## Derivative Securities Fall 2013, Assignment 3

## Instructor: Marco Avellaneda

Problem 1

Using the code given in the class notes, program and implement an American option pricer in which the asset pays a continuous dividend (no ``lumpy'' dividends). Do this in Matlab or simply cut and paste the code given in the lectures in VBA.

Calibrate the parameters of the code by pricing a 1 year ATM call with 45% volatility with the numerical code and with the Black-Scholes closed-form solution. In this comparison, assume that the interest rate is 10% and that the dividend is zero.

Henceforth, this is the code that you will use for implied volatility calculations in the rest of the assignment

Problem 2

Compute the implied dividend yield for December 2013 DIA options according to the data provided in the Excel spreadsheet. (Notice that there are some lines containing the same strike price, which correspond to different US exchanges trading the same option.) Assume an interest rate of 0.12% per year.

Compare with the actual dividend yield of DIA, which is an ETF. Look at Yahoo to understand the actual dividend payout of DIA.

Problem 3

Compute the implied volatility curve for December 2013 DIA options. If there is more than one quote available, use the best bid and the best ask to price the option for each strike

(continued on next page)

## Problem 4

Compute the implied dividend yield for the stock of Neostem, Inc. based on the option panels given below. Assume an interest rate of 12 basis points per year. The trade date is 10/29/2013.

Neostem, Inc. (NBS)
NBS: last 6.52 (1.32%) 3:54PM EDT
Options Expiring Saturday, November 16, 2013
NBS=6.52

| Calls | | | | | | Strike Price | Puts | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Last | Change | Bid | Ask | Volume | Open Int | | Last | Change | Bid | Ask | Volume | Open Int |
| 2.1 | 0 | 1.35 | 1.8 | 2 | 22 | 5 | N/A | 0 | N/A | 0.3 | 0 | 0 |
| 0.25 | 0 | 0.1 | 0.3 | 94 | 368 | 7.5 | 0.98 | 0 | 1 | 1.35 | 2 | 101 |
| 0.1 | 0 | N/A | 0.25 | 6 | 10 | 10 | 2.15 | 0 | 3.2 | 3.9 | 12 | 64 |

Options Expiring Saturday, December 21,2013

| Calls | | | | | | Strike Price | Puts | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Last | Change | Bid | Ask | Volume | Open Int | | Last | Change | Bid | Ask | Volume | Open Int |
| 1.8 | 0 | 1.5 | 2 | 40 | 60 | 5 | 0.2 | 0 | 0.05 | 0.3 | 4 | 64 |
| 0.35 | 0 | 0.25 | 0.6 | 4 | 186 | 7.5 | 1.3 | 0 | 1.25 | 1.8 | 120 | 427 |
| 0.45 | 0 | N/A | 0.45 | 18 | 61 | 10 | 2.9 | 0 | 3.2 | 4 | 5 | 8 |

Options Expiring Saturday, March 22,2014

| Calls | | | | | | Strike Price | Puts | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Last | Change | Bid | Ask | Volume | Open Int | | Last | Change | Bid | Ask | Volume | Open Int |
| 1.9 | 0 | 1.9 | 2.3 | 25 | 81 | 5 | 0.65 | 0 | 0.55 | 0.9 | 2 | 83 |
| 1 | 0.45 | 1.05 | 1.25 | 2 | 420 | 7.5 | 2.1 | 0 | 2 | 2.2 | 14 | 194 |
| 0.6 | 0 | 0.4 | 0.8 | 37 | 443 | 10 | 4.2 | 0 | 3.9 | 4.5 | 10 | 163 |

The website Yahoo! Finance indicates that NBS has not paid dividends in the past. If the implied dividend is not zero, give a possible explanation for this.

## Problem 5

(a) Compute implied volatility curves for NBS assuming the implied dividend yields computed above.
(b) Compute implied volatility curves for NBS assuming that the dividend is zero.
(c) Compare the two sets of results and discuss. Which set of curves should be used in practice?

## Problem 6

Put-call parity does not hold in general for American –style options. Describe how the curve

$$D(k,T) = -\frac{1}{T} ln\left(\frac{C(k,T) - P(k,T) + ke^{-rT}}{S}\right)$$

behaves as the strike price varies from 0 to $\infty$ for American-style options (assuming positive interest rate and dividend). You can do this by a numerical example, or just argue the point from first principles. Stock is not hard-to-borrow.

Problem 7

Consider an ETF XYZ along with 3-month options on the ETF. Interest rate is 0.10% and the ETF pays no dividends for the next 3 months. Furthermore, we have

| Instrument | Bid | Ask |
|---|---|---|
| XYZ | 100 | 100.01 |
| XYZ 3m 95 call | 5.86 | 5.89 |
| XYZ 3m 100 call | 3.21 | 3.22 |
| XYZ 3m 105 call | 0.88 | 0.89 |

Verify that there are no clear arbitrage opportunities by entering a position in these 4 securities (i.e. check that monotonicity holds and that there are no ``free butterflies'' in sight). Performing analysis of implied volatilities of the options, analyze the risk-reward of selling the 95-100-105 butterfly spread. Calculate the Delta, Gamma and Vega of such portfolio. Describe scenarios for which the trade will make money and scenarios for which it will lose money.