Performance Measures

Return	The average upside/downside
Risk	The variability in the Return
Risk adjusted Return	Accounts for both of the above

Risk Adjusted Return

There are some special measures which help account for both the Return and Risk of a trading strategy

Sharpe Ratio

is a pretty famous Risk adjusted return measure

Average Return

Risk-free rate of return

$$\text{Sharpe Ratio} = \frac{r_p - r_f}{\sigma_p}$$

Risk i.e. Standard deviation of Return

$$\text{Sharpe Ratio} = \frac{r_p - r_f}{\sigma_p}$$

The Sharpe Ratio is a very standard measure to evaluate a trading strategy

$$\text{Sharpe Ratio} = \frac{r_p - r_f}{\sigma_p}$$

There are a few conventions to how it is calculated

$$\text{Sharpe Ratio} = \frac{r_p - r_f}{\sigma_p}$$

Often, the risk-free rate is assumed to be 0

$$\text{Sharpe Ratio} = \frac{r_p - r_f}{\sigma_p}$$

Often, the risk-free rate is assumed to be 0

Information Ratio

$$\text{Sharpe Ratio} = \frac{r_p - r_f}{\sigma_p}$$

In the US, the risk-free rate of return (from treasury bonds) ~ 0

$$\text{Sharpe Ratio} = \frac{r_p - r_f}{\sigma_p}$$

For futures? - add explanation here

$$\text{Sharpe Ratio} = \frac{r_p - r_f}{\sigma_p}$$

The Sharpe ratio is normally calculated using Annualized Returns

$$\text{Sharpe Ratio} = \frac{r_p - r_f}{\sigma_p}$$

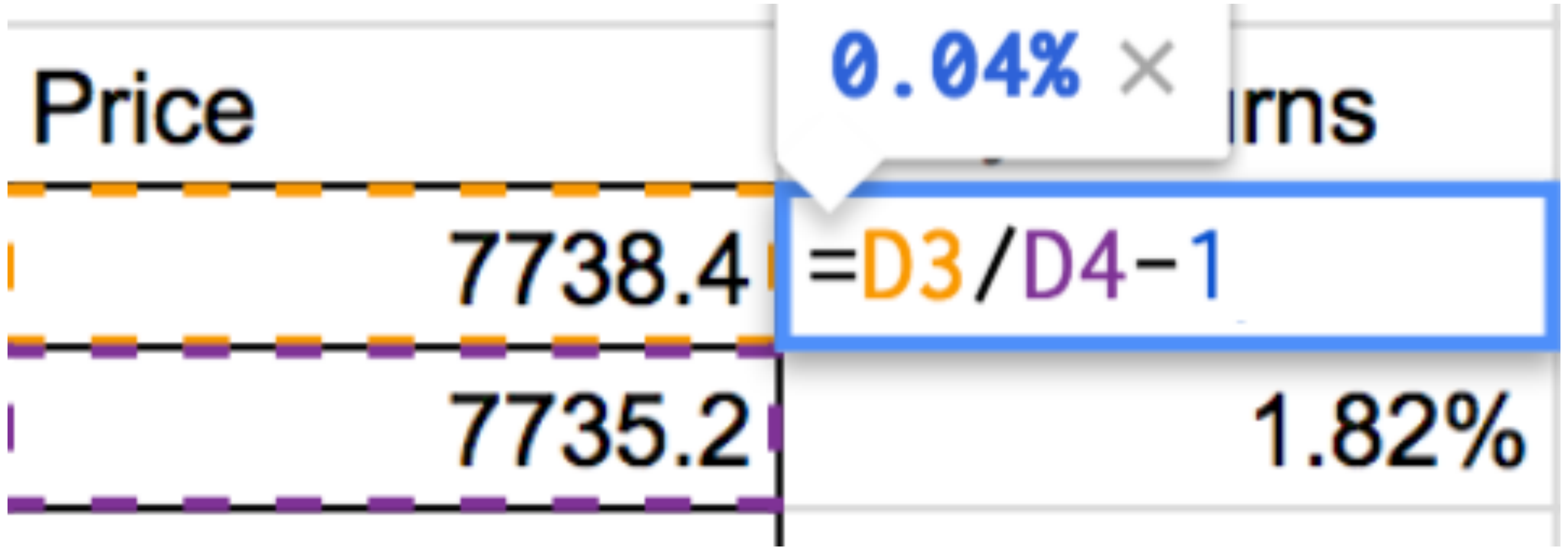
First, let's consider the relationship between daily and annual returns

Here is a time series of price data for the NIFTY

Date	Price
3/31/2016	7738.4
3/30/2016	7735.2
3/29/2016	7597
3/28/2016	7615.1
3/23/2016	7716.5
3/22/2016	7714.9
3/21/2016	7704.25
3/18/2016	7604.35
3/17/2016	7512.55
3/16/2016	7498.75
3/15/2016	7460.6
3/14/2016	7538.75
3/11/2016	7510.2
3/10/2016	7486.15
3/9/2016	7531.8
3/8/2016	7485.3
3/4/2016	7485.35
3/3/2016	7475.6
3/2/2016	7368.85
3/1/2016	7222.3
2/29/2016	6987.05
2/26/2016	7029.75
2/25/2016	6970.6
2/24/2016	7018.7

Date	Price	DailyReturns
3/31/2016	7738.4	0.04%
3/30/2016	7735.2	1.82%
3/29/2016	7597	-0.24%
3/28/2016	7615.1	-1.31%
3/23/2016	7716.5	0.02%
3/22/2016	7714.9	0.14%
3/21/2016	7704.25	1.31%
3/18/2016	7604.35	1.22%
3/17/2016	7512.55	0.18%
3/16/2016	7498.75	0.51%
3/15/2016	7460.6	-1.04%
3/14/2016	7538.75	0.38%
3/11/2016	7510.2	0.32%
3/10/2016	7486.15	-0.61%
3/9/2016	7531.8	0.62%
3/8/2016	7485.3	0.00%
3/4/2016	7485.35	0.13%
3/3/2016	7475.6	1.45%
3/2/2016	7368.85	2.03%
3/1/2016	7222.3	3.37%
2/29/2016	6987.05	-0.61%
2/26/2016	7029.75	0.85%
2/25/2016	6970.6	-0.69%
2/24/2016	7018.7	-1.28%

We can compute the daily returns from the prices



Return = Ptoday/Pyest-1

Date	Price	DailyReturns
3/31/2016	7738.4	0.04%
3/30/2016	7735.2	1.82%
3/29/2016	7597	-0.24%
3/28/2016	7615.1	-1.31%
3/23/2016	7716.5	0.02%
3/22/2016	7714.9	0.14%
3/21/2016	7704.25	1.31%
3/18/2016	7604.35	1.22%
3/17/2016	7512.55	0.18%
3/16/2016	7498.75	0.51%
3/15/2016	7460.6	-1.04%
3/14/2016	7538.75	0.38%
3/11/2016	7510.2	0.32%
3/10/2016	7486.15	-0.61%
3/9/2016	7531.8	0.62%
3/8/2016	7485.3	0.00%
3/4/2016	7485.35	0.13%
3/3/2016	7475.6	1.45%
3/2/2016	7368.85	2.03%
3/1/2016	7222.3	3.37%
2/29/2016	6987.05	-0.61%
2/26/2016	7029.75	0.85%
2/25/2016	6970.6	-0.69%
2/24/2016	7018.7	-1.28%

Let's consider a simple trading strategy where we hold a long position on the Nifty for the entire period

Date	Price	DailyReturns
3/31/2016	7738.4	0.04%
3/30/2016	7735.2	1.82%
3/29/2016	7597	-0.24%
3/28/2016	7615.1	-1.31%
3/23/2016	7716.5	0.02%
3/22/2016	7714.9	0.14%
3/21/2016	7704.25	1.31%
3/18/2016	7604.35	1.22%
3/17/2016	7512.55	0.18%
3/16/2016	7498.75	0.51%
3/15/2016	7460.6	-1.04%
3/14/2016	7538.75	0.38%
3/11/2016	7510.2	0.32%
3/10/2016	7486.15	-0.61%
3/9/2016	7531.8	0.62%
3/8/2016	7485.3	0.00%
3/4/2016	7485.35	0.13%
3/3/2016	7475.6	1.45%
3/2/2016	7368.85	2.03%
3/1/2016	7222.3	3.37%
2/29/2016	6987.05	-0.61%
2/26/2016	7029.75	0.85%
2/25/2016	6970.6	-0.69%
2/24/2016	7018.7	-1.28%

Then these would be the returns we would get as a result of the trading strategy

Date	Price	DailyReturns
3/31/2016	7738.4	0.04%
3/30/2016	7735.2	1.82%
3/29/2016	7597	-0.24%
3/28/2016	7615.1	-1.31%
3/23/2016	7716.5	0.02%
3/22/2016	7714.9	0.14%
3/21/2016	7704.25	1.31%
3/18/2016	7604.35	1.22%
3/17/2016	7512.55	0.18%
3/16/2016	7498.75	0.51%
3/15/2016	7460.6	-1.04%
3/14/2016	7538.75	0.38%
3/11/2016	7510.2	0.32%
3/10/2016	7486.15	-0.61%
3/9/2016	7531.8	0.62%
3/8/2016	7485.3	0.00%
3/4/2016	7485.35	0.13%
3/3/2016	7475.6	1.45%
3/2/2016	7368.85	2.03%
3/1/2016	7222.3	3.37%
2/29/2016	6987.05	-0.61%
2/26/2016	7029.75	0.85%
2/25/2016	6970.6	-0.69%
2/24/2016	7018.7	-1.28%

We can compute the average and Standard deviation for this series

Date	Price	DailyReturns
3/31/2016	7738.4	0.04%
3/30/2016	7735.2	1.82%
3/29/2016	7597	-0.24%
3/28/2016	7615.1	-1.31%
3/23/2016	7716.5	0.02%
3/22/2016	7714.9	0.14%
3/21/2016	7704.25	1.31%
3/18/2016	7604.35	1.22%
3/17/2016	7512.55	0.18%
3/16/2016	7498.75	0.51%
3/15/2016	7460.6	-1.04%
3/14/2016	7538.75	0.38%
3/11/2016	7510.2	0.32%
3/10/2016	7486.15	-0.61%
3/9/2016	7531.8	0.62%
3/8/2016	7485.3	0.00%
3/4/2016	7485.35	0.13%
3/3/2016	7475.6	1.45%
3/2/2016	7368.85	2.03%
3/1/2016	7222.3	3.37%
2/29/2016	6987.05	-0.61%
2/26/2016	7029.75	0.85%
2/25/2016	6970.6	-0.69%
2/24/2016	7018.7	-1.28%

Then we know that this trading strategy has

Average daily return = r

Risk = σ

The return on each day is a
random variable

with mean = r
standard deviation = σ

Average daily return = r
Risk = σ

There are, on average, ~252 trading days in a year in the US markets

$$\text{Annual return} = R_1 + R_2 + R_3 + \ldots + R_{252}$$

Each of these represents a daily return

$$\text{Annual return} = R_1 + R_2 + R_3 + \dots + R_{252}$$

Each of these daily returns is a random variable

$$\text{Annual return} = R_1 + R_2 + R_3 + \dots + R_{252}$$

It is safe to assume that these random variables are

1) Independent
2) Identically distributed

Mean and SD for each Random Variable

Average daily return = r

Risk = σ

Annual return = $R_1 + R_2 + R_3 + \ldots + R_{252}$

It is safe to assume that these random variables are

1) Independent
2) Identically distributed

IID

Average daily return = r

Risk = σ

$$\text{Annual return} = R_1 + R_2 + R_3 + \ldots + R_{252}$$

If each of these random variables has

Mean = r

SD = σ

$$\text{Annual return} = R_1 + R_2 + R_3 + \ldots + R_{252}$$

$$\text{Mean} = 252 * r$$

$$\text{SD} = \sqrt{252} * \sigma$$

$$\text{Mean} = r$$

$$\text{SD} = \sigma$$

Going back to the Annualised Sharpe

Going back to the Annual Sharpe

$$\text{Daily Sharpe} = \frac{r}{\sigma}$$

Assuming the risk free rate =0

$$\text{Annualised Sharpe} = \frac{252*r}{\sqrt{252}*\sigma}$$

Going back to the Annual Sharpe

$$\text{Daily Sharpe} = \frac{r}{\sigma}$$

$$\text{Annualised Sharpe} = \frac{\sqrt{252 * r}}{\sigma}$$

$$\text{Annualised Sharpe} = \frac{\sqrt{252} * r}{\sigma}$$

This factor will depend on the trading frequency - daily, weekly, monthly

Performance Measures

Return The average upside/downside

Risk The variability in the Return

Risk adjusted Return Accounts for both of the above

Quantitative Trading

involves trading in Financial Markets

with the help of Trading Strategies

developed using Mathematical Models

Quantitative Trading

involves trading in Financial Markets

with the help of Trading Strategies

developed using Mathematical Models

Now, we come to the heart of the matter

Mathematical Models

A Quant trader

Studies Historical Data

Mathematical Models

A Quant trader

Studies Historical Data

Identifies patterns in security prices

Mathematical Models

A Quant trader

Studies Historical Data

Identifies patterns in security prices

Develops mathematical models that capture these patterns

Mathematical Models

A Quant trader

Studies Historical Data

Identifies patterns in security prices

Develops mathematical models that capture these patterns

Uses these mathematical models to develop trading strategies

Mathematical Models

There are generally **2 steps involved** in developing a trading strategy

Building a model

Testing the model

Backtesting

Building a model

This step answers one question

Should the trader go long or short on a given security/index?

Building a model

The objective is to build a model

Historical data → $\boxed{\text{Model}}$ → Long/Short

The model inputs could be historical data for the security, for the market, macroeconomic factors etc

Mathematical Models

There are generally **2 steps involved** in developing a trading strategy

Building a model

Testing the model

Backtesting

Backtesting

Backtesting evaluates how the model would have performed in the past

The return, risk, Sharpe Ratio are calculated by applying the trading strategy to past data

Backtesting

Backtesting is a standard way to evaluate how well a trading strategy might perform in reality