Investment Theory | Prof. Lorenzo Naranjo
FIN 5320 | Fall 2025

Group Project

Instructions

This group assignment is due no later than Friday 10/17 at 11:59pm CST. You can do the assignment either in Microsoft Excel (recommended) or Python.

- If you do your assignment in Excel, please submit your spreadsheet showing your work and a pdf document with your report. I expect your spreadsheet and report to be formatted professionally.
- If you do your assignment in Python, please convert your Jupyter notebook to HTML and submit the HTML file. Please submit the resulting HTML file and a pdf document with your report. Using ChatGPT to get the Python code to run is okay, but copy-and-pasting full paragraphs in your report is not.

Your grade on this assignment depends exclusively on what you write in your report, and how you format the document. Your report must use titles, proper capitalization, paragraphs explaining your work, properly formatted tables and figures, equations if necessary, and full sentences. Your report should read and look like a professional report generated by a large investment bank for an important client.

I will check all assignments for plagiarism using Turnitin.

Objective

As a group of portfolio managers at an asset management firm, you have been tasked with implementing a Treynor-Black style model to construct a portfolio designed to outperform the market. You know that you could use the formulas derived by Treynor and Black (1973) in their original paper, but you would like to add portfolio weights constraints, and also try with other alternatives, so you decide to modify their approach.

Security Selection

Begin by selecting **six stocks** that you believe are either underpriced or overpriced. For each stock, provide a justification for your selection, such as financial ratios suggesting mispricing, recent news events, a broker's recommendation, or other relevant factors.

For each selected security, perform a standard OLS regression as follows:

$$R_i = \alpha_i + \beta_i R_m + e_i, \tag{1}$$

where $R_i = r_i - r_f$ represents the monthly excess returns for security i over the risk-free rate, and $R_m = r_m - r_f$ represents the monthly excess returns of the market. Use the 13-week Treasury Bill CBOE Index (^IRX) as a proxy for the risk-free rate, and be sure to convert its annualized rate into a monthly rate compounded monthly for your calculations. For the market proxy, use the SPDR S&P 500 ETF Trust (SPY), and ensure that you use `Adjusted Prices` to account for dividends when computing returns. Run the regressions using five years of historical data.

I do not need to see the output of each regression. Instead, generate one single table that displays the relevant information for all securities at once:

- Alpha (per year)
- Beta
- R-square
- Volatility of returns (per year)
- Firm-specific volatility (per year)

To compute the firm-specific volatility, you can use

$$\sigma^2(e_i) = \sigma_i^2 - \beta_i^2 \sigma_M^2.$$

Therefore, you will also need to compute the volatility of excess market returns.

For each security, generate a scatter plot that includes the regression line. Display all your plots tightly in a three-row two-column configuration.

Maximizing the Sharpe Ratio of Individual Stocks

In this part of the analysis, I want you to maximize the Sharpe ratio of a portfolio consisting only of the six stocks you selected in the previous part. You will constraint the weights to be positive, and no weight can be larger than 40% of the portfolio. Your estimation problem is then given by

$$\max_{\{w_1,\ldots,w_n\}} \frac{\mu_P - r_f}{\sigma_p} \quad \text{s.t.} \quad \sum_{i=1}^{n} w_i = 1, \text{ and } 0 \leq w_i \leq 0.4 \text{ for each asset } i = 1, 2, \ldots, n.$$

In this particular case we have $n = 6$ stocks. You can compute the portfolio risk-premium as

$$\mu_P - r_f = \sum_{i=1}^{n} w_i(\mu_i - r_f)$$

where $\mu_i - r_f = \alpha_i + \beta_i(\mu_m - r_f)$. You can use the α_i and β_i estimated in (1), and assume a market risk-premium of $\mu_m - r_f = 6\%$ per year. To compute σ_P, first compute for each month $t = 1, \ldots, T$ the return of the portfolio as

$$r_{P,t} = \sum_{i=1}^{n} w_i r_{i,t},$$

and then compute an annualized sample standard deviation as

$$\sigma_P = \sqrt{12} \times \sqrt{\frac{1}{T-1} \sum_{t=1}^{T} (r_{P,t} - \hat{r}_P)^2},$$

where $\hat{r}_P = \frac{1}{T} \sum_{t=1}^{T} r_{P,t}$. Note that this is how the Excel function `=stdev.s()` computes the standard deviation.

Your Sharpe ratio is now a function of the portfolio weights that can be maximized using Excel or Python by imposing the appropriate constraints.

Report the composition, expected return, standard deviation, Sharpe ratio, alpha and information ratio of your portfolio. Comment on the strengths and weaknesses of using only six stocks to form your optimal portfolio.

Adding the Market

The idea of Treynor and Black (1973) was to add the market to the previous optimization problem. That way you have an active portfolio composed of six stocks and a passive portfolio which is the market portfolio. You can use the SPY to proxy for the market which is now your seventh stock.

Report the composition, expected return, standard deviation, Sharpe ratio, alpha and information ratio of your new portfolio. Comment on the strengths and weaknesses of adding the market in addition to your original six stocks to form your optimal portfolio.

Assess the proportion of the portfolio that stays passive vs. active, and whether the weights of the active portfolio make sense.

Conclusion

Based on your previous results, write a convincing paragraph with a recommendation as to what is the best approach to form your portfolio. Contrasts the benefits vs. costs of adding the market in your portfolio allocation.

References

Treynor, Jack L., and Fischer Black. 1973. “How to Use Security Analysis to Improve Portfolio Selection.” *Journal of Business* 46 (1): 66–86.