MFE 237I: Financial Risk Management
Problem set 1

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due 4/10 before midnight

You should work with your assigned group but should write up your answer individually. Give the name of your group memebers in your writeup and email it to the TAs at shenje.hshieh.1@anderson.ucla.edu and yingcong.tang.1@anderson.ucla.edu before Monday April 10 at midnight.

1 Bank balance sheets

1.1 Creating the bank

Show the evolution of the bank balance sheet after each step below. In other words, start from a new bank and assume you do all these transactions successively.

1. The bank raises $30 in equity.

2. The bank borrows $50.

3. The bank buys $40 of Treasury bonds.

4. The bank receives $60 of deposits ($40 in checking accounts, $20 in saving accounts).

5. The bank makes $90 of loans. (Loans are illiquid, if they are sold early, they loose 75% of their value.)

1.2 Bank risks

Consider each of the following scenarios individually as if they happen to the bank after step 5 of the previous question. For each situation, show the balance sheet and explain your answer.

1. Customers of the bank take out $30 from their checking acounts.

   (a) Show the new balance sheet if the bank uses its cash to pay the customers.

(b) Show the new balance sheet if the bank sells its treasury bonds to pay the customers.

(c) What are the pros and cons of the two solutions?

2. What if the customers of the bank take out all their deposits? Which assets will the bank choose to sell? Comment on why this case is different from the previous one.

3. Now assume that the loans are not performing well. There are defaults and now the loans are only worth $50. What happens to the bank?

4. The bank thinks that its equity ratio is too low. It decides to raise it to 25%. Show two ways the bank can do this. Discuss the implication of each way for profits and risks of the bank.

2   VaR for an exponential distribution

1. Assume an asset value in 10 days follows an exponential distribution with mean W_0. Derive a formula for the value-at-risk for confidence c and reference level W_0 for the asset. Apply with $W_0 = 10$ and $c = 99\%$.

2. Now assume you are short this asset. Compute your value-at-risk for confidence c and apply with the same numerical values.

3. Comment on the similarity or difference between the results in the two questions.

4. Repeat the previous questions with expected shortfall.

3   VaR for options

You will need to write code to solve this question.

You are a hedge fund manager with $1 million of capital, and you can take any long or short position as long as you keep the 99% 10-day VaR for your portfolio under your capital. You have limited liability.
You have access to long and short positions on a stock, 3-month European calls and puts on the underlying, and risk free bonds. You choose your positions today and must hold them for the next 10 days. Assume the risk-free asset has annual rate of return $r = 1\%$, and the stock price S_t has dynamics:

$$\frac{dS_t}{S_t} = \mu dt + \sigma dW_t$$

with $\mu = 8\%$ and $\sigma = 20\%$ (again, in annual units), and the current value $S_0 = 10$. Assume there are 252 trading days in a year.

1. Find a formula for the 10-day VaR for one share of the stock as a function of μ and σ.

2. If you can only invest in stocks and bonds and want to maximize the average return on equity (subject to the VaR constraint), which portfolio do you choose?

3. If you can only invest in ATM calls and bonds, which portfolio do you choose?

4. If you can only invest in ATM puts and bonds, which portfolio do you choose?

5. Now you can choose one of the stock, call, or put (with arbitrary strike) to combine with bonds. Plot the optimal portfolio position as well as your expected return for each strike. Which strike and portfolio do you choose? Explain the intuition behind this result.

6. *Extra question.* What happens if you have to respect a constraint on expected shortfall instead of value-at-risk?