Exam 8
Investments and Financial Analysis

May 12, 2008

INSTRUCTIONS TO CANDIDATES

1. This 75 point examination consists of 45 problem and essay questions.

2. For the problem and essay questions, the number of points for each full question and 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 only on the front lined side of the paper — **DO NOT WRITE ON THE BACK OF THE PAPER.** Be careful to give the number of the question you are answering on each sheet. 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.

   - The answer should be concise and confined to the question as posed. **When a specified number of items are requested, do not offer more items than requested.** For example, if you are requested to provide three items, only the first three responses will be graded.

   - 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.

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

CONTINUE TO NEXT PAGE OF INSTRUCTIONS

©2008 Casualty Actuarial Society
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. You will also not be allowed to use calculators.** The supervisor has additional exams for those candidates who have defective exam booklets.

- Verify that the table of the Normal Distribution is attached to the examination after the last question.

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. The examination starts after the reading period is complete. 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 sheets in your envelope in question number order. Insert a numbered page for each question, even if you have not attempted to answer that question. Nothing written in the examination booklet will be graded. **Only the answer sheets will be graded.** Also place any included reference materials in the Examination Envelope. **BEFORE YOU TURN THE EXAMINATION ENVELOPE IN TO THE SUPERVISOR, BE SURE TO SIGN IT IN THE SPACE PROVIDED ABOVE THE CUT-OUT WINDOW.**

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 from the CAS Web Site.

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 and the Canadian Institute of Actuaries 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 Web Site in the "Admissions/Exams" section. Please submit your survey by June 2, 2008.

**END OF INSTRUCTIONS**
1. (3 points)

A fund manager recently attended a presentation on a new weather catastrophe bond offering and is considering adding the catastrophe bond to his current optimal risky portfolio. Assume the following:

<table>
<thead>
<tr>
<th></th>
<th>Expected Return</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current optimal risky portfolio</td>
<td>8%</td>
<td>12%</td>
</tr>
<tr>
<td>New catastrophe bond</td>
<td>95%</td>
<td>300%</td>
</tr>
<tr>
<td>Treasury bills (T-bills)</td>
<td>5%</td>
<td>0%</td>
</tr>
</tbody>
</table>

The fund manager has estimated the correlation coefficient between his current optimal risky portfolio and the new catastrophe bond to be 0.1.

a. (1.75 points)

Determine the expected return and the standard deviation of the new optimal risky portfolio if the new catastrophe bond is added.

b. (0.5 point)

Assume the utility function \( U = E(r) - 0.005A\sigma^2 \) and risk aversion parameter \( A = 3 \). Calculate the proportion of the new optimal complete portfolio that should be invested in T-bills.

c. (0.75 point)

Assume that the fund manager invested $100,000 in the new optimal risky portfolio and T-bills in the proportions determined in part b. above at the beginning of the year. One year later, the investments have grown to $78,000 in the risky portfolio fund and $37,800 in T-bills. The investor's risk aversion and the expected returns and standard deviation of the new optimal risky portfolio and T-bills remain unchanged.

The investor wants to rebalance the portfolio by either buying or selling T-bills.

Determine the amount of T-bills required to rebalance the portfolio and state whether the investor must buy or sell these.

SHOW ALL WORK.
2. (1 point)

You are given the following information:

- The stock of Company X sold for $51.25 per share on January 1, 2008.
- Company X will pay a dividend of $0.92 per share on December 31, 2008.
- Stock X’s beta is 0.8.
- The expected annual return on the market portfolio is 13%.
- The risk-free rate of return is 4%.

Calculate the expected stock price of Company X on January 1, 2009.

SHOW ALL WORK.
3. (1.5 points)

Consider the two regression lines of monthly excess returns for stocks Y and Z in the following graphs.

![Graphs of Stock Y and Stock Z](image)

a. (0.25 point)

Briefly explain which stock has greater systematic risk based on interpretation of the graphs.

b. (0.25 point)

Briefly explain which stock has higher firm-specific risk based on interpretation of the graphs.

c. (1 point)

Briefly explain for each stock whether the intercepts and slopes of the regression lines are consistent with the Capital Asset Pricing Model.
4. (1.5 points)

You are given the following information:

- There are three independent economic factors: $F_1$, $F_2$, and $F_3$.
- The risk-free rate is 3%.
- The risk premium for $F_3$ is 10%.

You are also given the following information about three well-diversified portfolios: A, B, and C:

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>Beta on $F_1$</th>
<th>Beta on $F_2$</th>
<th>Beta on $F_3$</th>
<th>Expected Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.80</td>
<td>0.70</td>
<td>1.65</td>
<td>20%</td>
</tr>
<tr>
<td>B</td>
<td>-0.25</td>
<td>1.80</td>
<td>0.30</td>
<td>11.9%</td>
</tr>
<tr>
<td>C</td>
<td>1.25</td>
<td>0.70</td>
<td>1.40</td>
<td>16.6%</td>
</tr>
</tbody>
</table>

Calculate the risk premium for $F_1$.

SHOW ALL WORK.
5. (2.25 points)
   
a. (1.5 points)
   Identify and briefly describe the three versions of the Efficient Market Hypothesis.

b. (0.75 point)
   Briefly state whether price drift subsequent to an earnings announcement would tend to invalidate the hypothesis for each version identified in part a. above.
6. (1.5 points)
   
a. (0.5 point)
   
   Define the Law of One Price.

b. (1 point)

   Describe two examples that violate the Law of One Price.
7. (1.5 points)

You read a report about 1,000 randomly selected, currently active mutual funds that are independently managed. Three hundred funds that were in the top half of the distribution of returns during one year were also in the top half during the following year.

a. (1 point)

Explain how this observation might lead an investor to question the concept of market efficiency.

b. (0.5 point)

Briefly describe how survivorship bias might be embedded in this report and how it might affect conclusions about market efficiency drawn from this report.
8. (1.75 points)

You are given the following information about inflation:

<table>
<thead>
<tr>
<th>Year</th>
<th>Annual Inflation Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>1.0%</td>
</tr>
<tr>
<td>2009</td>
<td>3.0%</td>
</tr>
<tr>
<td>2010</td>
<td>2.0%</td>
</tr>
</tbody>
</table>

Consider a Treasury Inflation Protected Security (TIPS) issued on January 1, 2008, with the following characteristics:

- The maturity date is December 31, 2010.
- The par value is $1,000.
- The annual coupon rate is 5%, paid annually.

a. (1 point)

Calculate the total payments for this security in years 2008, 2009, and 2010.

b. (0.75 point)

Calculate the real rate of return in 2009.

SHOW ALL WORK.
9. (1 point)

You are given the following information about a bond:

- The par value is $1,000.
- The current price is $950.
- The number of years to maturity is 3 years.
- The annual coupon rate is 5%.
- Coupons are paid semiannually.

Assume all interest is compounded semiannually.

At the end of Year 2, the bond will have a yield-to-maturity of 5%.

Calculate the realized compound yield for an investor with a 2-year holding period and a reinvestment rate of 4% over the period.

SHOW ALL WORK.
10. (2 points)

You are given the following information about a bond that matures in 10 years:

- Par value is $10,000.
- Annual coupon rate is 4%.
- Coupons are paid annually.
- Effective yield-to-maturity is 9%.
- Tax rate on interest income is 35%.
- Tax rate on capital gains is 20%.
- Assume annual compounding.

a. (1 point)

Calculate the pre-tax holding-period return for a one-year investment period if the yield-to-maturity is 7% at the end of the year.

b. (1 point)

Calculate the dollar amount of tax owed if the bond is sold after one year.

SHOW ALL WORK.
11. (0.75 point)

   a. (0.5 point)

       Briefly describe two ways a sinking fund call differs from a conventional call.

   b. (0.25 point)

       Briefly describe one disadvantage to an investor holding a bond with a sinking fund.
12. (2 points)

You are given the following information about bonds with coupons paid semi-annually:

<table>
<thead>
<tr>
<th>Bond Par Value</th>
<th>Time to Maturity (years)</th>
<th>Annual Coupon Rate</th>
<th>Bond Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>$100</td>
<td>0.5</td>
<td>0%</td>
<td>$97.47</td>
</tr>
<tr>
<td>$100</td>
<td>1.0</td>
<td>0%</td>
<td>$94.00</td>
</tr>
<tr>
<td>$100</td>
<td>1.5</td>
<td>5%</td>
<td>$95.75</td>
</tr>
<tr>
<td>$100</td>
<td>2.0</td>
<td>8%</td>
<td>$102.00</td>
</tr>
</tbody>
</table>

Calculate the continuous 1.5 year zero rate using the bootstrap method.

SHOW ALL WORK.
13. (1 point)

A corporate bond has the following features on the morning of January 28, 2009:

- One year to maturity.
- 11% semi-annual coupon.
- 15% promised yield-to-maturity.

Due to financial turmoil during the morning of January 28, 2009, investors believe the following:

- Bondholders will receive 80% of par value at maturity.
- All remaining coupon payments will be made in full.
- The bond’s price will drop by 15% by market close on January 28, 2009.

Calculate the expected yield-to-maturity if the bond is purchased at market close on January 28, 2009.

SHOW ALL WORK.
14. (1.5 points)

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

<table>
<thead>
<tr>
<th>Maturity Year</th>
<th>Risk-free Zero Rate</th>
<th>Corporate Bond Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.0%</td>
<td>7.3%</td>
</tr>
<tr>
<td>2</td>
<td>7.0%</td>
<td>7.6%</td>
</tr>
<tr>
<td>3</td>
<td>7.0%</td>
<td>7.8%</td>
</tr>
<tr>
<td>4</td>
<td>7.0%</td>
<td>8.0%</td>
</tr>
<tr>
<td>5</td>
<td>7.0%</td>
<td>8.2%</td>
</tr>
</tbody>
</table>

Assume a recovery rate of 30%.

a. (1 point)

Calculate the probability of default between years 2 and 4.

b. (0.5 point)

Calculate the hazard rate between years 2 and 4.

SHOW ALL WORK.
15. (1 point)

You are given the following information about a portfolio of bonds as of January 1, 2009:

<table>
<thead>
<tr>
<th>Bond</th>
<th>Value</th>
<th>Maturation Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$25,000</td>
<td>December 31, 2010</td>
</tr>
<tr>
<td>B</td>
<td>$50,000</td>
<td>December 31, 2012</td>
</tr>
<tr>
<td>C</td>
<td>$45,000</td>
<td>December 31, 2009</td>
</tr>
<tr>
<td>D</td>
<td>$10,000</td>
<td>December 31, 2012</td>
</tr>
<tr>
<td>E</td>
<td>$40,000</td>
<td>December 31, 2011</td>
</tr>
</tbody>
</table>

- Bond B will default on August 5, 2009.
- Bond D will be redeemed from a call on December 31, 2010.
- Bond E will default on April 27, 2010.

Calculate the cumulative mortality rate of the portfolio through December 31, 2010.

SHOW ALL WORK.
16. (2.25 points)

You are given the following information about Company XYZ:

- The volatility of assets is 60%.
- The risk-free rate is 5% per annum.
- The amount of debt interest and principal to be repaid in 3 months is $2,000,000.

a. (1 point)

Calculate the minimum amount of assets that Company XYZ must have in order to limit its probability of default to 5%.

b. (0.5 point)

Determine the value of the company’s equity today using the amount of assets calculated in part a. above.

c. (0.75 point)

Calculate the expected loss on the debt as a percentage of its no-default value.

SHOW ALL WORK.
17. (1.75 points)

You are given the following information about a May gold futures contract:

<table>
<thead>
<tr>
<th>Date</th>
<th>Futures Settlement Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 7</td>
<td>$483</td>
</tr>
<tr>
<td>April 8</td>
<td>480</td>
</tr>
<tr>
<td>April 9</td>
<td>475</td>
</tr>
<tr>
<td>April 10</td>
<td>477</td>
</tr>
</tbody>
</table>

a. (0.5 point)

On April 7, an investor contracted to buy three futures contracts at $485 per ounce, with a contract size of 100 ounces. The initial margin is $2,500 per contract.

Calculate the value of the margin account at the end of trading on April 7.

b. (0.75 point)

Assume the maintenance margin is 75% of the initial margin. Determine the date when a margin call will be sent and the amount of the margin call.

c. (0.5 point)

Calculate the cumulative gain or loss on the contract and the value of the margin account as of close of trading on April 10. Assume no withdrawals from the margin account have been made.

SHOW ALL WORK.
18. (1 point)

You are given the following information about a jewelry manufacturer:

- On February 22, the manufacturer expects to acquire 20,000 troy ounces of silver in July.
- The spot price of silver on February 22 is 600 cents per troy ounce.
- The futures price for July delivery is 590 cents per troy ounce.
- There is no daily settlement.
- Each futures contract is for the delivery of 5,000 troy ounces of silver.

a. (0.5 point)

Develop a hedging strategy that the jewelry manufacturer could use on February 22 to lock in the price it will pay for silver in July.

b. (0.5 point)

Assume the spot price of silver on July 15 is 585 cents per troy ounce.

Calculate the gain or loss on July 15 of the hedging strategy from part a. above. State all assumptions.

SHOW ALL WORK.
19. (1 point)

You are given the following information:

- The current price of assets underlying a futures contract is $50.
- The time to delivery date is 2 years.
- The risk-free interest rate is 5%.
- The futures contract delivery price is $60.

a. (0.5 point)

Calculate the futures price of the asset. Assume that the asset provides no income.

b. (0.5 point)

Assume that the asset provides income with present value of $10. Calculate the value of a long forward contract.

SHOW ALL WORK.
20. (2.5 points)

Company A has arranged to borrow $100 million at a floating rate of LIBOR plus 100 basis points, but Company A would prefer to borrow at a fixed rate of 6.6%. Company B has arranged to borrow $100 million at a fixed rate of 6% but would prefer to borrow at a floating rate.

Both Company A and Company B are aware of a financial institution that will arrange a swap at a cost of 3 basis points on a pair of offsetting transactions.

a. (1.5 points)

Diagram the swap’s cash flows among Company A, Company B, and the financial institution, as well as the cash flows from Companies A and B to their respective lenders.

Include all interest rates in the diagram. Ignore day count issues and assume that the creditworthiness of Company A and Company B does not change over the term of the swap.

b. (1 point)

Discuss the conclusions one could draw about the creditworthiness and comparative advantage(s) of Company A versus Company B.

SHOW ALL WORK.
21. (1.5 points)

You are given the following information about a swap between a financial institution and Company A:

- The notional principal is $200,000,000.
- The financial institution pays 6-month LIBOR.
- Company A pays 7% per annum (with semiannual compounding).
- The swap’s remaining life is 9 months.
- The LIBOR rates with continuous compounding for 3-month, 9-month, and 15-month maturities are 9.0%, 9.25%, and 9.5%, respectively.
- The 6-month LIBOR rate at the last payment date was 9.1% (with semiannual compounding).

Calculate the value of the swap from the perspective of the financial institution.

SHOW ALL WORK.
22. (1.5 points)

You are given the following information about 6-month put options on a stock:

<table>
<thead>
<tr>
<th>Strike Price</th>
<th>Put Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>$95</td>
<td>$5</td>
</tr>
<tr>
<td>$100</td>
<td>$7</td>
</tr>
<tr>
<td>$105</td>
<td>$10</td>
</tr>
</tbody>
</table>

Use this information to explain how to create a butterfly spread and draw a profit diagram for this butterfly spread.

SHOW ALL WORK.
23. (1.5 points)

You are given the following information:

- The stock price is $16.
- The risk-free interest rate is 0%.
- The risk-neutral value of a 6-month European call option with a strike price of $17 is $2.

Over each of the next two 3-month periods, the stock price is expected to increase by X% or decrease by X%.

Determine all possible value(s) for X.

SHOW ALL WORK.
24. (2.5 points)

You are given the following information about Company XYZ:

- The number of outstanding shares of stock is 2,000,000.
- The current stock price is $50.
- The risk-free interest rate is 5% per annum.
- The volatility is 20% per annum.
- Company XYZ does not pay any dividends.

Company XYZ issues warrants, each of which gives the holder the right, in three years, to buy one share at a strike price of $65.

As a result of this announcement, the share price immediately drops to $49.50.

Calculate the number of warrants that were issued.

SHOW ALL WORK.
25. (2 points)

You are given the following information about a bond that matures in 2 years:

- The bond is callable at 101% of par in one year.
- The par value is 1,000.
- The annual coupon rate is 7%.
- The current one-year spot rate is 5% (compounded annually).

One year from now, there is an equal probability that the one-year spot rate will be 6.25% or 3.65%.

Calculate the value of the embedded call option.

SHOW ALL WORK.
26. (2.5 points)

You are given the following information for an American call option on a stock:

- The time to maturity is 15 months.
- The stock has a current price of $60.
- The exercise price is $63.
- The volatility is 30%.
- The risk-free rate is 5% compounded continuously.
- Dividends of $1.00 and $1.25 are expected in 4 months and 10 months, respectively.

a. (1 point)

Demonstrate that it can never be optimal to exercise the option on either of the two dividend dates.

b. (1.5 points)

Calculate the price of the call option.

SHOW ALL WORK.
27. (1 point)

A tradable derivative's theoretical price follows the formula:

\[ F(S, t) = S + \frac{1}{t} \]

Use the Black-Scholes-Merton differential equation to determine whether or not this derivative creates arbitrage opportunities.

SHOW ALL WORK.
28. (1.5 points)

You are given the following information:

- The annual risk-free interest rate in Britain is 8%.
- The current exchange rate is $2.20 per pound.
- The one-year forward exchange rate is $2.15 per pound.

a. (0.5 point)

A U.S. investor invests $20,000 in British pounds.

Calculate the dollar-denominated rate of return after one year if the exchange rate drops to $2.10 per pound.

b. (0.5 point)

Determine what investment the investor can make to ensure a riskless return in U.S. dollars.

c. (0.5 point)

Calculate the riskless dollar-denominated return the investor can earn following the approach described in part b. above.

SHOW ALL WORK.
29. (1 point)

Describe American Depository Receipts as an approach to investing in international securities and explain whether they are more likely to be used in a passive or active investment strategy.
30. (1.5 points)

A 3-year $100 bond with a yield of 12% with continuous compounding pays a 6% coupon at the end of each year.

a. (0.5 point)

Calculate the price of the bond.

b. (0.5 point)

Calculate the duration of the bond.

c. (0.5 point)

Use the duration from part b. above to estimate the effect of a 0.3% decrease in the bond yield on the bond price.

SHOW ALL WORK.
31. (1.75 points)

An insurance company has an obligation to make a payment of $15,485 eight years from today. The market interest rate is 11%. The insurer plans to fund the obligation using zero-coupon bonds that mature in four years and perpetuities that pay annual coupons.

Determine the amounts to be invested today by the insurer in perpetuities and zero-coupon bonds to immunize the obligation.

SHOW ALL WORK.
32. (3 points)

You are given the following information about a property/casualty insurer as of January 1, 2009:

<table>
<thead>
<tr>
<th></th>
<th>Annual Value</th>
<th>Present Value</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premiums</td>
<td>$105</td>
<td>$630</td>
<td>8.038</td>
</tr>
<tr>
<td>Losses</td>
<td>$70</td>
<td>$400</td>
<td>7.620</td>
</tr>
<tr>
<td>Expenses</td>
<td>$31</td>
<td>$31</td>
<td>6.670</td>
</tr>
<tr>
<td>Risk-free interest rate</td>
<td>5.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firm’s target return on surplus</td>
<td>15.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firm’s client retention ratio</td>
<td>90.0%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- The total economic value of the insurer is $101.33.
- Premium is written and expenses are paid on January 1 of every year.
- Losses are paid on December 31 of every year.
- The insurer’s target return on surplus does not vary with prevailing interest rates.

a. (1 point)

Calculate the current economic value of this firm on January 1, 2009.

b. (1.5 points)

Calculate the duration of the total economic value of this firm.

c. (0.5 point)

Reducing the duration of the firm’s invested assets is one approach to reducing the interest rate sensitivity of the insurer’s total economic value.

Describe another approach.

SHOW ALL WORK.
33. (2.25 points)

You are given the following information about a financial institution’s portfolio of options on corn:

<table>
<thead>
<tr>
<th>Type</th>
<th>Position</th>
<th>Number of Options Held</th>
<th>Delta of Option</th>
<th>Gamma of Option</th>
<th>Vega of Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Call</td>
<td>Long</td>
<td>100,000</td>
<td>0.50</td>
<td>0.40</td>
<td>1.00</td>
</tr>
<tr>
<td>Call</td>
<td>Short</td>
<td>50,000</td>
<td>0.75</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Put</td>
<td>Short</td>
<td>150,000</td>
<td>-0.60</td>
<td>0.70</td>
<td>1.50</td>
</tr>
</tbody>
</table>

a. (0.75 point)

Determine the delta, gamma, and vega of the portfolio.

b. (1.5 points)

There are two options available for trading:

<table>
<thead>
<tr>
<th>Option</th>
<th>Delta of Option</th>
<th>Gamma of Option</th>
<th>Vega of Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.10</td>
<td>0.50</td>
<td>2.00</td>
</tr>
<tr>
<td>2</td>
<td>0.50</td>
<td>0.80</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Determine the positions in corn and in traded options 1 and 2 that would make the portfolio delta-, gamma-, and vega-neutral.

SHOW ALL WORK.
34. (1 point)

   a. (0.5 point)
   Briefly describe one advantage and one disadvantage to the historical simulation approach for estimating Value at Risk (VaR).

   b. (0.5 point)
   Briefly describe one advantage and one disadvantage to the model-building approach for estimating VaR.
35. (2.25 points)

You are given the following information about an insurance line of business:

- The expected premium is $5,000,000.
- The expected expense ratio is 5%.
- The expected annual investment return is 4%.
- The expected discounted loss ratio is 90%.
- The target risk-adjusted return on capital (RAROC) is 15%.
- The co-conditional tail expectation (Co-CTE) allocated risk capital at 99th percentile is $4,000,000.

a. (1.25 points)

Calculate the expected RAROC using the Co-CTE (99%) allocation for this line of business.

b. (1 point)

Calculate the additional risk margin in dollars required to produce the target RAROC using an economic value added (EVA) approach.

SHOW ALL WORK.
36. (2 points)

Assume a monoline insurance company has $7,500,000 of capital. The company’s only three sources of risk are market risk, loss reserve risk, and underwriting risk.

These key risk components were simulated and the aggregate loss was determined for each of 1,000 simulation scenarios. The five largest simulated aggregate losses are shown in the following table.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Market Risk</th>
<th>Reserve Risk</th>
<th>Underwriting Risk</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>($950,000)</td>
<td>$3,600,000</td>
<td>$1,900,000</td>
<td>$4,550,000</td>
</tr>
<tr>
<td>2</td>
<td>250,000</td>
<td>2,750,000</td>
<td>750,000</td>
<td>3,750,000</td>
</tr>
<tr>
<td>3</td>
<td>100,000</td>
<td>1,900,000</td>
<td>950,000</td>
<td>2,950,000</td>
</tr>
<tr>
<td>4</td>
<td>(400,000)</td>
<td>1,200,000</td>
<td>1,400,000</td>
<td>2,200,000</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>1,500,000</td>
<td>550,000</td>
<td>2,050,000</td>
</tr>
</tbody>
</table>

a. (0.5 point)

Calculate the 99.5% Conditional Tail Expectation (CTE) for the total aggregate loss.

b. (1.5 points)

Allocate the capital to each source of risk (market, reserve, underwriting) in proportion to the 99.5% Co-CTE allocation percentages.

SHOW ALL WORK.
37. (1.5 points)

You are given the following information about two lines of business written by an insurer for which economic profit equals net income:

<table>
<thead>
<tr>
<th></th>
<th>Line A</th>
<th>Line B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual discounted loss ratio</td>
<td>95.0%</td>
<td>85.0%</td>
</tr>
<tr>
<td>Economic profit</td>
<td>500,000</td>
<td>900,000</td>
</tr>
<tr>
<td>Co-conditional tail expectation (99%) allocated capital</td>
<td>2,000,000</td>
<td>4,000,000</td>
</tr>
<tr>
<td>Cost of capital</td>
<td>10%</td>
<td>18%</td>
</tr>
</tbody>
</table>

a. (0.75 point)

Explain which line of business performed better based on the risk-adjusted return on capital (RAROC) performance measure.

b. (0.75 point)

Explain whether each line of business adds value for the insurer based on the economic value added (EVA) performance measure.

SHOW ALL WORK.
38. (1 point)

a. (0.5 point)

One approach to using Value at Risk (VaR) in capital allocation is to use exceedence probability. Define exceedence probability.

b. (0.5 point)

Briefly discuss two issues with using exceedence probabilities with VaR for capital allocation.
39. (1 point)

You are given the following information about insurers A and B:

- Insurers A and B both have assets of $13,000.
- Insurers A and B both have unpaid losses of $10,000.
- Insurers A and B both have capital of $3,000.

- Insurer A’s Loss Probability Distribution

<table>
<thead>
<tr>
<th>Probability</th>
<th>Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>20%</td>
<td>$6,900</td>
</tr>
<tr>
<td>60%</td>
<td>$10,000</td>
</tr>
<tr>
<td>20%</td>
<td>$13,100</td>
</tr>
</tbody>
</table>

- Insurer B’s Loss Probability Distribution

<table>
<thead>
<tr>
<th>Probability</th>
<th>Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>20%</td>
<td>$2,000</td>
</tr>
<tr>
<td>60%</td>
<td>$10,000</td>
</tr>
<tr>
<td>20%</td>
<td>$18,000</td>
</tr>
</tbody>
</table>

Demonstrate why probability of ruin is inadequate as a measure of risk with respect to solvency for insurers A and B.

SHOW ALL WORK.
40. (2.5 points)

You plan to allocate capital to a line of business with the following characteristics:

- Both assets and liabilities are risky.
- The risk parameter is 0.5.
- The asset-to-liability ratio is 1.75.
- The time to maturity is one year.
- The risk-free rate is 1%.

Calculate the expected policyholder deficit as a percentage of liabilities.

SHOW ALL WORK.
41. (2.5 points)

You are given the following information about a pass-through security that consists of ten identical loans:

- The amount of each loan is $100,000.
- The interest rate for each loan is 6%.
- The term for each loan is four years.
- Interest payments are made annually.

The payment schedule for each loan follows:

<table>
<thead>
<tr>
<th>Payment</th>
<th>Principal</th>
<th>Interest</th>
<th>Total</th>
<th>Balance After Payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$22,859.15</td>
<td>$6,000.00</td>
<td>$28,859.15</td>
<td>$77,140.85</td>
</tr>
<tr>
<td>2</td>
<td>24,230.70</td>
<td>4,628.45</td>
<td>28,859.15</td>
<td>52,910.15</td>
</tr>
<tr>
<td>3</td>
<td>25,684.54</td>
<td>3,174.61</td>
<td>28,859.15</td>
<td>27,225.61</td>
</tr>
<tr>
<td>4</td>
<td>27,225.61</td>
<td>1,633.54</td>
<td>28,859.15</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Units of this pass-through security are being sold in three different tranches. During each year, each tranche receives interest in proportion to the tranche’s outstanding principal balance. Initially, all principal payments go to Tranche A. Once Tranche A is fully paid off, all principal payments go to Tranche B.

Within the pass-through security being offered, Tranche A units account for 40% of the principal, Tranche B units account for 30% of the principal and Tranche C units account for 30% of the principal.

Assume 3 out of the 10 loans pay their remaining loan value with payment #2.

Calculate how much undiscounted income is lost by the investors in each of tranches A, B, and C.

SHOW ALL WORK.
42. (1 point)

a. (0.5 point)

In the 1970s, homeowners in many parts of the United States had difficulty obtaining mortgage loans for their homes. Explain how the creation of mortgage-backed securities helped alleviate this problem.

b. (0.5 point)

Explain how insurance securitization products, such as catastrophe bonds, are fundamentally different from securitization products offered outside the insurance industry, such as mortgage-backed securities.
43. (1.5 points)

You are given the following information from the financial statements of Company XYZ, a large oil conglomerate.

- XYZ expects to pay out $2.50 per share in dividends at year-end.
- XYZ’s stock price is $125 per share.
- Oil stocks currently provide an expected return of 12%.

a. (0.5 point)

Calculate the market’s expectation for growth of XYZ’s dividends.

b. (0.5 point)

Calculate XYZ’s new stock price if dividend growth forecasts for XYZ are revised to 11% per year.

c. (0.5 point)

Explain what will happen to the company’s price/earnings (P/E) ratio based on the new dividend growth forecasts specified in part b. above.

SHOW ALL WORK.
44. (2.5 points)

A financial analyst uses a dividend discount model with a 3-year holding period to value the stock price of Company ABC, a major motion picture producer. After a recent announcement about a new imaging technology, the analyst makes the following estimates about Company ABC:

- The estimated dividend growth rate is 20%.
- The stock’s beta is 1.25.

You are given the following additional information about Company ABC:

- The stock price on December 31, 2008 is $26.25.
- The 3-month Treasury bill rate is 5.0%.
- The market capitalization rate is 12.0%.
- The long-term growth rate (beyond the 3-year holding period) for earnings and dividends is 11.5%.
- The dividend per share forecast for 2009 is $0.454.

a. (0.5 point)

Calculate the risk-adjusted required rate of return on Company ABC’s stock.

b. (1 point)

Calculate the intrinsic value of Company ABC’s stock on January 1, 2009.

c. (0.5 point)

Explain whether the analyst should recommend that investors buy or sell the stock of Company ABC.

d. (0.5 point)

Company ABC expects the new technology to increase the value of its stock.

Explain why this expectation is or is not consistent with your recommendation from part c. above.

SHOW ALL WORK.
45. (1 point)

An analyst reviewed the stock of Company ABC and Company XYZ. ABC is a start-up company that designs new websites. XYZ is an established company that has sold household appliances for 40 years. The analyst prepared the following table to compare the two companies.

<table>
<thead>
<tr>
<th></th>
<th>ABC</th>
<th>XYZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current price</td>
<td>$20.00</td>
<td>$22.50</td>
</tr>
<tr>
<td>Current price/earnings (P/E) ratio</td>
<td>20</td>
<td>12</td>
</tr>
<tr>
<td>5-year average P/E ratio</td>
<td>24</td>
<td>15</td>
</tr>
<tr>
<td>Current price/book value (P/BV) ratio</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>5-year average P/BV ratio</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Beta</td>
<td>1.4</td>
<td>1.1</td>
</tr>
<tr>
<td>Expected dividend per share</td>
<td>$0.25</td>
<td>$3.00</td>
</tr>
</tbody>
</table>

a. (0.5 point)

Briefly explain why the disparity in P/E and P/BV ratios may not indicate that the shares of ABC are overvalued relative to the shares of XYZ.

b. (0.5 point)

Using the constant-growth dividend discount model, the analyst estimates the value of ABC to be $30 per share and the value of XYZ to be $33.75 per share.

Briefly explain one weakness of this model and why it may be less suitable for valuing ABC than for valuing XYZ.


END OF EXAMINATION
# Tables of the Normal Distribution

## Probability Content from $-\infty$ to $Z$

<table>
<thead>
<tr>
<th>$z$</th>
<th>0.00</th>
<th>0.01</th>
<th>0.02</th>
<th>0.03</th>
<th>0.04</th>
<th>0.05</th>
<th>0.06</th>
<th>0.07</th>
<th>0.08</th>
<th>0.09</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.5000</td>
<td>0.5040</td>
<td>0.5080</td>
<td>0.5120</td>
<td>0.5160</td>
<td>0.5199</td>
<td>0.5239</td>
<td>0.5279</td>
<td>0.5319</td>
<td>0.5359</td>
</tr>
<tr>
<td>0.1</td>
<td>0.5398</td>
<td>0.5438</td>
<td>0.5478</td>
<td>0.5517</td>
<td>0.5557</td>
<td>0.5596</td>
<td>0.5636</td>
<td>0.5675</td>
<td>0.5714</td>
<td>0.5753</td>
</tr>
<tr>
<td>0.2</td>
<td>0.5793</td>
<td>0.5832</td>
<td>0.5871</td>
<td>0.5910</td>
<td>0.5948</td>
<td>0.5987</td>
<td>0.6026</td>
<td>0.6064</td>
<td>0.6103</td>
<td>0.6141</td>
</tr>
<tr>
<td>0.3</td>
<td>0.6179</td>
<td>0.6217</td>
<td>0.6255</td>
<td>0.6293</td>
<td>0.6331</td>
<td>0.6368</td>
<td>0.6406</td>
<td>0.6443</td>
<td>0.6480</td>
<td>0.6517</td>
</tr>
<tr>
<td>0.4</td>
<td>0.6554</td>
<td>0.6591</td>
<td>0.6628</td>
<td>0.6664</td>
<td>0.6700</td>
<td>0.6736</td>
<td>0.6772</td>
<td>0.6808</td>
<td>0.6844</td>
<td>0.6879</td>
</tr>
<tr>
<td>0.5</td>
<td>0.6915</td>
<td>0.6950</td>
<td>0.6985</td>
<td>0.7019</td>
<td>0.7054</td>
<td>0.7088</td>
<td>0.7123</td>
<td>0.7157</td>
<td>0.7190</td>
<td>0.7224</td>
</tr>
<tr>
<td>0.6</td>
<td>0.7257</td>
<td>0.7291</td>
<td>0.7324</td>
<td>0.7357</td>
<td>0.7389</td>
<td>0.7422</td>
<td>0.7454</td>
<td>0.7486</td>
<td>0.7517</td>
<td>0.7549</td>
</tr>
<tr>
<td>0.7</td>
<td>0.7580</td>
<td>0.7611</td>
<td>0.7642</td>
<td>0.7673</td>
<td>0.7704</td>
<td>0.7734</td>
<td>0.7764</td>
<td>0.7794</td>
<td>0.7823</td>
<td>0.7852</td>
</tr>
<tr>
<td>0.8</td>
<td>0.7881</td>
<td>0.7910</td>
<td>0.7939</td>
<td>0.7967</td>
<td>0.7995</td>
<td>0.8023</td>
<td>0.8051</td>
<td>0.8078</td>
<td>0.8106</td>
<td>0.8133</td>
</tr>
<tr>
<td>0.9</td>
<td>0.8159</td>
<td>0.8186</td>
<td>0.8212</td>
<td>0.8238</td>
<td>0.8264</td>
<td>0.8289</td>
<td>0.8315</td>
<td>0.8340</td>
<td>0.8365</td>
<td>0.8389</td>
</tr>
<tr>
<td>1.0</td>
<td>0.8413</td>
<td>0.8438</td>
<td>0.8461</td>
<td>0.8485</td>
<td>0.8508</td>
<td>0.8531</td>
<td>0.8554</td>
<td>0.8577</td>
<td>0.8599</td>
<td>0.8621</td>
</tr>
<tr>
<td>1.1</td>
<td>0.8643</td>
<td>0.8665</td>
<td>0.8686</td>
<td>0.8708</td>
<td>0.8729</td>
<td>0.8749</td>
<td>0.8770</td>
<td>0.8790</td>
<td>0.8810</td>
<td>0.8830</td>
</tr>
<tr>
<td>1.2</td>
<td>0.8849</td>
<td>0.8869</td>
<td>0.8888</td>
<td>0.8907</td>
<td>0.8925</td>
<td>0.8944</td>
<td>0.8962</td>
<td>0.8980</td>
<td>0.8997</td>
<td>0.9015</td>
</tr>
<tr>
<td>1.3</td>
<td>0.9032</td>
<td>0.9049</td>
<td>0.9066</td>
<td>0.9082</td>
<td>0.9099</td>
<td>0.9115</td>
<td>0.9131</td>
<td>0.9147</td>
<td>0.9162</td>
<td>0.9177</td>
</tr>
<tr>
<td>1.4</td>
<td>0.9192</td>
<td>0.9207</td>
<td>0.9222</td>
<td>0.9236</td>
<td>0.9251</td>
<td>0.9265</td>
<td>0.9279</td>
<td>0.9292</td>
<td>0.9306</td>
<td>0.9319</td>
</tr>
<tr>
<td>1.5</td>
<td>0.9332</td>
<td>0.9345</td>
<td>0.9357</td>
<td>0.9370</td>
<td>0.9382</td>
<td>0.9394</td>
<td>0.9406</td>
<td>0.9418</td>
<td>0.9429</td>
<td>0.9441</td>
</tr>
<tr>
<td>1.6</td>
<td>0.9452</td>
<td>0.9463</td>
<td>0.9474</td>
<td>0.9484</td>
<td>0.9495</td>
<td>0.9505</td>
<td>0.9515</td>
<td>0.9525</td>
<td>0.9535</td>
<td>0.9545</td>
</tr>
<tr>
<td>1.7</td>
<td>0.9554</td>
<td>0.9564</td>
<td>0.9573</td>
<td>0.9582</td>
<td>0.9591</td>
<td>0.9599</td>
<td>0.9608</td>
<td>0.9616</td>
<td>0.9625</td>
<td>0.9633</td>
</tr>
<tr>
<td>1.8</td>
<td>0.9641</td>
<td>0.9649</td>
<td>0.9656</td>
<td>0.9664</td>
<td>0.9671</td>
<td>0.9678</td>
<td>0.9686</td>
<td>0.9693</td>
<td>0.9699</td>
<td>0.9706</td>
</tr>
<tr>
<td>1.9</td>
<td>0.9713</td>
<td>0.9719</td>
<td>0.9726</td>
<td>0.9732</td>
<td>0.9738</td>
<td>0.9744</td>
<td>0.9750</td>
<td>0.9756</td>
<td>0.9761</td>
<td>0.9767</td>
</tr>
<tr>
<td>2.0</td>
<td>0.9772</td>
<td>0.9778</td>
<td>0.9783</td>
<td>0.9788</td>
<td>0.9793</td>
<td>0.9798</td>
<td>0.9803</td>
<td>0.9808</td>
<td>0.9812</td>
<td>0.9817</td>
</tr>
<tr>
<td>2.1</td>
<td>0.9821</td>
<td>0.9826</td>
<td>0.9830</td>
<td>0.9834</td>
<td>0.9838</td>
<td>0.9842</td>
<td>0.9846</td>
<td>0.9850</td>
<td>0.9854</td>
<td>0.9857</td>
</tr>
<tr>
<td>2.2</td>
<td>0.9861</td>
<td>0.9864</td>
<td>0.9868</td>
<td>0.9871</td>
<td>0.9875</td>
<td>0.9878</td>
<td>0.9881</td>
<td>0.9884</td>
<td>0.9887</td>
<td>0.9890</td>
</tr>
<tr>
<td>2.3</td>
<td>0.9893</td>
<td>0.9896</td>
<td>0.9898</td>
<td>0.9901</td>
<td>0.9904</td>
<td>0.9906</td>
<td>0.9909</td>
<td>0.9911</td>
<td>0.9913</td>
<td>0.9916</td>
</tr>
<tr>
<td>2.4</td>
<td>0.9918</td>
<td>0.9920</td>
<td>0.9922</td>
<td>0.9925</td>
<td>0.9927</td>
<td>0.9929</td>
<td>0.9931</td>
<td>0.9932</td>
<td>0.9934</td>
<td>0.9936</td>
</tr>
<tr>
<td>2.5</td>
<td>0.9938</td>
<td>0.9940</td>
<td>0.9941</td>
<td>0.9943</td>
<td>0.9945</td>
<td>0.9946</td>
<td>0.9948</td>
<td>0.9949</td>
<td>0.9951</td>
<td>0.9952</td>
</tr>
<tr>
<td>2.6</td>
<td>0.9953</td>
<td>0.9955</td>
<td>0.9956</td>
<td>0.9957</td>
<td>0.9959</td>
<td>0.9960</td>
<td>0.9961</td>
<td>0.9962</td>
<td>0.9963</td>
<td>0.9964</td>
</tr>
<tr>
<td>2.7</td>
<td>0.9965</td>
<td>0.9966</td>
<td>0.9967</td>
<td>0.9968</td>
<td>0.9969</td>
<td>0.9970</td>
<td>0.9971</td>
<td>0.9972</td>
<td>0.9973</td>
<td>0.9974</td>
</tr>
<tr>
<td>2.8</td>
<td>0.9974</td>
<td>0.9975</td>
<td>0.9976</td>
<td>0.9977</td>
<td>0.9978</td>
<td>0.9979</td>
<td>0.9979</td>
<td>0.9979</td>
<td>0.9980</td>
<td>0.9981</td>
</tr>
<tr>
<td>2.9</td>
<td>0.9981</td>
<td>0.9982</td>
<td>0.9982</td>
<td>0.9983</td>
<td>0.9984</td>
<td>0.9984</td>
<td>0.9985</td>
<td>0.9985</td>
<td>0.9986</td>
<td>0.9986</td>
</tr>
<tr>
<td>3.0</td>
<td>0.9987</td>
<td>0.9987</td>
<td>0.9987</td>
<td>0.9988</td>
<td>0.9988</td>
<td>0.9988</td>
<td>0.9989</td>
<td>0.9989</td>
<td>0.9989</td>
<td>0.9990</td>
</tr>
</tbody>
</table>
Sample Solutions

Exam 8, May 2008

Released: August 4, 2008
Version 2
Exam 8, Question 1

a) New optimal risky portfolio

Weight in cat bond = \( \frac{(95 - 5) \cdot 12^2 - (8 - 5) \cdot (0.1 \times 12 \times 300)}{(95 - 5) \cdot 12^2 + (8 - 5) \cdot 300^2 - (95 - 5 + 8 - 5) \cdot (0.1 \times 12 \times 300)} \)

= 0.048

Expected return of new optimal risky portfolio = 0.048 of 95% + 0.952 of 8%

= 12.1%

Standard deviation of new optimal risky portfolio

= \( \sqrt{(0.048^2 \times 300^2 + 0.952^2 \times 12^2 + 2 \times 0.048 \times 0.952 \times 0.1 \times 12 \times 300)} \)

= 19.2%

b) \( y^* = \frac{E(r) - rf}{A\sigma_p^2} \)

\( = \frac{12.15 - 0.05}{3 \times 0.1918^2} \) = 0.6478

OR

\( y^* = \frac{E(r) - rf}{0.01A\sigma_p^2} \)

\( = \frac{12.15 - 5}{0.01 \times 3 \times 19.18^2} \) = 0.6478

64.78% should in invested in the new risky portfolio
35.22% should be invested in risk free assets.

(c) Amount of T-bills to be purchased or sold

At end of year, % invested in risky portfolio = \( \frac{78000}{78000 + 37800} \) = 67.36%

$78,000 needs to represent 64.78% of the portfolio.

Portfolio must be \( \frac{78,000}{0.6478} = 120,408 \)

T-bill portion should be \( 120,408 - 78,000 = 42,408 \)

Rebalancing requires purchase of \( 42,408 - 37,800 = 4,608 \) in T-bills

OR

Total portfolio at t=1 is \( 115,800 \) ($78,000 + $37,800)

T-bills must be 35.22% \( \times 115,800 = 40,785 \)

Need to buy \$2,985 (~$40,785 - 37,800) in T-bills
Exam 8, Question 2

\[
E(r) = r_t + \beta(E(r_\mu) - r_t)
\]

\[
= 4 + 0.8 (13 - 4) = 11.2\%
\]

Price = 51.25  
\[\text{div} = 0.92\]  
\[1/1\]  
\[12/31\]

\[
P_0 = \frac{E(DIV_1) + E(P_1)}{1 + E(r)}
\]

\[
51.25 = 0.92 + E(P_1)
\]

\[
1.112
\]

\[
E(P_1) = $56.07 = \text{price on 1/1/2009}
\]
Exam 8, Question 2

\[ \beta = .8 \quad E(r_m) = .13 \quad rf = .4\% \quad K = rf + \beta[E(r_m) - rf] = 11.2\% \]

<table>
<thead>
<tr>
<th>Price/Share</th>
<th>Dividend</th>
</tr>
</thead>
<tbody>
<tr>
<td>51.25</td>
<td>.92</td>
</tr>
</tbody>
</table>

\[ g = bxR0E \]

<table>
<thead>
<tr>
<th>Jan 2008</th>
<th>Jan 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>Dividend</td>
</tr>
<tr>
<td>51.25</td>
<td>.92</td>
</tr>
</tbody>
</table>

\[ \text{Price}_{\text{Jan 2009}} = \frac{\text{Dividend Jan 2010}}{k - g} = \frac{\text{Dividend Jan 2009} (1 + g)}{k - g} \]

\[ \text{Price}_{\text{Jan 2008}} = \frac{\text{Dividend Jan 2009}}{k - g} \]

\[ 51.25 = \frac{.92}{11.2\% - g} \]

\[ \rightarrow g = .094 \]

\[ \text{Price}_{\text{Jan 2009}} = .92 (1.094) = 55.92 \]

\[ .112 - .094 \]
a. The slope is the measure of systematic risk so Z has greater systematic risk since it has a higher slope.

b. Z has higher firm specific risk since the plot points are more spread out from the regression line.

c. The slopes are consistent with CAPM since CAPM is \( E(r_i) = r_f + \beta (E(r_m) - r_f) \) so any slope is appropriate.

   The intercept of CAPM is 0, so Y is consistent with CAPM while Z is not.
Exam 8 Question 4

A: \[ .20 = .03 + .80 \times F_1 + .70 \times F_2 + 1.65 \times .10 \]
C: \[ .166 = .03 + 1.25 \times F_1 + .70 \times F_2 + 1.40 \times .10 \]

A: \[ .005 = .80 \times F_1 + .70 \times F_2 \]
C: \[ -.004 = 1.25 \times F_1 + .70 \times F_2 \]

A-C: \[ .009 = -.45 \times F_1 \]

\[ F_1 = -.02 = \text{risk premium} \]
Exam 8, Question 5

a. weak-form: stock price reflects all past trading data
   
   semistrong form: stock price reflects all publicly available information regarding a firm
   
   Strong form: stock price reflects all information available for a firm, including inside information

b. not violate weak form because earning is not trading data
   
   violates semistrong form and strong form
Exam 8, Question 5

(a) weak form efficient market hypothesis (EMH): a stock’s price reflects all available information attainable through review of market trading data.

   semi-strong form EMH: a stock’s price reflects all publicly available information

   strong-form EMH: a stock’s price reflects all information, even insider information

(b) weak: post-earnings announcement drift would invalidate this because you can see in market data the effect of this, and would be able to predict it (in the book they claimed that it invalidated the semi-strong form, but we would be able to see the effects in market trading data, so it should invalidate the weak form too)

   semi-strong: this would be invalidated

  strong-form: since semi-strong is a subset of strong form EMH, this effect would invalidate strong-form efficiency too
Exam 8, Question 6

a) effectively identical assets should have the same price.

b) 1) Siamese twins
   Royal Dutch / Shell are effectively one company split 60/40. So stock prices should move in sync accordingly, but they don’t.

2) Equity carve-outs
   3Com announced its decision to spin off Palm, and gave each shareholder 1.5 Palm share. In theory, 3com stock price should have been higher than Palm’s, but it was not.
a) The concept of market efficiency says that the market is efficient at pricing stocks and there is little value in actively managing a fund. There are few stocks that are not correctly valued, and the transaction costs incurred with active management would eliminate any excess returns over the market.

In any given year, one would expect 50% of funds to be in the top half of performers. In the subsequent year 50% of those top performers will remain in the top half, or 250 in our example. The fact that 300 remain in the top half leads an investor to question the market efficiency concept since it is higher than the expected value of 250.

b) Survivorship bias is the idea that poorly managed funds are closed. So the 300 top performers that remain in the top half the second year is more likely if a certain number of mutual fund managers drop out of the pool. Therefore the idea of market efficiency still holds, however it should be viewed on a conditional basis each year instead of the initial number of funds.
Exam 8, Question 8

(a)

<table>
<thead>
<tr>
<th>Year</th>
<th>Infl</th>
<th>Par</th>
<th>CPN %</th>
<th>CPN $</th>
<th>TOTAL PMT by Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>-</td>
<td>1000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>1%</td>
<td>1010</td>
<td>5%</td>
<td>50.5</td>
<td>$50.5  2008</td>
</tr>
<tr>
<td>2009</td>
<td>3%</td>
<td>1040.3</td>
<td>5%</td>
<td>52.015</td>
<td>$52.02 2009</td>
</tr>
<tr>
<td>2010</td>
<td>2%</td>
<td>1061.106</td>
<td>5%</td>
<td>53.0553</td>
<td>$1,114.16 2010</td>
</tr>
</tbody>
</table>

(b)

Real ROR = \frac{1 + \text{Nominal ROR} - 1}{1 + \text{inflation}}

Nominal ROR (2009) = \frac{\text{Appreciation} + \text{Coupon}}{\text{Initial price}}

= \frac{1040.3 - 1010 + 52.015}{1010} = 8.15%

Real ROR = \frac{1 + 8.15\% - 1}{1 + 3\%} = 5\%
Exam 8, Question 9

FV = 1000  P = $950  t = 3 years  coupon = 5% annual
PV = -$950  N = 6  PMT = \frac{0.05 \times 1000}{2} = 25

\[ P_{\text{Year 2}} \rightarrow \frac{25}{1.025} + \frac{1.025}{1.025^2} = 1000 \]

Realized Compound Yield = \[ \left( \frac{25 + 25(1.02) + 25(1.02)^2 + 25(1.02)^3 + 1000}{950} \right)^{1/2} \]

= 7.75%
Exam 8, Question 9

$P_0 = 950$
$FV = 1000$
$T = 3 \text{ Yrs}$
$\text{Coupon} = 50 \text{ annual pd} 25 \text{ semi}$

$P_2 = 1000$
$N = 2 \quad 1/Y = 2.5 \quad \text{PMT} = 25 \quad FV = 1000$

$\text{Coupon Value} = 25 (1.02)^3 + 25 (1.02)^2 + 25 (1.02) + 25 = 103.04$

$\text{Return} = \sqrt{\frac{1000 + 103.04}{950}} - 1 = 7.75\%$
Exam 8, Question 10

a) \( PV_0 = 6,791.17 \) \( FV = 10,000 \) \( PMT = 400 \) \( I = 9\% \) \( N = 10 \)
\( P_1 = 8,045.43 \) \( FV = 10,000 \) \( PMT = 400 \) \( I = 7\% \) \( N = 9 \)

\[
8,045.43 + 400 - 6791.17 \\
6791.17
\]

= 24.36 \%

b) Interest Income

\[ \text{Price } @ \text{ 1 Yr } @ 9\% = 7002.38 \] \( FV = 10,000 \) \( PMT = 400 \) \( I = 9\% \) \( N = 9 \)

\[
(7,002.38 - 6791.17 + 400) * 0.35 = 213.92
\]

Capital Gains = \((8,045.43 - 7002.35) (.2) = 208.61\)

Total tax owed = 213.92 + 208.61

= 422.53
Exam 8, Question 10

a) \( FV = 10000 \)
\( \text{PMT} = 10,000 (.04) = 400 \)
\( \text{YTM} = 9 \)
\( N = 10 \)  
\[
\text{Price now} = 6791.17 
\]
\[\text{FV} = 10000 \]
\[\text{PMT} = 400 \]
\[\text{YTM} = 7 \]
\[N = 9 \]  
\[
\text{Price in 1 year} = 8045.43 
\]
\[
\text{Pre tax HPR} = \frac{400 + 8045.43 - 6791.17 - 1}{6791.17} = .2436 
\]

b) \( FV = 10000 \)
\( \text{PMT} = 400 \)
\( \text{YTM} = 9 \)
\( N = 9 \)  
\[
\text{price in 1 year with no change in yield} = 7002.38 
\]
\[
\text{\$ tax owed} = .35 [400 + 7002.38 - 6791.17] + .20 [8045.43 - 7002.38] = 422.53 
\]
Exam 8, Question 11

(a)  First, The firm can repurchase only a limited fraction of the bond issue at the sinking fund call price

    Second, Callable bonds have generally call prices above par value, but the sinking fund call price usually is set at the bond’s par value.

(b) If interest rate fall and bond price rise, an investor holding a bond with a sinking fund will lose because the firm can repurchase their bonds at below-market price.
Exam 8, Question 11

a) date & price are set for sinking fund call, happens no matter what. For callable bond, call is made only if beneficial to call holder.

S. fund call price usually a bit of a premium over par, call price on callable bond usually = par. Note, if bond selling @ discount S.F need to “officially” call → simply buy bond in open mkt @ better price.

b). holding period will be cut short & usually at time when int. rate declining (bond worth more than SF price paid). If int. rate ↑, price < S.F price & investor gets mkt value. So investor always gets min (SF price, mkt price) & shorter duration.
Exam 8, Question 12

\[ 97.47 = 100e^{-R_{0.5}(0.5)} \]
\[ R_{0.5} = 0.05125 \]

\[ 94.00 = 100e^{-R_1(1)} \]
\[ R_1 = 0.06188 \]

\[ 95.75 = 2.5e^{-0.05125(0.5)} + 2.5e^{-0.06188(1)} + 102.5e^{-R_{1.5}(1.5)} \]
\[ R_{1.5} = 0.0796 \]
Exam 8, Question 12

\[
\begin{align*}
100 & = 97.47 \\
(1+y_1) \\
100 & = 94 \\
(1+y_2)^2 \\
\frac{2.5}{1+y_1} + \frac{2.5}{(1+y_2)^2} + \frac{102.5}{(1+y_3)^3} & = 95.75 \\
\frac{2.5}{100} + \frac{2.5}{100} + \frac{102.5}{94} & = 95.75 \\
\frac{102.5}{97.47} & = 90.96325 \\
\frac{102.5}{(1+y_3)^3} & = 90.96325 \\
1+y_3 & = 1.0406 \\
(1+y_3)^2 & = e^r \\
r & = 7.96\%, contin
\end{align*}
\]
Exam 8, Question 13

Assuming 100 original par value

\[ P = \frac{5.5}{(1.075)} + \frac{105.5}{(1.075)^2} = 96.41 \]

After turmoil expected par is 80 and price is 96.41 (.85) = 81.95. So

\[ 81.95 = \frac{5.5}{(1+y/2)} + \frac{85.5}{(1+y/2)^2} \]

\[ \rightarrow y = 11.11\% \]
Exam 8, Question 14

a. \( (100Q_1 \times .3 + 100(1 - Q_1))e^{-0.07} = 100e^{-0.073} \)
\( (1 - .7Q_1)e^{-0.07} = e^{-0.073} \)
\( Q_1 = \frac{1 - e^{-0.073} + 0.07}{0.7} \)
\( = 0.0043 \) YR1 Prob of Default

\( (1 - .7Q_2)e^{-0.07 \times 2} = e^{-0.076 \times 2} \)
\( Q_2 = \frac{1 - e^{(-0.076 + 0.7) \times 2}}{0.7} \)
\( = 0.0170 \) YR2

\( (1 - .7Q_4)e^{-0.07 \times 4} = e^{-0.08 \times 4} \)
\( Q_4 = \frac{1 - e^{(-0.08 + 0.7) \times 4}}{0.7} \)
\( = 0.0560 \) YR 4

\( Q_4 - Q_2 = 0.0560 - 0.0170 = 0.039 = 3.9% \)

b. \( \gamma = \frac{Q_4 - Q_2}{1 - Q_2} = \frac{0.0560 - 0.0170}{1 - 0.0170} = \frac{0.0397}{0.983} = 4.0% \)
Exam 8, Question 14

a) \( q = Q(4) - Q(2) \)

\[ Q(4) = 1 - e^{4(\lambda(4))} \]

\[ \lambda(4) = \frac{S}{1-R} = \frac{0.08 - 0.07}{0.7} = 0.0143 \]

\[ \lambda(2) = \ldots = \frac{0.076 - 0.07}{0.7} = 0.00857 \]

\[ \rightarrow Q(2) = 1 - e^{-2(0.00857)} = 0.017 \]

\[ Q(4) = 1 - e^{-4(0.0143)} = 0.0556 \]

\[ \rightarrow q = 0.0556 - 0.017 = 3.86\% \]

b) \( \lambda = Q(4) - Q(2) = \frac{0.0386}{1 - 0.017} = 3.93\% \)
Exam 8, Question 15

1: \[
\frac{50k}{25k + 50k + 45k + 10k + 40k} = .2941
\]
Include all, B defaults

2: \[
\frac{40k}{25k + 10k + 40k} = .533
\]
B defaulted, C matured, E defaults

\[
CMR = 1 - (1 - .2941)(1 - .533) = .671
\]
Exam 8, Question 16

a. probability of liability > asset = 1 – N(d2)

\[ d_2 = \frac{\ln(S/K) + (r - \sigma^2/2)T}{\sigma\sqrt{T}} \]

K = 2M  
T = 0.25  \( \sigma = 0.6 \)  \( r = 5\% \)

N(d2) = 1.645

S0 = 3.38M  (asset value today)

b. \( E = S_0N(d_1) - ke^{-rt}N(d_2) \)

\[ d_1 = d_2 + \sigma\sqrt{T} = 1.945 \]

N(d1) = 0.9741  
N(d2) = 0.95

E = 1.42M

c. Expected liability : without default

\[ EL = 2 \times e^{-0.05 \times 0.25} = 1.975 \]

EL with default = 3.38 – 1.42 = 1.96

Percentage of default = \( \frac{1.975 - 1.96}{1.975} = 0.76\% \)
Exam 8, Question 17

3 contracts @ 100 oz per contract = 300 oz

K = 485

Initial margin = 2500 x 3 = 7500

Maintenance margin = .75 x 7500 = 5625

a) 7500 – (485 – 483) 300 = 6900

b) 7500 – 5625 = 1875
   1875/300 = 6.25 per oz movement from 485
   So when price dips below 478.75 on April 9 there will be a margin call
   
   (485 – 475) 300 = 3000

   The margin call will be $3000 on April 9

c) loss on contract 300 x (485 – 477) = 2400

   on April 9 the value of margin = 7500
   So on April 10 value = 7500 + (477-475) 300 = 8100 in margin call
17. 485 per ounce
   100 oz per contract
   x 3 contracts
   145,500

   Initial margin = 3 x 2500 = 7500

   Margin account = 7500 – (2) (100) (3) = 6900

   Contracts = 144900 = 483 x 100 x 3

b) maintenance = 75% of 7500 = 5625

   April 8   -3 (100) (3) = -900
   +6900
   6000

   April 9   -5 (100) (3) = -1500
   6000
   4500      will now have a margin call

   Margin call April 9th for $3000 to get back up to original margin.

(c) Loss on contract (485 – 477) (100) (3) = 2400
    Value of margin account = 7500 + 2 (100) (3) = 8100
Exam 8, Question 18

a. Hedging strategy would be to take a long position in $20,000/5,000 = 4$ futures contracts. This long position protects the manufacturer in case the spot price increases.

b. Initial spot price = 600 cents
   Futures price = 590c.
   Spot price in July = $S_1 = 585c$
   Assume futures price = $F_1 = 585c$ [This is because if $S_1 \neq F_1$, there will be arbitrage opportunities].

   Spot price paid = 585 per ounce.
   Gain on futures = $F_2 - F_1 = 585 - 590 = -5$ cents
   ie. a loss of -5 cents per ounce
   Therefore gain or loss on hedging strategy = $-5 \times 20,000 = -100,000$ cents
   or $1000.
   Final effective price paid = $(585 + 5) = 590$ cents per ounce.
Exam 8, Question 19

$S_0 = 50$
$T = 2 \text{ yrs}$
$R = 5\%$
$K = $60

a) $F_0 = S_0 e^{rT} = 50e^{0.05(2)} = 55.26$

b) $f = (F_0 - K)e^{-rT}$

$= S_0 - I - Ke^{-rT} = 50 - 10 - 60e^{-0.05(2)} = 14.29$
Exam 8, Question 20

a) gain to F.I. = 0.03%

\[(6.6 - 6.0) + [(L + X) - (L + 1)] = 0.03\]
\[0.6 + X - 1 = 0.03\]
\[X = 0.43\]

b) Company B is more creditworthy than Company A as evidenced by the fact that it can borrow at a lower fixed rate and a lower floating rate.

Company B appears to have a comparative advantage over company A in fixed rates since the difference between each company’s fixed rates is greater than the difference in floating rates.

\[(6.6 - 6.0) = 0.6\% \text{ vs. } (L + 1.0) - (L + 0.43) = 0.57\%\]

Therefore Company A has a comparative advantage over Company B in floating rates.
Exam 8, Question 21

<table>
<thead>
<tr>
<th>Time</th>
<th>Company A pays</th>
<th>Fin. Inst. Pays</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 months</td>
<td>(0.07/2)200 = 7</td>
<td>(0.091/2)200 = 9.1</td>
</tr>
<tr>
<td>9 months</td>
<td>7</td>
<td>((9.598%/2))200 = 9.598</td>
</tr>
</tbody>
</table>

6 month fund rate in 3 mos = \(\frac{0.0925 \times 0.75 - 0.09 \times 0.25}{0.75 - 0.25}\)  
\[= 0.09375\]

0.09375 on a continuous basis  
\[= \frac{0.09375}{2 \times (e - 1) = 9.598\% \text{ annual, compounded semiannually}}\]

Value of swap = \((7 - 9.1)e^{-0.09\times 0.25} + (7 - 9.598)e^{-0.0925\times 0.75}\)  
\[= -4.477 \text{ million}\]
Exam 8, Question 21

Notional = 200m
6m LIBOR

\[ V_{\text{FinIntn}} = \beta_{\text{FIXED}} - \beta_{\text{FLOAT}} \]

\[ \beta_{\text{FIXED}} = 3.5\% (200m)e^{-0.09(0.25)} + 1.035(200m)e^{-0.0925(0.75)} \]

\[ = 199.97m \]

\[ \beta_{\text{FLOAT}} = (200m(0.09/2) + 200m)e^{-0.09(0.25)} = 204.45 \]

\[ VFI = 199.97m - 204.45m = -4.478m \]
Exam 8, Question 21

Bank pays LIBOR & gets 3.5% every 6 months

\[
T = 9 \text{ months} \quad F_3 = .75(.0925) - .25(.09) = \frac{9.375\%}{.5} \quad \text{continuous} \quad \frac{9.6\%}{\text{semi-annually}}
\]

\[
F_9 = 1.25(.095) - .75(.0925) = \frac{9.875\%}{.5} \quad 10.12\%
\]

<table>
<thead>
<tr>
<th>(T)</th>
<th>net amt received</th>
</tr>
</thead>
<tbody>
<tr>
<td>.25</td>
<td>200m (.07 - .091)(.5) = -2.1m</td>
</tr>
<tr>
<td>.75</td>
<td>200m (.07 - .096)(.5) = -2.6m</td>
</tr>
</tbody>
</table>

Value of swap = -2.1m \(e^{-0.25(0.09)}\) – 2.6m \(e^{-0.75(0.0925)}\) = -$4.479 million
Butterfly spread:
   Buy one put with $K = 95$
   Sell two puts with $K = 100$
   Buy one put with $K = 105$
   Up-front premium = $-5 + 2 \times 7 - 10 = -1$

Breakdown occurs @ price $96$ or $104$
In general
\[ f = e^{-rT} \times (f_u \times p + f_d \times (1-p)) = f_u \times p + f_d \times (1-p) \]

in our case since \( r = 0\% \)

assume \( u = 1 + x \) \( d = 1 - x \)

then \( p = \frac{e^{rT} - d}{u - d} = \frac{1 - \frac{4}{2} - x}{1 + x - \frac{4}{2} + x} = 50\% \)

so \( f = \frac{1}{2} (f_u + f_d) \)

\[ S_0 = 16 \]
\[ f = 2 \]
\[ f = 0 \]
\[ f = 0 \]
\[ f = 0 \]

note, initially call is out of money
so \( f = 0 \)

since for all \( x \in (0,1) \) and \( 16 (1 - x)(1 + x) \) always < 17 \( 16 (1 - x)^2 \)

so it must be that call is
exercised when \( S_T = 16 (1 + x)^2 \) so

\[ f = 2 = 0.5 \left[ 0 + 0.5[0 + (16(1 + x)^2 - 17)] \right] = 0.5^2(16(1+x)^2 - 17) \]

\[ 2/(0.5)^2 = 16x^2 + 32x -1 \rightarrow 16x^2 + 32x - 9 \]
\[ x = \frac{-32 + \sqrt{32^2 + 16 \times 9 \times 4}}{2 \times 16} \]
\[ X = 25\% \]
Exam 8, Question 23

Stock price tree

\[
\begin{array}{c|c|c|c}
T_0 & T_{3\text{mo}} & T_{6\text{mo}} & \text{Value Call} \\
\hline
16 (1+x) & 16 (1+x)^2 & 16 (1+x)^2 & 16 (1+x)^2 - 17 \\
16 & 16 (1+x)(1-x) & 0 & \\
16 (1-x) & 16 (1-x)^2 & 0 & \\
\end{array}
\]

European call with \( K = 17 = $2 \)

\[
P = \frac{e^{r(T)} - d}{u - d}
\]

\[
= \frac{1 - (1 - x)}{1 + x - (1 - x)} = \frac{1 - 1 + x}{1 + x - 1 + x} = \frac{x}{2x} = 0.5
\]

\[
2 = (0.5)^2 (16 (1 + x)^2 - 17)
\]

\[
8 = 16 (1 + x)^2 - 17
\]

\[
1.5625 = (1 + x)^2
\]

\[
1.25 = 1 + x
\]

\[
X = 25\%
\]
Value of company = \( 2,000,000 \times 50 = 100,000,000 \)

Then it becomes \( 2,000,000 \times 49.5 = 99,000,000 \)

So value of the warrants = 1,000,000 in total

Value of the call option = \( c = S_0N(d_1) - Ke^{-rT}N(d_2) \)

\[
\begin{align*}
    d_1 &= -0.1512 \\
    d_2 &= d_1 - \sigma \sqrt{T} = -0.4976 \\
    N(d_1) &= \text{from normal table} = 1 - [.5596 + .12(.5636 - .5596)] \\
        &= 1 - 0.56 = 0.4399 \\
    N(d_2) &= 1 - [.6879 + .76(.6915 - .6879)] = 0.3094 \\
    c &= 50(.4399) - 65e^{-0.05(3)}(.3094) \\
    c &= 4.6883
\end{align*}
\]

so value of one warrant = \( \frac{N}{M + N} \) * call

\( N = 2,000,000 \) = # of current shares

\( M = \# \) of warrants.

\[
\begin{align*}
    1,000,000 &= \frac{2,000,000}{2,000,000 + M} \times 4.6883 \times M \\
    2,000,000 + M &= 9.376632M \\
    M &= 238,759
\end{align*}
\]
Exam 8, Question 25

\[ \begin{align*}
V_H &= \frac{1070}{1.0625} = 1007.06 \\
V_L &= \frac{1070}{1.0365} = 1032.32 \text{ – called here at } 1000 \times 1.01 = 1010 \\
V &= \left( 70 + \frac{1}{2}(1007.06 + 1010) \right) \div 1.05 = 1027.17
\end{align*} \]

If there were no call feature, then
\[ V = \left( 70 + \frac{1}{2}(1007.06 + 1032.32) \right) / 1.05 = 1037.80 \]

Value of call option = 1037.80 – 1027.17 = 10.63
Exam 8, Question 25

Callable @ 1010

6.25%

\[ P_U = \frac{1070}{1.0625} = 1007.06 \]

coupon = 70

Par + coupon

1000 + 70

5%

3.65%

\[ \frac{1070}{1.0365} = 1032.32 \]

-called @ 1010.00

Lose 22.32

\[ P_U \text{ value of embedded call} = \frac{(22.32 \div 2)}{1.05} = \$10.63 \]
Exam 8, Question 26

a) \[ S = 60 \quad K = 63 \quad \sigma = .3 \]
\[ r = .05 \]
\[ PV \text{ (div}_4) = 1e^{-.05(4/12)} = .9835 \quad (A) \]
\[ PV \text{ (div}_10) = 1.25e^{-.05(10/12)} = 1.19899 \quad (B) \]

Use Black’s approximation
- evaluate call value at each dividend payment & to maturity
- take the highest value

Exercise at 4 months
\[ c = SN(d_1) - Ke^{-rtN(d_2)} \]
\[ d_1 = \ln(60/63) + (.05 + (.3)^2/2)\frac{4}{12} = -.0989 \]
\[ .3\sqrt{4/12} \]
\[ d_2 = -.0989 - .3\sqrt{4/12} = -.2721 \]
\[ c = 60 (1 - N(.0989)) - 63e^{-.05(4/12)}(1 - N(.2721)) \]
\[ = 27.63774 - 24.3362 = 3.3015 \]

Exercise at 10 months
\[ S^* = 60 - (.9835) = 59.0165 \]
\[ d_1 = \ln \left(\frac{59.0165}{63} \right) + (.05 + (.3)^2/2)\frac{10}{12} = .0506 \]
\[ .3\sqrt{10/12} \]
\[ d_2 = .0506 - .3\sqrt{10/12} = -.2233 \]
\[ c = 59.0165 \left(N(.0506)\right) - 63e^{-.05(10/12)}\left(1-N(.2233)\right) \]
\[ = 30.69684 - 24.3362 = 5.8235 \]

Held to maturity
\[ S^* = 60 - .9835 - 1.19899 = 57.8175 \]
\[ d_1 = \ln \left(\frac{57.8175}{63} \right) + (.05 + (.3)^2/2)\frac{15}{12} = .0981 \]
\[ .3\sqrt{15/12} \]
\[ d_2 = .0981 - .3\sqrt{15/12} = -.2373 \]
\[ c = 57.8175 \left(N(.0981)\right) - 63e^{-.05(15/12)}\left(1-N(.2373)\right) \]
\[ = 31.1670 - 24.0415 = 7.1256 \]
Since holding until maturity results in the largest value, do not exercise early

b) \[ \text{option} = \max (3.3015, 5.8235, 7.1256) = 7.1256 \]
a) In general,

1) Not optimal to exercise early if
\[ D_n \leq K (1 - e^{-r(T - t_n)}) \]

2) Optimal to exercise early if
\[ D_n > K (1 - e^{-r(T - t_n)}) \]

This is because dividends drop the stock price immediately after a dividend has been issued.

For the $1 dividend in 4 months.
\[ 1 \leq 63 (1 - e^{-0.05((10/12) - (4/12))}) \]
\[ 1 \leq 1.55 \text{ Not optimal in 4 months to exercise early} \]

For $1.25 dividend
\[ 1.25 \leq 63 (1 - e^{-0.05((15/12) - (10/12))}) \]
\[ 1.25 \leq 1.30 \text{ Not optimal to exercise early.} \]

b) \[ S_0^* = 60 - 1.00 e^{-0.05(4/12)} - 1.25 e^{-0.05(10/12)} \]
\[ = 57.82 \]

\[ d_1 = \ln \left( \frac{57.82}{63} \right) + \frac{0.05 + 30^2/2}{15/12} \cdot 0.30 \sqrt{15/12} \]
\[ = 0.098 \text{ round to .10} \]

\[ d_2 = 0.098 - 0.30 \sqrt{15/12} \]

\[ N(d_1) = 0.5398 \]
\[ N(d_2) = 1 - 0.5948 = 0.4052 \]

\[ C = 57.82 \cdot 0.5398 - 63e^{-0.05(15/12)} \cdot 0.4052 \]
\[ = 7.230 \]
Exam 8, Question 27

BSM

\[ rf = \frac{\delta F}{\delta S} r_S + \frac{\delta F}{\delta t} + 1 \frac{\delta^2 F}{\delta S^2} \sigma^2 S^2 \]

\[ \frac{\delta F}{\delta S} = 1 \quad \frac{\delta^2 F}{\delta S^2} = 0 \quad \text{and} \quad \frac{\delta F}{\delta t} = -1 \]

\[ r_S + r \neq r_S - 1 + 0 \]

\[ t \quad t^2 \]

creates arbitrage opportunities.
Exam 8, Question 28

a. Assume investor invests the British pounds at risk free, assume continuous rates

\[
\text{\$20,000} = 9076.91 \text{ GBP invested at 8\%} \quad 9090.91e^{.08} = 9848.06
\]

In US dollars → \(9848.06 \times 2.1 = \$20,680.93\)

\[
\text{Return} = \frac{20680.93 - 1}{20,000} = 3.4\%
\]

b. Assuming that the investment in GBP will be 9848.06 at end of the year (he can since it is invested risk free)
   he can enter into futures contracts to buy US dollars at $2.15 per pound

c. \(9848.06 \times 2.15 = 21.173.33\)

\[
\text{return} = \frac{21.173.33 - 1}{20,000} = 5.9\%
\]
Exam 8, Question 28

(A) $r_F = .08 \quad r_{US} = (1 + r_F) \frac{E_0}{F_0} = (1.08) (2.10) = 1.0309$

$E_0 = $2.20/pound \quad F_0 = (2.20)$

3.09%

(B) Convert $20,000 to pounds, which becomes $\frac{20,000}{2.2} = 909.09$

Invest this for one year at 8% → $909.09 \text{ GBP} \ (1.08) = 9819$

Convert back to US for $2.15/pound \rightarrow 9819 \times 2.15 = 21,109 \text{ at } T = 1$

By shorting the forward contract

Riskless return $= \frac{21,109}{20,000} = 1.0555 \rightarrow 5.55\%$
An ADR is created when a bank or other institution buys shares of foreign companies in their country. The institution holds these shares and sells claims to them in US currency on a US market. Buying ADR’s lets you invest internationally. This is an active strategy since it is shares of stocks as opposed to WEBS which is an index and managed passively.
Exam 8, Question 30

t = 3yr
coup = 6% ann
r = .12

a) \[ B = \frac{6}{e^{.12}} + \frac{6}{e^{.12}(2)} + \frac{106}{e^{.12}(3)} = 83.995 \]

b) \[ D = \frac{6}{e^{.12}} + \frac{12}{e^{.12}(2)} + \frac{106(3)}{e^{.12}(3)} = \frac{236.62}{83.995} = 2.817 \]

c) \[ \Delta B = -D \times B \times \Delta y \\
-2.817 \times (83.995)(-.3\%) = .71 \]
Duration of liability

\[ d_L = 8 \]

Duration of zero-coupon bonds \( \rightarrow d_z = 4 \)

Duration of perpetuity \( \rightarrow d_p = \frac{1 + y}{y} = 10.0909 \)

\[ d_L = w_z d_z + (1 - w_z) d_p \]

\[ 8 = w_z (4) + (1 - w_z) 10.0909 \]

\[ w_z \times 6.0909 = 2.0909 \]

\[ w_z = 34.33\% \]

PV (liabilities) = 6719.35

Invest $2306.75 in present value (face value = $3501.81) in zero coupon bonds

$4412.60 in PV in perpetuity
Exam 8, Question 31

Payment 15485 in 8 years
\( r = 11\% \)

Duration of obligation = 8 years

\( \Delta \) of 4 year zero = 4

Duration of Perpetuity = \((1.11)/.1 = 10.09\)

\( w4 + (1 – w)(10.09) = 8 \) years

\[ 4w + 10.09 – 10.09w = 8 \]
\[ 2.09 = 6.09w \]
\[ w = .3432 \]
\[ (1 – w) = .6568 \]

Therefore PV of Payment = \( 15.485 / (1.11)^8 = 6719.35 \)

Therefore (.3432)(6719.35) = 2306.08 in 4 year zero coupon bond

+ (.6568)(6719.35) = 4413.27 in Perpetuity
Exam 8, Question 32

a. DEFECTIVE

b. DEFECTIVE

c. Select a target ROE that varies with the risk-free rate, i.e. $K = a + by$ with non-zero $b$. This will reduce the duration of franchise value, reducing the total duration as well.
Exm 8, Question 33

Short put should have positive delta

a) Delta = 100,000(0.5) + 50000(-0.75) + 150,000(0.60) = 102.500

Short call should have a negative delta for portfolio

Short options should have negative gammas for portfolio
(0.4)(100,000) + (-0.50)(50,000) + (-0.70)(150,000) = -90,000

Vegas are negative for short positions
(100,000)(1.00) + (50,000)(-0.50) + 150,000(-1.50) = -150,000

b) Long 150,000 option 2 new vega = 0, \( \Gamma = 30,000, 177,500 \)

\[ y = -352,941 \]

\[ 0.50x + 0.8y = +90,000 \]
\[ 2.00x + 1.0y = +150,000 \]

\[ 2.2y = 210,000 \]
Option 2 = 95,455
Option 1 = 27,273

New delta = 50,455, short 50,455 in corn

Long 27,273 Option 1
Long 95,455 Option 2
Short 50,455 Corn
Exam 8. Question 34

(a) advantage = hist. data provides joint probabil.
Distribution of market variables

disadvantage = computationally slow

(b) advant → quick production of results
   disadv → not very good results for portfolios w/ low delta
Exam 8, Question 34

a) Adv: No need to use cash flow mapping  
   Diadv: It requires a lot of computer time

b) Adv: Result can be produced quickly  
   Diadv: Assume a multivariate normal distribution between the different risk, which is likely to be inappropriate
Exam 8, Question 34

a. Ad: No assumption necessary about joint distribution of market variables (determined from actual historical values)
   Dis: Computationally intensive

b. Ad: Not computationally burdensome → easy to calculate.
   Dis: Requires an assumption about multivariate normality of market variables.
Exam 8, Question 35

Prem = 5M  Expense = 5%  investment = 4%
LR = 90%  Target K = .15  allocated capital = 4M

a.  1. Prem 5,000,000
2. Expenses 5%(5M) = 250,000
3. Investment [(1) - (2)] x .04 = 190,000
4. Losses Line (1) x (.9) = 5M(.9) = 4,500,000
5. Income 1 – 2 + 3 – 4 = 5M - .25M + .19M – 4.5M
   = 440,000

RAROC = \(
\frac{440,000}{4,000,000}
\) = 11%

b. additional risk margin:
   required income = 4m (.15) = 600,000
   actual = 440,000
   \((600,000 – 440,000) / 1.04 = 153,846\)
Exam 8, Question 36

a). \[ 1000 \times (1 - 99.5\%) = 5 \]

\[ \text{Co–CTE.} \]

Market risk \[ (-950 + 250 + 100 - 400) \times \frac{1}{5} = -200 \]

Reserve \[ (3600 + 2450 + 1900 + 1200 + 1500) \times \frac{1}{5} = 2190 \]

UW \[ (1900 + 750 + 950 + 1400 + 550) \times \frac{1}{5} = 1110 \]

Total \[ (4550 + 3750 + 2950 + 2200 + 2050) \times \frac{1}{5} = 3100 \]

\[ \text{Total 99.5\% CTE} = 3100 \]

b) \[ 7500000 \times \frac{-200}{3100} = -483870.97 \quad \text{market} \]

\[ \times \frac{2190}{3100} = 5298387.1 \quad \text{Reserve} \]

\[ \times \frac{1110}{3100} = 2685483.87 \quad \text{UW} \]
Exam 8, Question 36

(a) CTE = Average of Total = $3,100,000$

(b)

<table>
<thead>
<tr>
<th>Allocated Capital</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Market CTE = -200,000</td>
<td>-483,871</td>
</tr>
<tr>
<td>Reserve CTE = 2,190,000</td>
<td>5,298,387</td>
</tr>
<tr>
<td>UIW CTE = 1,110,000</td>
<td>2,685,484</td>
</tr>
</tbody>
</table>
Exam 8, Question 37

a.  
\[
\begin{align*}
\text{Income} & = \text{RAROC} \\
\text{Risk-adj capital} & \\
A & = \frac{500}{2,000} = 25\% \\
B & = \frac{900}{4,000} = 22.5\%
\end{align*}
\]

Line A performed better since its RAROC is bigger.

b.  
\[
\begin{align*}
\text{EVA A} & = 500,000 - 2M(.10) = 300,000 \\
\text{EVA B} & = 900,000 - 4M(.18) = 180,000
\end{align*}
\]

Each line of business adds value since their EVA’s are greater than 0.
Exam 8, Question 37

a) \[ A = \frac{500,000}{2m} = .25 \]

\[ B = \frac{900,000}{4m} = .225 \]

A performed better

b) \[ A = .25 - .10 = .15 = \text{EVA} \]

\[ B = .225 - .18 = .045 = \text{EVA} \]

Both A & B add value as their RAROC is greater than their cost of capital.
Exam 8, Question 38

a) Exceedence Prob = P(L_i > E(L_i) + C_i)

The probability that a line of business’s losses will be greater than the expected losses and the allocated capital to absorb shocks.

b) (1) There may not be enough capital of the firm to use the exceedence probability for all lines.

(2) Does not take into account the diversification of the company between lines of business.
Exam 8, Question 39

Prob of ruin does not consider the severity of ruin. In both cases, insurers have a prob of ruin of 20% but the severity is much smaller for A (13100 – 13000 = 100) than for B (18000 – 13000 = 5000).

Therefore it is inadequate
Exam 8, Question 39

P(Ruin) for A = .20
P(Ruin) for B = .20

EPD for A = 100 (.2) = 20
EPD for B = 5,000 (.2) = 1,000

Each has the same probability of ruin, but B has a much larger expected policyholder deficit. Prob of ruin does not consider the amount of the shortfall.
Exam 8, Question 39

\[
\text{EPD}_A = \frac{100 \cdot (0.2)}{E[L]} = 0.002
\]

\[
E[L] = 6.9k(0.2) + 10k(0.6) + 13.1k(0.2)
\]

\[
\text{EPD}_B = \frac{5,000 \cdot (0.2)}{E[L]} = 0.10
\]

\[
E[L] = 2k(0.2) + 10k(0.6) + 18k(0.2)
\]

Probability of ruin is 0.2 for both insurer, both severity of ruin is much higher for B.
Exam 8, Question 40

EPD ratio

\( \sigma = 0.5 \)

\( S_0 = A/L = 1.75 \quad K = 1 \quad T = 1 \quad rf=1\% \)

\[
11 = \frac{\ln(5/k) + (rt + \sigma^2/2)T}{\sigma \sqrt{T}} = \frac{\ln(1.75) + (1\% - 0.5^2/2)}{0.5} = 1.389
\]

\[
d_2 = d_1 = \sigma \sqrt{T} = 1.389 - 0.5 = 0.889
\]

\( N(d_1) = 0.9177 \)
\( N(d_2) = 0.8133 \)

\[
C = S_0N(d_1) = ke^{-RT}N(d_2)
= 1.75(0.9177) - e^{-0.01}(0.8133) = 0.801
\]

\[
P = c + ke^{-RT} - S_0
= 0.801 + e^{-0.01} - 1.75 = 0.041
\]
Exam 8, Question 40

\[ \sigma = 0.5 \quad \text{Asset} = 1.75 \quad T = 1 \quad r = 0.01 \]

Put = Ke^{-rt}N(-d_2) - SN(-d_1)

\[ \ln(1.75) + (0.01 + 0.5^2/2) \times 1 = d_1 = 1.389 \]

\[ d_2 = d_1 - \sigma \sqrt{t} = 0.889 \]

\[ N(-d_1) = 0.082 \]

\[ N(-d_2) = 0.187 \]

Put = \(1e^{-0.01 \times 1} \times 0.187 - 1.75 \times 0.082\)

= 0.0416
### Exam 8, Question 41

#### O/S Balance of Loans

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>40,000</td>
<td>30,000</td>
<td>30,000</td>
</tr>
<tr>
<td>Payment 1</td>
<td>17,140.85</td>
<td>7,089.85</td>
<td>0</td>
</tr>
<tr>
<td>Payment 2</td>
<td>0</td>
<td>22,910.15</td>
<td>2,774.39</td>
</tr>
<tr>
<td>Payment 3</td>
<td>0</td>
<td>0</td>
<td>27,225.61</td>
</tr>
</tbody>
</table>

#### Expected Payout Principal

<table>
<thead>
<tr>
<th>Payment</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>22,859.15</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>17,140.85</td>
<td>7,089.85</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>22,910.15</td>
<td>2,774.39</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
<td>27,225.61</td>
</tr>
</tbody>
</table>

#### Interest

<table>
<thead>
<tr>
<th>Payment</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2,400</td>
<td>1,800</td>
<td>1,800</td>
</tr>
<tr>
<td>2</td>
<td>1,028.45</td>
<td>1,800</td>
<td>1,800</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>1,374.61</td>
<td>1,800</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
<td>1,633.54</td>
</tr>
</tbody>
</table>

**Int. Inc. per loan** 3,428.45 4,974.61 7,033.54  
**Inc. for 10 loans** 34,284.50 49,746.10 70,335.40

3 of 10 loans pay remaining value w/Payment #2

#### Principal

<table>
<thead>
<tr>
<th>Payment</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>228,591.50</td>
<td>0</td>
<td>0</td>
<td>228,591.50</td>
</tr>
<tr>
<td>2</td>
<td>171,408.50</td>
<td>229,628.95</td>
<td>0</td>
<td>401,037.45</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>70,371.05</td>
<td>109,420.73</td>
<td>179,791.78</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
<td>190,579.27</td>
<td>190,579.27</td>
</tr>
</tbody>
</table>

#### Interest

<table>
<thead>
<tr>
<th>Payment</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24,000</td>
<td>18,000</td>
<td>18,000</td>
</tr>
<tr>
<td>2</td>
<td>10,284.50</td>
<td>18,000</td>
<td>18,000</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>4,222.26</td>
<td>18,000</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
<td>11,434.76</td>
</tr>
</tbody>
</table>

**Total** 34,284.50 40,222.26 65,434.76

**Lost Income** 0 9,523.84 4,900.64
## Exam 8, Question 41

<table>
<thead>
<tr>
<th>Time</th>
<th>Pmt amount</th>
<th>Int A</th>
<th>Int B</th>
<th>Int C</th>
<th>Princ A</th>
<th>Princ B</th>
<th>Princ C</th>
<th>Outst A</th>
<th>Outst B</th>
<th>Outst C</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>400k</td>
<td>300k</td>
<td>300k</td>
</tr>
<tr>
<td>1</td>
<td>228.5915k</td>
<td>24k</td>
<td>18k</td>
<td>18k</td>
<td>228.5915k</td>
<td>-</td>
<td>-</td>
<td>171.4085k</td>
<td>300k</td>
<td>300k</td>
</tr>
<tr>
<td>2</td>
<td>447.32195k</td>
<td>10.28481k</td>
<td>18k</td>
<td>18k</td>
<td>171.4065k</td>
<td>229.62895k</td>
<td>-</td>
<td>70.37105k</td>
<td>300k</td>
<td>300k</td>
</tr>
<tr>
<td>3</td>
<td>202.01405k</td>
<td>-</td>
<td>4.22226k</td>
<td>18k</td>
<td>-</td>
<td>70.37105k</td>
<td>109.42074k</td>
<td>-</td>
<td>-</td>
<td>190.57926k</td>
</tr>
<tr>
<td>4</td>
<td>202.01405k</td>
<td>-</td>
<td>-</td>
<td>11.43476k</td>
<td>-</td>
<td>-</td>
<td>190.57926k</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Actual interest income:** 34.28451k 40,22226k 65.43436k

<table>
<thead>
<tr>
<th>Time</th>
<th>Pmt amount</th>
<th>Int A</th>
<th>Int B</th>
<th>Int C</th>
<th>Princ A</th>
<th>Princ B</th>
<th>Princ C</th>
<th>Outst A</th>
<th>Outst B</th>
<th>Outst C</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>400k</td>
<td>300k</td>
<td>300k</td>
</tr>
<tr>
<td>1</td>
<td>228.595k</td>
<td>24k</td>
<td>18k</td>
<td>18k</td>
<td>228.5915k</td>
<td>-</td>
<td>-</td>
<td>171.4085k</td>
<td>300k</td>
<td>300k</td>
</tr>
<tr>
<td>2</td>
<td>228.595k</td>
<td>10.2841k</td>
<td>18k</td>
<td>18k</td>
<td>171.4085k</td>
<td>70.89849k</td>
<td>-</td>
<td>229.10151k</td>
<td>300k</td>
<td>300k</td>
</tr>
<tr>
<td>3</td>
<td>228.595k</td>
<td>-</td>
<td>13.74609k</td>
<td>18k</td>
<td>-</td>
<td>229.10151k</td>
<td>27.7439k</td>
<td>-</td>
<td>-</td>
<td>272.2561k</td>
</tr>
<tr>
<td>4</td>
<td>228.595k</td>
<td>-</td>
<td>-</td>
<td>16.33537k</td>
<td>-</td>
<td>-</td>
<td>272.2561k</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Expected interest income:** 34.28451k 49.74609k 70.33537k

### Income Lost

A  
-40,222.26 + 34,284.51 = 0

B  
49,746.09 – 40,222.26 = 9,523.83

C  
70,335.37 – 65,434.76 = 4,900.61
Exam 8, Question 42

(a) If credit conditions locally could not allow for servicing home mortgage loans, by pooling them together and passing them through to investors or the capital markets, then funds all over the US (i.e., investors in the securities backed by the pool) could be channeled to areas in need of funding very efficiently. Local banks still service the mortgage, pass through the principal and interest to the investors. Alleviated local supply and demand problem.

(b) Cat bonds – the successful cat bond issuances, that is – have offered relatively high excess levels of protection for very volatile and infrequent losses. Mortgage-backed securities offer ground up financing for large volumes of stable “losses” (same with student loans, credit cards, etc.)

Cat bonds also are for relatively short maturities and have relatively high coupon payments. Traditional mortgage-backed pass throughs would not – although CMO products are similar in that certain tranches absorb prepayment risk disproportionately in exchange (presumably) for higher yields.
Exam 8, Question 43

a) \[ \frac{2.50}{0.12 - g} \]
\[ 12.50 = 125g \]
\[ g = 0.10 \]

b) Assuming Div 1 is still $2.50 → p = \frac{2.50}{0.12 - 0.11} = \$250

c) Since \( \frac{1}{k - g} \), the P/E ratio will increase (higher g makes the denominator lower)
Exam 8, Question 44

a) \(0.05 + 1.25 (0.12 - 0.05) = 13.75\%

b) \(\frac{0.454}{1.1375} + \frac{0.454 (1.2)}{(1.1375)^2} + \frac{0.454 (1.2)^2}{(1.1375)^3} + \frac{0.454 (1.2)^2 (1.115)}{(1.1375)^3}
\)
\[= 0.8202 + 0.4442 + 22.012\]
\[= 23.28\]

c) sell the stock since the intrinsic value is less than the price

d) new technology has already been factored into the price so there should be no expectation the price will rise
Exam 8, Question 45

a. Company ABC may have greater growth opportunities.

b. It assumes the growth of ABC will continue forever – it probably will not due to competition.