Asset Return Computations

1 Simple net returns

Assume we observe the price of an asset at the end of a period where the period could be days, months, or years, etc. We could then say that at the end of period $t$, the asset price is $P_t$ and at the end of the previous period, $t-1$, the price was $P_{t-1}$. We define the simple net return as the percentage change in the price:

$$R_t = \frac{P_t - P_{t-1}}{P_{t-1}} = \frac{P_t}{P_{t-1}} - 1 = \% \Delta P_t$$

2 Log returns

If we let $R_t$ denote the simple net return, then we can define the continuously compounded return, $r_t$, as:

$$r_t = \ln(1 + R_t) = \ln \left( \frac{P_t}{P_{t-1}} \right)$$

where $\ln(\cdot)$ is the natural log function. We call this the continuously compounded return because we can manipulate the above equation into:

$$P_t = P_{t-1} e^{r_t}$$

so that $r_t$ is the continuously compounded growth rate in prices between periods $t-1$ and $t$ whereas $R_t$ is the simple growth rate in prices between periods $t-1$ and $t$ without any compounding. Note that the continuously compounded return is often referred to as the log return.

3 Annualized returns and annualized volatility

We can annualize continuously compounded returns and return volatility (the standard deviation of returns) using the following formulas:

$$r_A = 100 \cdot T \cdot \text{mean}(r_t)$$

$$\sigma_A = 100 \cdot \sqrt{T} \cdot \text{sd}(r_t)$$

where:

- $r_A$ = annualized continuously compounded return
- $\sigma_A$ = annualized volatility
- $T$ = number of time periods per year
- $r_t$ = continuously compounded return series