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Course Syllabus/Outline

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Course Outline
PDF document

Session 1

Expected Utility Theory

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Wikipedia: Expected Utility Hypothesis
Link

Wikipedia: Risk Aversion
Link

Wikipedia: Taylor Series

Link

Lecture 1: Expected Utility Theory

PDF document

Session 2

Efficient Frontier

`Industry_Portfolios.xlsx` contains monthly nominal (net) returns (expressed as percentages) for ten industry portfolios, over the ten-year period from Jan 2004 through Dec 2013.

Use these returns to estimate the vector of mean returns and the covariance matrix of returns for the ten industry portfolios:

- Create a table showing the mean return and standard deviation of return for the ten industry portfolios.
- Plot the minimum-variance frontier (without the riskless asset) generated by the ten industry portfolios:
    - This graph must have expected (monthly) return on the vertical axis vs standard deviation of (monthly) return on the horizontal axis.
    - This graph must cover the range from 0% to 2% on the vertical axis, in increments of 0.1% (or less).
- Briefly explain (in words, without mathematical equations or formulas) the economic significance and relevance of the minimum-variance frontier to an investor.

Now suppose that the (net) risk-free rate is 0.13% per month:

- Plot the efficient frontier (with the riskless asset) on the same graph as the minimum-variance frontier generated by the ten industry portfolios.

- Briefly explain the economic significance and relevance of the efficient frontier to an investor.

The two frontiers will intersect at single point: the tangency portfolio:

- Calculate Sharpe ratio for the tangency portfolio, and also portfolio weights for the tangency portfolio.

- Briefly explain the economic significance and relevance of the tangency portfolio to an investor.

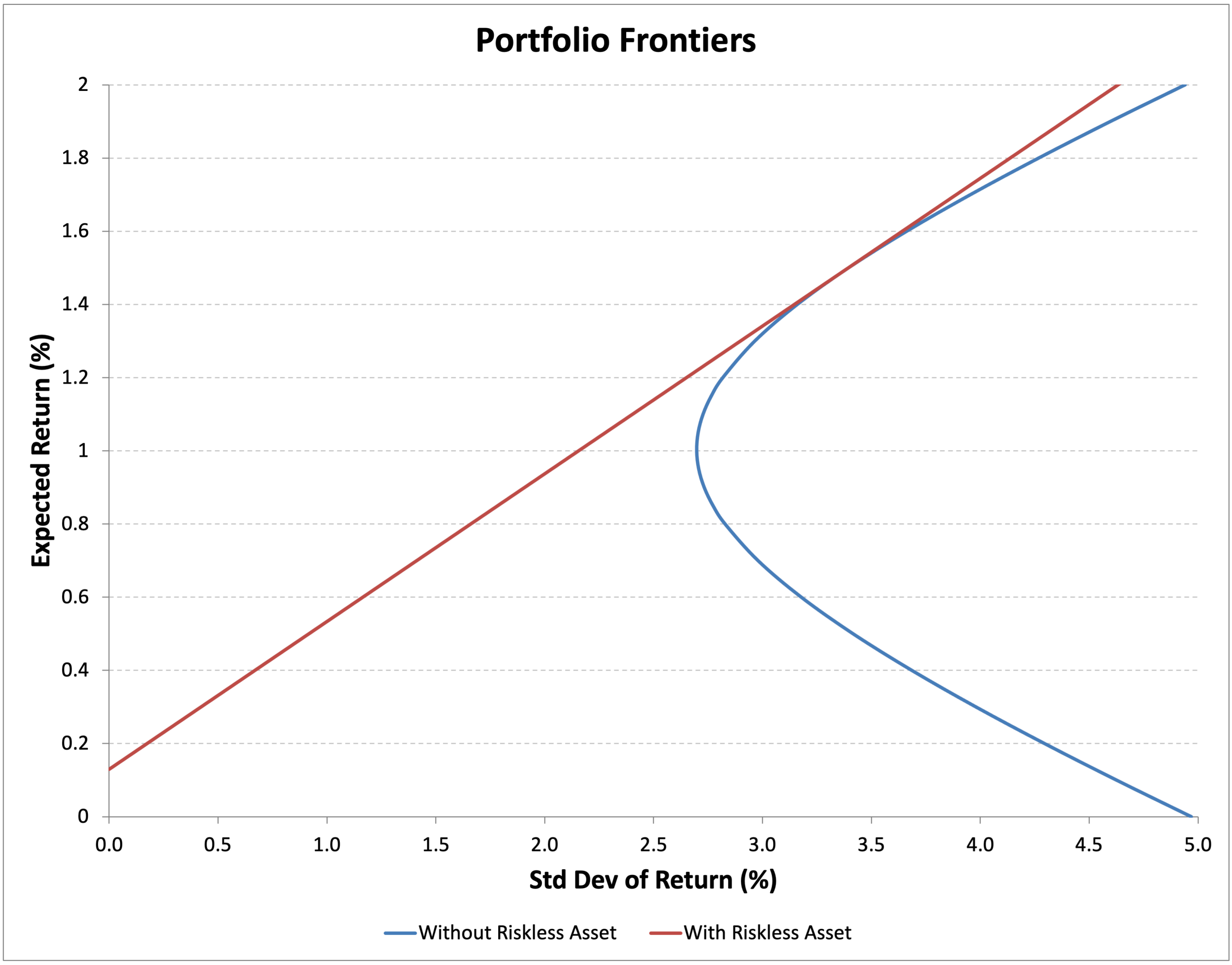
Please submit your results (including relevant tables and graphs) as an Adobe PDF file to Homework 1.

Economic significance:

- Minimum-variance frontier represents outermost envelope of attainable portfolios ⇒ no attainable portfolio exists to the left of the minimum-variance frontier.

- Efficient frontier consists of portfolios with highest mean return for specified standard deviation of return ⇒ risk-averse investor will invest in (optimal) portfolio on efficient frontier that maximises expected utility (of wealth).

- Tangency portfolio has the highest possible Sharpe ratio.



100 % 5 of 5 topics complete

Wikipedia: Modern Portfolio Theory ✓

Link

Wikipedia: Sharpe Ratio ✓

Link

Wikipedia: Lagrange Multiplier ✓

Link

Lecture 2: Efficient Frontier ✓

PDF document

Industry Portfolios ✓

Excel Spreadsheet

Session 3

Capital Asset Pricing Model (CAPM)

`Market_Portfolio.xlsx` contains monthly nominal (net) returns (expressed as percentages) for the market portfolio, over the ten-year period from Jan 2004 through Dec 2013. Assume that the (net) risk-free rate is 0.13% per month.

Market Model

Estimate the intercept coefficient (α) and slope coefficient (β) for each of the ten industry portfolio using the market model: regress the monthly *excess* returns for each industry portfolio on the monthly *excess* returns for the market portfolio.

- Create a table showing the intercept and slope coefficients for the ten industry portfolios.

- Briefly explain (in words, without mathematical equations or formulas) the economic significance and pricing implications of the intercept and slope coefficients.

Security Market Line (SML)

Calculate the mean monthly return for each of the ten industry portfolios, as well as the market portfolio.

Regress the mean monthly returns of the ten industry portfolios and the market portfolio on the corresponding β's. This will give you the intercept and slope coefficients for the SML. (Note that the results may be very different from what you would expect!)

- Use the estimated intercept and slope coefficients for the SML to plot the SML in the range of β from zero to two on the horizontal axis.

- Also plot the positions of the ten industry portfolios and the market portfolio. (You are NOT required to label the individual portfolios.)

- Briefly explain the economic significance and pricing implications of the SML.

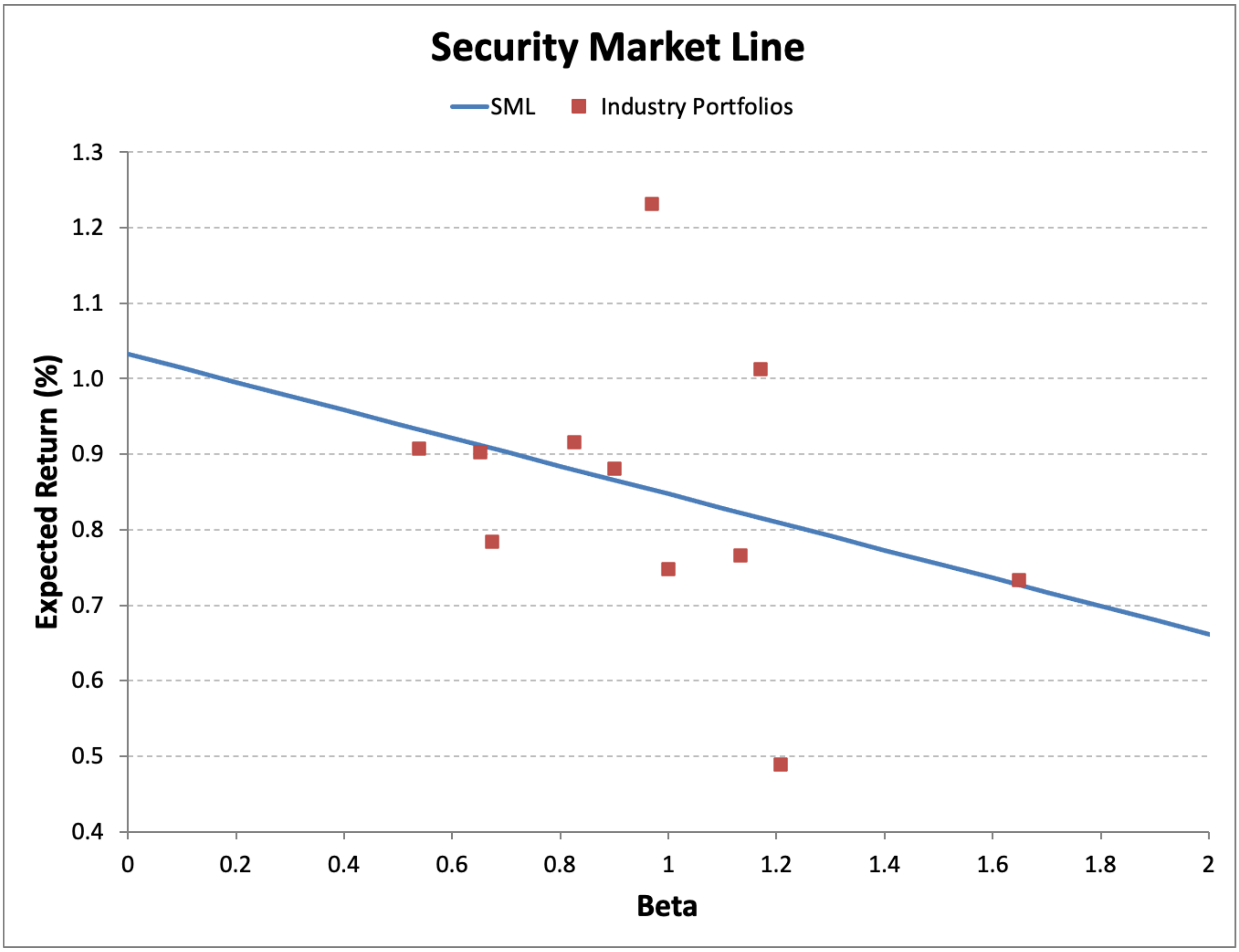
Please submit your results (including relevant tables and graphs) as an Adobe PDF file to Homework 2.

Economic significance:

- Intercept coefficient from market model regression shows pricing error based on CAPM: α > 0 (or α < 0) ⇒ asset has outperformed (or underperformed) market portfolio on risk-adjusted basis

- Slope coefficient from market model regression shows level of exposure to market risk: β > 1 (or β < 1) ⇒ more (or less) exposure to market risk than market portfolio

- SML shows that all appropriately-priced assets have same Treynor ratio ⇒ assets that lie above (or below) SML are underpriced (or overpriced)



Wikipedia: Capital Asset Pricing Model

Link

Wikipedia: Linear Regression

Link

Lecture 3: Capital Asset Pricing Model

PDF document

Market Portfolio

Excel Spreadsheet

Session 4

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:

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

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.

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

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

- 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).

Please submit your results (including relevant tables and graphs) as an Adobe PDF file to Homework 3.

Economic significance:

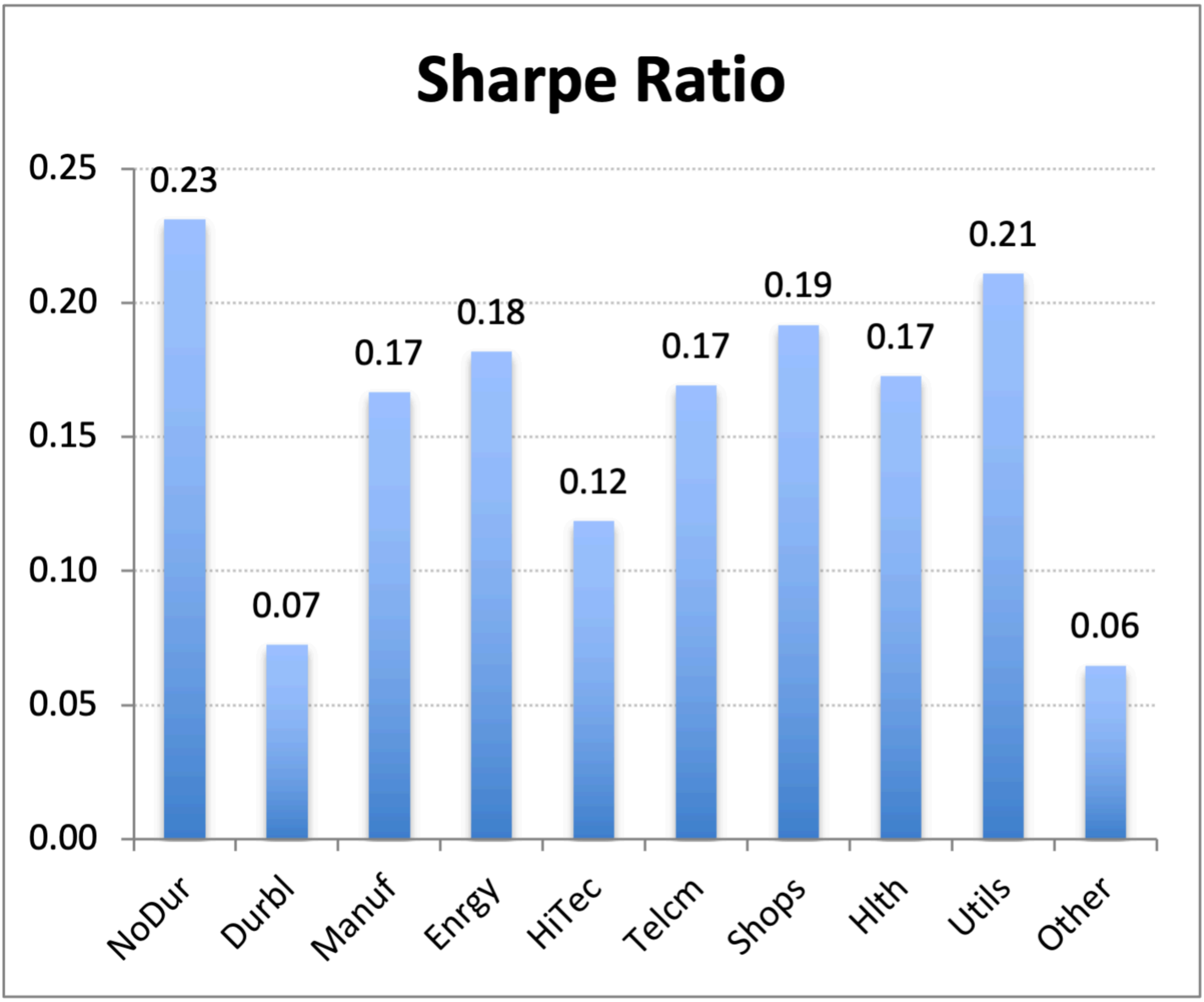
- Sharpe ratio shows risk premium per unit of total risk:

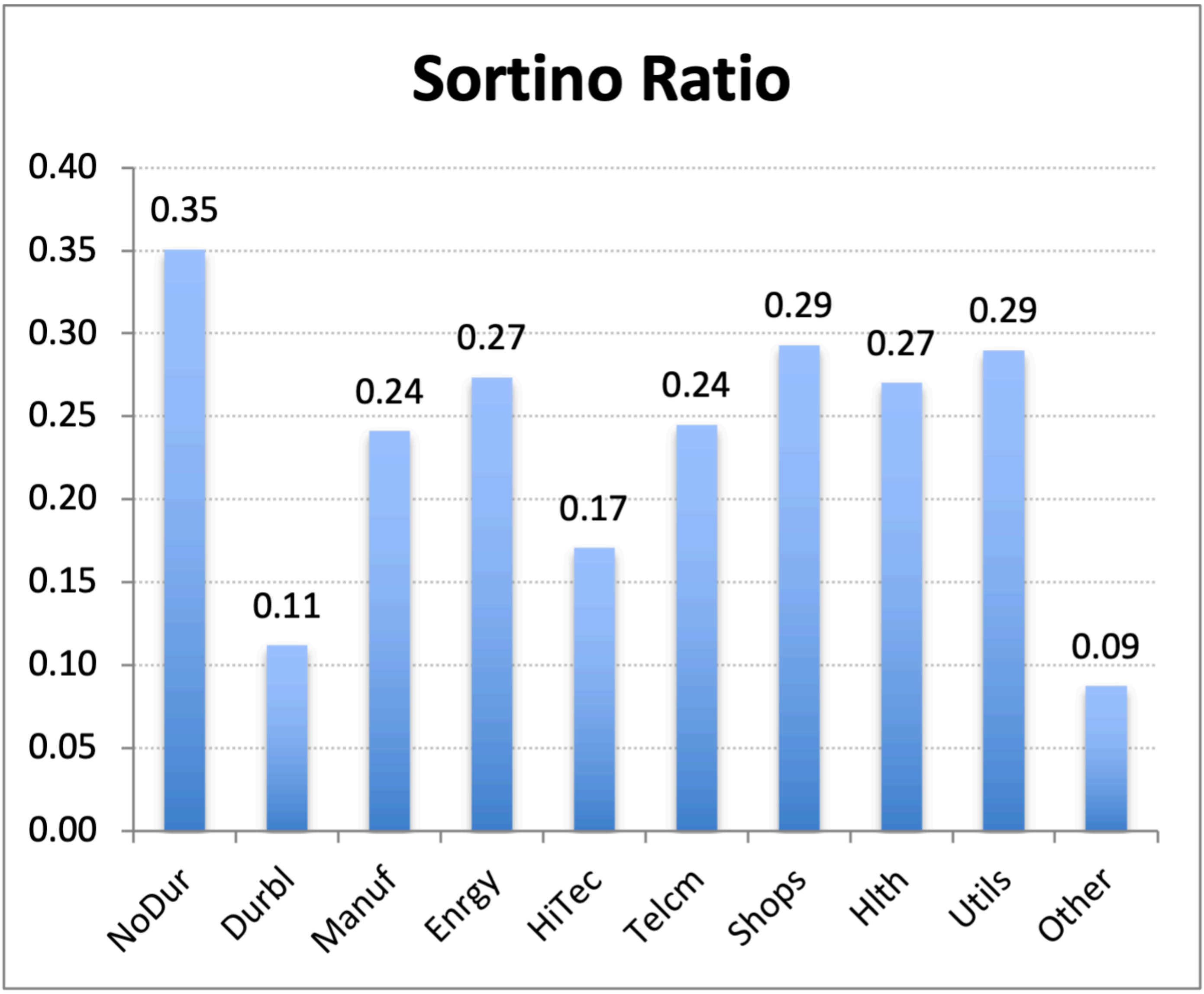
    - Includes idiosyncratic risk, which doesn't contribute to risk premium ⇒ should not be used to compare performance for investments with different amounts of idiosyncratic risk

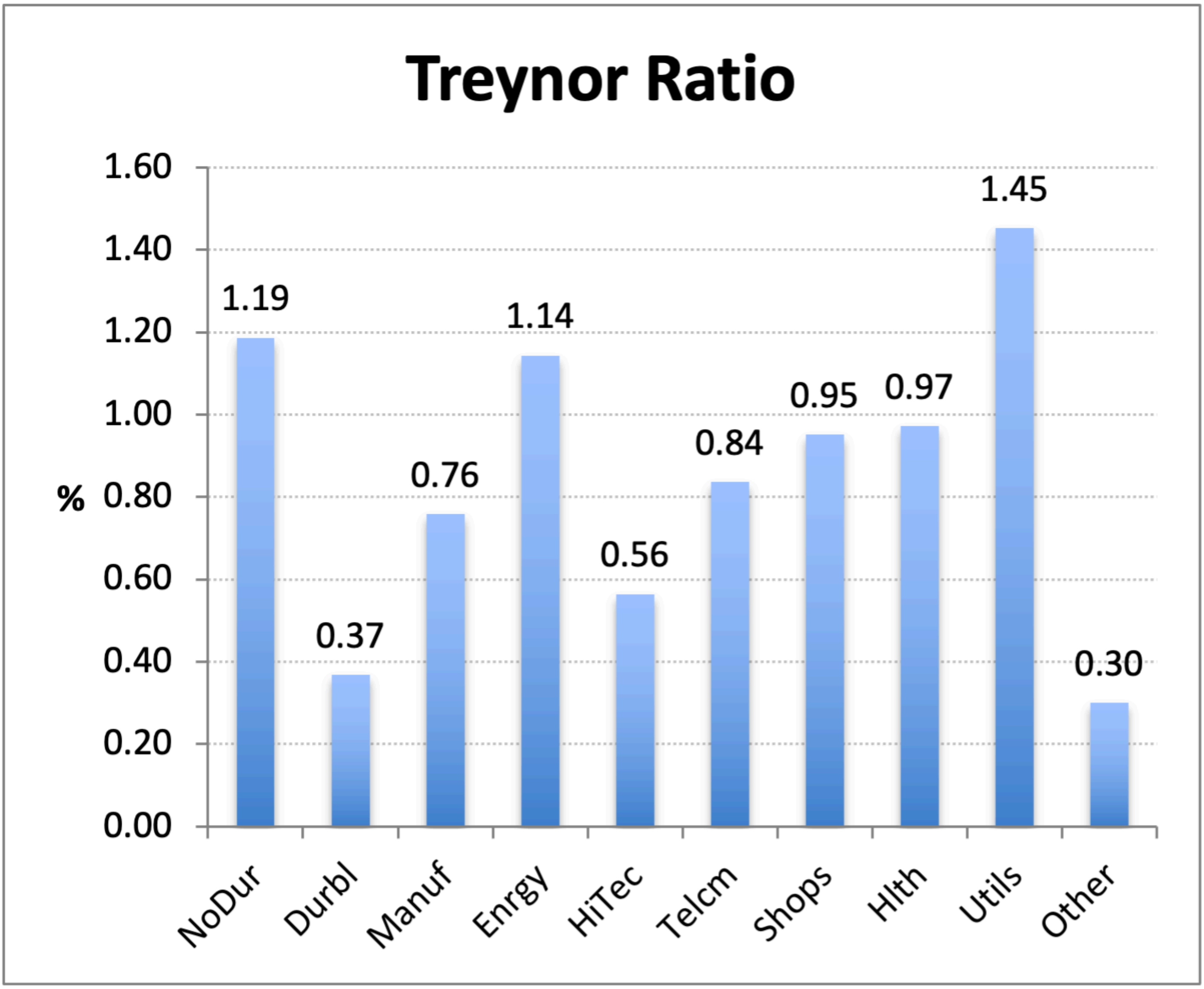
    - Implicitly assumes normal returns ⇒ should not be used to measure performance for investments with asymmetric return distribution

- Sortino ratio shows risk premium per unit of downside risk: can be used to measure performance for investments with asymmetric return distribution, since downside risk can distinguish between distributions with same variance but different skewness

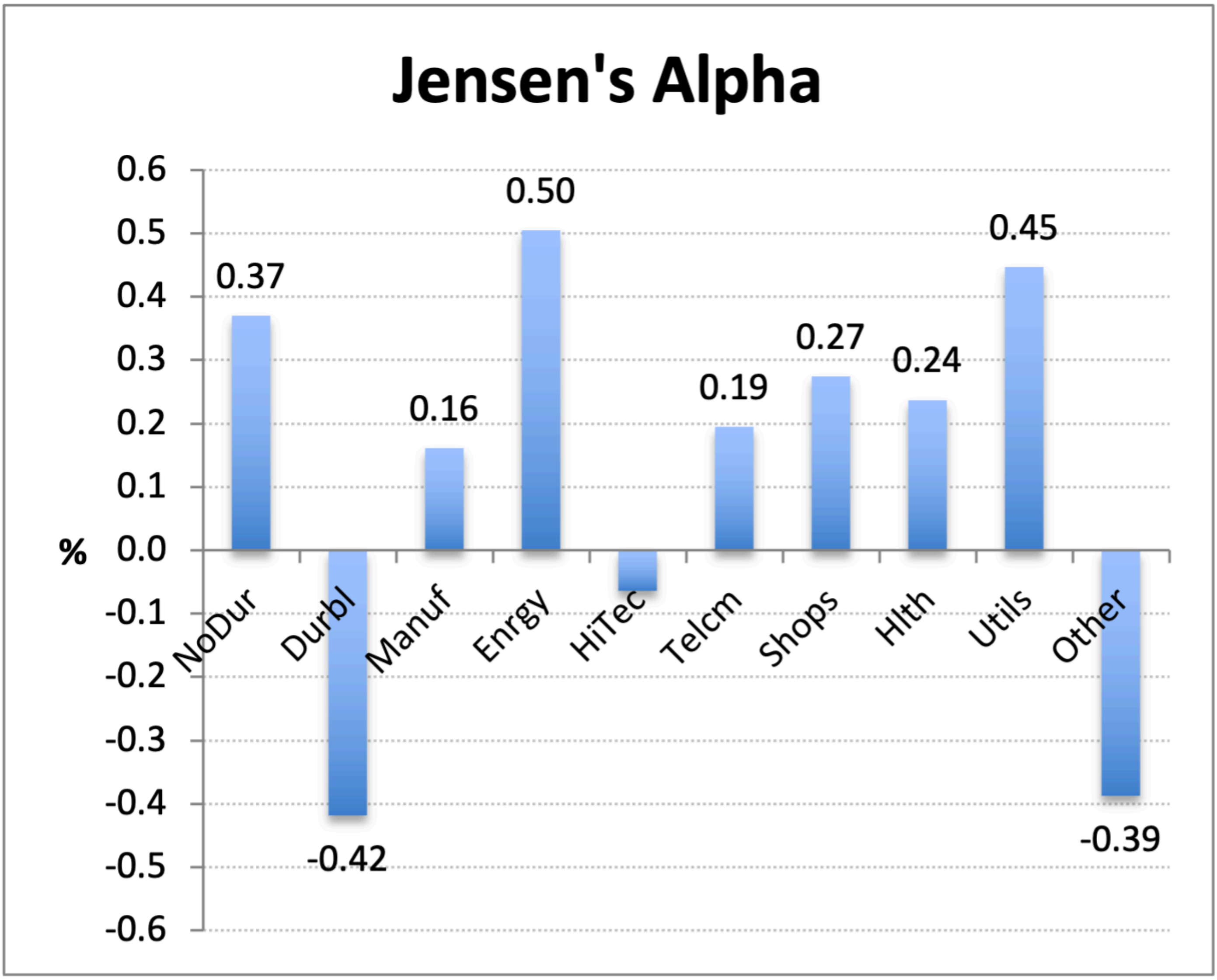
- Treynor ratio shows risk premium per unit of (exposure to) market risk:
    - Ignores idiosyncratic risk ⇒ can be used to compare performance for investments with different amounts of idiosyncratic risk
    - Ignores other types of systematic risk ⇒ should not be used to measure performance for investments with significant exposure to other types of systematic risk



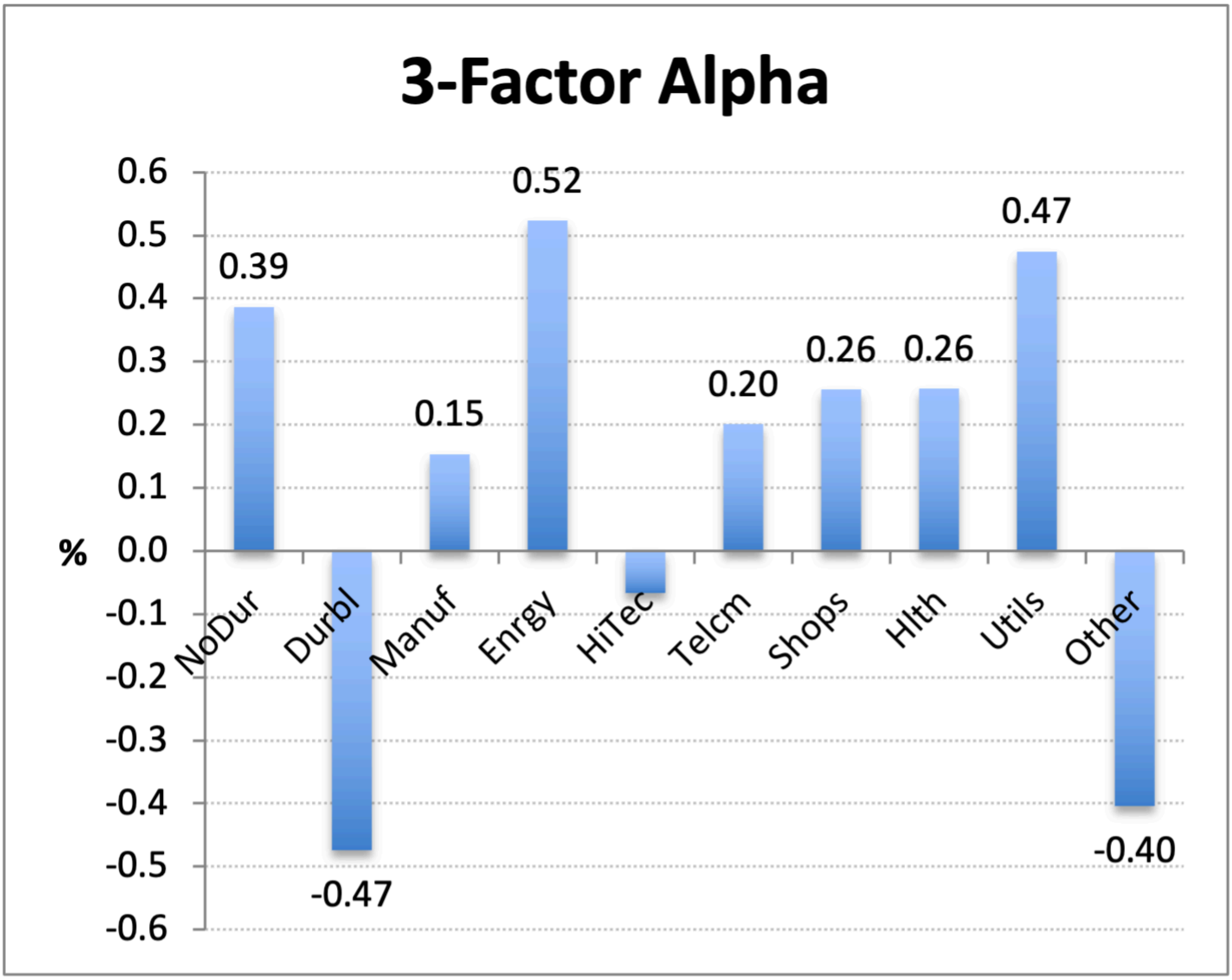

Sortino Ratio
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.35
0.11
0.24
0.27
0.17
0.24
0.29
0.27
0.29
0.09
NoDur
Durbl
Manuf
Enrgy
HiTec
Telcm
Shops
Hlth
Utils
Other



Treynor Ratio
%
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
1.19
0.37
0.76
1.14
0.56
0.84
0.95
0.97
1.45
0.30
NoDur
Durbl
Manuf
Enrgy
HiTec
Telcm
Shops
Hlth
Utils
Other



Jensen's Alpha
%
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
0.37
-0.42
0.16
0.50
0.19
0.27
0.24
0.45
-0.39
NoDur
Durbl
Manuf
Enrgy
HiTec
Telcm
Shops
Hlth
Utils
Other



100 % 4 of 4 topics complete

Wikipedia: Fama–French Three-Factor Model

Link

Wikipedia: Sortino Ratio

Link

Lecture 4: Linear Factor Models & Performance Measurement

PDF document

Risk Factors

Excel Spreadsheet

Session 5

Efficient Frontier Revisited

Part 1: Minimum-Tracking-Error Frontier

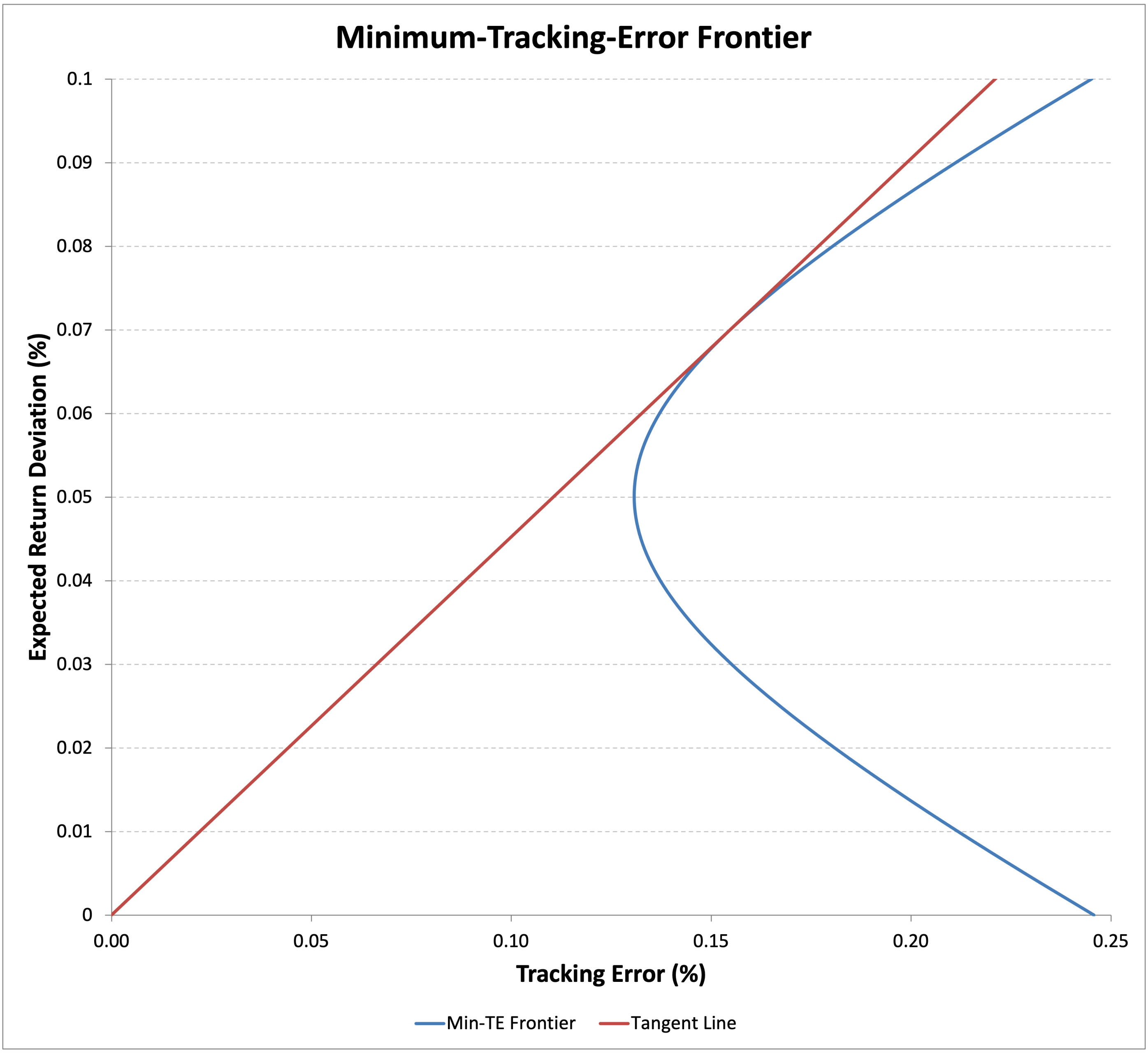
Let market return be the target return. Estimate expected deviation from market return, for the ten industry portfolios:

$$R_i = E\left(\tilde{R}_i - \tilde{R}_m\right)$$

Also estimate covariance matrix of return deviations, for the ten industry portfolios:

$$V_{ij} = \mathrm{Cov}\left[\left(\tilde{R}_i - \tilde{R}_m\right), \left(\tilde{R}_j - \tilde{R}_m\right)\right]$$

- Plot the minimum-tracking-error frontier generated by the ten industry portfolios:
    - This graph must have expected (monthly) return deviation on the vertical axis vs (monthly) tracking error on the horizontal axis.
    - This graph must cover the range from 0% to 0.1% on the vertical axis, in increments of 0.005% (or less).
- Also plot the line starting from the origin that is tangent to the upper half of the minimum-tracking-error frontier.
- Calculate information ratio and portfolio weights for the "tangency" portfolio.



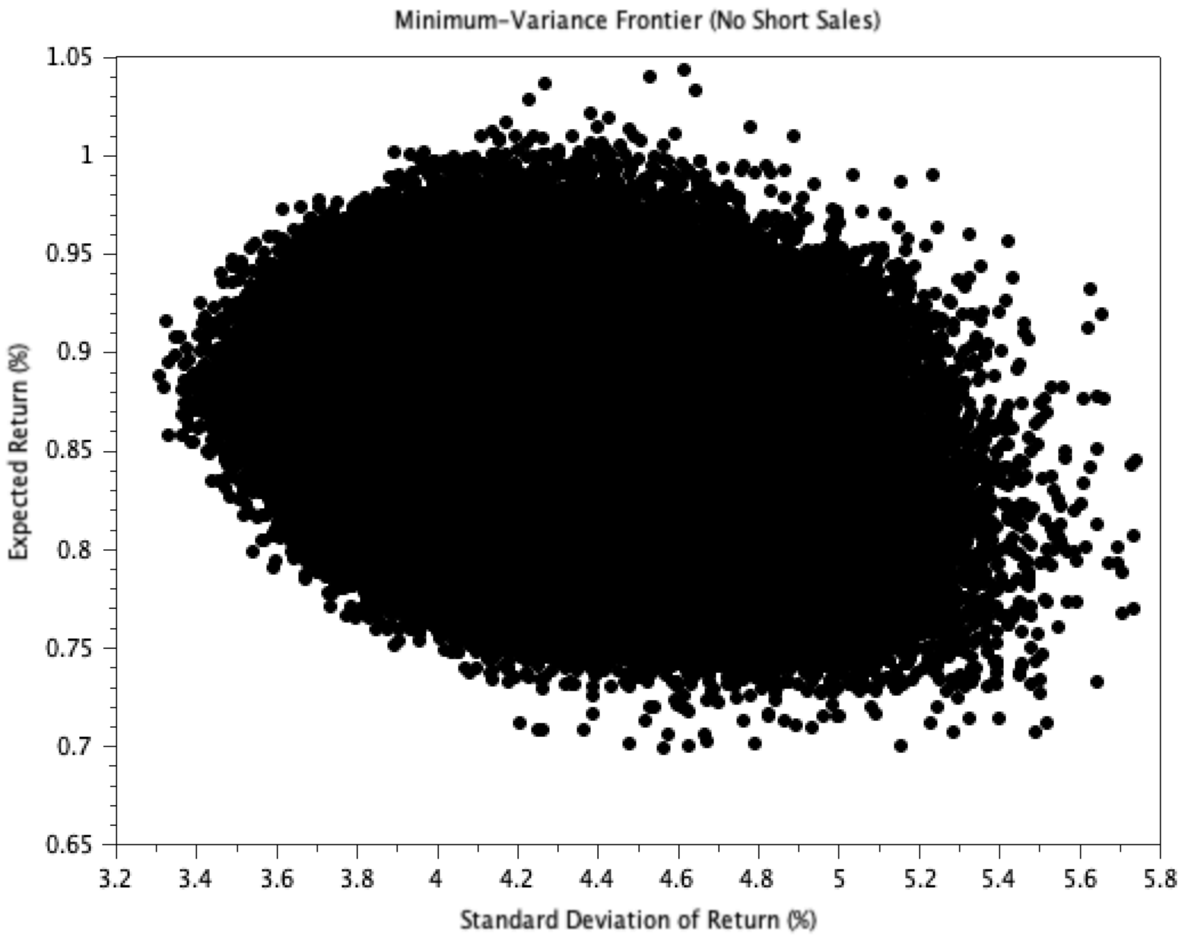
Part 2: Minimum-Variance Frontier w/o Short Sales

Use Monte Carlo method to simulate the minimum-variance frontier without short sales, generated by the ten industry portfolios. Portfolio weights will be limited to the range [0, 1].

Randomly draw each element of **w**, the 10 × 1 vector of portfolio weights, from the (standard) uniform distribution in the range [0, 1]. Divide **w** by the sum of portfolio weights, to ensure that the portfolio weights sum to one. This normalised **w** represents portfolio weights for one simulated portfolio, without short sales.

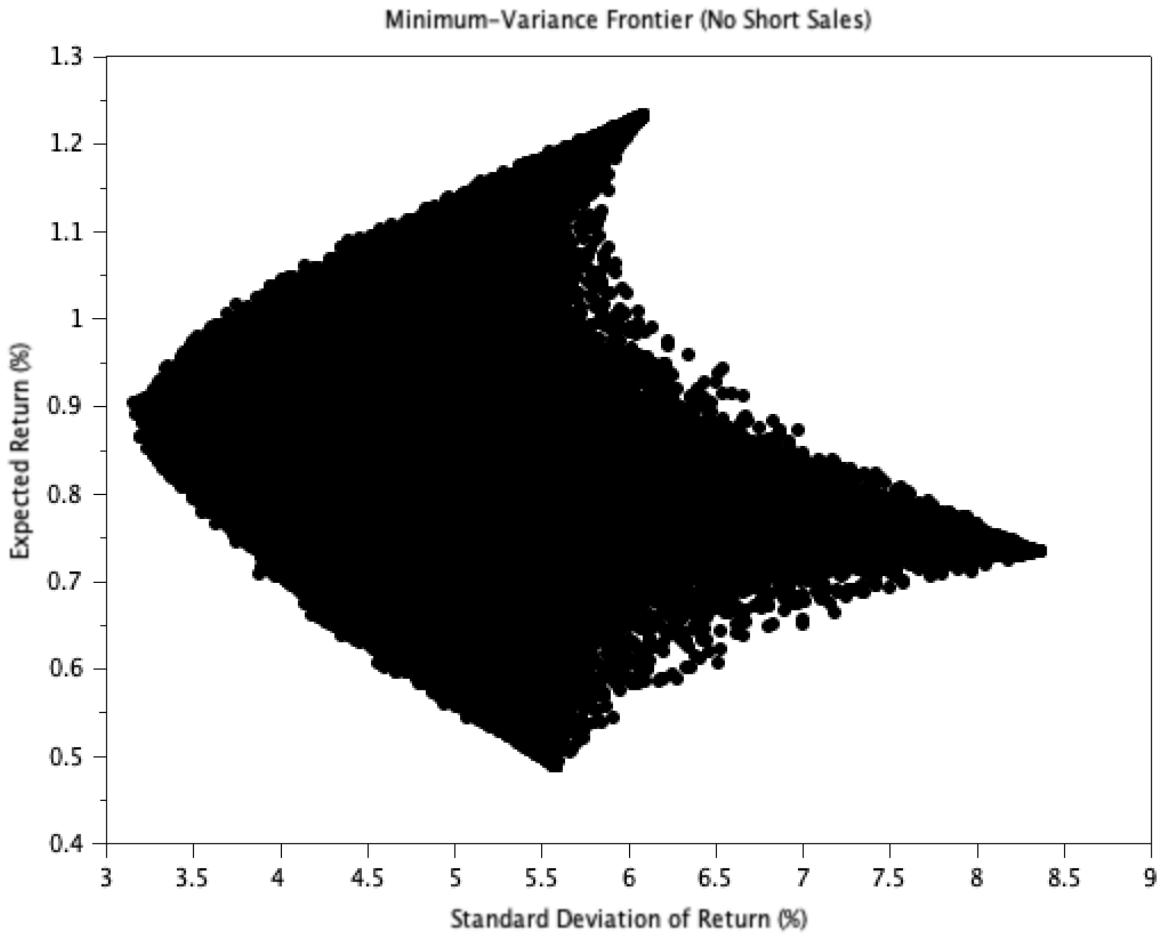
Use the normalised **w** along with the vector of mean returns and the covariance matrix of returns (for the ten industry portfolios) to calculate the mean return and standard deviation of return for the simulated portfolio. Repeat this process until you have (at least) 10^5 data points.

- Plot the data points with mean return on the vertical axis vs standard deviation of return on the horizontal axis.



Repeat this entire process by simulating 1/w using the standard uniform distribution ⇒ take the reciprocal of the random draw from the standard uniform distribution as the portfolio weight.

- Plot the new data points (on a separate graph) with mean return on the vertical axis vs standard deviation of return on the horizontal axis.



Please submit your results (including relevant tables and graphs) as an Adobe PDF file to Homework 4.

100 % 3 of 3 topics complete

Wikipedia: Black–Litterman Model ✓

Link

Wikipedia: Monte Carlo Method ✓

Link

Lecture 5: Efficient Frontier Revisited ✓

PDF document

Session 6

Stochastic Discount Factor

Suppose that consumption growth has lognormal distribution with the possibility of rare disasters:

$$\ln \tilde{g} = 0.02 + 0.02\tilde{\epsilon} + \tilde{\nu}$$

Here ε is a standard normal random variable, while ν is an independent random variable that has value of either zero (with probability of 98.3%) or ln(0.65) (with probability of 1.7%).

Simulate ε with (at least) 10^4 random draws from standard normal distribution, and simulate ν with (at least) 10^4 random draws from standard uniform distribution.

Use the simulated distribution of consumption growth to find the simulated distribution of the pricing kernel for power utility of consumption:

$$\tilde{M} = 0.99\tilde{g}^{-\gamma}$$

Repeat this process for values of γ in the range from 1 to 4, in increments of 0.1 (or less). (You can reuse the same simulated distribution of consumption growth for all values of γ)

- Calculate the mean (μ_M) and standard deviation (σ_M) of pricing kernel for each value of γ, and plot the volatility ratio (σ_M/μ_M) on the vertical axis vs γ on the horizontal axis.

- Find the smallest value of γ (in your data) for which $\sigma_M/\mu_M > 0.4$. Explain (in words, without using mathematical equations or formulas) the economic significance of this result.

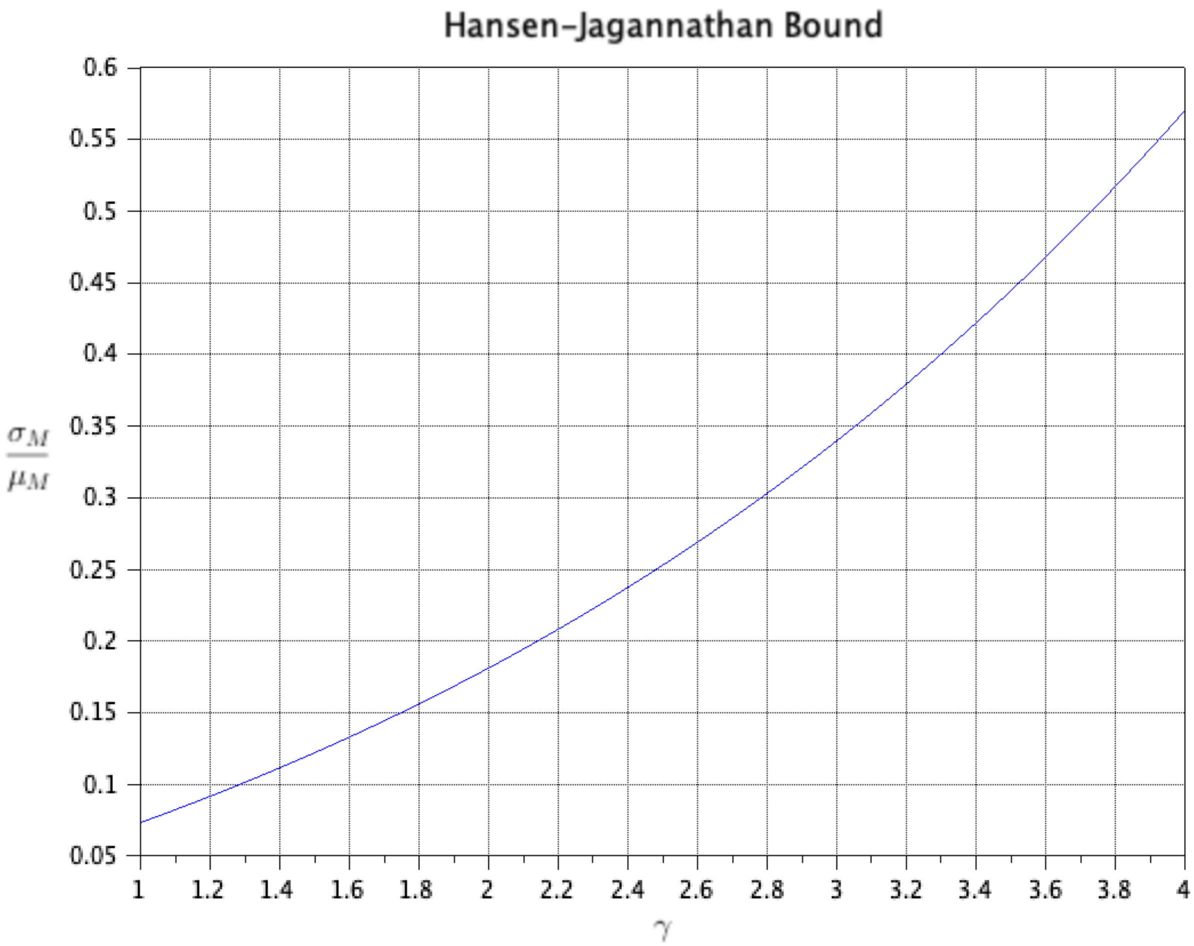
Please submit your results (including relevant tables and graphs) as an Adobe PDF file to Homework 5.

Economic Significance:

- H–J bound: volatility ratio of pricing kernel must exceed Sharpe ratio of 0.4 for US stock market

- Investor's coefficient of relative risk aversion (γ) magnifies volatility (and skewness) of consumption growth to give volatility (and skewness) of pricing kernel ⇒ H–J bound sets lower bound on γ

- Consumption growth becomes more volatile and more heavily skewed after adding rare disasters, so H–J bound is satisfied for reasonable value of γ ⇒ no equity premium puzzle



50 % 1 of 2 topics complete

Wikipedia: Stochastic Discount Factor

Link

Lecture 6: Stochastic Discount Factor

PDF document

Session 7

Multi-Period Asset Pricing

100 % 1 of 1 topics complete

Lecture 7: Multi-Period Asset Pricing

PDF document

Session 8

Behavioural Finance

Assume Barberis, Huang, and Santos economy where investor receives utility from consumption as well as recent financial gain or loss. Use these parameters:

$$\delta = 0.99, \quad \gamma = 1, \quad \lambda = 2$$

Consumption growth has lognormal distribution:

$$\ln \tilde{g} = 0.02 + 0.02\tilde{\epsilon}$$

where ε is standard normal random variable. Simulate probability distribution for consumption growth with (at least) 10^4 random draws from standard normal distribution.

With these parameters, risk-free rate is around 3% per year:

$$R_f = \frac{e^{0.0198}}{0.99} = 1.0303$$

Define x as one plus dividend yield for market portfolio:

$$x = \left(1 + \frac{P}{D}\right)\frac{D}{P} = 1 + \frac{D}{P}$$

and define error term:

$$e(x) = 0.99 b_0 E[v(x\tilde{g})] + 0.99x - 1$$

where utility from recent financial gain or loss is given by:

$$v(R) = R - 1.0303 \quad \text{for} \quad R \geq 1.0303$$

$$v(R) = 2\,(R - 1.0303) \quad \text{for} \quad R < 1.0303$$

Solve for e(x) = 0 to find equilibrium value of x, using bisection search:

1. Set x_- = 1 and x_+ = 1.1, and use simulated distribution of consumption growth to confirm that $e(x_-) < 0$ and $e(x_+) > 0$ ⇒ solution must lie between x_- and x_+
2. Set $x_0 = 0.5*(x_- + x_+)$ and use simulated distribution of consumption growth to calculate $e(x_0)$
3. If $|e(x_0)| < 10^{-5}$, then you have converged to solution
4. Otherwise if $e(x_0) < 0$, then solution lies between x_0 and x_+ ⇒ repeat from step 2 with $x_- = x_0$
5. Otherwise if $e(x_0) > 0$, then solution lies between x_- and x_0 ⇒ repeat from step 2 with $x_+ = x_0$

Repeat for b_0 in range from 0 to 10, in increments of 0.1 (or less).

- Calculate price-dividend ratio for market portfolio:

$$\frac{P}{D} = \frac{1}{x-1}$$

Plot price-dividend ratio (on vertical axis) vs b_0.

- Calculate expected market return:

$$E\left(\tilde{R}_m\right) = E(x\tilde{g}) = xe^{0.0202}$$

Plot **equity premium** (on vertical axis) vs b_0.

- Briefly describe (in words, without using mathematical equations or formulas) main characteristics of v(·) as well as economic significance and implications of b_0 and λ.

Please submit your results (including relevant tables and graphs) as an Adobe PDF file to Homework 6.

100 % 2 of 2 topics complete

Wikipedia: Prospect Theory

Link

Lecture 8: Behavioural Finance

PDF document

Session 9

State Prices in Complete Market

66.67 % 2 of 3 topics complete

Wikipedia: State Prices

Link

Lecture 9: State Prices

PDF document

Extended Example

PDF document

Session 10

Stock Valuation

(This topic will not tested on exam)

0 % 0 of 4 topics complete

Wikipedia: Stock Valuation

Link

Wikipedia: Dividend Discount Model

Link

Lecture Notes: Stock Valuation

PDF document

AAPL Valuation

Excel Spreadsheet

Session 11

Session 12

Session 13

Session 14

Session 15

Miscellaneous