Broadcom Risk Analysis Notes

12.11.2025

Simple Returns

Let P_t be the closing price of a stock on day t.

Thus, we say the return R_t on a given day t is

growth factor for e.g. 1.02

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

we must minus 1 to get the 2%

change in price

and can be thought of the percentage from the day before day t, day $t-1$, to day t.

We can calculate the gross return $R_{t-k,t}$ from day $t-k$ to day t by the following;

$$R_{t-k,t} = (1 + R_{t-k}) \cdot (1 + R_{t-k+1}) \cdot \dots \cdot (1 + R_t) - 1$$

Log Returns

The log return r_t is defined as

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

on a given day t.

Similarly to simple returns, we can define the gross log return from day $t-k$ to day t;

$$r_{t-k,t} = r_{t-k} + r_{t-k+1} + \cdots + r_t .$$

Rolling Volatility

We denote the rolling volatility over a k-day period as how much a metric (in this case log returns) fluctuates over k days,

$$\sigma_{k,t} = \text{std}(r_{t-k+1}, r_{t-k+2}, \cdots, r_t)$$

$$= \sqrt{\left(\frac{\sum r^2}{k} - \left(\frac{\sum r}{k}\right)^2\right)} \quad \text{for } r \in (r_{t-k+1}, r_t).$$

We annualise this value to a consider "the annual risk" of the stock;

there are 252 trading days in a calendar year

$$\sigma_{annual} = \sigma_{daily} \cdot \sqrt{(252)}$$

$\text{Var}_{annual} = \text{Var}_{daily} \cdot 252$ as variance scales linearly

GARCH Model

We use the GARCH (Generative Autoregressive Conditional Heteroskedasticity) to forecast future volatility. The idea is that vol. is not const. and tends to cluster, high vol. days tend to be followed by high vol. days and low. vol days tend to be followed by low vol. days.

Let us denote the following :

- Unconditional volatility : standard deviation of all historical returns (assumes constant risk over time)
- Conditional volatility : Volatility of a given time, based on past returns — this what GARCH estimates

The simplest version of the model GARCH (1,1) suggests

Long-term avg. variance

yesterday's variance persists, if large then forecasted will also be large

$$\mathrm{Var}_t = \alpha_0 + \underbrace{\alpha_1 \epsilon^2_{t-1}}_{\text{yesterday's shock matters}} + \beta\, \mathrm{Var}_{t-1}$$

or

yesterday's variance

$$\sigma^2_t = \alpha_0 + \alpha_1 \epsilon^2_{t-1} + \beta_1 \sigma^2_{t-1}$$

Forecasted variance

where α_0, α_1 and β_1 are model parameters and ϵ^2_{t-1} is the "squared shock" from yesterday (how big yesterday's surprise return ans.