City University of Hong Kong
Department of Economics and Finance
Course EF5213 Assignment #1 **(due February 5, 2023)**

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1. In the Exponentially weighted moving average model (EWMA), future variance is a weighted average of its immediate past estimation and the most recent observation of squared residual of price return. It follows an iteration equation given by

$$\sigma_{t+1}^2 = (1-\lambda)(r_t - \mu)^2 + \lambda\, \sigma_t^2$$

with weight factor $1 > \lambda > 0$. The parameter μ can be estimated based on the historical mean of a given time series $\{r_1, \ldots, r_n\}$ as $\mu \cong (1/n)(r_1 + \ldots + r_n)$.

(a) Given, in file *HSI.csv*, historical daily closing prices for Hang Seng Index from 2001 to 2020 as

$$\{timestamp, open, high, low, close, volume\}$$

use VBA to develop a procedure that captures the time series of price returns as

$$This\ return = \frac{This\ close - Last\ close}{Last\ close}$$

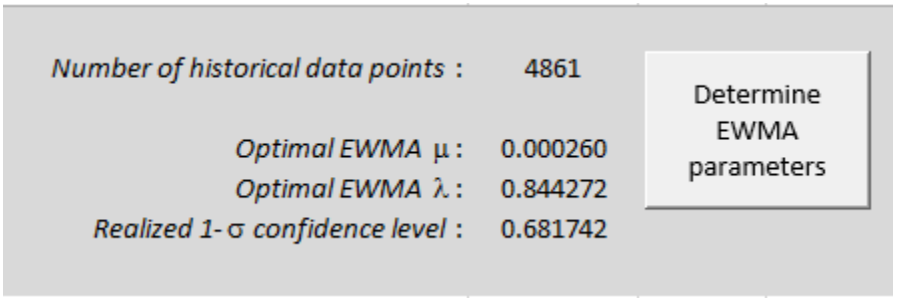
(b) Determine the EWMA model for the extracted time series in **(a)**. The parameter α should be determined by considering the notion of minimizing root-mean-square error (*RMSE*) defined as

$$RMSE = \sqrt{\frac{1}{n}\sum_{t=1}^{n}\left[\,\sigma_t^2 - (r_t - \mu)^2\,\right]^2}$$

based on the historical time series of price returns $\{\, r_1, r_2, \ldots, r_n \,\}$. For this purpose, use the enclosed Brent's minimizer from netlib with your own modification.

(c) Use the same time series $\{\, r_2, \ldots, r_n \,\}$ to backtest the 1-σ confidence level of the optimal EWMA model.

Sample user interface is given below:



(40 points)