Linear Factor Models & Performance Measurement

Date: 6th Oct 2024

Problem Statement:

Linear Factor Models & Performance Measurement:

Risk_Factors.xlsx contains monthly observations of the risk-free rate and the three Fama–French risk factors (expressed as percentages), over the ten-year period from Jan 2004 through Dec 2013.

1. Regress the monthly excess returns for each industry portfolio on the three Fama–French risk factors:

- Create a table showing the factor loadings on SMB and HML for the ten industry portfolios.

2. Using monthly excess returns for the ten industry portfolios, calculate the following performance metrics:

- Sharpe ratio
- Sortino ratio (using risk-free rate as target)
- Treynor ratio (using CAPM β)
- Jensen's α
- Fama–French three-factor α

The sample semi-variance can be estimated as:

$$\frac{1}{T}\sum_{t=1}^{T}\min\{R_{it}-R_{ft},0\}^2$$

where Ri is return on industry portfolio and Rf is risk-free rate.

3. Create a table showing the performance metrics for the ten industry portfolios.

4. Plot your results as a bar chart for each performance metric.

5. Briefly explain (in words, without mathematical equations or formulas) the economic significance and pricing implications of each of the three performance ratios (but not α's).

Solution:

1. The table showing the factor loading on SMB and HML is plotted below:

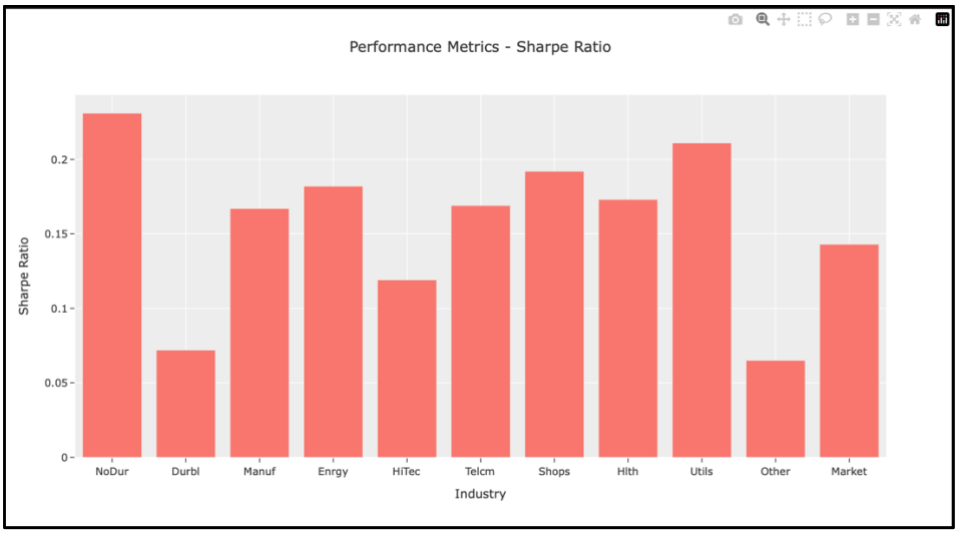
	Industry	Alpha (Intercept)	Beta (Market Risk)	Gamma (SMB)	Delta (HML)
0	NoDur	0.387	0.712	-0.229	-0.023
1	Durbl	-0.474	1.447	0.671	0.241
2	Manuf	0.153	1.142	0.087	0.028
3	Enrgy	0.523	1.028	-0.259	-0.008
4	HiTec	-0.066	1.153	0.336	-0.557
5	Telcm	0.201	0.924	-0.080	-0.019
6	Shops	0.256	0.770	0.280	-0.039
7	Hlth	0.257	0.752	-0.213	-0.144
8	Utils	0.474	0.632	-0.388	-0.017
9	Other	-0.404	1.123	-0.062	0.547
10	Market	0.000	1.000	0.000	0.000

2,3. The Performance metrics were calculated below: (Market portfolio's performance metrics were not explicitly asked to calculate, I just did it for my understanding). All are charted below:

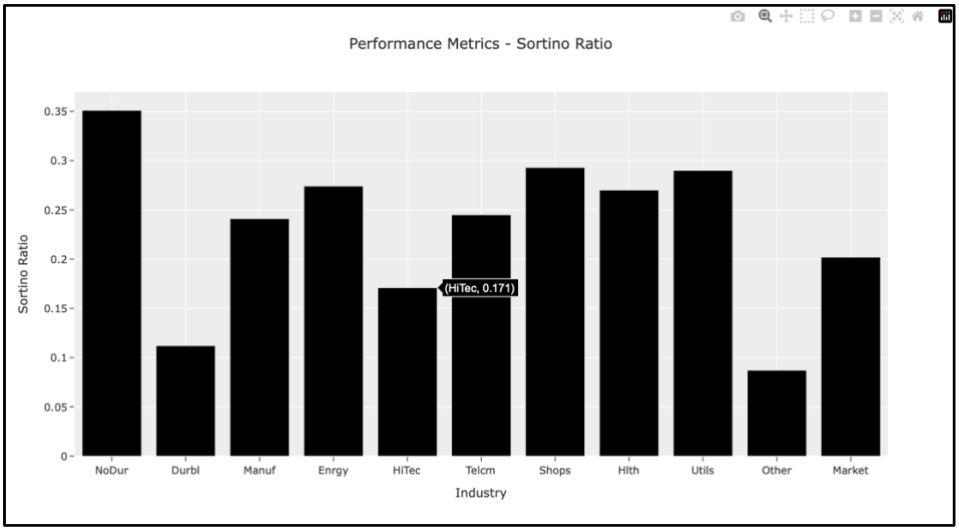
	Industry	Sharpe Ratio	Sortino Ratio	Treynor Ratio	Jensens Alpha
0	NoDur	0.231	0.351	1.188	0.370
1	Durbl	0.072	0.112	0.368	-0.417
2	Manuf	0.167	0.241	0.757	0.159
3	Enrgy	0.182	0.274	1.138	0.502
4	HiTec	0.119	0.171	0.564	-0.064
5	Telcm	0.169	0.245	0.837	0.195
6	Shops	0.192	0.293	0.955	0.276
7	Hlth	0.173	0.270	0.976	0.239
8	Utils	0.211	0.290	1.449	0.446
9	Other	0.065	0.087	0.300	-0.388
10	Market	0.143	0.202	0.621	0.000

4. The graphs for each industry's Performance metrics are plotted below:

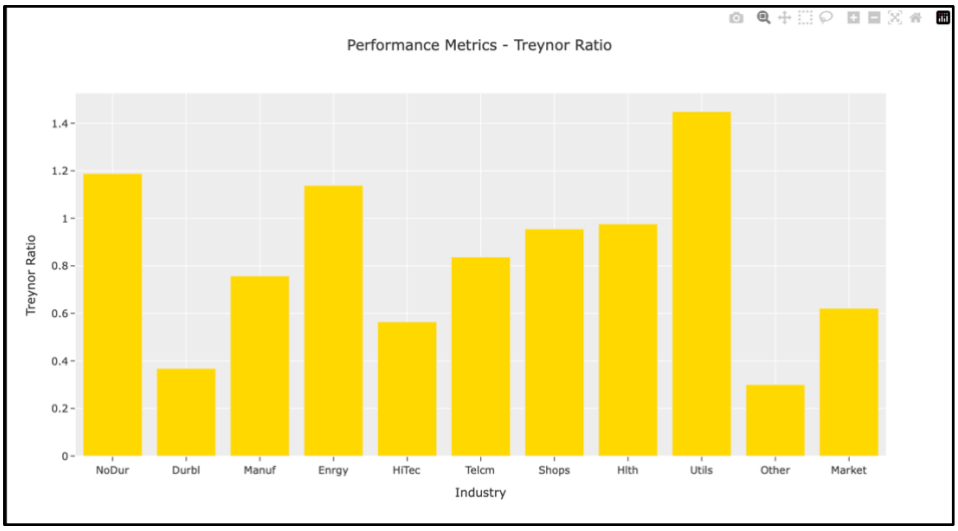
a. Sharpe Ratio:



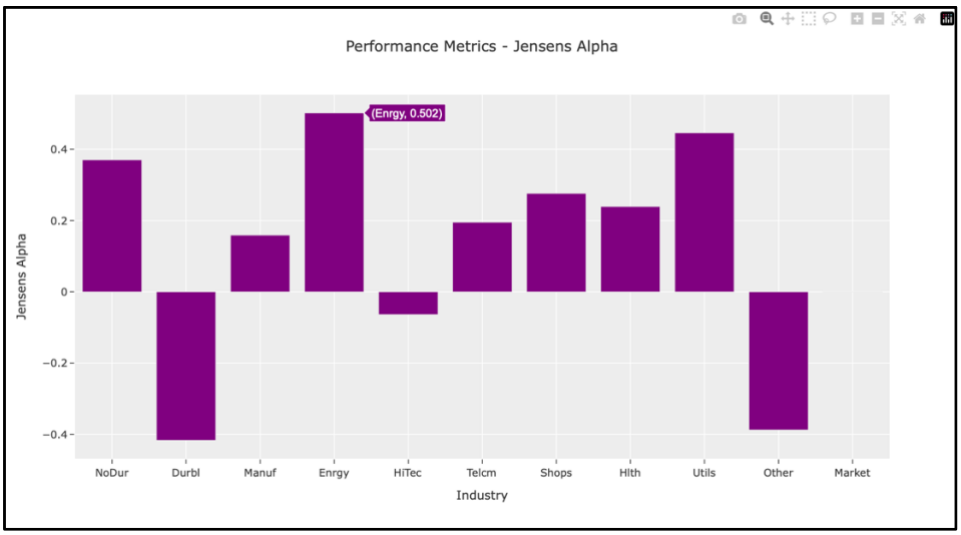
b. Sortino Ratio:



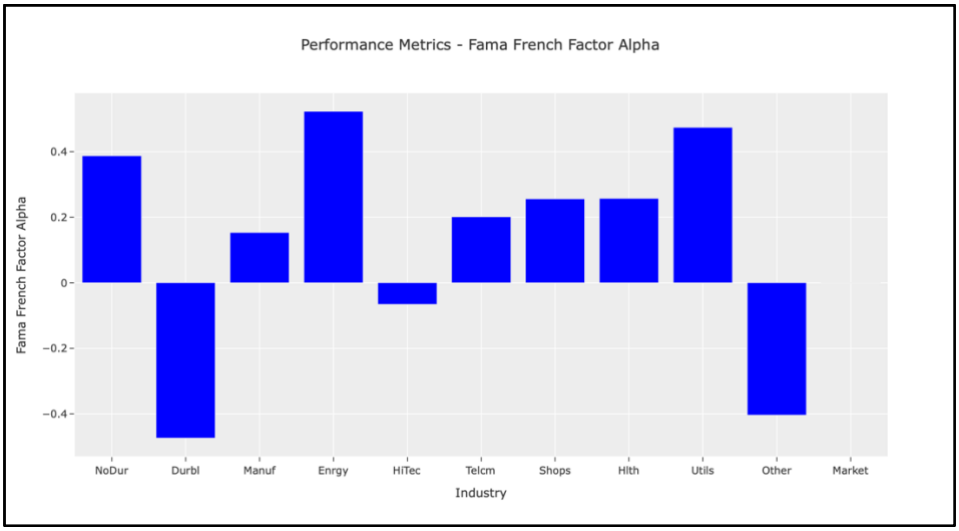
c. Treynor Ratio:



d. Jensens' α:



e. Fama French α:



6. The economic significance is explained below:

Sharpe Ratio: Measures the excess return per unit of total risk (volatility), helping investors evaluate if they're adequately compensated for the risk taken. A higher Sharpe ratio indicates better risk-adjusted performance, and a lower sharpe, vice versa. Unfortunately, Sharpe accounts for both upward and downwards volatility, which dampens the downwards volatility – something which investors and portfolio managers specifically look to reduce.

Sortino Ratio: Refines the Sharpe by focusing on downside risk (returns falling below a risk-free rate). It's useful when investors are more concerned with minimizing losses than overall volatility, making it better for analyzing asymmetric risk or strategies that aim to limit losses.

Treynor Ratio: Assesses performance based on systematic risk. It's suitable for portfolios that are diversified, as it evaluates returns against market risk. A higher Treynor ratio implies better compensation for market risk.

In pricing terms, these ratios guide investors in choosing strategies or assets that maximize return for acceptable risk levels, with different ratios emphasizing distinct risk factors.