FINM 25000 **Mark Hendricks**
Summer 2023

Midterm (A)

You have **180 minutes** to work through **120 points**. Pace yourself accordingly. If you finish early, you are welcome to submit your work and leave the exam.

The exam uses data posted on Canvas.

- The data file is `midterm_A_2023_data.xlsx`.

1 Return Analysis (35pts)

This section only uses the excess return data from the `commodities` tab.

1. (5pts) For each of the 14 assets, report the following **annualized** excess return statistics:
   - mean
   - volatility
   - Sharpe ratio
2. (5pts) For each of the 14 assets, report the following statistics (no annualization needed).
   - VaR (0.01). That is to say, the 1st quantile of returns.
   - CVaR (0.01). That is to say, the average of the returns less than the 1st quantile.
   - maximum drawdown[1] Though we usually calculate maximum drawdown on **total** returns, keep things simple and just continue to use the **excess** returns we're already using in all the other problems.
3. (5pts) **Conceptual question:** Suppose you could only invest in one of these assets, not an entire portfolio. Which statistics would you recommend that an investor consider in choosing the single asset.
4. (5pts) **Conceptual question:** Suppose you already have a large portfolio and are considering which of these assets to hold as an additional investment, along with your other assets. Would your answer be the same? Conceptually, which other statistics might interest you?
5. (10pts) Run a Linear Factor Decomposition of sugar (SB1) on coffee, (C1). That is, use the two return series r^{SB1} and r^{C1}. Report the following (annualized) statistics:
   - market alpha

[1] No need to identify the period over which it happens.

- market beta
- market Information ratio

6. (5pts) Based on the statistics above, what is the hedge ratio between sugar (SB1) and coffee (C1)?

2 Mean-Variance Optimization (35pts)

This section only uses the excess return data from the `commodities` tab.

1. (10pts) Calculate the weights of the tangency portfolio formed from the 14 assets.
2. (5pts) What are the weights of the optimal portfolio, w^*, with a targeted mean excess return of 0.0075 per month?
3. (5pts) Does the tangency portfolio weight securities in order of their individual Sharpe ratios? Why or why not?
4. (5pts) Report the mean, volatility, and Sharpe ratio for the optimized portfolio, w^*, (calculated in the previous question.) Annualize the statistics.
5. (5pts) **Conceptual question:** How does Harvard make their portfolio allocation more realistic than a basic mean-variance optimization would imply?
6. (5pts) **Conceptual question:** State one reason that Mean-Variance optimization is not robust, (i.e. the solution is fragile with respect to the inputs.)

3 Pricing (30pts)

This section uses a two-factor pricing model: the market (MKT) and momentum (UMD).

$$\mathbb{E}\left[\tilde{r}^i\right] = \beta^{i,m}\mathbb{E}\left[\tilde{r}^m\right] + \beta^{i,\text{umd}}\mathbb{E}\left[\tilde{r}^{\text{umd}}\right] \tag{1}$$

- Get the assets from the `commodities` tab of the data file.
- Get the factors from the `factors` tab of the data file.

1. (10pts) Estimate the time-series test of the pricing model.

   Report, for each asset,

   - annualized alpha
   - beta
   - r-squared.

2. (5pts) If the pricing model worked perfectly, what would these statistics be?
3. (5pts) Which asset does the pricing model fit best?
4. (5pts) Which factor has a higher risk premium in the estimated model above?
5. (5pts) **Conceptual question:** Instead of the 2-factor model above, suppose the CAPM is true and fits perfectly in our sample.

   For n assets, what do we know about their...

   - time-series r-squared metrics?
   - Treynor Ratios?
   - Information Ratios?

4 Forecasting (20pts)

Forecast (total) returns on gold as tracked by the ETF ticker, GLD. As signals, use two interest rate signals: the yield on T-bills and the change in T-bill yields.

- Find the data in the `forecasting (weekly)` tab.

1. (7pts) Consider the lagged regression, where the regressor, $(X,)$ is a period behind the target, (r^{GLD}).

$$r_t^{GLD} = \alpha^{GLD,\boldsymbol{X}} + (\boldsymbol{\beta}^{GLD,\boldsymbol{X}})' \boldsymbol{X}_{t-1} + \epsilon_t^{GLD,\boldsymbol{X}} \tag{2}$$

   Estimate (2) and report the $\mathcal{R}^2$, as well as the OLS estimates for α and β. (No need to annualize these stats.)

   Do this using both interest rate signals together. So we are estimating just one model:

   - $\boldsymbol{X}$ as the two regressors: Tbill rate and Tbill change.

2. (5pts) Use the forecasted GLD returns, $\hat{r}_{t+1}^{\text{GLD}}$, to build trading weights:

$$w_t = 0.2 + 80\ \hat{r}_{t+1}^{\text{GLD}}$$

   Calculate the return on this strategy:

$$r_{t+1}^{\text{x}} = w_t r_{t+1}^{\text{GLD}}$$

   Report the first and last 5 values.

3. (3pts) For both r^{x} and r^{GLD}, report

   - mean
   - volatility

   Which strategy seems better?

4. (5pts) Suppose we were going to forecast GLD using just one of our two signals. Which of the signals would likely lead to a result where the long-term forecast compounds the effect over long horizons, as we saw for forecasting SPY using dividend-price ratios? Explain.