

The Johns Hopkins Carey Business School

Financial Risk Management

Fall 2009

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Midterm Exam

MIDTERM– DUE ON Thursday, November 5th, 2009 (in class, bring a hard copy of your answers, please do not submit electronic copy)

Late submissions will not be graded.

Show your calculations. Do not just report the final numerical answer! Obey page limits.
If a question has multiple parts, indicate exactly where you answer each part.
This exam has five (5) sections; be sure to follow the directions for each section. Use Times New Roman 12pt in your writing.

The plagiarizing, in any form, of the work of another is a form of academic dishonesty and will result in an automatic failing grade. By the act of submitting written work to satisfy the homework assignment, you make the claim that the work is your own.

A. DEFINITIONS: (10 points) (Suggested time: 20 minutes)

ANSWER ALL OF THESE. Carefully define the following terms. Whenever possible, give *both* mathematical and verbal definition.

Page limit: 1/4 page per definition.

VaR	Minimum Variance Hedge Ratio
Positive Skewness	Brownian Motion
Ito's Lemma	Gamma
Relative Risk Aversion	Systematic Risk
Theta	Duration Hedging

B. TRUE-FALSE: (10 points) (Suggested time: 20 minutes)

ANSWER ALL OF THESE. Please comment the following statements. (True or False). Write down your reason. Each question is equally weighted.

Page limit: 1/4 page per question.

1. The equation used by Black and Scholes to characterize the behavior of an option, expressed with Greeks, holds true for American options as well as European options.
2. Since volatility of options is higher than stocks, they do not have the same risk premiums, however, they will have the same Sharpe measures.
3. As time decreases drift becomes undetectable and returns tend to reflect a random Brownian motion.
4. Delta as a measurement of option price sensitivity will understate actual call option price changes when stock prices rise and overstate actual call option price changes when stock prices decline.
5. Your portfolio is worth \$200,000. The standard deviation of its annual returns is 0.20 and the expected return is 11.0%. The 10-day value at risk at a 95% confidence level is \$12831.6

C. MULTIPLE CHOICE: (10 points) (Suggested time: 20 minutes)

ANSWER ALL OF THESE. Please show your work. Answers without explanation will not be accepted.

- 1) A bond portfolio has a value of \$10 million and a modified duration of 4.65. Interest rates are currently 8% and external VaR provider believes that there is a 5% chance that the interest rates will go above 8.5% at the end of the year. What would be the VaR for the portfolio at 95% confidence interval?

- a) \$125,000
- b) \$232,500
- c) \$465,500
- d) \$683,252

- 2) In the Black-Scholes formula for a vanilla call option the probability of being in the money almost equals the delta of the option when:

- a) the volatility is very low ;
- b) the volatility is very high;
- c) the volatility is very high and the risk free rate is low;
- d) the risk free rate is very low;

- 3) Which of the following is true:

- a) Higher the gamma, lower the theta;
- b) Higher the gamma, higher the theta;
- c) With higher gamma theta increase till a certain point and then remain constant;
- d) There is no relationship between gamma and theta.

- 4) A Wiener process implies that :

- a) A continuously compound rate of return R obtained by holding an asset for a given interval of time is normally distributed with a variance that is proportional to holding period;
- b) A continuously compound rate of return R obtained by holding an asset for a given interval of time is normally distributed with a variance that is proportional to the square root of holding period
- c) A continuously compound rate of return R obtained by holding an asset for a given interval of time is normally distributed with a variance that is proportional to the square root of the average level of the asset during the holding period;
- d) None of the above;

- 5) In a world of three currency pairs, Euro-Dollar, Dollar-Yen, and Euro-Yen, if the implied correlation between Euro-Dollar and Dollar-Yen remain constant and the implied volatilities of Euro-Dollar and Dollar-Yen both increase then the volatility of Euro-Yen will:

- a) remain constant

- b) increase
- c) decrease
- d) cannot be computed

6) Rho, the sensitivity of an option to the interest rate, is proportional to T , the time to maturity of an option, whereas vega, the sensitivity of an option to the volatility of the asset, is proportional to the square root of T . Therefore, in the long run:

- a) Volatility risks will dominate interest rate risks
- b) Interest rate risks will dominate volatility risks
- c) both volatility risk and interest rate risk will become equal
- d) None of the above;

7) Given the constant volatility assumption of Black-Scholes model, which of the following risk sensitivities (greeks) are inconsistent with the model assumption:

- a) vega
- b) gamma
- c) rho
- d) both (a) and (c);

8) Vasicek's Model of Interest Rate is based on:

- a) A combination of stochastic volatility and binomial process;
- c) A combination of liquidity preference and expectations hypothesis;
- b) Two factor model with one for short rate and the other for long rate.
- d) A process of mean reverting drift;

9) If the daily volatility of an asset is 1% and if there are 252 trading days in a year then the annualized volatility of the asset would be:

- a) 16.35%
- b) 14.35%
- c) 15.87%
- d) 15.15%

10) An option on Istanbul stock index is struck on 5,000 Turkish Lira (TL). The delta of the option is 0.5, and the annual volatility of the index is 30%. Using delta normal assumptions, what is the 20 day VAR at the 95% confidence level (approximately)? Assume 252 days per year?

- a) 348 TL
- b) 694 TL
- c) 139 TL
- d) 44 TL

D. SHORT QUESTIONS: (66 points) (Suggested time: 120 minutes)

ANSWER ALL OF THESE. Please show your work. Answers without derivation will not be evaluated.

Question 1

Consider a bond, which is selling at par value (\$100). The bond has three years to maturity and semiannual coupon 10%.

- Compute Macaulay duration and Modified duration of this bond.
- Compute convexity of this bond.
- If the worst increase in yield at the 95% is 1.645%, what is the VaR of this bond?
- Using the Taylor expansion, compute the new bond prices if the yield moves by 2%.

Question 2

Consider a zero-coupon bond.

The price of a zero-coupon bond is given by

$$P = \frac{F}{(1+y)^T}$$

where F is the face value, y is the yield and T is the maturity.

- Compute the first (analytical) derivative of the bond price with respect to the yield: i.e. dP/dy .
- Compute the second (analytical) derivative of the bond price with respect to the yield: i.e. d^2P/dy^2 .
- Relate and comment your results in a) and b) with respect to duration and convexity.
- Use the same symbol above, what is the Macaulay duration for a consol.

Question 3

- Consider a stock that pays no dividends, has an expected return of 10% per annum, and volatility of 30% per annum. The current price is \$100 and the stock price evolves according to the following process

$$\Delta S = S(\mu\Delta t + \sigma\sqrt{\Delta t} \times \varepsilon)$$

where $\varepsilon \sim i.i.d. Normal(0,1)$.

If the interval is a day, and $\varepsilon_{t+1} = -0.5$, what is the stock price next day (i.e. S_{t+1})?

- Assume the price in one week is given by $S = \$100e^R$, where R has annual expected value of 20% and volatility of 30%. Construct a 90% confidence interval for S .

Question 4

- Why are financial asset prices often modeled by Markov processes?

b) Carefully explain the difference between a Wiener process, a generalized Wiener process and a Geometric Brownian motion.

Question 5

Table 1 contains relevant data for the return on the stock Alcoa.

a) Comment Table 1 with respect to the “stylized fact” of asset returns.

Table 1	
	Ret(AA)
Mean	0.037045
St. Dev.	2.2351
Skewness	-0.22637
Excess Kurtosis	2.6871
Correlation(Ret, Ret ²)	-0.11966

Table 2 contains autocorrelations for lag 1 to 5 for returns and squared returns.

b) Comment Table 2 with respect to the “stylized fact” of asset returns.

Table 2		
	Returns	Squared Returns
Lag 1	-0.00056628	0.15181
Lag 2	-0.043197	0.13525
Lag 3	0.043029	0.10659
Lag 4	-0.042107	0.09670
Lag 5	0.0035261	0.089947

Question 6

Assume that the following one-factor model describes the term structure of interest rates

$$\Delta r_t = \kappa(\theta - r_t)\Delta t + \sigma r_t^\gamma \Delta z_t$$

where:

Δz_t is the usual Wiener process, $0 \leq \kappa < 1$, $\theta \geq 0$, $\sigma \geq 0$.

This model becomes the Vasicek model when $\gamma = 0$, while when $\gamma = 0.5$ this is the Cox, Ingersoll, and Ross model.

Using the following table for the stochastic factor, simulate both the Vasicek and the Cox, Ingersoll, and Ross models assuming that $r_0 = 5\%$, $\theta = 7\%$, $\kappa = 0.6$, $\sigma = 0.10$, $T = 52$.

N(0,1)
0.1
-0.2
-0.3
0

Question 7

Consider a par bond with the following characteristics: Maturity 3 years, semiannual coupon 8%. A portfolio manager holds \$2,000,000 worth of this bond. The current future price of is 92-16, with a notional of \$100,000. The duration of the futures contract is measured by that of the cheapest to deliver bond which has the following characteristics: zero coupon bond with 3 years maturity.

Compute

- a) The notional of the futures contract. (5 points)
- b) The number of contracts that minimizes the risk. (5 points)

Question 8

An airline knows that it will need to purchase 20,000 metric tons of jet fuel in three months. It wants some protection against an upturn in prices using futures contracts. The company can hedge using heating oil futures contracts traded on NYMEX. The notional for one contract is 42,000 gallons. There is no futures contract on jet fuel, the risk manager wants to check if heating oil could provide an efficient hedge. The current price of jet fuel is \$300/metric ton. The futures price of heating oil is \$0.7/gallon. The standard deviation of the rate of change in jet fuel prices over three months is 20%, that of futures is 15%, and the correlation is 0.8.

Compute

- a) The notional and the standard deviation of the un-hedged fuel cost in dollars
- b) The optimal number of futures contract to buy/sell, rounded to the closest integer
- c) The standard deviation of the hedged fuel cost in dollars

Question 9

On Feb 2th, JHU wants to hedge a July 17th issue of \$5 million of commercial paper with maturity 180 days, leading to anticipated proceeds of \$ 20 million. The September Eurodollar futures trades at 87, and has a notional amount of \$1 million.

Compute

- a) The current dollar value of the futures contract
- b) The number of contracts to buy/sell for optimal protection.

Question 10

- a) Explain value at risk (VaR).
- b) How can we measure VaR?
- c) Explain pros and cons of VaR.

Question 11

- a) The price of non-dividend paying stock is \$55 per share. A 6-month, at the money call option is trading for \$1.89. If the interest rate is 6.5%, what is the likely price of a European put at the same strike and expiration?
- b) Suppose that a \$60 strike call has 45 days until expiration and pays a 1.5% continuous dividend. Assume $S = \$58.5$, volatility is 0.25 and $r = 0.06$. What is the option elasticity given an immediate price increase of \$1.5.
- c) Compute delta for the following call option. The stock is selling for \$23.5. The strike price is \$25. The possible stock prices at the end of 6 months are \$27.25 and \$21.75. (Assume annual volatility is 20% and interest rate is 5%) Do not assume equal probabilities).
- d) Assume that a \$75 strike call has a 1% continuous dividend, 90 days until expiration, and stock price of \$72.00. What is the rho of the option as the interest rate changes from 6% to 5%.

E. LONG QUESTIONS: (4 points) (Suggested time: Unlimited)

1. How many hours did you spend for this exam?
2. If you are asked to grade the difficulty of this exam, what will be your grade? (1 is very easy, 2 is easy, 3 is moderate, 4 is difficult, 5 is very difficult)
3. What grade are you expecting from this exam (give me a range not greater than 10; i.e you can say I expect to get between 80 and 90)?
4. After this exam, if you are given the chance to choose between take-home and in-class final exam, which one will you choose?