Name _____

Northwestern University
Kellogg Graduate School of Management

Kathleen Hagerty   Fall 2004
Finance 465

Midterm Exam

You are allowed one 8 ½" by 11" page of notes (both sides). Answer the questions in the space provided. SHOW ALL YOUR WORK! <u>Assume all the interest rates are annualized continuously compounded rates</u>. You can spend up to 2 hours on the exam. There are 100 total points on the exam.

The exam is **due Monday, November 1 by 5 pm** in the Finance Dept.

I. Answer the following questions true or false and explain why.

a. (5 points) The spot price of silver is $420/ounce and the continuously compounded annual risk free rate is 3%. Consider the following forward curve for silver:

Year	0	1	2	3
Forward Price	420	441.53	464.17	487.97

The forward curve given above implies that silver has a carrying cost.

b. (5 points) Suppose that a gold mining firm would like to collar its exposure to gold prices. If they put a $425 floor and a $450 cap on the position, the cost is $3.50/ounce. If the firm wants to keep the width of the collar at $25 but make the position zero cost, they need to lower the strikes on the call and put.

c. (5 points) When investors become more optimistic about the future prospects of the firms that make up the S&P 500, the forward curve for the S&P 500 index futures should become more steeply sloped.

d. (5 points) A student receives a hiring bonus in the stock of the company she is going to work for. The student would like to repay her student loans by the selling the stock once she starts working. She is worried that the stock will fall in value between now and when she starts working. To hedge this risk, she takes a position in a futures contract on this stock. The futures price is $50/share, the initial margin is $1000/contract and the maintenance margin is $500/contract. A contract is for 100 shares. If the futures price rises to $56, she will receive a margin call.

II.   This question is based on an article which appeared in the WSJ on February 2,2000 entitled "With Stock Hedges, Outcomes Can Vary with the Strategies." An excerpt from the article is given below.

"Mr. Volpe was an executive at Kemet Corp when the maker of ceramic and tantalum capacitors went public in 1992. He decide to opt for hedging strategies last year when the stock – which had traded as low as $8.75 in 1998 – was trading in the mid-20's. "If that's where all your eggs are, it's not a good feeling," says Mr Volpe, 62, who retired as president of Kemet in 1996, but remains a director of the Greenville, S.C. company and still has most of his assets in Kemet stock.

At Tuesday's 4 pm NYSE price of $51.1875 per share, his stake on paper is worth nearly $16 million, though the hedging strategy means that he may not realize a sizable portion of the gain.

Mr Volpe last summer entered into two complex arrangements with his broker intended to offer downside protection and free up cash to diversify, without actually selling his shares. "I wasn't ready to sell my Kemet stock," he says. "It was a way to insure the future."

The first hedge, know as a "zero cost collar," give Mr Volpe the right to sell 100,000 shares of his 305,266 shares for $22.37 when the collar expires next January; his broker has the right to buy those same shares at $30.07 at that time.

Mr. Volpe also entered into a "liquidity contract," or a "prepaid variable forward" to free up money for diversification. His broker gave him $2.162 million or $21.62 per share, against 100,000 Kemet shares. When the agreement expires next August, Mr Volpe will pay the broker a sum based on the Kemet closing price and a price range set when the contract was established.

If that hedge expires with Kemet trading at $51.1875, Mr Volpe will hand over to his broker roughly $4.75 million - equivalent to nearly $2.6 million in interest on what he received from his broker just a year earlier. Mr Volpe true cost will be lower, however because he earned a profit investing money he was advanced."
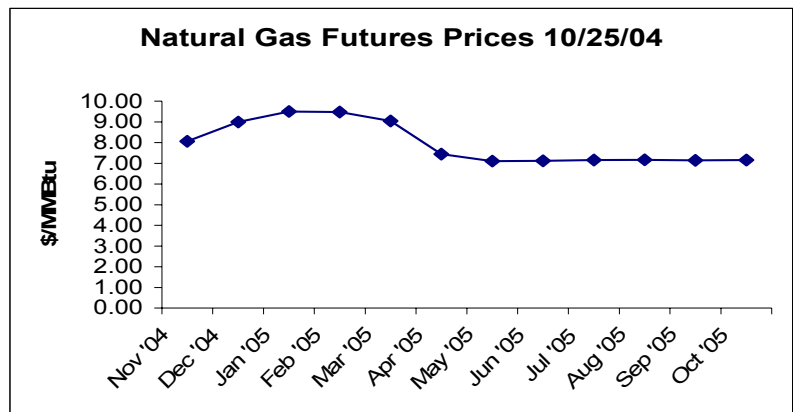

a. (10 points) Suppose you are Mr Volpe. How would you create a zero cost collar like the one described above (i.e., what <u>specifically</u> should you buy or sell)?

b. (15 points) Suppose that Mr Volpe would like to consider a variant of the pre-paid forward described in the article. In particular, he would like to receive a certain dollar amount up front and in two years repay the loan with a fixed number of Kemet shares. This would allow Mr Volpe to receive money today but not sell the shares for two years. Assume that Kemet's continuously compounded dividend yield is 2%, the current continuously compounded risk free rate is 5.5% and the current Kemet share price is $24.
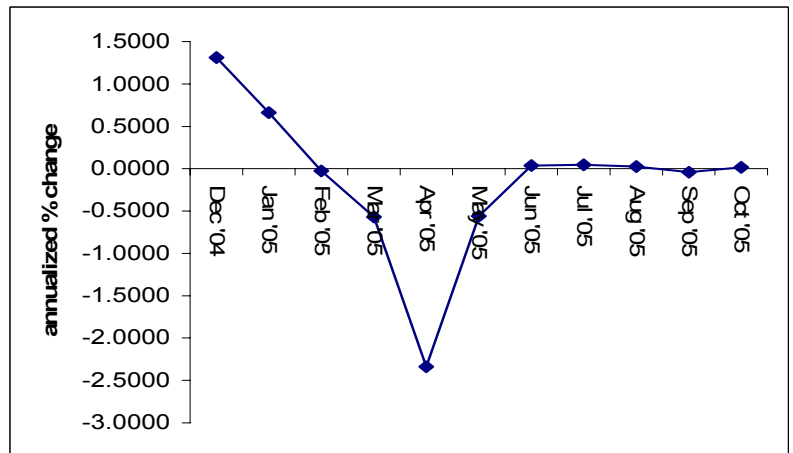
If Mr Volpe wants to have $3 million up front, how many shares does he need to promise to transfer to the broker in two years? What would the number of shares be if the loan was for one year?

III. Consider the following information. Assume the November delivery date is in one month.

Natural Gas Futures 10/25/04		
Delivery Month	Price	Annualized % Change in Price
Nov '04	8.06	
Dec '04	8.99	1.3104
Jan '05	9.50	0.6621
Feb '05	9.48	-0.0253
Mar '05	9.04	-0.5703
Apr '05	7.44	-2.3375
May '05	7.10	-0.5613
Jun '05	7.12	0.0388
Jul '05	7.15	0.0454
Aug '05	7.17	0.0251
Sep '05	7.14	-0.0419
Oct '05	7.15	0.0168

6 Month T-bill Rate	
	1.99%

Natural Gas Futures Prices 10/25/04

a. (10 points) What is the annualized net convenience value, δ –k, between November 04 and December 04 and between March 04 and April 04. Given an intuition for your results.

b. (15 points) Suppose a utility would like to offer their customers a fixed price for natural gas between November 2004 and April 2005. What price they could offer? How would they hedge this position?

IV. Consider the following data:

Canadian Dollar Comp. - cme
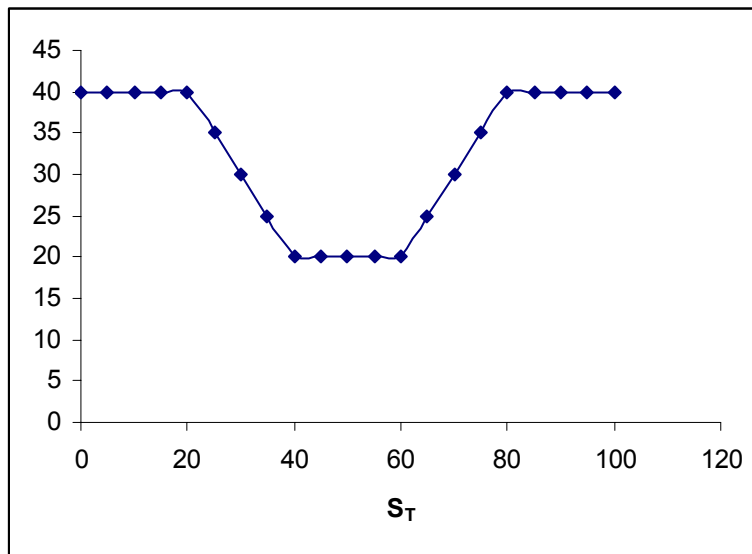Data retrieved at 10/26/04 16:53:55 •

Contract Month		Futures Price
Canadian Dollar	Dec '04	0.8154
Canadian Dollar	Mar '05	0.8145
Canadian Dollar	Jun '05	0.8138
Canadian Dollar	Sep '05	0.8131
Canadian Dollar	Dec '05	0.8124
Canadian Dollar	Mar '06	0.8117
Canadian Dollar Index		0.8167

The US risk free rate is 1.8%.

a. (5 points) What is the Canadian risk free rate for the period between December 04 and March 05?

b. (15 points) Suppose the spot price of a Canadian dollar changed from .8167 to .840 but the March 05 futures price didn't change. Explain how you would earn an arbitrage profit. Assume the March delivery date is in six months. Give the exact positions you would take and the cash flows associated with those positions today and at delivery.

V. (10 points) Replicate the following payoff diagram using puts, calls and T-bills.

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Answers to the Midterm Exam

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Year	0	1	2	3
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The forward curve given above implies that silver has a carrying cost.

TRUE

Year	Futures Price	$[\ln(F_{t,T2}/F_{t,T1})/(T2-T1)]$
0	420.0000	
1	441.5300	0.0500
2	464.1700	0.0500
3	487.9700	0.0500

Since $\dfrac{\ln\left(\dfrac{F_{t,T2}}{F_{t,T1}}\right)}{(T2-T1)} = r + k - \delta = .05$ **and the risk free rate is 3%, there must be a**
carrying cost for silver.

b. (5 points) Suppose that a gold mining firm would like to collar its exposure to
gold prices. If they put a $425 floor and a $450 cap on the position, the cost is
$3.50/ounce. If the firm wants to keep the width of the collar at $25 but make the
position zero cost, they need to lower the strikes on the call and put.

TRUE
A gold mining firm has a long exposure to gold prices, so to collar their
position, they would buy a put and sell a call. To make the collar cheaper,
they need to lower the strike on the put (buy less insurance) and lower the
strike on the call (sell off more gains).

c. (5 points) When investors become more optimistic about the future prospects of the firms that make up the S&P 500, the forward curve for the S&P 500 index futures should become more steeply sloped.

FALSE

The slope of the forward curve depends on the interest rate and the dividend yield and the intercept depends on the current spot price. If investors become more optimistic, spot price will increase but the slope will remain unchanged.

d. (5 points) A student receives a hiring bonus in the stock of the company she is going to work for. The student would like to repay her student loans by the selling the stock once she starts working. She is worried that the stock will fall in value between now and when she starts working. To hedge this risk, she takes a position in a futures contract on this stock. The futures price is $50/share, the initial margin is $1000/contract and the maintenance margin is $500/contract. A contract is for 100 shares. If the futures price rises to $56, she will receive a margin call.

TRUE

To hedge her position she should be short a future. If the price rises by $6 she will have lost $600 which is more than enough to trigger a margin call.

II.   This question is based on an article which appeared in the WSJ on February 2,2000 entitled "With Stock Hedges, Outcomes Can Vary with the Strategies." An excerpt from the article is given below.

"Mr. Volpe was an executive at Kemet Corp when the maker of ceramic and tantalum capacitors went public in 1992. He decide to opt for hedging strategies last year when the stock – which had traded as low as $8.75 in 1998 – was trading in the mid-20's. "If that's where all your eggs are, it's not a good feeling," says Mr Volpe, 62, who retired as president of Kemet in 1996, but remains a director of the Greenville, S.C. company and still has most of his assets in Kemet stock.

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a. (10 points) Suppose you are Mr Volpe. How would you create a zero cost collar like the one described above (i.e., what <u>specifically</u> should you buy or sell)?

Buy a put on Kemet with K=22.37 and T = 1/01
Sell a call on Kemet with K=30.07 and T = 1/01

b. (15 points) Suppose that Mr Volpe would like to consider a variant of the pre-paid forward described in the article. In particular, he would like to receive a certain dollar amount up front and in two years repay the loan with a fixed number of Kemet shares. This would allow Mr Volpe to receive money today but not sell the shares for two years. Assume that Kemet's continuously compounded dividend yield is 2%, the current continuously compounded risk free rate is 5.5% and the current Kemet share price is $24.

If Mr Volpe wants to have $3 million up front, how many shares does he need to promise to transfer to the broker in two years? What would the number of shares be if the loan was for one year?

The futures price of Kemet shares for delivery in one year: $F = P\, e^{(r-d)(T-t)} = 24*e^{(.055-.02)*1} = 24.855$

The futures price of Kemet shares for delivery in two years: $F = P\, e^{(r-d)(T-t)} = 24*e^{(.055-.02)*2} = 25.74$

Broker's Position:

	today	two years from now
loan $3 million and return for X shares in the two years	-$3 million	**receive shares and deliver against the futures position**
sell X shares forward		**$25.74* X**
Total	-$3 million	**$25.74*X**

For a two year loan, the rate of return on the broker's position is:
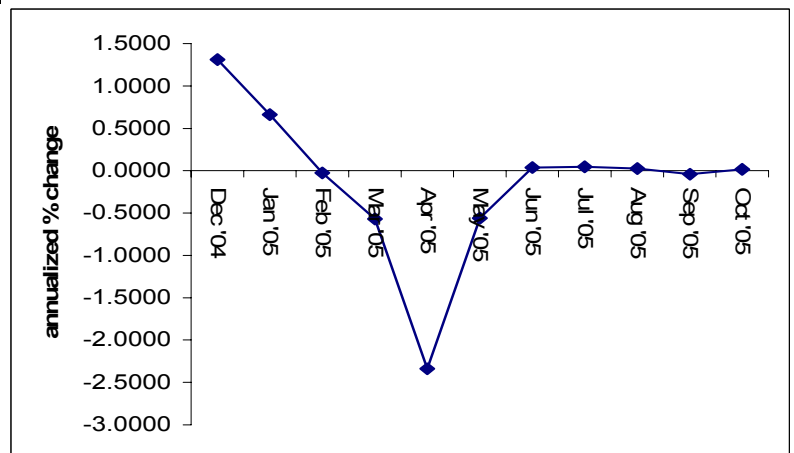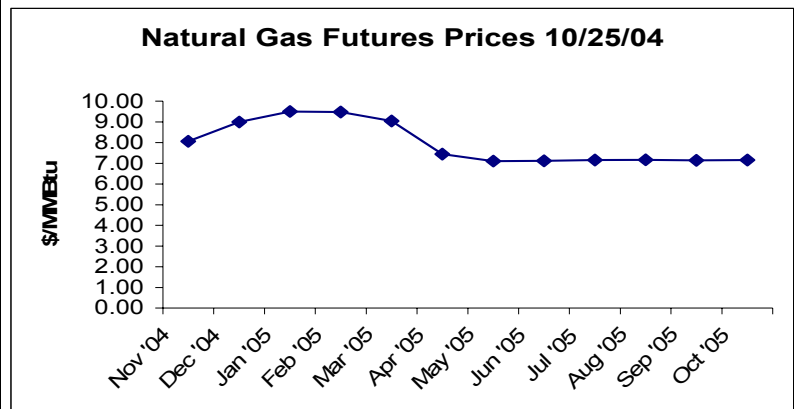Rate of return: ($25.74*X)/$3 million = $e^{.055*2}$ ==> X = 130,102 shares

For a one year loan, the rate of return on the broker's position is:
Rate of return: (24.855*X)/$3 million = $e^{.055*1}$ ==> X = 127,524 shares

III. Consider the following information. Assume the November delivery date is in one month.

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Delivery Month	Price	Annualized % Change in Price
Nov '04	8.06	
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6 Month T-bill Rate	1.99%

Natural Gas Futures Prices 10/25/04

c. (10 points) What is the annualized net convenience value, δ –k, between November 04 and December 04 and between March 04 and April 04. Given an intuition for your results.

The annualize percentage change in price is equal to r+k-δ. There for δ-k is equal to

1.99 – (131.04) = -129.05%   for November to December

  and is equal to

1.99 – (-233.75) = 235.74%   for March to April.

Investors must expect that inventories will be very high in November so in order for the marginal investor to be willing to carry the natural gas the futures price must cover all carrying costs plus the risk free rate. Investors must expect in that In March inventories will be low, so that the marginal investor is willing to take a loss in order to carry the gas.

d. (15 points) Suppose a utility would like to offer their customers a fixed price for natural gas between November 2004 and April 2005. What price they could offer? How would they hedge this position?

The firm could effectively offer their customers a swap. The swap is the constant price which has the same present value as a strip of futures.

Months	Discount Factor	PV of Futures Price
1	0.998343	8.046645
2	0.9966888	8.960233
3	0.9950374	9.452855
4	0.9933886	9.417324
5	0.9917426	8.965353
6	0.9900993	7.366339
Total	5.9652998	52.20875

Swap Price	8.752075

The firm would hedge this position by buy a strip of futures using months November 04 through April 05.

IV. Consider the following data:

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The US risk free rate is 1.8%.

a. (5 points) What is the Canadian risk free rate for the period between December 04 and March 05?

$$R_{canada} = .018 - \frac{\ln\left(\frac{.8145}{.8154}\right)}{.25} = .0224$$

b. (15 points) Suppose the spot price of a Canadian dollar changed from .8167 to .840 but the March 05 futures price didn't change. Explain how you would earn an arbitrage profit. Assume the March delivery date is in six months. Give the <u>exact</u> positions you would take and the cash flows associated with those positions today and at delivery.

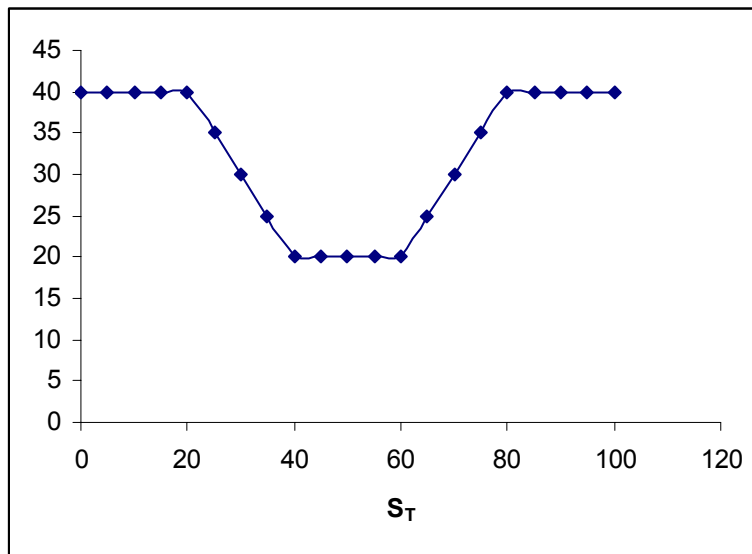**Using the interest rate computed in part a., the future price should be**

$$F_{t,T} = .84e^{(.018-.0224).5} = .8382$$

If the March 05 futures price is .8145, then the future is undervalued relative to the theoretical value. To arbitrage this you should buy the future, sell $e^{-.0224*.5}$ units of the spot and lend the proceeds. The exact cash flows are:

	Today	At Delivery
Buy the future		-.8145
Sell $e^{-.0224*.5}$ units of the spot	$e^{-.0224*.5} .84 = .8306$	Cover short with a Canadian dollar from the futures contract
Lend proceeds of the short sale	$-e^{-.0224*.5} .84 = -.8306$	$e^{-.0224*.5} .84\ e^{.018*.5} = .8382$
Total	**0**	**.0237**

V. (10 points) Replicate the following payoff diagram using puts, calls and T-bills.

There are a number of ways to replicate this payoff. One way is:

Buy a t-bill with FV=20
Buy a put with K=40
Sell a put with K=20
Buy a call with K=60
Sell a call with K=80