FIN 372 / STA 372

Optimization Method in Finance: Project 4

Exotic Option Pricing

In this project, we will build code to price some 'exotic' options. The term 'exotic' is used for all options that do not have a contract structure similar to the regular options – European and American options (also called 'vanilla' options). As opposed to vanilla options that are well traded in financial markets, exotic options have features that make them more complex than the vanillas and mostly do not have established markets. An example would be what is called an Asian option that has a payoff equal to the average stock price during a period.

For this project, each group will choose one non-dividend paying stock and evaluate one exotic option on this stock.

In class, we used historical estimates of stock return volatility to price a simple European option. However, we also saw that the option price we calculated in class was not that close to the option price from the market. The primary reason for this is that the historical prices are not accurate estimates of what the market believes for the future. So in this project, we will not use historical data. Instead, we will get a call option price from the market and find the volatility that best matches this option price and then use this estimated volatility (also called implied volatility) to estimate the exotic option's price.

Specific steps

1. First choose one non-dividend paying stock –a stock that did not pay any dividend in the last calendar year and had no plans for dividends this calendar year. Use financial websites such as Yahoo! Finance to help you choose.

   For non-dividend paying assets, the price of American and European Call options are the same. Though the prices that you see in the market are mostly prices for American options, by picking non-dividend paying call options, we can assume that these are the right prices for a European option and hence use the European Call option pricier to estimate the stock parameters.

2. Next use Yahoo! Finance to find the call option closest in a strike to the current stock price and has an expiry closest to 6-months from now. Note the price, C, of this option as the average of the ask and the bid quotes. Also note down the strike K and calculate T, the number of business days (approx.) to expiry from today. Make sure you report all of this clearly in your report.

   In this step, you will have to write an R function that prices a European option for a given stock. The function will be have the following inputs and outputs in this order:

   opionPrice=callPricer(p0,K,T,r,sigma,N).

   Here p0 is the initial price of the underlying stock, K is the strike, T is the number of business days to expiry, r is the risk-free rate per business day, sigma is the standard deviation of daily stock return, and N is the number of simulations to use. This code is nothing more than a modified version of the code from class. You just have to make the code a function.

3. Next use the function above to estimate the volatility of the stock, which is sigma, for the stock you choose. The way you do this is to come up with a long list of possible choices for sigma and each choice, use the function above and find the one that gives the price closest to the price you found on Yahoo! Finance. Use a constant r=0 since risk-free interest rates, especially for the short term, are currently very low. Use at least 12 different annual volatilities from 5% to 60%. Remember that sigma in our calculations and code is daily volatilities.

   Choose an exotic option. Use the Internet, especially websites like Investopedia and Wikipedia to look up descriptions of various exotic options. You can choose any option (other than European and American). Just make sure that it is an option on one stock and not on a set of stocks.

   I would suggest running your choice by me before working on the next step to price it. This is just to make sure you will not have an unnecessarily complicated next step because you chose something way too complicated.

4. Finally, write an R code that prices this option. The code does not have to be a function and can be a script. Use the estimated volatility from step 3 as your volatility estimate of the returns to price this option. Again use r=0.

Deliverables

a. A report detailing your findings in each of the above steps. Use of visualizations when useful is encouraged.

b. The code that you used in steps 2, 3 and 4 – in 3 separate files.

All of the above zipped together and named **project4_gZ.zip** (where Z is your group number).