Linear Factor Models

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QF600: Asset Pricing

1 Introduction

The main task of this assignment is to calculate various performance metrics using the excess returns of the industry portfolio, over a ten-year period from Jan 2004 to Dec 2013.

From the previous assignment, the Capital Asset Pricing Model (CAPM) was used to estimate the intercept coefficient (α) and slope coefficient (β). For this assignment, the fixed risk-free rate was changed to the given numbers in the new Risk_Factors.xlsx file. The results are summarised in the table below:

Industry	Alpha (Intercept)	Beta (Slope)
NoDur	0.369	0.653
Durbl	-0.416	1.649
Manuf	0.160	1.170
Enrgy	0.502	0.970
HiTec	-0.064	1.133
Telcm	0.195	0.901
Shops	0.275	0.826
Hlth	0.238	0.673
Utils	0.445	0.538
Other	-0.387	1.207

Figure 1: Intercept and Slope Coefficients of the monthly excess returns of each industry portfolio against the market portfolio

As preparation for the calculation of Jensen's Alpha and the Three-Factor Alpha's, the monthly excess returns of each industry portfolio were regressed with

the Fama-French risk factors included in the new Risk_Factors.xlsx file to find the respective factor loadings (labelled Beta_MKT, Beta_SMB and Beta_HML):

	Alpha	Beta_MKT	Beta_SMB	Beta_HML
NoDur	0.387	0.712	-0.229	-0.023
Durbl	-0.474	1.447	0.671	0.241
Manuf	0.153	1.142	0.087	0.028
Enrgy	0.523	1.028	-0.259	-0.008
HiTec	-0.066	1.153	0.336	-0.557
Telcm	0.201	0.924	-0.080	-0.019
Shops	0.256	0.770	0.280	-0.039
Hlth	0.257	0.752	-0.213	-0.144
Utils	0.474	0.632	-0.388	-0.017
Other	-0.404	1.123	-0.062	0.547

Figure 2: Intercept and Slope Coefficients of the monthly excess returns of each industry portfolio against the Fama-French risk factors

2 Performance Metrics

The performance metrics assigned were tabulated and arranged in the following table:

	Sharpe Ratio	Sortino Ratio	Treynor Ratio	Jensen's Alpha	Three-Factor Alpha
NoDur	0.231	0.212	1.186	0.370	0.387
Durbl	0.072	0.074	0.367	-0.418	-0.474
Manuf	0.167	0.144	0.758	0.160	0.153
Enrgy	0.182	0.168	1.143	0.504	0.523
HiTec	0.119	0.111	0.564	-0.064	-0.066
Telcm	0.169	0.152	0.836	0.194	0.201
Shops	0.192	0.179	0.951	0.274	0.256
Hlth	0.173	0.176	0.971	0.237	0.257
Utils	0.211	0.157	1.452	0.447	0.474
Other	0.065	0.055	0.300	-0.388	-0.404

Figure 3: Performance metrics for each industry portfolio

And the results are plotted in a series of bar charts:

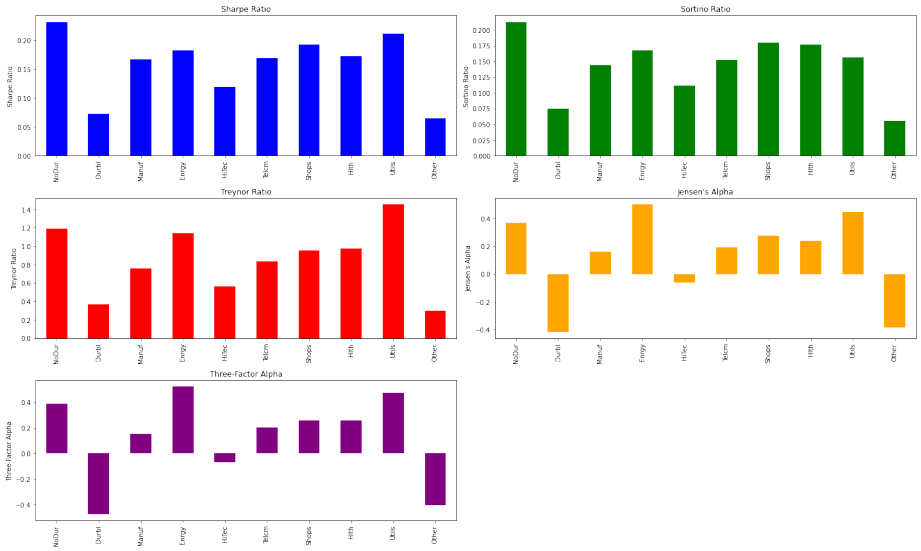

Figure 4: Performance metrics for each industry portfolio as bar charts

The subsections below briefly explain how each metric was calculated.

2.1 Sharpe Ratio

The Sharpe ratio is given by the formula:

$$\text{Sharpe Ratio} = \frac{R_i - R_f}{\sigma_i}$$

where R_i is the monthly return of each industry portfolio, R_f is the risk-free rate and σ_i is the risk (standard deviation) of each industry portfolio.

2.2 Sortino Ratio

The Sortino ratio is given by:

$$\text{Sortino Ratio} = \frac{R_i - R_f}{\sigma_d}$$

where the numerator is the same as that of Sharpe Ratio's, but denominator σ_d is the semi-variance, which measures downside risk:

$$\sigma_d = \sqrt{\frac{1}{T}\sum_{t=1}^{T} \min(R_i - R_f, 0)^2}$$

2.3 Treynor Ratio

The Treynor Ratio is given by:

$$\text{Treynor Ratio} = \frac{R_i - R_f}{\beta_i}$$

where the denominator β_i is the corresponding industry portfolio beta's (sensitivity to market risk).

2.4 Jensen's Alpha

The Jensen's Alpha is the excess return above what is predicted by the CAPM:

$$\alpha_i = R_i - [R_f + \beta_i(R_m - R_f)]$$

It should be noted that the calculation here tallies with the CAPM intercept coefficients in the first table, which is what we expect.

2.5 Three-Factor Alpha

The Three-Factor Alpha for the Fama-French factor model is given by:

$$\alpha_i = R_i - [R_f + \beta_{\text{MKT}}(R_m - R_f) + \beta_{\text{SMB}}\text{SMB} + \beta_{\text{HML}}\text{HML}]$$

where β_{MKT}, β_{SMB}, β_{HML} are the respective factor loadings for market, size and value factors.

3 Economic Significance and Pricing Implications

3.1 Sharpe Ratio

The Sharpe ratio measures the risk-adjusted return of a portfolio. It shows how much excess return (over the risk-free rate) is earned per unit of total risk (volatility). A higher Sharpe ratio indicates that the portfolio delivers better returns for the risk taken.

Investments with higher Sharpe ratios are more attractive to investors, as they offer better compensation for risk. A high Sharpe ratio suggests the asset is well-priced for its risk, while a low or negative Sharpe ratio suggests that the investment is either too risky for the return offered or overpriced.

3.2 Sortino Ratio

The Sortino ratio focuses on downside risk, measuring returns relative to only the negative volatility (as opposed to total volatility). It is useful for risk-averse investors who are more concerned with avoiding losses than achieving higher returns.

A higher Sortino ratio indicates that the portfolio generates good returns without exposing the investor to significant downside risk. Assets with higher Sortino ratios might be considered safer or more efficiently priced in terms of downside protection, which can make them appealing to conservative investors.

3.3 Treynor Ratio

Treynor ratio measures the portfolio's excess return relative to systematic risk, as represented by its beta (sensitivity to market movements). It evaluates how well the portfolio compensates investors for market-related risk.

A higher Treynor ratio suggests that the portfolio is delivering superior returns given its exposure to market risk, indicating that the asset is underpriced relative to its risk. Conversely, a low Treynor ratio might indicate that the portfolio's returns are insufficient for the amount of market risk taken, implying that it could be overpriced.