**Problem Set 7**

Directions:

For each of the following problems, use Python to find your answers.

Show me the Python code you used in your answer.

1. This problem has two purposes. First, to get you estimating changing VaR models with changing conditional variances. Second, to get you to look at some FX series. As I’ve mentioned many times in class, most of the features we’ve talked about in financial time series are pretty universal to many financial series. For this example I have pulled data from the FRED data system (open source) at the Federal Reserve Bank of St. Louis. (I highly recommend an internet field trip to this site.)
   * 1. Plot the exchange rate closing values. Try to generate a **pretty** plot with grid lines and label you axes.
     2. Repeat this for the 1 day log returns series.
     3. Now find the 1 day static VaR (p=0.025) using standard parametric VaR assuming a normal distribution. Assume a portfolio which (as usual) starts with a value of 100, and you are interested in the one day VaR.
     4. Now estimate the rolling standard deviation for the series. Plot this over time. Repeat what we did in class. Use a 50 day moving average over the squared returns, and take the square root of this value for an estimate of the changing conditional standard deviation.
     5. Estimate the **standardized returns** by dividing the returns by the standard deviation at each period. Report the estimated kurtosis for the original 1 day returns and also the standardized returns. Run a Jarque-Bera test on the both these series, and report the p-value.
     6. Now estimate the rolling 1 day VaR. In this case, use the normal critical values, but using the rolling (changing) standard deviation as we did in class. Find the VaR again for the portfolio starting at 100. Plot this VaR over time.
     7. Timing question. Given that this VaR uses the close in prices at time t, which exact 1 day horizon is it referring to?
     8. Repeat your estimation using the *riskmetrics* exponential moving average with lambda = 0.94. Find the rolling VaR, and plot this along with the moving average VaR from question ?
     9. Now plot a scatter plot comparing your two VaR estimates. Put the moving average VaR on the x-axis, and the exponential moving average on the y-axis.
     10. Estimate the VaR exceptions as we did in class, and plot a 250 day moving average of these for both the static and changing VaR levels. (This might be easiest if you did this in return space.) For the changing VaR use the 250 moving average method.

Data file: [**euro.csv**](http://people.brandeis.edu/~blebaron/classes/fin285a/_downloads/euro.csv)

Time series data of daily rates are from FRED (Federal Reserve Economic Data):

<https://fred.stlouisfed.org/series>

A couple of quick side points:

1. Note how I have handled multiple plots using the plt.figure() function.
2. Problem 7 asked about timing. This is important. Technically, your VaR estimate on day (t) uses (t) information. Therefore, it is a VaR number for one day in the future, day (t+1). When looking at exceptions you need to be careful about this. See line 124 in the code where R-star is lagged one day.
3. Note that the Kurtosis falls by a large amount (but not completely to 3) for the standardized residuals.
4. Also, note that they still fail the JB test for normaliity. This is a pretty common result for many return series. Volatility is a big part of the fat tailed story, but probably not all of it.