$= 107.681$$

So the equivalent cash interest rate of platinum loan is

$$\frac{107.681}{100} \times \frac{102.5}{100} - 1 = 0.104 > 0.10$$

Therefore the interest on platinum loan is too high compared to cash loan.
Question 24:

24. Since it is 18 years and 5 months, we regard it as 18 years and 3 months.

\[
\begin{array}{c|c|c|c|c}
  t=0 & t=3/12 & t=18 & t=18(3/12) \\
  \text{(in years)} & & & \\
\end{array}
\]

The value at 3 months from now = 100 * 8% * (1/2) * \[\sum_{i=1}^{36} \frac{1}{1.03^i}\] * (1/1.03) + 100 * (1/1.03^{36}) + 4

= 87.32 + 34.5 + 4 = $121.82 + 4 = $125.82

The discount rate for 3 months is \(\sqrt[1.03]{1.03} = 1.0149\)

\(\Rightarrow\) PV 125.82/1.0149 = $123.973

\(\Rightarrow\) The accrued interest is $4/2 = $2 therefore price = $123.973 – 2 = $121.973

\(\Rightarrow\) The conversion factor = 121.973/100 = 1.21973

Alternatively:

round down to nearest 3 months
18 years and 3 months at delivery

\[\text{PV} = (N=37, \text{pmt} = 4, \text{i} = 3\%, \text{FV}=100) \times 1.03^{0.5} \]

= 122.17 * 1.03^{0.5}

= 123.99

accrued interest = 3/6 * 4 = 2
conversion factor = (123.99 – 2)/100

= 1.220
25. Cost of bankruptcy is value of forward contract to ABC

This is the cost of a Swiss bond less the cost of a U.S. bond 7 years from now (including coupon paid in 7 years)

\[ B_{U.S.} = 8\% \times 10M + \frac{8\% \times 10M}{1.09} + \frac{8\% \times 10M}{1.09^2} + \frac{8\% \times 10M + 10M}{1.09^3} \]

\[ = 10.5469 \text{ M} \]

\[ B_{\text{swiss}} = 0.80\left[ 4\% \times 13M + \frac{4\% \times 13M}{1.04} + \frac{4\% \times 13M}{1.04^2} + \frac{4\% \times 13M + 13M}{1.04^3} \right] \]

\[ = 10.816 \text{ M} \]

Thus cost of default = \( B_{\text{swiss}} - B_{U.S.} \)

\[ = 10.816 \text{ M} - 10.547 \text{ M} \]

\[ = 0.269 \text{ M} \]

or 269,000

Alternatively,

ABC receives 4% Swiss on 13M
pays 8% US on 10M

if bankruptcy is declared before the end of year 7, 4 payments are lost

amt ABC would have received @ end of year 7 = \(.04 \times 13M \times .8\) = 416,000

present value at year 7 = \(520 \times (.8) + \frac{(520) \times .838}{1.09} + \frac{(520) \times .879}{1.09^2} + \frac{13520 \times .921}{1.09^3} \)

\[ = 10,815.662 \]

\( f_1 = .8 \times (1.09/1.04) = .838 \)
\( f_2 = .8 \times (1.09/1.04)^2 = .879 \)
\( f_3 = .8 \times (1.09/1.04)^3 = .921 \)

present value of payments

\[ 800 + (800/1.09) + (800/1.09^2) + (10800/1.09^3) = 10,546.870 \]

Therefore ABC lost 10,815,662 – 10,546,871 = $268,791

Alternatively,
Receive \(0.04(13M\text{ fr}) = 520,000\text{ fr.}\)

Pay = \(0.08(10,010,010) = 800,000\)

\[
\begin{align*}
f(x_7) &= 0.80 \\
\frac{f(x_8)}{1.09/1.04} &= 0.8385 \\
f(x_9) &= 0.8788 \\
f(x_{10}) &= 0.9210
\end{align*}
\]

<table>
<thead>
<tr>
<th></th>
<th>Pay</th>
<th>fr</th>
<th>f(x)</th>
<th>$ value</th>
<th>Change</th>
</tr>
</thead>
<tbody>
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<td>7</td>
<td>800,000</td>
<td>520,000</td>
<td>.800</td>
<td>416,000</td>
<td>384,000</td>
</tr>
<tr>
<td>8</td>
<td>800,000</td>
<td>520,000</td>
<td>.8385</td>
<td>436,020</td>
<td>363,980</td>
</tr>
<tr>
<td>9</td>
<td>800,000</td>
<td>520,000</td>
<td>.8788</td>
<td>456,972</td>
<td>343,024</td>
</tr>
<tr>
<td>10</td>
<td>10,800,000</td>
<td>13,520,000</td>
<td>.9210</td>
<td>12,452,202</td>
<td>1,652,202</td>
</tr>
</tbody>
</table>

\[
\text{PV} = (384,000) + (363,980/1.09) + (343,024/1.09^2) + (1,652,202/1.09^3)
\]

\[
\text{PV} = $269,160\text{ loss}
\]
Question 26:

26. \( S_0 = 54.6 \)
\( \sigma = 0.7071 \)
\( E(r) = 0.15 \)
\( k = 75 \)

Prob. of being exercised = \( N(d_2) \)

\[
\begin{align*}
\frac{d_1}{\sigma \sqrt{t}} &= \frac{\ln(S_0/k) + (r + (\sigma^2/2))t}{\sigma \sqrt{t}} \\
&= \frac{\ln(54.6/75) + (0.15 + ((0.7071^2)/2))2}{0.7071\sqrt{2}} = 0.4825 \\
\frac{d_2}{\sigma \sqrt{t}} &= d_1 - \sigma \sqrt{t} = 0.4825 - 0.7071\sqrt{2} = -0.5175 \\
N(-0.5175) = 0.3024 \quad \text{linear using interpolation in normal table.}
\end{align*}
\]

Alternatively,

\[
\begin{align*}
\ln S_T &\sim N(\ln S_0 + (N - (1/2)\sigma^2)T, \sigma \sqrt{T}) \\
\ln S_T &\sim N(\ln(54.60) + (15\% - ((1/2)(70.71\%))^2) * 2, 70.71% \sqrt{2}) \\
\ln S_T &\sim N(3.8, 1)
\end{align*}
\]

\[
\begin{align*}
\Pr(\ln S_T > \ln 75) &= \frac{\ln S_T - 3.8 > \ln 75 - 3.8}{1} \\
&= 1 - N\left(\frac{\ln 75 - 3.8}{1}\right) = 1 - N(0.5175) \\
N(0.51) &= 0.6950 \\
N(0.52) &= 0.6985
\end{align*}
\]

\[
\Rightarrow \\
N(0.5175) = (3/4) * 0.6985 + 0.6950 * (1/4) = 0.697625
\]

\[
\Pr(\ln S_T > \ln 75) = 1 - 0.697625 = 0.3024
\]

Alternatively,

\[
\begin{align*}
\text{Prob (Stock price } > 75)
\end{align*}
\]

Which to get stock price of 75 it is a return of
\( 75/54.5 = 1.3736 \)

So

\[
\begin{align*}
(1/T)\ln(S_T/S_0) &\sim N(M - (\sigma^2/2), \sigma/\sqrt{t}) \\
.1587 &= (1/2)\ln(75/54.6) \sim N(.15 - (.7071^2/\sqrt{2}), .7071/\sqrt{2})
\end{align*}
\]
$1 - \Phi\left(\frac{.15 - .7071^2}{\sqrt{2}}\right)$

$= 1 - \Phi(.5174) = 1 - .69759 = .3024$

Probability it will be exercise is 30.24%
Question 27:

27.

\[
V_H = \left( \frac{V_{HH} + V_{HL} + 2C}{2(1 + r_H)} \right), 100 \text{ max}
\]

\[
r_L = \left( \frac{V_{HL} + V_{LL} + 2C}{2(1 + r_L)} \right), 100 \text{ max}
\]

\[
V_o = \frac{V_{HH} + V_{LL} + 2C}{2(1 + r)} = \frac{100 + 101.08 + 2(6)}{2(1.0595)} = 100.56
\]

\[
V_o = 100.56
\]
Question 28:

\[ \text{Prob} = P \quad S_o u \]
\[ S_o \]
\[ \text{Prob} = 1 - P \quad S_o d \]

At \( T \) \text{"risk-neutral"} expected value of stock is
\[ P(S_o u) + (1 - P)(S_o d) \]
This must equal \( S_o e^{rT} \) since stock value grows by risk-free rate

\[ S_o e^{rT} = P(S_o u) + (1 - P)(S_o d) \]
\[ e^{rT} = P * u + d - P * d \]
\[ e^{rT} = P(u - d) + d \]
\[ e^{rT} - d = P(u - d) \]
\[ P = (e^{rT} - d)/(u - d) \]

Alternatively,

28. \( p = (e^{rT} - d)/(\mu - d) \) \( f = e^{-rT}(p f_u + (1-p)f_d) \)

buy \( \Delta \) shares & sell 1 call for a risk neutral investment

\( \Delta S_o \mu - f_u = \Delta S_o d - f_d \) \( \leftarrow \) same value of position if up or down movement

\[ \Delta = \frac{f_u - f_d}{S_o \mu - S_o d} \]

initial investment = \( S_o \Delta - f \)

value at time 1 = \( \Delta S_o \mu - f_u = \Delta S_o d - f_d \)

earn risk free rate

\[ S_o \Delta - f = e^{rT}(\Delta S_o \mu - f_u) \]
\[ S_o \left( \frac{f_u - f_d}{S_o \mu - S_o d} \right) - f = e^{rT}(S_o \mu(\frac{f_u - f_d}{S_o \mu - S_o d}) - f_u) \]
\[ \frac{f_u - f_d}{u - d} = u(\frac{f_u - f_d}{u - d}) e^{rT} - f_u(e^{rT}) + f \]
\[ f = \frac{(f_u - f_d)ue^{-rT} + (f_u - f_d) + fue^{-rT}(u - d)}{u - d} \]
\[= e^{-\tau} \left[ \frac{e^{\tau} - d}{u - d} f_u + \frac{u - e^{\tau}}{u - d} f_d \right] \]

\[= e^{\tau T} (pf_u + (1 - p)f_d) \]

\[p = \frac{e^{\tau} - d}{u - d} \]

\[1 - P = \frac{u - d - e^{-\tau} + d}{u - d} \quad \text{(the d’s in the numerator cancel out)} \]
Question 29:

29. Own 1 share.
   Buy 1 put, \( k = 20, p = 2.5 \)
   Sell 1 call, \( k = 40, p = 1.5 \)

<table>
<thead>
<tr>
<th>Stock Price</th>
<th>Stock</th>
<th>Long Put</th>
<th>Short Call</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>( S_T &lt; 20 )</td>
<td>( S_T )</td>
<td>( 20 - S_T )</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>( 20 &lt; S_T &lt; 40 )</td>
<td>( S_T )</td>
<td>0</td>
<td>0</td>
<td>( S_T )</td>
</tr>
<tr>
<td>( S_T \geq 40 )</td>
<td>( S_T )</td>
<td>0</td>
<td>( 40 - S_T )</td>
<td>40</td>
</tr>
</tbody>
</table>
Question 30:

30a. Collect the data of past $n$ days, find the stock price daily stock return, 
$\mu_i = \ln S_i / S_{i-1}$, then estimate standard deviation of the stock return by 

$$ S^2 = \frac{1}{n-1} \sum_{i=1}^{n} (\ln S_i - \bar{\mu})^2, $$ 

assuming 252 trading days per year.

$S_i$ is the closing stock price today
$S_{i-1}$ is the closing stock price of previous day

30b. Implied volatilities are the volatilities that make an option price equal to its Black Scholes value. We need an iterative technique because $\sigma$ can’t be isolated in the B-S formula.
Question 31:

31a. # of shares per call = 100
K = 65
T = 8/12
σ = 30%
S₀ = 61
r_f = 6%

1 call = S₀N(d₁) − Ke^{−rt}N(d₂)
= 61(.5106) − 65e^{−.06(8/12)}(.413524)
= 5.32; so 100 * 5.32 = $532

d₁ = \frac{\ln(61/65) + (.06 + (.3²/2))(8/12)}{.3\sqrt{8/12}} = 0.0265

N(.0265) = N(.02) + .65(N(.03) − N(.02))
= .5080 + .65(.5120 - .5080) = .5106

d₂ = d₁ − r\sqrt{t} = .0265 − .3\sqrt{8/12} = −0.2184

N(-.2184) = 1 − .586476 = .413524
N(.2184) = N(.21) + .84(N(.22) − N(.21))
=.5832 + .84(.5871 - .5832)
=.586476
31b.

Is \( \text{DIV}_{3\text{mo}} > K(1 - e^{-(3/12) \cdot 0.06}) \)

\[ 1 > 65(0.014888) \]

\[ 1 > 0.968 \quad \text{Yes, so may be optimal exercise at } t = 3 \text{ mos} \]

Is \( \text{DIV}_{6\text{mo}} > 65(1 - e^{-(2/12) \cdot 0.06}) \)

\[ 1 > 0.647 \quad \text{Yes, so may be optimal exercise at } t = 6 \text{ mos} \]

At \( t = 6 \text{ mos} \) value of 1 call is \( S_0 N(d_1) - Ke^{-rt}N(d_2) \)

Alternatively,

31a. No dividends = No early exercise

\[
d_1 = \frac{\ln(61/65) + (0.06 + (0.3^2/2))(8/12)}{0.3\sqrt{8/12}} = 0.0265
\]

\[ d_2 = 0.265 - 0.3\sqrt{8/12} = -0.2185 \]

\[ N(d_1) = 0.65(0.5120) + 0.35(0.5080) = 0.5106 \]

\[ N(d_2) = 0.85(0.4129) + 0.15(0.4168) = 0.4135 \]

\[ C = 0.5106(61) - 0.4135(65)e^{-0.06(8/12)} = 5.323 \times 100 = 532.30 \text{ per option} \]

31b. Using Black’s Approximation:

If no early exercise, \( S_0 = 61 - e^{-0.06(3/12)} - e^{-0.06(6/12)} \)

\[ = 59.04 \]

\[
d_1 = \frac{\ln(59.04/65) + (0.06 + (0.3^2/2))(8/12)}{0.3\sqrt{8/12}} = -0.1065
\]

\[ d_2 = -0.3515 \]

\[ N(d_1) = 0.65(0.4562) + 0.35(0.4602) = 0.4576 \]

\[ N(d_2) = 0.15(0.3594) + 0.85(0.3632) = 0.3623 \]

\[ C = 0.4576(59.04) - 0.3623(65)e^{-0.06(3/12)} = 4.37 \]

If exercised at \( t = 6 \text{ mths} \), \( S_0 = 61 - e^{-0.06(3/12)} = 60.01 \)
\[
d_1 = \frac{\ln(60.01/65) + (.06 + (.3^2 / 2)(.5))}{.3\sqrt{5}} = -1287
\]
\[
d_2 = -3408
\]
\[
N(d_1) = .87(.4483) + .13(.4522) = .4488
\]
\[
N(d_2) = .08(.3632) + .92(.3669) = .3666
\]
\[
C = .4488(60.01) - .3666(65)e^{-0.03} = 3.81
\]

If exercised at t = 3 mths, \( S_0 = 61 \)

\[
d_1 = \frac{\ln(61/65) + (.06 + (.3^2 / 2)(1/4))}{.3\sqrt{1/4}} = -2484
\]
\[
d_2 = -3984
\]
\[
N(d_1) = .84(.4013) + .16(.4052) = .4019
\]
\[
N(d_2) = .84(.3446) + .16(.3483) = .3452
\]
\[
C = .4019(61) - .3452(65)e^{-0.06(25)} = 2.41
\]

Since the value is highest when it is not exercised early, it should not be exercised early.
Question 32:

32. Black-Scholes-Merton differential equations do not contain any variables that are affected by risk preference.

When moving from a risk-neutral to a risk-averse world, changes in growth rate are offset by changes in the discount rate.

Alternatively,

When inspecting the Black-Scholes-Merton equation, all the variables in the equation are independent of risk preference, the only variable related to risk preference is \( u \) (expected return) which is not in the equation. So the equation applies to all expected returns including risk-free rate. So the equation obtained in a risk-neutral is also valid in a risk-averse world.
Question 33:

33a. Interest rate swap – swap assets for better on, can be tax advantaged so better than restructuring and triggering capital gains.

33b. Issuing puts instead of buying/selling stocks lowers taxes and transaction costs.

33c. Swap assets, lower costs than buying and selling the assets. (lower transaction costs)
Do not have to do accounting on new assets, since swapped.
Question 34:

par = F = 1000
coupon = 6% semiannually
y = .05

\[ D^* = \text{Modified duration} = \frac{\text{MacaulayDuration}}{1 + \frac{y}{k}} \]

\[
\begin{array}{cccc}
30 & 30 & 30 & 1030 \\
\hline
| & | & | \\
1 & 2 \\
\end{array}
\]

\[ \text{Macaulay duration} = \frac{30}{1.025} + \frac{30(1.025^2)}{1.025^2} + \frac{30(1.5)}{1.025^3} + \frac{1030(2)}{1.025^4} \]

\[ = \frac{1951.23}{1018.81} = 1.915 \]

34a. \[ D^* = \frac{1.915}{1.025} = 1.868 \]

34b. \[ \text{Convexity} = \frac{1}{P(1 + \frac{y}{k})^2} \sum \frac{CF_m(n+1)}{k^2(1 + \frac{y}{k})^n} \]

\[ = \frac{1}{(1018.81)(1.025)^2(4)} \left[ \frac{30(2)(1)}{1.025} + \frac{30(2)(3)}{1.025^2} + \frac{30(3)(4)}{1.025^3} + \frac{1030(4)(5)}{1.025^4} \right] \]

\[ = \frac{1}{4281.549} (19,226.742) = 4.491 \]

34c. \[ \frac{\text{dP}}{P} = -D^*(\text{dy}) + (1/2)C(\text{dy})^2 \]

\[ \text{dy} = -.01 \]
\[ D^* = 1.868 \]
\[ C = 4.491 \]

\[ \frac{\text{dP}}{P} = -(1.868)(-.01)+(1/2)(4.491)(-.01)^2 \]

\[ = .0189 \Rightarrow \text{% change in price is + 1.89%} \]
Question 35:

35a. - transform u/w cash flows into marketable securities
     - transfer u/w risk to the capital markets

35b. Reinsurance does not transform u/w cash flows into a marketable security.
     Reinsurance contracts are not traded

     Reinsurance does not transfer u/w risk to the capital markets, it is only
     transferring risk to another insurance company.
Question 36:

36a.  \( S_0 = 49.16 \)
\( K = 50 \)
\( r_f = .05 \)
\( \sigma = .20 \)
\( T = 20/52 \)

\[
d_1 = \frac{\ln(S_0 / K) + (r + (\sigma^2 / 2))T}{\sigma \sqrt{T}}
\]

\[
d_1 = \frac{\ln(49.16 / 50) + (.05 + (.2^2 / 2))(20 / 52)}{.2 \sqrt{20 / 52}}
\]

\( \Delta = N(d_1) - 1 \)
\( = N(.0805) - 1 \)
\( = .5321 - 1 \)
\( = -.4679 \)

Buy \(.4679(100,000) = 46,790 \) shares

36b.  \( \Delta_1 = N(d_1) - 1 = N(.1) - 1 = .5398 - 1 = -.4602 \)
\( \Delta_2 = N(d_1) - 1 = N(.05) - 1 = .5199 - 1 = -.4801 \)

At time 0, bought 46,790 shares \((49.16) = 2,300,196.4 \) cost
At end of wk 1, want \(.4602(100,000) = 46,020 \) shares
  Therefore since have 46,790 shares
  Buy 48,010 - 46,020 = 770 shares
  \( 770(49.33) = -37,984.10 \)

At end of wk 2, want \(.4801(100,000) = 48,010 \) shares
  Therefore since have 46,020 shares
  Buy 48,010 - 46,020 = 1,990 shares
  \( 1,990(49.09) = 97,6819.10 \)

Cumulative Cost of hedge = \( 2,300,196.40e^{.05(2/52)} - 37,984.10e^{.05(1/52)} + 97,689.10 \)
\( = 2,364,292.57 \)
Question 37:

37a. \( \sigma_{AL} = 100,000(.007) = 700 \)
\( \sigma_2 = 400,000(.002) = 800 \)
\( \sigma_{Z,AL} = .8(700)(800) = 448,000 \)
\( \sigma_{Port} = \sqrt{700^2 + 800^2 + 2(448,000)} = 1423.4 \)
15 day, 99%ile VaR = 1423.4(\( \sqrt{15} \))(2.33) = 12,844

37b. with perfect correlation, VaR would be (700+800)(\( \sqrt{15} \))(2.33)
diversification is worth (1500 – 1423.4)(\( \sqrt{15} \)(2.33)) = 691

37c. Fit a quadratic model where

\[ \delta P = \Delta \delta S + (1/2) \Gamma (\delta s)^2 \]

Find mean + variance and assume follows normal rules
Question 38:

38a. VaR calculates the amounts of money that can be expected to be lost over the next N days with X% certainty. Shortfall Rick sets a level below which the company’s assets cannot fall and produces estimates of risk accordingly.

38b. Shortfall risk penalizes bigger shortfalls more than smaller ones.
Question 39:

39. Companies in distress have no need for risk management. Any benefits from activities such as hedging would go to debt holders. If they take risks, there is a chance that there would be enough of a gain to escape financial distress. Any downside risk would affect bondholders.
Question 40:

40a. Managers behave opportunistically and fail to realize the owner’s objective of maximizing value, adverse solution, and moral hazard arise, thus informational and agency costs reduce return.

40b. Investment income on insurer’s securities are taxed twice once at corporate level, once via return to shareholders through dividends thus reduce the return.

40c. By limiting the amount of certain types of investments that insurance companies can hold, you create a situation where portfolios may not be optimal thus lowering returns.

Also, RBC gives regulation authority to take over a company and seize its assets. This risk will lower returns as well.
Question 41:

RBC:

Advantage: The RBC method does capture most of the elements of risk.

Disadvantage: It excludes other important categories of risk, like derivative risk and interest rate risk.

VaR:

Advantage: Based upon traditional actuated theories, like probability of ruin and maximum probable loss.

Disadvantage: Does not reflect diversification across lines of business.
Question 42:

a) \[ \text{RAROC} = \frac{(\text{Premium} - \text{PV (Expected claims)} - \text{PV (Expenses)} + \text{interest on capital}) \times (1-\text{tax})}{\text{PV (Economic Capital)}} \]
\[ = \frac{(3900-2500-1170+179) \times (1-.34)}{2250} = 12\% \]

Where \( \text{PV (Economic Capital)} = (0.95) \times (5000) - 2500 = 2250. \)

No, RAROC does not exceed hurdle.

b) \[ \text{Available Equity Capital} = \text{Statutory Surplus} + \text{Unrealized gains on bonds} + \text{Discounting adjustment to reserves} + \text{Adjustment for reserve conservatism} + \text{real Estate appreciation} \]
\[ = 2000 + 250 + (3000-2500) + 0 = 2750. \]

Yes, available capital exceeds required capital of 2250.

c) Nakada’s study suggests the P&C industry has enough capital to support catastrophe risk to a high degree of solvency, but that it does not price this risk to earn an adequate return on that capital for its shareholders. For catastrophe prone lines of business, available capital is adequate, but the return on that capital is well below 10%.
Question 43:

a. Company B -- a higher P/E ratio implies the ROE on projects invested in with the
retained funds is higher than the required return, k.

b. Company A -- a lower P/E ratio implies a higher required rate of return, k. One
may argue that a low P/E means that it is a stable cash cow with a lower rate of
return.

c. You could look at the price-to-cash-flow ratio because it does not rely on
accounting practices.

Note other answers could be given full credit as long as the argument was solidly made
for the response.
Question 44:

a) \( D_0 = .80 \)
\( k = .15 \)
\( g = b \times \text{ROE} = .18 \times .6 = .108 \)
\( P = \frac{D_0(1+g)}{(k-g)} = \frac{.8 \times (1.108)}{.15 - .108} = \$21.10 \text{ per share} \)

b) Dividend at end of year 1 = \( .8 \times 1.108 = .8864 \)
Dividend at end of year 2 = \( .8 \times 1.108^2 = .9821 \)
Revised dividends (after year 2) = \( 2 \times 1.108^2 \times .6 = 1.4732 \)
Revised \( g = .15 \times .4 = .06 \)
\( P = \frac{.8864}{1.15} + \frac{.9821}{1.15^2} + \frac{[1.4732 \times 1.06]}{(1.15 - .06)} / 1.15^2 = \$18.86 \text{ per share} \)

c) The competitive information would immediately be reflected, thus decreasing the price per share.
Question 45:

Due to the one-time shift in claim reserve levels, historical loss development patterns may not provide good guidance on expected future development.

Industry development patterns (e.g., from aggregate industry-wide schedule P) may provide additional guidance.

The actuary would need to determine the credibility of internal and external data and perhaps weight the two together somehow when making final selections.