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QF600 (Asset Pricing) – Homework 3

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.

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

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

   Answer:

Industry	Gamma (SMB)	Delta (HML)
NoDur	-0.229102	-0.023342
Durbl	0.670878	0.240949
Manuf	0.087388	0.027727
Enrgy	-0.25936	-0.008158
HiTec	0.335674	-0.556947
Telcm	-0.080299	-0.019063
Shops	0.280191	-0.03908
Hlth	-0.212655	-0.143765
Utils	-0.387961	-0.016881
Other	-0.061676	0.547325

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 R_i is return on industry portfolio and R_f is risk-free rate.

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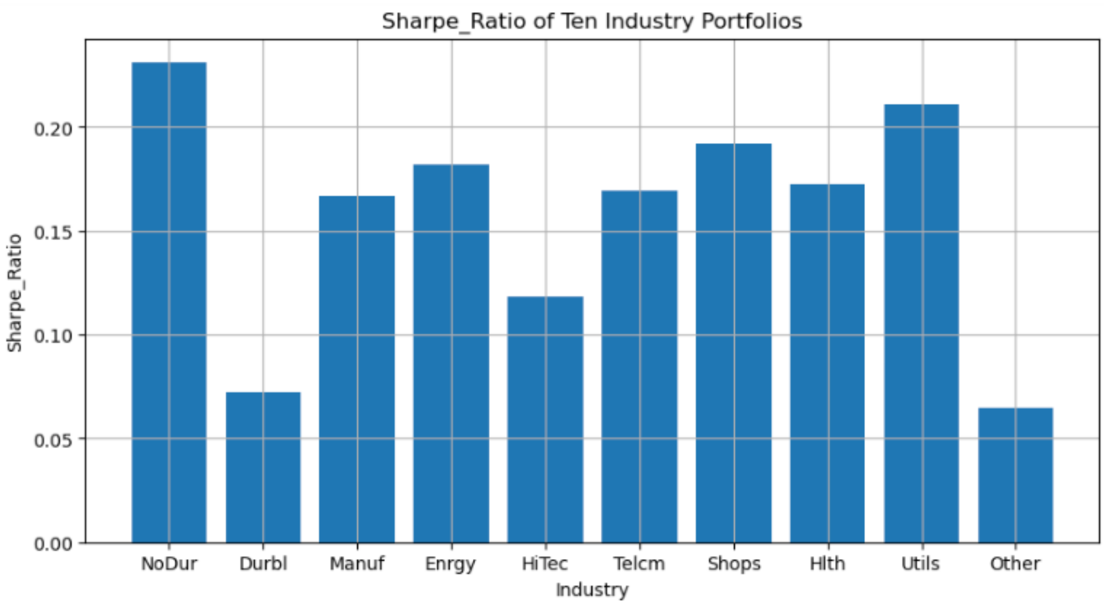
a. Create a table showing the performance metrics for the ten industry portfolios.
Answer:

Industry	Sharpe Ratio	Sortino Ratio	Treynor Ratio	Jensen's Alpha	Fama-French 3 Factor Alpha
NoDur	0.231099	0.350804	1.186372	0.369717	0.386704
Durbl	0.072356	0.111967	0.367463	-0.417903	-0.474342
Manuf	0.166616	0.24126	0.758251	0.160494	0.153285
Enrgy	0.181708	0.273612	1.14333	0.504485	0.523007
HiTec	0.118552	0.17062	0.564295	-0.064024	-0.065979
Telcm	0.169064	0.24494	0.836363	0.194348	0.200724
Shops	0.191753	0.293032	0.951258	0.274093	0.255941
Hlth	0.172529	0.270294	0.971435	0.236968	0.257472
Utils	0.210948	0.290044	1.452334	0.446523	0.474411
Other	0.064693	0.087351	0.299781	-0.387508	-0.404412

b. Plot your results as a bar chart for each performance metric.
Answer:



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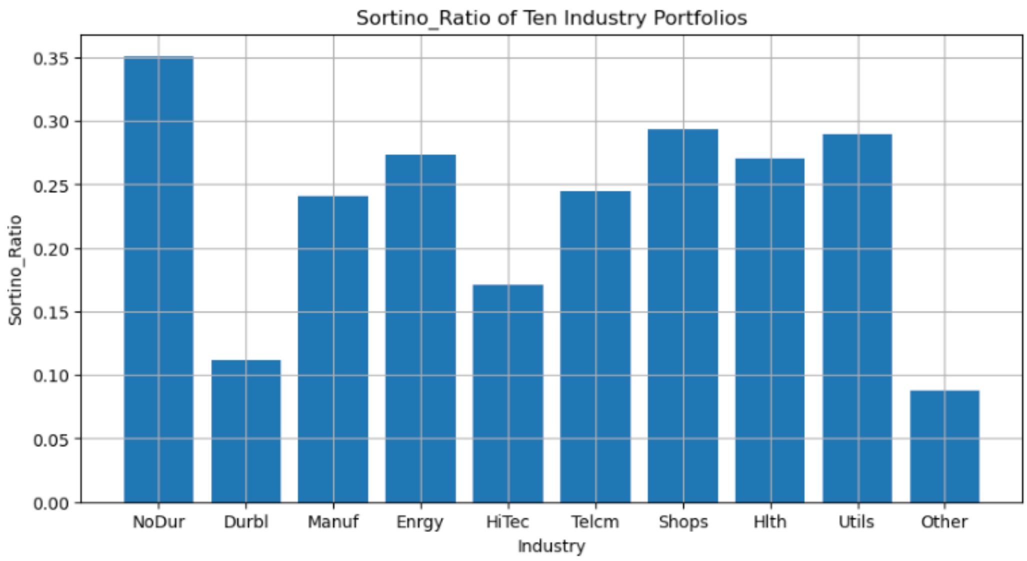

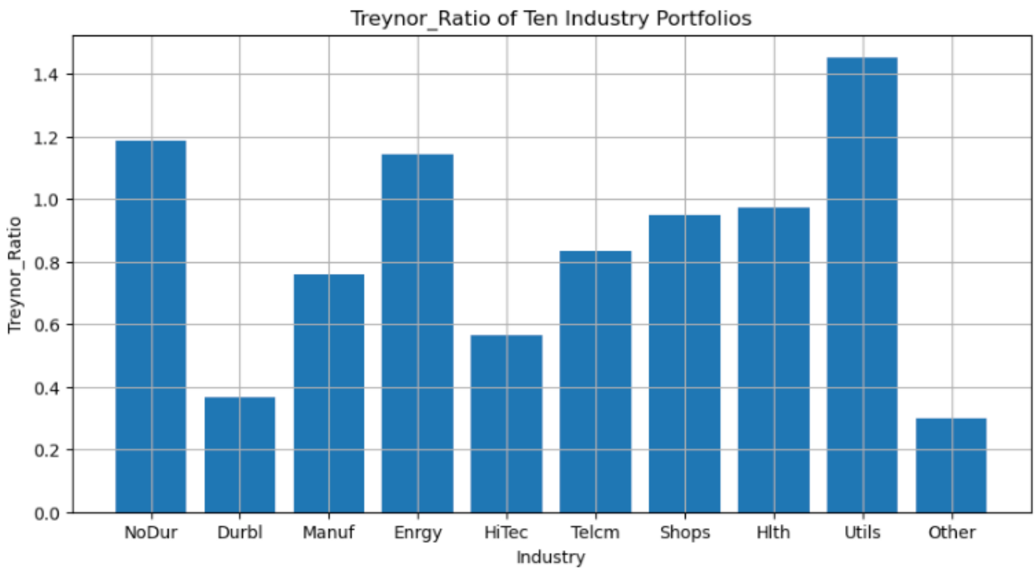

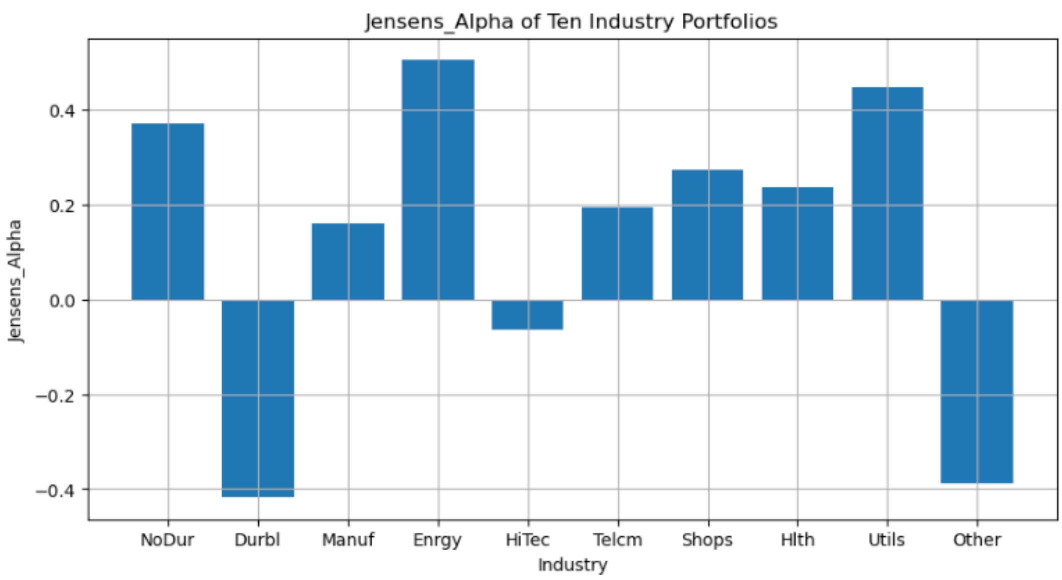

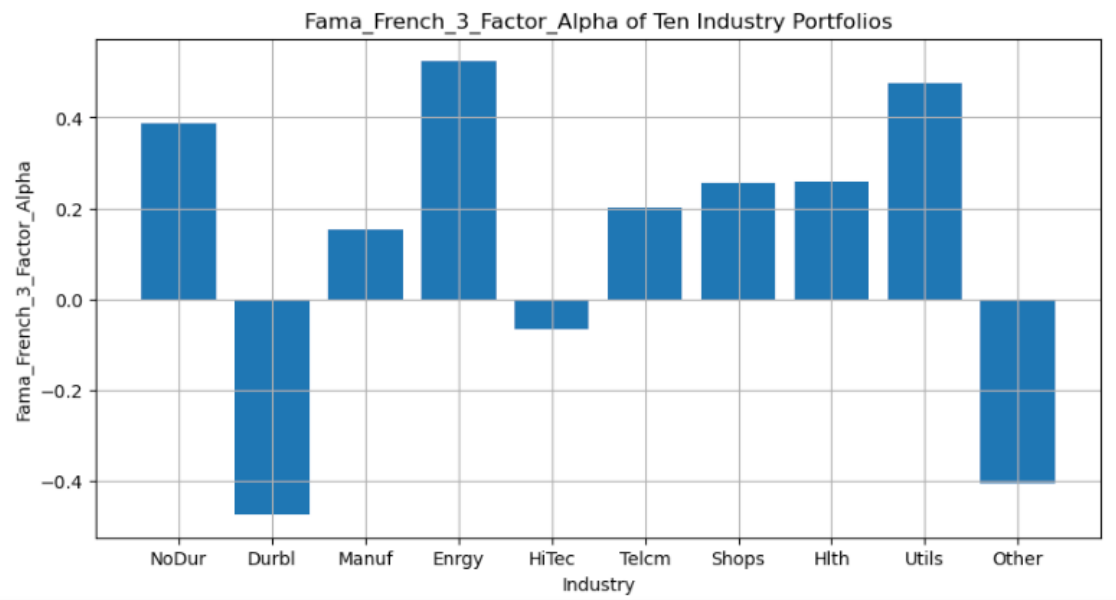

c. Briefly explain (in words, without mathematical equations or formulas) the economic significance and pricing implications of each of the three performance ratios (but not α's).
Answer:

- **Sharpe Ratio**
    - *Economic Significance:* Sharpe Ratio measures the risk premium per unit of excess return standard deviation. However, it is not ideally used to compare individual investment with diversified portfolio, as the Sharpe Ratio takes into account all risks, including systematic and idiosyncratic risk, in which diversified portfolios have no idiosyncratic risk (does not compensate diversifiable risk). The denominator also does not consider higher moments such as skewness and kurtosis and hence cannot fully reflect risk of investment if return distribution is not normal.
    - *Pricing Implication*: A high Sharpe Ratio indicates a higher expected excess return given overall risk (standard deviation), and hence is more desirable to investors. If the asset has a higher Sharpe Ratio compared to similar assets, it can be seen as underpriced relative to other assets.

- **Sortino Ratio**
    - *Economic Significance:* Sortino Ratio is the expected deviation from target return per unit of below-target semi-deviation. Unlike Sharpe ratio, the Sortino Ratio only penalizes the downside or below-target returns (denominator only counts for squared errors of negative returns and is zero for positive returns). This ratio also works for non-normal distributions (non-symmetric) and hence can be more

informative than Information Ratio or Sharpe Ratio when return distribution is not normal. This ratio produces similar rankings to Information Ratio when the return distribution is symmetric, and expected asset return is close to expected target return.
  - *Pricing Implication:* A higher Sortino Ratio is more desirable to investors as it gives a higher risk premium (from target) for the same below-target risk / downside risk. If the asset has a higher Sortino Ratio compared to similar assets, it can be seen as underpriced relative to other assets.

- **Treynor Ratio**
  - *Economic Significance:* Treynor Ratio calculates the risk premium per unit of market risk (beta), risk that is inherent to market that can't be diversified away. The denominator beta only captures systematic (market) risk and ignores idiosyncratic risk. In practice, it also fails to account for other types of systematic risk besides market risk, such as size risk and value risk. Hence, in the SML, all assets have the same Treynor Ratio. In principle, this can be used to compare performance of individual investment to diversified portfolio. The Treynor Ratio is also the slope of the SML, where all risky assets/ portfolios must have the same Treynor Ratio in equilibrium.
  - *Pricing Implication:* A higher Treynor Ratio is more desirable to investors because investment generates better return per unit of market risk. If the asset has a higher Treynor Ratio compared to similar assets, it can be seen as underpriced relative to other assets.