CMSC 5718 Introduction to Computational Finance

Assignment 2: Hedging and trading strategies (25% of total grade)

Instructions

1) Submit a copy of your report by email to klchau@cuhk.edu.hk **on or before April 6, 2017, 11:59pm.** You may submit any supporting worksheets if necessary (as a zipped file). The **file name** of the zipped file or your report should have the following format, **e.g. ChauKL_Assign1**.
2) Late submission of one week or less will attract a penalty of 20% of the assignment mark. ***Submission will not be accepted after April 13, 2017, 11:59pm.***
3) You can either submit your work **individually** or work together in a **group of two students**. Students in the same group will get the same assignment grade. Please state the name(s) and student number(s) clearly in the report. However, if you are submitting as a group, you only need one of the names in the file name (described in (1) above).
4) Please observe the university's plagiarism guidelines.

Part I: Option Hedging (76%)

1. Choose the stock that you have to work on

Use your student number to decide which stock you have to use to perform the analysis. Take the last two digits of your student number and use modulo 40 to obtain the order number, and look up the stock code from the given data sheet. For example, if your student number ends with 12, the order number is (12 mod 40 = 12), and the stock is thus Sino Land Co. Ltd. (stock code 83). If your student number ends with 72, the order number is (72 mod 40 = 32), and the stock is AIA Group Ltd. (stock code 1299). If you work in a group, select a stock based on one of your student numbers. This stock is known as stock X in the questions below.

2. Volatility calculation and option pricing (16%)

i) Calculate the volatilities of the Hang Seng Index (HSI) and stock X, using the data of Jan 5, 2015 to Jan 5, 2016. Repeat the above calculations using the data between Jan 5, 2016 to Jan 5, 2017. (Refer to the formula in Lecture 8, slide 43 or from Assignment 1).

ii) Use the implied volatilities given and the Black-Scholes equation to price the following options for HSI and stock X:

European call option, at-the-money (as of Jan 5, 2016), continuously compounded interest rate = 0.75%, dividend yield = *d*%, maturity = 1.00274 year (Jan 5, 2017).

[Black-Scholes formula for a stock with dividend yield q:

$$C = \exp(-qt)SN(d_1) - K\exp(-rt)N(d_2)$$

where $d_1 = \dfrac{\ln(S/K) + (r - q + \sigma^2/2)t}{\sigma\sqrt{t}}$, $d_2 = d_1 - \sigma\sqrt{t}$]

[delta for a European call option with dividend yield q: $\exp(-qt)N(d_1)$]

3. Testing of delta hedging strategy

i) Assume that you are short M call options on HSI and N call options on stock X as described in (2(ii)). Furthermore, assume that the index HSI can be bought or sold as a stock. Using the price data given in the spreadsheet, construct a delta hedging strategy for each of these positions for the period between Jan 5, 2016 to Jan 5, 2017 (the format is given in the spreadsheet). The account balance on each day is calculated by summing the following components:

- Previous account balance
- Interest cost (assume that this amount has to be borrowed, and interest is calculated daily)
- Dividend received (assume ex-date = pay date): You have to try to obtain data for the discrete dividends for stock X within this period; for HSI, assume dividend = 0.
- Cash required / received from share transaction

You have to perform two sets of calculations for each of the two underlyings. In the first set, use the given implied volatility to calculate the deltas under the Black-Scholes framework. In the second set, use the realized volatility between Jan 5, 2016 to Jan 5, 2017 that you calculate in 2(i) above. In your report, include a few lines of this table (but no need to include all the dates). What is the final account balance on the maturity date in each case?

ii) On Jan 5, 2016, you have deposited the money that you received from shorting the call options (as in 2(ii) above) into a deposit account, earning a continuously compounded interest of 0.75% p.a. The maturity of the deposit is Jan 5, 2017. Calculate the amounts that you would obtain at maturity. Compare this amount with the final account balance obtained in 3(i) above, which has to include the following calculation. If the option is in-the-money, calculate the cash amount that you need to pay the option holder when the option expires, using the closing price as of Jan 5, 2017. Also, you should be holding some shares and you need to sell the whole position at maturity. Does the total amount in the account match the total amount in the deposit account? Comment briefly on the result.

4. Hedging strategy and transaction costs

Repeat the hedging exercise for stock X for the period between Jan 5, 2016 and Jan 5, 2017. This time, you should use the realized volatility to calculate the deltas. However, you have to include a proportional transaction cost of 0.22% to the account balance, taking into account of the correct sign. (For example, if you need to buy shares worth $10000, you have to pay $10022. If you are selling shares worth $10000, you would only receive $9978.) Comment on its effect on the final account balance.

Part II – Theoretical performance of leveraged ETFs (24%)

The SFC in Hong Kong has now given approval for the listing of leveraged ETFs based on non-China indices. The providers of the product need to make available a "performance simulator" to simulate the historical performance of the product (see paragraph 18 of the guideline). While initially only funds tracking non-Hong Kong and non-Mainland foreign equity indices can be included, authorization has now been extended to equity indices in Hong Kong. As an analyst, you are asked to provide information of the theoretical performance of the following funds based on the Hang Seng Index (HSI) and Hang Seng Chinese Enterprise Index (HSCEI), assuming there is no slippage on the tracking.

Fund 1: 2 times the daily performance of HSI
Fund 2: -1 time the daily performance of HSI
Fund 3: 2 times the daily performance of HSCEI
Fund 4: -1 times the daily performance of HSCEI

For each fund, obtain two sets of results and plot graphs (similar to lecture 10, slide 9). Set 1 should be generated based on 1 year historical data, between Jan 5, 2016 and Jan 5, 2017. Set 2 should be generated based on 2 years of historical data, between Jan 5, 2015 and Jan 5, 2017.

[Theoretical performance of a fund can be calculated as the asset value $A(t)$ as in the examples in lecture 10, slide 14 or 16.]