**Lecture 4 (Options Markets) Assignment**

Due start of class, Wednesday October 2, 2019

**Question 1 (4 marks)**

The current time is Wednesday at 1pm and you see the overnight implied volatility (for 10am expiration on Thursday) trading at 9%. The FX markets are open for trading every hour between now and tomorrow at 10am.

The Federal Reserve Chairwoman is speaking about the economy from 2-3pm, and that event adds an extra 0.5 trading days worth of variance on top of the usual variance for that time period.

What should the overnight implied volatility be at 3pm, all else being equal?

**Question 2 (3 marks)**

In stochastic volatility models, why is there a smile? Describe the genesis of the smile in terms of vega gamma.

Similarly, describe why stochastic volatility models generate a skew, in terms of vega dspot.

**Question 3 (2 marks)**

Why do most FX shops use a “sticky delta” volatility market model when defining delta for hedging purposes, even though that might not give the most accurate estimate of how implied volatilities, and hence portfolio prices, change when spot moves?

**Question 4 (4 marks)**

Consider an ATM EURGBP option with 0.5y to expiration. Assume the EURGBP ATM volatility is 3.5%, the EURUSD ATM volatility is 8.5%, and the GBPUSD ATM volatility is 7.5%. What is the implied correlation between EURUSD and GBPUSD spots?

EURUSD spot is 1.25 and GBPUSD spot is 1.56; assume zero interest rates.

Use the Black-Scholes vega formula to calculate the vegas of all three options and determine the notionals of EURUSD and GBPUSD options needed to hedge the vegas of 1 EUR notional of the EURGBP option, assuming correlation stays constant.

**Question 5 (10 marks)**

In this question you will look at implied correlations and see how much moves in implied correlation contribute to moves in cross volatility, versus moves in the underlying USD-pair volatilities.

Consider the AUDJPY market, where the underlying USD pairs are AUDUSD and USDJPY.

For a given expiration tenor, one can calculate the market-implied correlation between moves in AUDUSD spot and USDJPY spot through the implied volatilities for the three pairs.

First step: write code to calculate these correlations in a window from 1Jan2007 to 31May2013. I have posted a spreadsheet with the ATM implied volatilities for AUDUSD, USDJPY, and AUDJPY for various expiration tenors on the class forum.

You should write a function that takes in the names of the three pairs (as strings like ‘AUDJPY’, ‘AUDUSD’, and ‘USDJPY’), a string tenor (like ‘3m’), a flag to define whether the cross spot is the product or the ratio of the two USD spots (which affects the sign of the correlation), and the start and end dates of the historical window.

It should start by loading the data for the ATM implied volatility for the three tenors from the spreadsheet into pandas DataFrames and then calculate a pandas DataFrame of implied correlations.

The next step: use the correlation from date i, along with the implied volatilities for the USD pairs on date i+1, to predict the cross volatility on date i+1. Do this with the pandas DataFrames you have already created.

Finally, construct two DataFrames: one holding day-to-day changes in the cross ATM volatility, and one holding differences between the predicted cross volatility (assuming the implied correlation from the day before) and the true cross volatility.

The function should print out statistics on both those series.

Run this for the following list of tenors: 1w, 1m, 6m, and 1y. Comment on any differences across tenors, and whether this seems like a good hedging strategy for hedging AUDJPY volatility. Make sure to refer to statistics of the two series, both standard deviations as well as maximum and minimum deviations.