The Erdős Institute Summer 2025 – Quant Finance Bootcamp

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Mini-Project 1: In this project we had to create two profitable investment portfolios, one of low and one of high volatility. I tried various approaches for this one, primarily on how we would select the tickers and how we would weigh them, i.e. what percentage of our assets would be invested into each portfolio.

The first thing I did, in order to appropriately come up with a low/high volatility portfolio, was apply a threshold on the volatility of each index (I focused on a threshold of 0.3) to a group of 20 indices in order to consider them separately in a high and low index portfolio. Another approach was to handpick some, though the former seemed to work better, as expected. The main things I had considered regarding the weighting were to have (within each group) each index of equal weight, then a weight inversely proportional to its individual volatility, another where we solved the quadratic program introduced in lecture, and finally optimize the Sharpe ratio.

What would be interesting is to see if these approaches can be extended to dynamically changing the weights after given periods or other indicators; and leveraging on the profits made by the portfolio up to that point, such as if volatility of an index increases or decreases.

Mini-Project 2: This project focused on the normality assumptions regarding the underlying distributions of prevalent financial models. I had tried various hypothesis testing approaches (rolling Shapiro-Wilk test, D'Agostino and Pearson's test) though none of them deduced that the log returns of stocks/indices are normally distributed, even in the case where we removed outliers. Finally, I observed that with the outliers, we actually had a Laplacian distribution, which I deduced through the Kolmogorov-Smirnov test, and this was also verifiable through Q-Q plots. This was also the conclusion on the log returns from a portfolio I had created in project 1.

To summarize, I had concluded that a Laplace distribution, which has heavier tails than a normal distribution, is a more plausible and appropriate assumption regarding the assumptions of the log returns in financial time series, as they also incorporate extreme or unexpected events and outliers.

Mini-Project 3: Here we would visually explore the rate of change of Black-Scholes call and put options, as time progresses. By tweaking the different parameters in the two cases, I deduced similar observations for the two (call and put) and there seemed to be a resemblance between them. This was justifiable to some extent by what is known as the "put-call parity". Furthermore, time to expiration is of great importance and a high sensitivity factor. In terms of the rate of change of Black-Scholes Put and Call Options, the general conclusion was that Put prices have more rapid rates of change compared to Call prices.

Mini-Project 4: In this project we explored different models for financial time series that exhibit time-varying volatility. The two I focused on were the GARCH (generalized autoregressive conditional heteroskedasticity) model, and the Heston model. Difference statistics were derived from the two models, with the most worthy noting was the fact that the correlation factor between the implied log returns and the change in variance was roughly 0 for the GARCH model, and consistently negative for the Heston model.

Furthermore, I had compared various ticker stock data with some of the emulated GARCH and Heston model variances. The conclusion from these experiments was that the GARCH model may be more appropriate for emulating the variability compared to the Heston model. It is worth noting that since the introduction of the GARCH model, there has been a great number of variants proposed, since its introduction in the 1980s.