

Sharpe Ratio

夏普率

J.-S. Roger Jang (張智星)

MIR Lab, CSIE Dept.

National Taiwan University

jang@mirlab.org, <http://mirlab.org/jang>

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Sharpe Ratio (SR)

○ Definition

- $SR = \frac{\mu - \mu_0}{\sigma}$

Bank deposit interest rate

- μ : mean **yearly** return rate, μ_0 : risk-free return rate, σ : standard deviation of **yearly** return rate
- σ is also known as “volatility” or “risk”

○ Use of Sharpe ratio

- A way to evaluate a long-term portfolio
- The return rate when the volatility is 1%

Assume $\mu_0 = 0$

○ Examples

- $SR = 0.5$
 - Expected return = 0.5% if the volatility is 1%
 - Expected return = 5% if the volatility is 10%

Assume $\mu_0 = 0$

Examples of Sharpe Ratio

Comparison of Sharpe ratios of two portfolios



<https://rich01.com/what-sharpe-ratio/>

Compute SR from Daily Return

- Time resolution of yearly μ_y and σ_y too low → How to compute μ_y and σ_y based on daily μ_d and σ_d ?

- $$\text{Daily return} = \frac{\text{Today's net worth} - \text{Yesterday's net worth}}{\text{Yesterday's net worth}}$$

- $$Y = X_1 + X_2 + \dots + X_{252}$$

252: Average trading days per year

- $\mu_y = 252 \mu_d$

- $\sigma_y^2 = 252 \sigma_d^2$

$Y: \mu = \mu_y \text{ and } \sigma = \sigma_y$

$X_i: \mu = \mu_d \text{ and } \sigma = \sigma_d$

$$\rightarrow SR_y = \frac{\mu_y - \mu_{y0}}{\sigma_y} = \frac{252\mu_d - \mu_{y0}}{\sqrt{252}\sigma_d} = \frac{\mu_d - \frac{\mu_{y0}}{252}}{\sigma_d} \times \sqrt{252} = SR_d \times \sqrt{252}$$

- Similarly, to compute SR from monthly return:

$$\rightarrow SR_y = SR_m \times \sqrt{12}$$

Example

- Assume the five days' prices of a stock are [6 8 7 9 8] and the risk-free return is 1%, what is the corresponding Sharpe ratio?
- Solution:
 - $\text{return} = [2/6, -1/8, 2/7, -1/9];$
 - $\mu = 0.0957$
 - $\sigma = 0.2477$
 - $SR_d = (\mu - 0.01/252) / \sigma = 0.3863$
 - $SR_y = \sqrt{252} * SR_d = 6.1330$