**Lecture 1 (Spot Markets) Assignment, MTH 9865**

Due start of class, September 9, 2015

**Question 1 (2 marks)**

Describe the four factors that contribute to the bid and ask prices a market maker will show to a client during voice trading?

**Question 2 (2 marks)**

Why has the daily turnover in the FX markets increased so much in the past fifteen years? Give some statistics.

**Question 3 (4 marks)**

Describe the OTC market structure and the different roles involved in executing a trade. Describe the steps involved in executing a trade for voice trading and then for electronic trading.

**Question 4 (4 marks)**

Today is October 27th, 2015. Tomorrow (October 28th) is a good business day for all three currencies. October 29th is a JPY currency settlement holiday. October 30th (a Friday) is a USD settlement holiday and November 2nd (a Monday) is a EUR settlement holiday. November 3rd is a good business day for all three currencies.

The EURUSD mid-market spot rate is 1.1300 (the price of a EUR in USD) and the USDJPY mid-market spot rate is 120.00 (the price of a USD in JPY). The USD interest rate is 0.25%, the EUR interest rate is 0.50%, and the JPY interest rate is 0.10%.

What are the spot dates for EURUSD, for USDJPY, and for EURJPY? What is the EURJPY mid-market spot rate implied from the triangle arbitrage?

**Question 5 (2 marks)**

Same market as Question 4. Assume zero bid/ask spread in interest rates.

Take the bid/ask for EURUSD as 1.1299/1.1301, and the bid/ask for USDJPY as 119.99/120.01. What is the bid/ask for EURJPY implied from the triangle arbitrage?

**Question 6 (10 marks)**

In Python, implement a variation of the “toy simulation algorithm” we discussed in class. Model parameters to assume:

* Spot starts at 1
* Volatility is 10%/year
* Poisson frequency  for client trade arrival is 1 trade/second
* Each client trade that happens delivers a position of either +1 unit of the asset or -1 unit of the asset, with even odds
* Bid/ask spread for client trades is 1bp
  + Receive PNL equal to 1bp\*spot\*50% on each client trade (since client trades always have unit notional in this simulation)
* Bid/ask spread for inter-dealer hedge trades is 2bp
  + Pay PNL equal to 2bp\*spot\*hedge notional\*50% on each hedge trade
* A delta limit of 3 units before the algorithm executes a hedge in the inter-dealer market.

Use a time step t equal to 0.1/ and assume that only a single client trade can happen in each time step (with probability equal to ). Use 500 time steps and a number of simulation runs to give sufficient convergence.

When converted between seconds and years, assume 260 (trading) days per year.

The variation in the algorithm: when the algorithm decides to hedge, it can do a partial hedge, where it trades such that the net risk is equal to the delta limit (either positive or negative depending on whether the original position was above the delta limit or below -1\*delta limit); or it can do a full hedge, like in the algorithm we discussed in class, where the net risk is reduced to zero.

Use the Sharpe ratio of the simulation PNL distribution to determine which of those two hedging approaches is better.

Your solution should deliver the Python script that implements the simulation, and you should explain your answer by giving numerical results from the simulation as well as some qualitative intuition behind the result. Include data that shows that you have used sufficient Monte Carlo simulation runs to show that your final result is not affected by statistical noise.

Marks will be given for both the numerical results generated from the simulation as well as the quality of your Python code. Remember to include lots of explanatory comments in your code and use variable names that are meaningful. Use external packages like numpy/scipy where applicable rather than rolling your own low-level numerical functions like random number generators. For top marks, use only vectorized operations across the Monte Carlo paths to speed up execution.