MIDDLESEX UNIVERSITY COURSEWORK

2018/19

MSO4112

Pricing and Stochastic Calculus

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This assignment is worth 25% of the overall grade. The submission date is **Friday**, **January 11**, **2019**. You should do the assignment **individually**.

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Aims and Objectives

The aim of the coursework is to demonstrate the ability to:

- 1. Estimate historical volatility of a stock and to price options using the Black-Scholes formulae.
- 2. Estimate implied volatility using options from a market.
- 3. Examine the assumptions of the Black-Scholes theory by analysing real stock data.

Your work will be assessed in the classroom and based on a written report, which should include the main results and conclusions.

Software Required

You will need a copy of Microsoft Excel or Open Office Calculator, which will be installed on the University computers. It is advised to back up your work.

Tasks and Assessment Weight

- 0.1 Estimation of historical volatility and Black-Scholes option pricing (30%)
 - Download historical quotes for a stock of your choice. You can access such data on:

http://finance.yahoo.com/ http://www.nasdaq.com/symbol/googl/historical

- Estimate historical drift and volatility from the data. You can find the required information in Roman, 2012, Chapter 10, p. 228 or Crack, 2014, Section 8.7.1, p. 148.
- Compute the values of European put and call options using Black-Scholes formula for a range of stock prices S, and using the average price as the strike price K. You can set arbitrary interest rate (e.g. r = .05) and arbitrary expiration time (e.g. T t = .5 years). The required information can be found in Roman, 2012, Chapter 10, p. 236 or Crack, 2014, Section 8.2, p. 122.
- Plot the values of options as functions of stock S.

0.2 Estimation of implied volatility (30%)

• Access option chain for your stock. You can view option chains on

http://www.nasdaq.com/ http://www.cboe.com/

- Copy the asking prices for call and put options for different expiration dates T t and for different strike prices K.
- Estimate implied volatility using the Black-Scholes formula. In MS Excel you can use the Goal Seek command to search for the value of volatility that is required to produce a given option price. See Roman, 2012, Chapter 10, pp. 237–239 or Crack, 2014, Section 8.7.2, p. 149 for more information.
- Plot implied volatilities as function of strike price K (these plots are called 'volatility smiles'). Plot such charts for different expiration dates.

0.3 Analysis of model assumptions and data (30%)

- You can use your stock data from previous tasks, but you may also wish to download a high frequency (intraday) data for this task. Such data is available on several sites, such as Nasdaq.
- Estimate historical volatility using different intervals from the data, and discuss the assumption that stock is a stationary process.
- Estimate autocorrelation function $k(\tau)$ by computing correlations between stock prices S(t) and $S(t + \tau)$ for a range of $\tau \in [0, T]$.
- Estimate the correlation time τ_{cor} by integrating (summing) the absolute values of the autocorrelation function, and compute the effective frequency. See Stratonovich, 2014, Chapter 2, Section 1, pp. 21–25 for the definitions.
- Discuss you findings in the context of the assumptions about the dynamics of the stock (i.e. δ -correlatedness, Markov property and spectrum of Gaussian white noise).

0.4 Presentation (10%)

Your report should be well presented. A good guide is the *Publication Manual* of the American Psychological Association (e.g. see http://www.apastyle.org/). At the very least, your report should be clear, typed or nicely hand-written document with good spelling, grammar and easy to understand English. There is no word limit, but a useful report should be just long enough to describe the work. A sensible limit is about 10 pages of typed text. Beyond this, you are probably being a bit too verbose. Tables, graphs, careful labelling and numbering are all well established and effective presentation tools.

Things to avoid are:

- Including images or diagrams that you did not create yourself or did not obtain the permission to use from the author (even if the image is from the Internet).
- Including graphs or diagrams that you do not describe in the text.
- Forgetting to label the axes on the charts.
- Using 3D charts to display 2D information.
- Including material irrelevant to the work.

Assignment Submissions

Submit your report to the the Unihelp office by **Friday, January 11, 2019**, 16:00 hours. Ensure that your work is clearly labelled with your name, student number, campus, course and the name of the module leader. Ensure that it is securely bound and easy to open. You should attach a coursework feedback form which will be dated and receipted. You should keep your receipt — it is for your own protection. Do not hand the coursework directly to your tutor.

References

- Crack, T. F. (2014). Basic Black-Scholes: Option pricing and trading (3rd ed.). Timothy Crack.
- Roman, S. (2012). Introduction to the mathematics of finance: Arbitrage and option pricing. Springer.
- Stratonovich, R. L. (2014). Topics in the theory of random noise (Vol. 1). Martino Fine Books.