BAF 640
Assignment 1

Today is August 3, 2020. You have 10,000,000 won in your brokerage account. You are considering a portfolio that invests in three individual KRX stocks and the KOSPI index with equal weights. Before making investments, you first want to understand how much risk you are taking.

Since the value of your portfolio depends on the volatilities of the market variables, you start your risk analysis by estimating the volatility for the KOSPI index using the EWMA and GARCH(1,1) model.

In answering the questions below, use the spreadsheet provided for the assignment in the course Dropbox folder.

Stock Selection and Data Download

1) You want to invest in Samsung Electronics Co Ltd (KRX: 005930), SK Hynix Inc (KRX: 000660), and Hyundai Motors Co (KRX: 005380). Using the fnDataGuide Excel Add-in tool, download daily adjusted closing price[1] data for the three stocks and KOSPI index from January 3, 2005 to August 3, 2020. Do not include weekends or holidays.

   (Hint: The data item code is I31000040F for the KOSPI index and S410000700 for individual stocks.)

   ➔ The spreadsheet already contains the data, so no additional work is required for Q1.

GARCH (1,1)

2) Estimate parameters for the GARCH (1,1) model on the KOSPI index data **over the most recent 1000 days** using the maximum likelihood method. Use the Solver tool in Excel.[2] To start the GARCH calculation, set the **variance forecast at the end of the first day** equal to the square of the return on that day.

   (Hint: The total sample period is from July 7, 2016 to Aug 3, 2020. The return observations are available from July 8, 2016 to Aug 3, 2020, and the variance and likelihood estimates for MLE are available from July 11, 2016 to Aug 3, 2020.)

3) What is the annualized volatility estimate at the end of August 3, 2020 based on the GARCH (1,1) model?

   (Hint: Note that this is the volatility estimate for August 4, 2020.)

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[1] The adjusted closing price amends a stock's closing price to reflect that stock's value after accounting for any corporate actions, such as stock splits, dividends, and rights offerings (www.investopia.com). Therefore, you can calculate the returns of a stock as the percentage changes in the stock's adjusted closing price.

[2] To load the Solver Add-in in Excel, follow the instruction here: https://support.microsoft.com/en-us/office/load-the-solver-add-in-in-excel-612926fc-d53b-46b4-872c-e24772f078ca.

EWMA

4) Estimate parameters for the EWMA model on the KOSPI index data **over the most recent 1000 days** using the maximum likelihood method. Use the Solver tool in Excel. To start the EWMA calculation, set the **variance forecast at the end of the first day** equal to the square of the return on that day.

   (Hint: The total sample period is from July 7, 2016 to Aug 3, 2020. The return observations are available from July 8, 2016 to Aug 3, 2020, and the variance and likelihood estimates for MLE are available from July 11, 2016 to Aug 3, 2020.)

5) What is the annualized volatility estimate at the end of August 3, 2020 based on the EWMA model?

   (Hint: Note that this is the volatility estimate for August 4, 2020.)

Comparison Between GARCH (1,1) and EWMA

6) Plot a line graph that shows the GARCH (1,1) and EWMA volatility estimates (primary axis) along with the KOSPI index level (secondary axis) between **January 2, 2018 and August 4, 2020**. Explain your findings.

The last two questions are independent of the previous questions.

Volatility

7) A company uses an EWMA model for forecasting volatility. It decides to change the parameter λ from 0.85 to 0.9. Explain the likely impact on the forecasts.

8) Suppose that GARCH(1,1) parameters have been estimated as $\omega = 0.00000135$, $\alpha = 0.0833$, and $\beta = 0.9101$. The current daily volatility is estimated to be 1%. Estimate the daily volatility in 30 days.

Principal Component Analysis

9) Recall the PCA result of swap rates (Table 1 and 2) and the portfolio's exposures to interest rate moves (Table 3) in example 4 of week 4 lecture note.

Table 1: Factor Loadings for Swap Data (bps)

	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8
1-year	0.216	−0.501	0.627	−0.487	0.122	0.237	0.011	−0.034
2-year	0.331	−0.429	0.129	0.354	−0.212	−0.674	−0.100	0.236
3-year	0.372	−0.267	−0.157	0.414	−0.096	0.311	0.413	−0.564
4-year	0.392	−0.110	−0.256	0.174	−0.019	0.551	−0.416	0.512
5-year	0.404	0.019	−0.355	−0.269	0.595	−0.278	−0.316	−0.327
7-year	0.394	0.194	−0.195	−0.336	0.007	−0.100	0.685	0.422
10-year	0.376	0.371	0.068	−0.305	−0.684	−0.039	−0.278	−0.279
30-year	0.305	0.554	0.575	0.398	0.331	0.022	0.007	0.032

Table 2: Standard Deviation of Factor Scores (bps)

PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8
17.55	4.77	2.08	1.29	0.91	0.73	0.56	0.53

Table 3: Change in portfolio value for a 1 bps rate move ($M)

3-Year Rate	4-Year Rate	5-Year Rate	7-Year Rate	10-Year Rate
+10	+4	−8	−7	+2

Since the first two factors together account for 97.7% of the variance in the data, let's use the first two factors to model the rate moves.

Using the data in Table 1 and Table 2, the portfolio's delta exposure to the first PC is $10 \times 0.372 + 4 \times 0.392 - 8 \times 0.404 - 7 \times 0.394 + 2 \times 0.376 = 0.05$ million dollars per unit of the factor. Likewise, the portfolio's delta exposure to the second PC is $10 \times (-0.267) + 4 \times (-0.110) - 8 \times 0.019 - 7 \times 0.194 + 2 \times 0.371 = -3.88$ million dollars per unit of the factor. In other words,

$$\Delta P = 0.05 \times PC_1 - 3.88 \times PC_2$$

Suppose we are interested in a "worst case" outcome for tomorrow where the loss has a probability of only 1% of being exceeded. What is the loss? Assume that the two PCs are independent from each other and follow a normal distribution with mean 0.

(Hint: PC1's standard deviation is the square root of the first eigenvalue and PC2's standard deviation is the square root of the second eigenvalue. See Table 2.)
(Hint: The sum of two normally distributed random variables is also normal.)