**Model Documentation**

1. **Purpose of the model**

This web-based risk calculation system aims to provide a user-friendly software for users getting known of risk indicators for an individual stock or portfolio. It allows users to enter basic attributes regarding their investment choice, and outputs graphs of VaR/ES with respect to time.

1. **Scope of use of the model**
   1. For the sections Individual Stock / Portfolio, it allows users to choose the specific method to calculate VaR/ES, which may satisfy different users’ preference accordingly:
      1. Parametrical method (Formula method):
         * It assumes either the individual stock or the portfolio price follow the geometric Brownian motion and returns are normal distributed. We don’t simulate the portfolio price by analyzing underlying prices and correlations.
         * Before running the risk calculation steps, the system will automatically calibrate the necessary parameters (drift and volatility) to historical price data, using the window lengths requested by users.
         * Below are the formulas being used:

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* + 1. Historical method:
       - Apply relative changes to stocks/portfolios, meaning that all analysis is based on log returns.
       - It has obvious advantages compared to the other to: no assumptions need to be made about the distribution of returns; no need to estimate the volatilities and correlations between the various assets
       - The drawback also exists since it is strongly backward looking. Extreme past events have a huge impact on estimations
    2. Monte Carlo method:
       - It shares the same assumptions with parametric method in terms of the price distribution, same calibration procedure before risk calculation.
       - In this system, we generate 5000 samples, select the according percentile from users input as the final values. Same strategy for both VaR and ES.
  1. The option section uses Monte Carlo simulation method by default, because either too complicated to derive formula combining the option parts, or not enough historical data available for option prices. The simulation steps number is 100000 for this part so that it would be more accurate. Since we only run for the current day, 100000 steps will not slow down the calculation a lot.
  2. Users can choose the window of length for parameter calibration. The numbers are in year, with the maximum of 10.
  3. The system can output for stocks/portfolio:
     1. Plot of historical price for the entered ticker and start/end date
     2. Parameter estimations:
        + Two graphs included here: drift and volatility
        + Both have three window lengths: 2/5/10
        + Both are from the start date to end date (users input)
     3. Risk measure:
        + Plot VaR and ES in the same graph in order to give a clearer comparison.
        + It also outputs a back-testing result, plotting calculated VaR vs actually loss in the past to show how accuracy the system can give out answers.
  4. Option part analyzes the portfolio of investing in stocks and its corresponding put options. Currently, the option VaR is only calculated for the current position date. The main purpose is to discover risk reduction through investing in corresponding put option. The output compares the VaR with/without options position. It doesn’t give plots against the history.
  5. Users can choose to download all the calculated values shown on the graph as a csv file, for further analysis or testing purpose.

1. **Performance requirements of the model**
   1. Users are responsible to enter reasonable inputs:
      1. Tickers must be consistent with Yahoo finance
      2. For portfolio parts, weights must sum up to exactly 1
      3. Historical prices plot only needs tickers, weights, start date and end date. The other functions need all the inputs displayed on the website.
      4. For option hedging part, the implied volatility provided must be consistent with the maturity of option being invested in the portfolio
   2. Users should make sure there is enough historical price data available from Yahoo finance, since the system will automatically retrieve data there. Enough data means that it has price history back until at least 10 years before the start date. (Parameter plots are using 10 years rolling windows)