expected_returns has multiple functions ⇒

① returns_from_prices function ⇒

- purpose: gives information on returns on the basis of prices.

Calculated as ⇒

$$\text{return} = \frac{\text{price} - (\text{price} - 1)}{\text{price} - 1}$$

gives % age change from one period to next. Here, period is set as one day (i.e. daily).

Log returns are useful for their time-additivity.

WHY??

① Log returns can be summed over time, which isn't the case with simple returns, when dealing with multiple time periods.

② Financial calculations often involve multiplication, which can be simplified, as log returns can be added.

other reasons which are imp but not specifically relevant to our case

↓

Normality Assumption: In finance, it's often assumed that log returns are more normally distributed than simple returns, especially for longer time horizons. This assumption is crucial for various statistical models and risk management techniques.

Volatility Clustering: Log returns can better handle the phenomenon of volatility clustering, a common occurrence in financial markets where periods of high volatility are followed by more high volatility and vice versa.

⇒ Log returns here ⇒

$$\log \text{return} = \log(\text{price}) - \log(\text{price}-1)$$

$$= \log(1+\text{return})$$

---

② prices_from_returns fn

Purpose: converts return data back into prices.

$$\text{price} = (\text{price}-1)(1+\text{return})$$

$$\log \text{return} \Rightarrow \text{price} = (\text{price}-1)\, e^{\text{return}}$$

WHY: Useful for reconstructing price info from data, which is often needed for analysis / visualisation.

---

(3) Mean_historical_return ⇒

purpose: gives data on future returns based on historical returns data.

2 ways ⇒

(a) for simple returns (AM)

Mean ⇒ arithmetic mean = $\frac{\sum_{t=1}^{n} \text{Return}_{(t)}}{n}$

{where n = no. of observations}

Annualized mean return

=

mean × frequency of period

(b) for compounded returns

mean ≡ geometric mean

☺

CAGR

$$CAGR = \left(\prod_{t=1}^{n} (1 + \text{Return}_t) \right)^{\frac{\text{frequency}}{n}} - 1$$

CAGR is better than AM as it takes into account effect of return volatility over time.

---

(4) ewma — historical_return fn

purpose: gives predictions on future returns on the basis of the concept of exponentially weighted mean

(which means giving more value to recent returns to account for trends & changing market forces)

EMA (for a certain time period) =>

$$EMA = \alpha \cdot Returns + [(1-\alpha)(EMA-1)]$$

where [α = smoothing factor]

$$\alpha = \frac{2}{span+1}$$

where span defines degree of weighting decrease

span $\propto$ weight of older data

(directly proportional)

Annualized EMA (compounded)

$$= (1 + EMA)^{frequency} - 1$$

Annualized EMA (simple)

$$= (EMA) \times (frequency)$$

WHY??

other than accounting for trends & market forces, the smoothing effect also smoothens out short term fluctuations, focussing on longer-term trends

(5) Capm_return function

CAPITAL ASSET PRICING MODEL

Formula ⇒ $R_i = R_f + B_i \times (R_m - R_f)$

- R_i = expected RoI
- R_f = risk free rate
- B_i = beta of investment
- R_m = expected returns from market

⇒ R_f is typically the yield from govt. bonds / gold as they tend to be risk-free irrespective of market climate.

⇒ R_m is expected return of market. The benchmarking for the same is often done through metrics of stocks like the NIFTY 50.

⇒ β_i helps measure the risk/security of a portfolio in comparison to the rest of the market.

$$\beta_i = \frac{\text{Covariance}(R_i, R_m)}{\text{variance}(R_m)}$$

now, the CAPM can be annualized like the other functions above.

WHY??

provides an industry-accepted framework to calculate the relation b/w risk & expected return over time, and can also be used to carry out a review analysis on current/past portfolio.