

# FE630 - Final Project

**Author:** Sid Bhatia

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**Pledge:** I pledge my honor that I have abided by the Stevens Honor System.

**Professor:** [Papa Momar Ndiaye](#)

## 1. Overview

### 1.1 Goal

The goal of this project is to build and compare *two factor-based long short allocation models* with constraints on their *betas*. The first strategy considers a **target Beta** in the interval  $[-0.5, 0.5]$ , while the second has a target Beta in the interval  $[-2, +2]$ .

The first strategy operates similar to a **Value-at-Risk Utility** corresponding to **Robust Optimization**; the second strategy incorporates an **Information Ratio** term to limit the deviations from a benchmark, provided those deviations yield a 'high return.'

Once the optimization models are built, we want to *compare* the outcomes of the two models while simultaneously evaluating their sensitivity to the *length* of the estimators for the **covariance matrix** in tandem with the **expected returns** under various market regimes/scenarios.

### 1.2 Reallocation

The portfolios will be *reallocated* or, in other words, 'reoptimized' weekly from the beginning of **March 2007** to the end of **March 2024**. Our *investment universe* encompasses a set of exchange-traded funds (**ETFs**) which is large enough to represent the '**Global World Economy**' (as according to some).

We will utilize the [Fama–French Three-Factor Model](#) which incorporates the following factors:

- Momentum
- Value
- Size.

Regarding data accessibility, these factors have historical values available for **free** from **Ken French's personal website** in tandem with Yahoo Finance.

## 1.3 Performance Evaluation

Naturally, the performance as well as the risk profiles of the aforementioned strategies may be (relatively) sensitive to the *target Beta* and the (current) market environment.

For example, a '**low Beta**' (essentially) means that a strategy is created with the objective or aim to be '**decorrelated**' (no linear relationship between entites) with the 'Global Market,' which, in our case, is represented by the **S&P 500** (i.e., no *systematic relationship*).

A '**high Beta**' is simply the antithesis, or opposite, of what we just discussed. In layman's terms, we have a (higher) appetite for '*risk*' (in this case, let's keep it simple and define our premise as  $\sigma$  or **standard deviation**) and desire to ride or 'scale up' the *market risk* (**systematic risk**).

Moreover, it's imperative that one acknowledges that such a (described) strategy is more probable to be (quite) sensitive to the *estimators* used for the **Risk Model** and the **Alpha Model** (e.g., the length of the *look-back period* utilized); therefore, it is necessary to understand and, most importantly, *comprehend* the impact of said estimators on the **Portfolio's** characteristics:

- (Realized) Return :  $\mu_h$
- (Historical) Volatility :  $\sigma_h$
- Skewness :  $(\mathbb{E}[(\frac{x-\mu}{\sigma})^3]) = \frac{\mu_3}{\sigma^3} = \frac{\kappa_3}{\kappa_2^{3/2}}$
- VaR / Expected Shortfall
- Sharpe Ratio :  $S_a = \frac{\mathbb{E}[R_a - R_b]}{\sigma_a} = \frac{\mathbb{E}[R_a - R_b]}{\sqrt{\mathbb{V}(R_a - R_b)}}$