1FP571
Special seminar – Advanced Corporate Finance

EVROPSKÁ UNIE
Evropské strukturální a investiční fondy
Operační program Výzkum, vývoj a vzdělávání

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Performance Measurement Risk and Return

What it risk?

"Quantifiable uncertainty", but …

Risk vs. Uncertainty

Uncertainty **positive** (chance) and **negative** (risk)

Risk/Return ratio: Comparing **returns** without **risks** is as meaningless as comparing prices without the currency denomination; risk is the denomination of return

Performance Measurement Risk and Return

A. Modern portfolio theory (MTP):
- Markowitz
- standard deviation
- Sharpe Ratio

B. Post-modern portfolio theory:
- Sortino Ratio
- Treynor
- Omega Ratio

Performance Measurement Risk and Return

Return/Risk performance measures

- 1. Standard Deviation / Coefficient of Variation
- 2. Sharpe Ratio
- 3. Treynor Ratio
- 4. Sortino Ratio
- 5. Gain-to-Pain Ratio
- 6. Upside Potential Ratio

Performance Measurement Risk and Return

"Comparing returns without risk is … as meaningless as comparing international hotel prices without the currency denomination: Risk is the denomination of return" (Jack D. Schwager)

Risk is the denomination of Return

$E(X)/\sigma(X)$

i.e. reciprocal Coefficient of Variation, $[\sigma(X)/E(X)]^{-1}$, return per unit of risk (st. dev.)

Performance Measurement Risk and Return

1. Standard Deviation (volatility as risk measure)

- Measure of dispersion
- Square root of variance
- Population and sample
- If returns normally distributed, 95% of returns will be within 2 standard deviations of the mean (rule of 3 σ)
- Coefficient of Variation: volatility relative to return = σ(X) / E(X)

$$s = \sqrt{\frac{\sum_{i=1}^{N} (x_i - \overline{x})^2}{N - 1}}$$

Performance Measurement Risk and Return

2. Sharpe Ratio (ShR)

- ShR = (R – I) / SD, where
  - R = return
  - I = risk-free interest rate (threshold)
  - SD = standard deviation

- ratio of **excess return** over the strategy's **st. dev.**
- does not distinguish between upside and downside volatility: it **penalizes** positive volatility (**excessive positive returns**)
- does not distinguish between intermittent and consecutive losses
- meaningless for negative returns
- leverage increases Sharpe Ratio
- Risk is denomination of Return, $E(X)/\sigma(X)$
  i.e. reciprocal Coefficient of Variation, $[\sigma(X)/E(X)]^{-1}$, return per unit of risk (st. dev.)

Performance Measurement Risk and Return

3. Treynor Ratio (TR) "reward to volatility ratio"

- TR = $(R_p - R_r) / \beta_p$ where
  - R_p = return of portfolio
  - R_r = return required (threshold)
  - β_p = portfolio's beta coefficient

- modification of ShR
- goal to determine whether an investor gets compensated for taking additional risk above the inherent risk of the market
- does not quantify the value added (if any), ranking criterion only
- Use of systematic risk instead of total risk

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4. Sortino Ratio (SoR)

- SoR = (ACR – MAR) / DD, where
  - ACR = annual compounded return
  - MAR = minimum acceptable return (target, risk-free, mean)
  - DD = downside deviation

    semi-dev, sqrt (semi-variar

$$DD = \sqrt{\frac{\sum_{i}^{N}\left(MIN\left(X_i - MAR, 0\right)\right)^2}{N}}$$

- Conventionally calculated, SoR ~ 2x ShR for symmetrically distributed returns -> SoR / sqrt(2) for comparability

Performance Measurement Risk and Return

4. SoR – Misinterpretation

- As conventionally calculated, the Sortino ratio will be approximately double the Sharpe ratio, even for symmetrically distributed returns
- Recommendation: Divide Sortino ratio by square root of 2; this will make it comparable with Sharpe ratio
- Implications: A Sortino Ratio divided by square root of 2 greater than Sharpe ratio implies returns right skewed (i.e., deviations more influenced by large positive returns); lower would imply returns negative skewed

Performance Measurement Risk and Return

5. Gain-to-Pain Ratio (GPR) – advantages

- Penalizes only for negative returns
- Counts all negative returns and in proportion to their size
- Intuitive meaning
- Easy to calculate
- Defined for negative returns (smaller negative GPR better than larger negative GPR)

$$GPR = \frac{\sum_{i=1}^{N} X_i}{\left| \sum_{i}^{N} MIN(X_i, 0) \right|}$$

where X_i = individual returns

Performance Measurement Risk and Return

6. Upside Potential Ratio

- Complements Sortiono Ratio SoR (same author)
- Deciding on investments with a relatively good upside performance per unit of the downside risk

$$U = \frac{\sum_{\min}^{+\infty} (R_r - R_{\min}) P_r}{\sqrt{\sum_{-\infty}^{\min} (R_r - R_{\min})^2 P_r}}$$

where R_r = return

R_{min} = minimum acceptable return (MAR)

P_r = probability of the given return

Performance Measurement Risk and Return

5. Upside Potential Ratio U

- Rational investors prefer good returns (deviations above the mean) and avoid bad returns (deviations below the mean)
- **U** rewards desirable results (>MAR) in the numerator and penalize bad results (<MAR) in the denominator
- Pragmatic measure of portfolio's returns
- Mathematically simple

Performance Measurement Risk and Return

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