NATIONAL UNIVERSITY OF SINGAPORE
Department of Mathematics

2017/2018 **QF4102 Financial Modelling** **Semester I**

QF4102 Assignment 2

A2.1 (i) Consider an American fixed-strike arithmetic-average put option which was initiated 0.25 year ago, and still has 0.25 year to its expiry. The underlier has a current price of \$100, volatility of 40%, dividend yield of 0.01 and a running average of \$95 (taken over the earlier period of 0.25 year). The risk free rate is 0.1, and the strike price is \$100.

- Write a Matlab function to implement the two-state-variable FSGM (with linear interpolation) for pricing the above option.
- With $\rho = 1$, use your function to generate results for the number of time periods in the lattice being 50, 100, 200 and 400 respectively.
- With $\rho = 1/2$, use your function to generate results for the number of time periods in the lattice being 50, 100, 200 and 400 respectively.
- With $\rho = 1/5$, use your function to generate results for the number of time periods in the lattice being 50, 100, 200 and 400 respectively.
- Comment on your numerical results and computation times taken.

(ii) Consider an American fixed strike lookback put option which was initiated 0.25 year ago, and still has 0.25 year to its expiry. The underlier has a current price of \$1, volatility of 40%, dividend yield of 0.01 and a running minimum of \$0.97 (taken over the earlier period of 0.25 year). The risk free rate is 0.1 and the strike price is \$0.95.

- Write a Matlab function to implement the two-state-variable FSGM for pricing the above option.
- Use your function to generate results for the number of time periods in the lattice being 50 to 500 in increments of 50. Comment on your numerical results and computation times taken.
- Re-run with the running minimum changed to \$0.57. Comment on the numerical results obtained.

Important: Besides the two .m files for the required Matlab functions, also prepare a Matlab script file (named `A2p1.m`) to contain all Matlab statements used to generate results in (i) and (ii). This file will be executed during the grading of the assignment.

A2.2 Consider the explicit difference scheme III (the third one in lecture notes) for approximating the solution vanilla **call** options. For the finite difference grid, take the maximum underlier price to be **four** times the strike price.

(i) Write a Matlab function to implement the explicit difference scheme III for pricing European vanilla calls. Test your implementation with a European vanilla call option which has a strike price of \$9, time to maturity of 0.25 year, current underlier price of \$9.8, volatility of 15%, dividend yield of 1% and the risk free rate of 0.1%. For $\Delta t = 0.01$

year and $h = \$0.05$, obtain the estimate to the option value, and compare it against the exact value.

(ii) Determine a lower bound for $N = T/\Delta t$ such that all coefficients in the finite difference equations are positive.

(iii) Use the bound obtained in (ii) to re-run your Matlab function for the given option in (i) to obtain another estimate to the option value. Comment on your answer.

(iv) Lower the value of N below the bound gradually and re-run the Matlab function multiple times and determine the cut-off value where the option estimate loses all its significant figures. Comment on your answer.

(v) Write another Matlab function (by modifying your Matlab function in (i)) for pricing American vanilla call options. Repeat (iii) with this Matlab function for valuing the corresponding American option. Comment on the values obtained.

Important: Besides the two .m files for the required Matlab functions, also prepare a Matlab script file (named `A2p2.m`) to contain all Matlab statements used to generate results in (i), (ii) and (v). This file will be executed during the grading of the assignment.

Due date, requirement, guidelines and regulations

(i) The due date/time for the Matlab programmes and brief report is **2359hr on 29 October, 2017**. No late submission will be accepted.

(ii) Work on the assignment problems should commence soonest possible as programming and debugging can be time consuming.

(iii) Use **Matlab** for all programming tasks.
Please add suitable amount of comments to your codes and test your codes thoroughly. The first line of each Matlab m-file should have a comment line containing the names of the group members.

(v) Prepare your report in the Windows Word format or the PDF format with a description of your work done plus supporting figures and tables etc, as well as all necessary analysis and comments.

(vi) The .doc/.pdf and all .m files should all be archived in a single Zip/Rar file. Name your .zip/.rar file with your group index (such as Gxx_Assignment.zip or Gxx_Assignment.rar where Gxx is your assigned group index), and submit it online to the IVLE workbin set up for this purpose. Only one such archive file from each group will be used in the grading process.

(vi) This assignment counts 10% towards the final assessment score of this module.

(vii) Plagiarism (copying work from fellow students, groups or others) **would not be tolerated and all parties involved would be penalized severely**.
Please refer to `http://emodule.nus.edu.sg/ac/` for more information on NUS's disciplinary process on plagiarism.

⋈⋈ The End ⋈⋈