

QUANTITATIVE INVESTMENT ANALYSIS

FREQUENTLY ASK QUESTIONS

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Time Value of Money

1. What is the concept of “Time Value Of Money”?

This concept is that the money in hand is worth more than a similar amount of money in the future. This occurs due to **Interest** that can be earned or borrowed, **Inflation** which is the general rise in the price of goods and services over a period of time which leads to drop in value of the money, and **Risk** is uncertainty about the cash flow that we are expecting.

Let us take a simple example. If you invest Rs.100 (the present value) for 1 year at a 5% interest rate, then at the end of the year, you will have Rs.105 (the future value). We can calculate this by the formula:

$$FV = PV (1 + i)^n$$

Where FV is Future value, PV is Present value, i stand for interest rate, n is the number of periods. Plugging in the values, we get, $Rs.100(1+0.05)^1 = Rs.105$. So, according to this example, Rs. 100 today is worth Rs.105 a year from today, which shows us the Time value of money. To continue this example, if this Rs 100 was invested with a bank and that bank goes bankrupt, possibility of recovering Rs 105 after one year is doubtful (Risk/Uncertainty) and if Rs 100 can buy 2 kg of potato today (at Rs 50 a kg) and if potato price goes up to Rs 60 in a year, Rs 105 can buy less than 2 kg of potato (Inflation). Therefore Rs 100 today in hand is more valuable than Rs 105 after one year.

2. How to calculate the Future Value of a sum of money invested for a specific time at an specific rate of Interest? And how to calculate the future value of cash flows as per time value of money?

Let us understand with the help of an example:

You have an amount of Rs. 10,00,000, which you want to invest in a mutual fund for 15 years, giving a consistent return of 14% per annum. What would be the sum's maturity value(Future Value) at the end of 15 years?

We can calculate the future value of the amount by using the simple formula of compound Interest, which is:

$$FV = PV (1 + i)^n$$

where FV= Future Value, PV= Present Value, r= rate of interest, n=number of periods. Plugging the values in the formula, we get the Future Value as:

$$FV = 10,00,000 * (1 + 0.14)^{15} = Rs. 71,37,937.97$$

We will receive an amount of Rs. 71,37,937.97 at the end of 15 years.

Let's assume that you invest Rs. 1,00,000 in any instrument at the end of every year for the next 15 years, at 14% interest per annum. What will be the Maturity Value at the end of 15 years?

This case, where we deposit money at the end of every period is also called ordinary annuity. We can calculate the future value of the series of cash flows with the simple, but a little modified formula of compound Interest, which is:

$$FV_{\text{Ordinary Annuity}} = C \times \left[\frac{(1 + i)^n - 1}{i} \right]$$

where C= Cash Flow amount, i= rate of Interest, n= no of periods. Plugging the values in the formula we get the Future Value as:

$$FV (\text{Ordinary Annuity}) = 100000 * ((1 + 0.14)^{15} - 1)/0.14 = \text{Rs. } 43,84,241.41$$

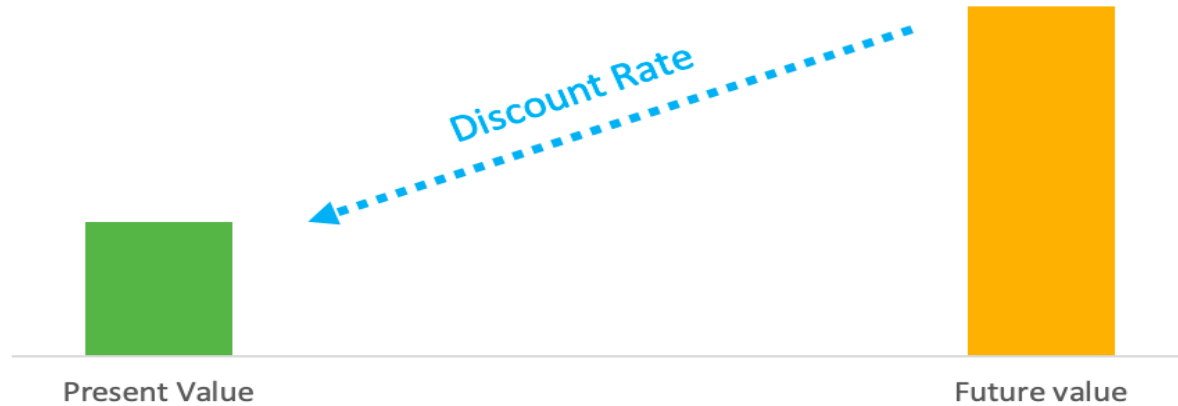
∴ We will receive an amount of Rs. 43,84,241.41 at the end of 15 years.

3. What is the Discount rate?

In the security market, we use the term “discount rate” which is the rate of return used to equate the value of “future cash flow” back to their “present value”.

This rate is usually the required rate of return or hurdle rate that investors expect, considering the risk associated with an investment. So, we add some risk premium associated with security to the risk-free rate (government bond) to get this discount rate. Risk premium depends on the company's size, cyclicity of business, corporate governance, economic moat, etc. Another way is by finding a weighted average cost of capital (WACC).

Figure 1 Discount Rate



Source: 1 Author's Diagram

4. Why and where we use Discount Rate?

The discount rate is used to calculate net present value (NPV) of a business, to do further discounted cash flow analysis. It is also accounted for

1. Time value of money
2. Risk associate with investment
3. Opportunity cost

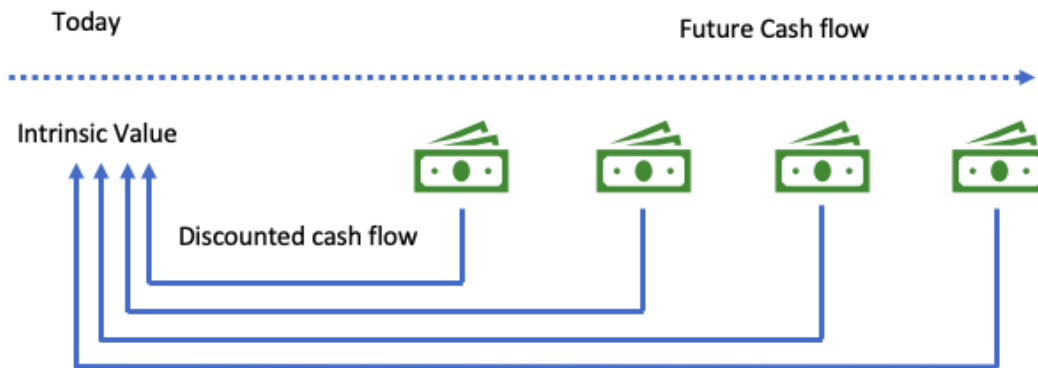
Discount rate is further used to find the intrinsic value of a security. Intrinsic value in general, fundamental value of securities.

Discounted Cash flow Applications

5. What is intrinsic value? How can we use the discount rate to calculate intrinsic value?

Intrinsic value means how much assets are worth. In the case of a security market, intrinsic value is equal to the present value of it's all future expected cash flow.

Figure 2 DCF Conceptual Design



Source: 2 Author's Diagram

Here is the formula for the DCF model

$$DCF = \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \frac{CF_3}{(1+r)^3} + \frac{CF_4}{(1+r)^4} + \dots + \frac{CF_n}{(1+r)^n}$$

Where,

CF = Cash flow in period

r = Discount rate

n = Period number

Where can we use the DCF formula

1. To value bond
2. To value the entire business
3. To find the intrinsic value of per share security

6. How to Use DCF formula to find intrinsic value of business:-

So, by using this equation, we can calculate the intrinsic value of the securities. You can follow the below step to find the intrinsic value of a security.

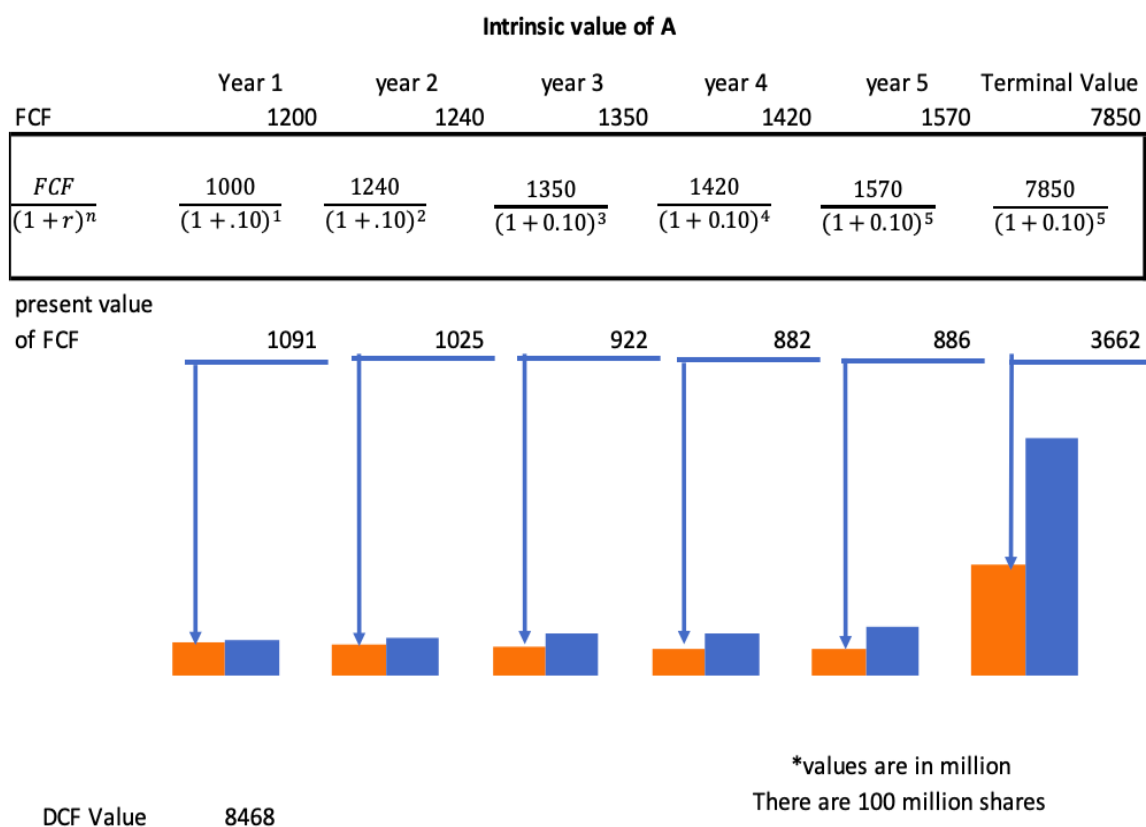
1. Forecast Free cash flow (FCF)
2. Find the terminal value
3. Discount Free cash flow and terminal value to present day
4. Sum all of these calculated present value
5. Divide it by number of shares

So, to find intrinsic value we just follow this step. First we forecast free cash flow for, say next 5 to 10 year then we find exit value which is a terminal value which is the price we receive to exit position then we find the present value of all this future cash flow and add them all to find current value of a business and divide it by number of shares, this way we can find intrinsic value of security

Let's take an example,

Security A has like below FCF, and at the end of five year we will sell it with an exit multiplier of 5x. So, at the end of five year its selling price will be $5 \times \text{FCF}$, which is its terminal value. And security A has 100 million outstanding shares. So, we can find intrinsic value per share like below

Figure 3 Intrinsic Value Conceptual Design



So, per share value of Security A is 84.68

Source : 3 Author's Diagram

Important to learn here is that

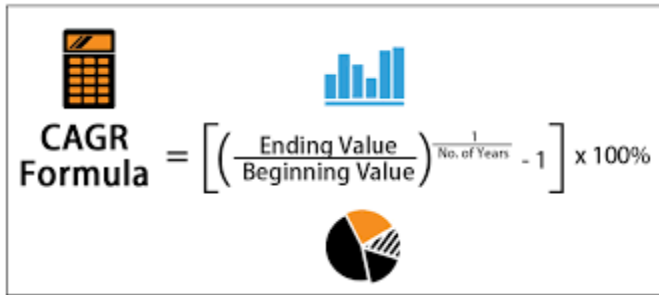
If you pay less than the calculated DCF value you will earn more than the discount rate, and if you pay higher than the calculated DCF value you will earn less than the discount rate.

Investment Return Analyses

7. What is CAGR?

A: We know that CAGR is Compounded Annual Growth Rate given by the formula

Figure 4 CAGR



CAGR Formula = $\left[\left(\frac{\text{Ending Value}}{\text{Beginning Value}} \right)^{\frac{1}{\text{No. of Years}}} - 1 \right] \times 100\%$

Source: [4 Investopedia.com](#)

We use CAGR if we know only the beginning and ending value

Let's say that price of HDFC Bank is Rs 100 today and assume that it reaches Rs 120 at the end of 3 years and I don't bother to check the price of HDFC Bank everyday, so at the end of 3 years if I want to know the average compound return for HDFC Bank, I would calculate return with the help of CAGR. We can do this with the help of excel and our CAGR is 6.27% which means that every year HDFC Bank is growing at the rate of 6.27%

8. What is Geometric Mean Return?

Geometric Mean is given by the formula:

$$\text{Geometric Return} = \sqrt[n]{(1 + r_1) \times (1 + r_2) \times \dots (1 + r_n)} - 1$$

r = rate of return

n = number of periods

GM is only used if **we have data for every time period.**

Let's consider other case in which I had the data of HDFC yearly prices and I computed Yearly return, now in order to calculate the average geometric mean return, we use growth factor and use GEOMEAN formula in excel to find the geometric mean return which we got the same result as 6.27%

9. What is the difference between CAGR and Geometric Mean Return?

Although both consider the compounding effect, CAGR assumes a constant compounding over some time whereas the geometric mean considers each time period's individual compounding. The major difference of application is We use CAGR if we know only the beginning and ending value whereas GM is only used if we have data for every time period.

As we calculated in the above cases let's compare them and see. Here we see that since the ending and beginning prices are the same in both cases, CAGR and GM are the same which is 6.27%.

Figure 5 CAGR & Geometric Mean

Year	Price	Return	Growth Factor
Year 0	100		
Year 1	105	5.00%	1.05
Year 2	110	4.76%	1.05
Year 3	120	9.09%	1.09
CAGR	6.27%	GM	6.27%

Source : 5 Author's Compilation

From the above two cases, we observed that CAGR gives us a constant annual return, but it is not the case in real-life scenarios. There might be many deviations from these returns. Whereas GM Return considers different periods. Essentially both give the same answers but the use case is different. We all know that Warren Buffet has generated 20.3% CAGR over 55 years. Does this mean that every year he is generating 20.3%? No, there are years where his return is more than 20.3% and less than 20.3 % as well, so to simplify things we say that he generated an average return of 20.3% for 55 years continuously.

10. What is NPV? Why do we use it?

NPV stands for Net Present Value, as the name suggests, it is the net present value of all the future cash flow including both positive and negative cash flow.

If we break down the name

Net :- Sum of all positive and negative cash flow

Present value:- Discounted to present value.

We mostly use NPV to value new capital projects, value a business and anything that involves cash flow.

So, it has a similar formula as discounted cash flow, except here we also accounted for cash outflow. Here is the formula so you can understand.

$$NPV = \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \frac{CF_3}{(1+r)^3} + \dots + \frac{CF_n}{(1+r)^n} - X_0$$

Where,

X_0 = cash out flow at time 0 (investment cost/ purchase price).

So, as you can see it is almost identical to DCF except we also include cash outflow at initial stage and also if there is cash outflow later on we also include that also.

We can easily find NPV in excel by using NPV or XNPV function

Use of NPV

By NPV we can analyze we can determine how much a project or business worth, Up to extent we can determine how much any cash flow is worth. So, we can have a real idea whether our investment is worth or not or should we invest in that project or business or not.

11. What is the meaning of Negative or positive NPV? And disadvantages of NPV.

If we get a negative NPV of our project that means that our project rate of return is lower than our discount rate. It does not mean that our project is losing money, it may generate net profit but considering our rate of return is lower than the discount rate (our expected return), our value is getting destroyed. So, in the case of negative NPV our rate of return will be lesser than our expected rate of return , which is our discount rate.

In the case of positive NPV, we are creating the value, which means that our return rate will be greater than our discount rate.

Disadvantage of NPV

1. We have to make many assumptions. We have to forecast future cash flow than we have assumed some discount rate. So, there is a chance of error in terms of this forecasting we get.
2. Also, it is sensitive to this small change in assumption. A small increment or decrement in the discount rate will yield way far result. That's why finding NPV and DCF is not just modeling but also an art.
3. We are humans to see our desired output. We sometimes take assumptions as our accordance and get them out as we want to see. So, we have to be disciplined not to manipulate our assumption.

12. What is the Internal rate of return (IRR) ?

IRR is the discount rate at which our NPV becomes zero. Think other way we can expect to earn a compounded rate of return equal to IRR over a life of an investment.

Let's understand it by example. Suppose, our business is already earning 12% net profits per annum. Suppose our project has an initial cost of 10 Lakh rupees and over its life (5 years) it's expected to yield present value (discounted at 12% per annum) of its future cash flow is also 10 lk Rupees.. In that case, we get NPV zero. If the discount rate at which future value is discounted to calculate present value is say 8%, the present value tends to be more than RS 10 lakhs and if the discount rate is 14%, the present value tends to be less than Rs 10 lk ; however at 12% discount rate, the present value of future inflows is zero ie., equal to initial investment. Such rate at which the present value of future cash flows is equal to the initial investment, such discount rate is called Internal Rate of Return (IRR) .

So, in IRR our NPV become 0

$$0 = NPV = \frac{CF_1}{(1+irr)^1} + \frac{CF_2}{(1+irr)^2} + \frac{CF_3}{(1+irr)^3} + \dots + \frac{CF_n}{(1+irr)^n} - X_0$$

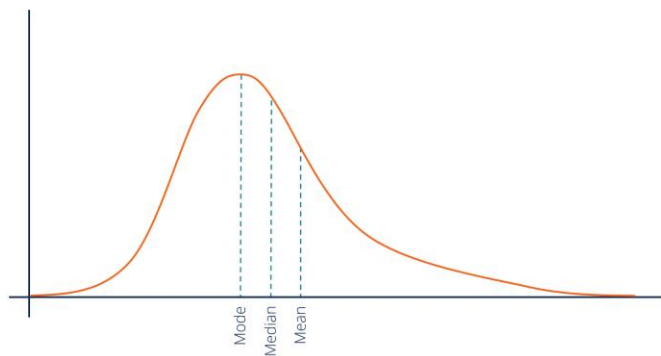
We, can find IRR by using MS excel XIRR function

Statistical Concepts for Investor

13. How to interpret a positively skewed equity price return?

Before interpreting the positive skewness let's understand what is skewness and what does that mean. Skewness is the measure of how much the probability distribution of a random variable deviates from the normal distribution. Equity Returns are assumed to be normally distributed but in real life sometime these returns are skewed. Skewness can be positive or negative. "A positively skewed (or right-skewed) distribution is a type of distribution in which most values are clustered around the left tail of the distribution while the right tail of the distribution is longer".

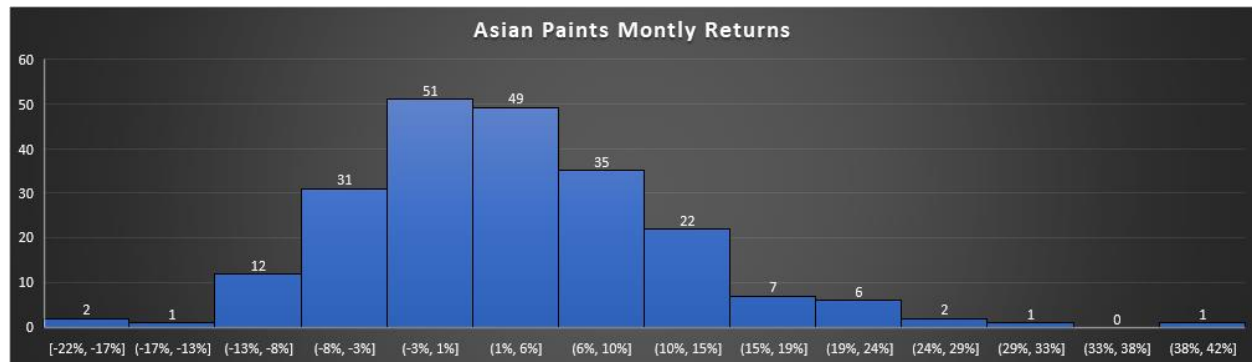
Figure 6 Skewed Distribution of returns



Source : 6 Author's Diagram

The positive skewness of distribution shows that an investor may expect frequent small losses and a few but large gains from the investment. Large gains recover all frequent small losses so the positively skewed distributions returns of securities return or portfolio return are desirable among investors. The probability of huge gains covers all the frequent small losses.

Figure 7 Asian Paints Monthly Return Histogram



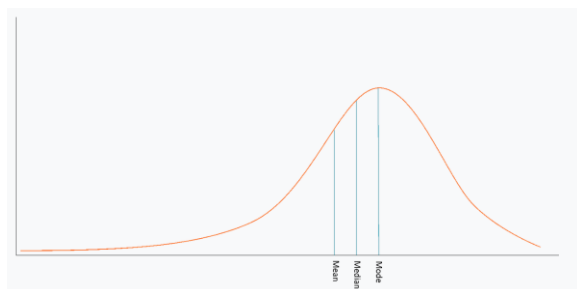
Source : 7 Author's Compilation

The above chart is the Asian Paints Monthly Returns for the last 18 years, as you can see from the distribution that it is positively skewed distribution(not accurate but close to positive skewed with skewness of 0.71) Though there might be frequent small losses there is some probability that it gains huge profits. In this way we can interpret positively skewed equity returns.

14. How to interpret negatively skewed equity price returns?

As we already discussed positive skewness, it's easier to interpret negative skewness. Negative skewness is the complete opposite of positive skewness. It implies that there are small negative returns that might be of very high magnitude.

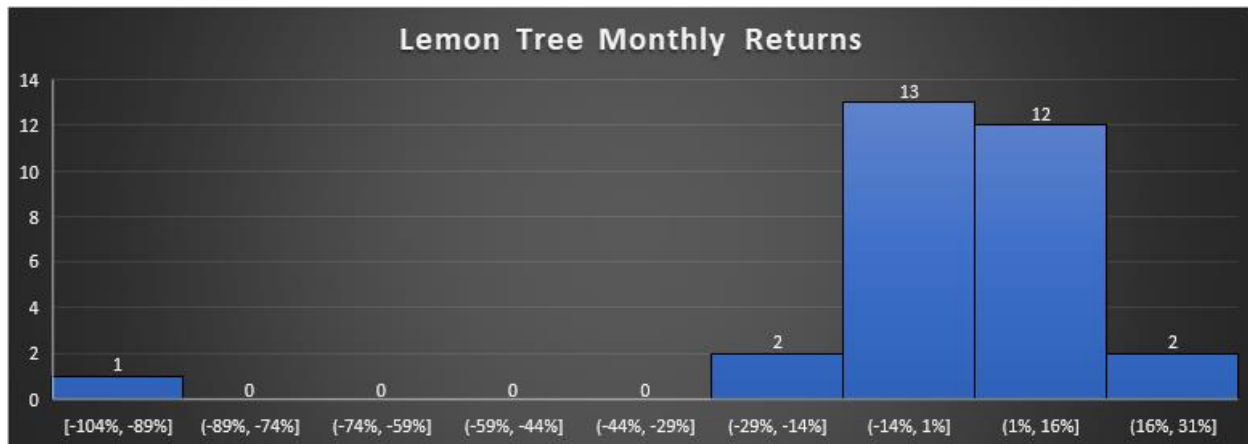
Figure 8 Left Skewed Distribution



Source : 8 Author's Compilation

The negative skewness of the distribution indicates that an investor may expect frequent small gains and a few large losses. These Large losses can wipe out Portfolio's entire profits, so investors have to be careful and a negatively skewed return is not desirable.

Figure 9 Lemon Tree Monthly Return Histogram



Source : 9 Author's Compilation

The above Chart is the Monthly Returns of Lemon Tree with a skewness of -3.59. We can interpret that though there are small frequent gains there is a very large loss of -104% in a month that could wipe out your entire portfolio in a month. So, an investor has to be careful while dealing with the negatively skewed distribution. This is how we interpret the negatively skewed equity price return.

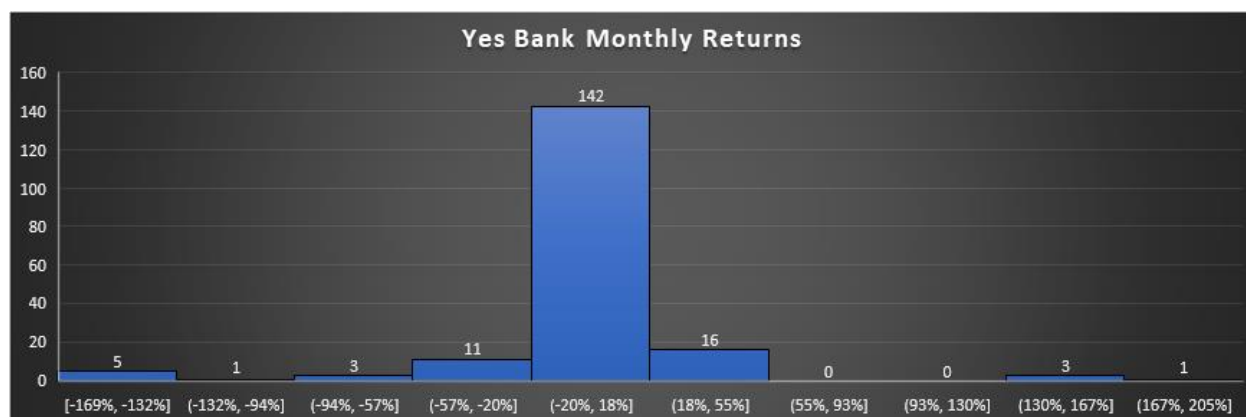
15. In case of securities price return distribution, how high kurtosis is interpreted as?

Kurtosis measures the fat tail of distribution as compared to the center of the distribution. It measures peak a distribution is. The fat tail means the number of events that occurred outside the normal range and extreme value of tail event.

Stock prices with a higher likelihood of outliers on either the positive or negative side of the mean closing price can be said to have either positive or negative skewness.

Let's take an example of Yes Bank monthly returns and see how the returns are distributed.

Figure 10 Yes Bank Monthly Return Histogram



Source : 10 Author's Compilation

Here, I took the monthly returns of YES BANK for the last 15 years and plotted the distribution. As you can see that there are very extreme values which are away from the mean. By using KURT function in Excel, the kurtosis of YES BANK is 10.387 which is very high. Kurtosis of Normal Distribution is 3. This suggests that there is a chance of high extreme values on both sides of the tail. As you can see, there are YES BANK instances where monthly returns are in the range of -160% and in the range of 200%. Investors have to be careful with such kind of kurtosis as they may erode the entire portfolio.

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16. What is frequency distribution? Explain the steps to compile customised histogram in excel?

Frequency distribution means how frequently each different value occurs. Histogram graphs are used to show frequency distribution.

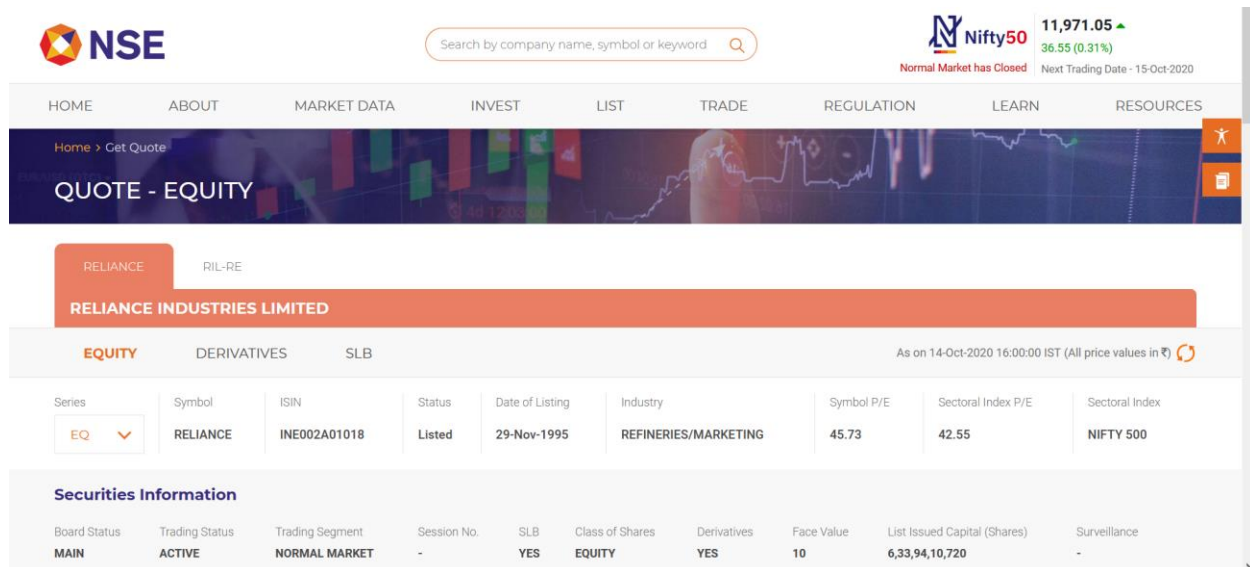
Constructing a customized histogram is very simple in Excel, all you need is price data of security you want to compile. As we all know these days, RELIANCE INDUSTRIES is a buzzing stock, let us try to construct a beautiful Histogram for Reliance Industries. We will discuss the process in multiple steps

Step 1: Collection of Data

We need Reliance Industries historical prices to make a histogram out of it. We can find historical data from many websites such as NSE, BSE, Yahoo Finance, Investing.com.

Let's go to the NSE website and type Reliance Industries in the search bar and. Once you select the company you will be shown like this:

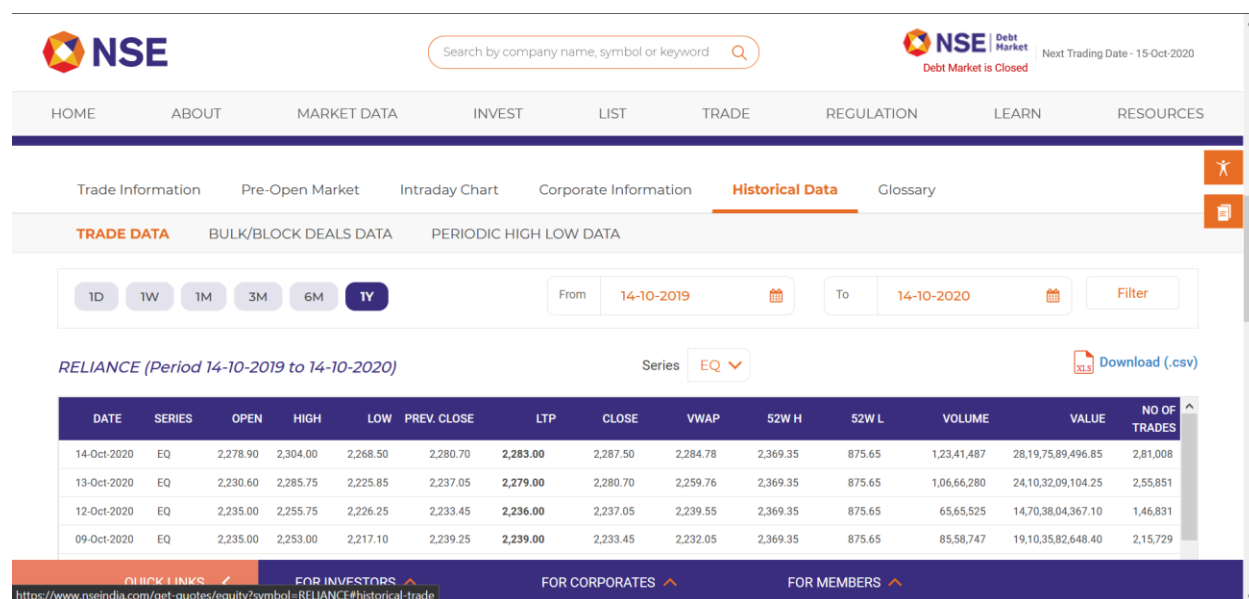
Figure 11 Screenshot RIL



Source: 11 www.nseindia.com

Select Historical data to download the prices of Reliance Industries. Once you click that you will go this page:

Figure 12 Screenshot RIL Data



Source: 12 www.nseindia.com

Here you will find the data for the last 1 year, if you want more data you can visit third party websites like Yahoo Finance and Investing.com for now let's stick with NSE. I'm downloading the 1-year data in csv format.

Step 2: Filtering the Data

Once you open the .csv file, you will see something like this

Figure 13 Import Data to Excel

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Date	series	OPEN	HIGH	LOW	PREV. CLO Itp	close	vwap	52W H	52W L	VOLUME	VALUE	No of trades					
2	14-Oct-20	EQ	2,278.90	2,304.00	2,268.50	2,280.70	2,283.00	2,287.50	2,284.78	2,369.35	875.65	12341487	28,197,589,496.85	281008				
3	13-Oct-20	EQ	2,230.60	2,285.75	2,225.85	2,237.05	2,279.00	2,280.70	2,259.76	2,369.35	875.65	10666280	24,103,209,104.25	255851				
4	12-Oct-20	EQ	2,235.00	2,255.75	2,226.25	2,233.45	2,236.00	2,237.05	2,239.55	2,369.35	875.65	6565525	14,703,804,367.10	146831				
5	09-Oct-20	EQ	2,235.00	2,253.00	2,217.10	2,239.25	2,239.00	2,233.45	2,232.05	2,369.35	875.65	8558747	19,103,582,648.40	215729				
6	08-Oct-20	EQ	2,259.00	2,268.00	2,222.10	2,257.50	2,241.50	2,239.25	2,242.24	2,369.35	875.65	9727508	21,811,437,285.25	251543				
7	07-Oct-20	EQ	2,235.00	2,309.00	2,220.00	2,210.35	2,259.40	2,257.50	2,276.27	2,369.35	875.65	24538620	55,856,495,761.45	542898				
8	06-Oct-20	EQ	2,225.25	2,233.90	2,201.65	2,212.20	2,213.00	2,210.35	2,213.64	2,369.35	875.65	8497352	18,810,040,908.25	230575				
9	05-Oct-20	EQ	2,244.00	2,249.15	2,206.00	2,225.25	2,215.00	2,212.20	2,222.94	2,369.35	875.65	8732890	19,412,649,755.80	237138				
10	01-Oct-20	EQ	2,263.80	2,263.80	2,214.00	2,234.35	2,229.05	2,225.25	2,237.62	2,369.35	875.65	9591467	21,462,014,627.70	237645				
11	30-Sep-20	EQ	2,260.00	2,267.00	2,225.00	2,245.05	2,231.00	2,234.35	2,251.01	2,369.35	875.65	11291280	25,416,740,703.85	232560				
12	29-Sep-20	EQ	2,225.00	2,264.00	2,216.25	2,216.25	2,241.90	2,245.05	2,242.30	2,369.35	875.65	11927459	26,744,967,680.50	269649				
13	28-Sep-20	EQ	2,227.00	2,238.00	2,207.05	2,201.70	2,218.00	2,216.25	2,221.39	2,369.35	875.65	9076787	20,163,062,603.55	213955				
14	25-Sep-20	EQ	2,189.00	2,212.80	2,167.30	2,181.20	2,198.85	2,201.70	2,191.17	2,369.35	875.65	13095950	28,695,471,561.35	329859				
15	24-Sep-20	EQ	2,207.90	2,226.00	2,176.05	2,230.80	2,195.00	2,181.20	2,200.65	2,369.35	875.65	13765321	30,292,605,688.25	328090				
16	23-Sep-20	EQ	2,260.00	2,276.75	2,205.30	2,211.15	2,228.00	2,230.80	2,242.58	2,369.35	875.65	19839809	44,492,265,342.30	384190				
17	22-Sep-20	EQ	2,277.00	2,277.00	2,201.55	2,255.85	2,220.05	2,211.15	2,225.36	2,369.35	875.65	16056621	35,731,708,478.55	348897				
18	21-Sep-20	EQ	2,300.00	2,336.00	2,247.35	2,305.70	2,250.00	2,255.85	2,291.38	2,369.35	875.65	15519433	35,560,977,455.15	347489				

Source : 13 Author's Compilation

Here we have many prices like Open, High, Low and Close which we call OHLC data, a general form of a candlestick. We also have previous Close price and volume, 52 weeks high and 52-week low along with number of trades. Now since we are interested in compiling Histogram for Returns data, we only need the Close price. So we create a new sheet in the same Excel and copy the data into the new sheet. I'll always suggest never modify the sheet containing original data. After filtering our sheet looks like this.

Figure 14 Data cleaning

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Date	close																
2	14-Oct-19	1,358.00																
3	15-Oct-19	1,364.15																
4	16-Oct-19	1,372.35																
5	17-Oct-19	1,396.50																
6	18-Oct-19	1,416.35																
7	22-Oct-19	1,414.15																
8	23-Oct-19	1,392.40																
9	24-Oct-19	1,436.45																
10	25-Oct-19	1,431.20																
11	27-Oct-19	1,434.25																
12	29-Oct-19	1,467.05																
13	30-Oct-19	1,479.10																
14	31-Oct-19	1,464.35																
15	01-Nov-19	1,456.90																
16	04-Nov-19	1,457.65																
17	05-Nov-19	1,447.30																
18	06-Nov-19	1,434.90																

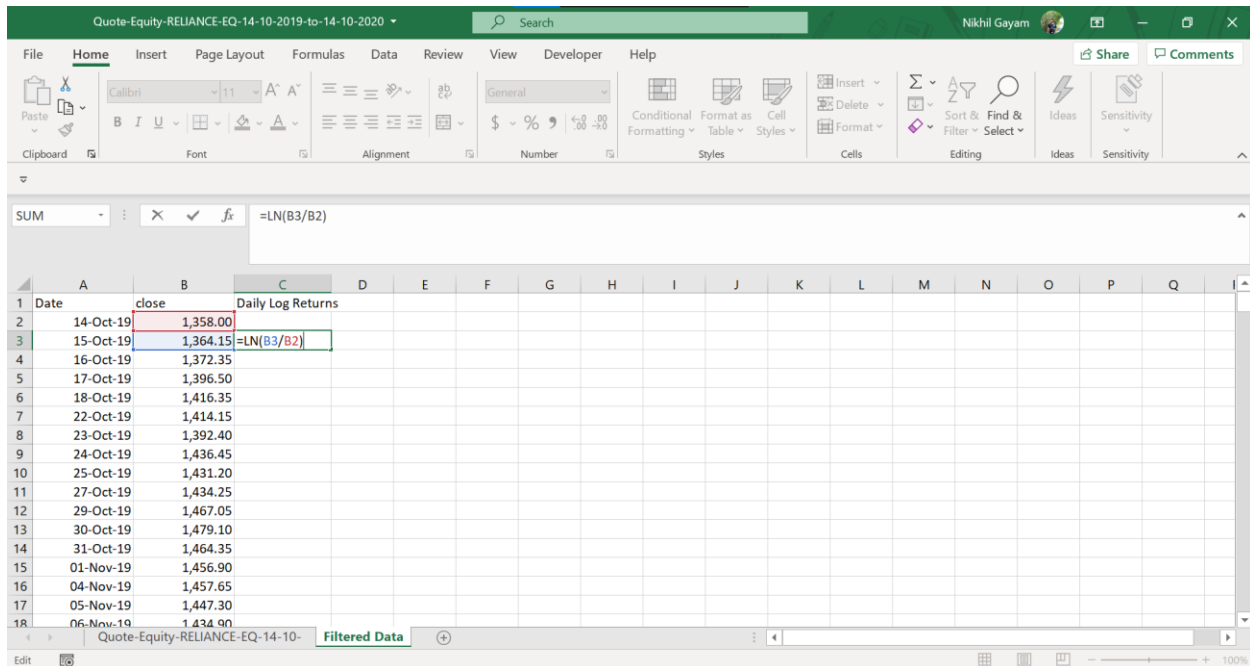
Source : 14 Author's compilation

Here I added a Date Column for my reference and sorted the data in chronological order.

Step 3: Computing the Returns

Since our data is filtered, it's time to find the returns using the closing prices. You can calculate simple returns as well as log returns, log-returns are preferred because they assume compounding. The formula for calculating log return in excel is $\text{LN}(\text{current close price} / \text{previous close price})$

Figure 15 stock log return



Source : 15 Author's Compilation

You can then copy the formula until the end of data by simply dragging the column down or copying paste the formula to all rows.

You can change this entire column format to percentage in Home Tab and also you can adjust the number of decimal places.

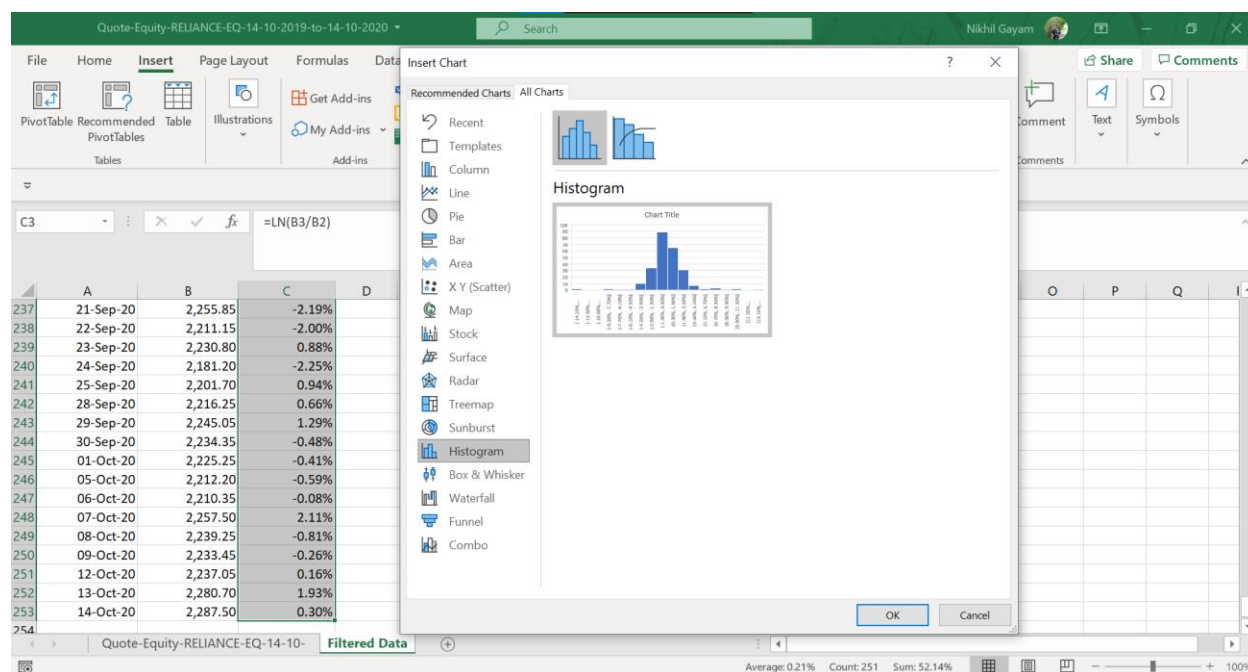
Step 4: Compiling Histogram

You can compile the histogram in two ways using Excel.

Method 1:

Select the entire Returns Data and go to Insert Tab and Select charts, you will be shown with a new tab, asking you to select the kind of chart you need. You will see histogram in those options select histogram

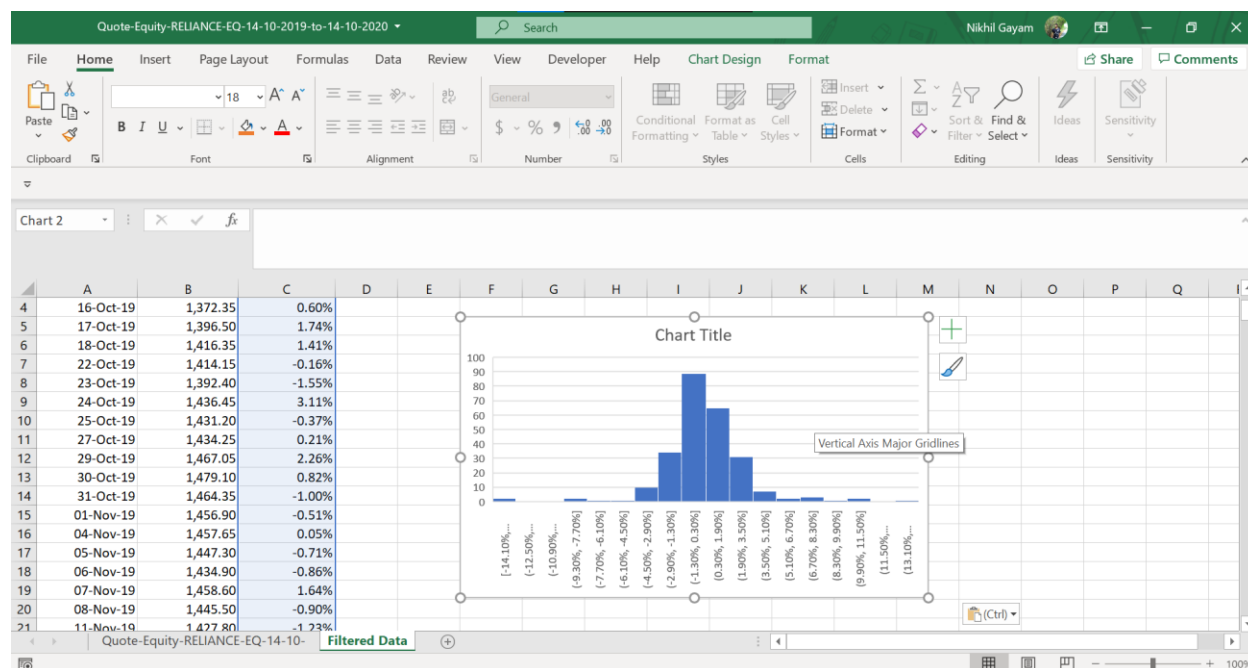
Figure 16 Method 1 Histogram



Source : 16 Author's Compilation

Once you select histogram, you will get two options select the first one as second is the cumulative distribution; we don't need that in this case. Once you click on OK, you will get an automatic histogram created by excel which looks like this

Figure 17 Histogram



Source : 17 Author's Compilation

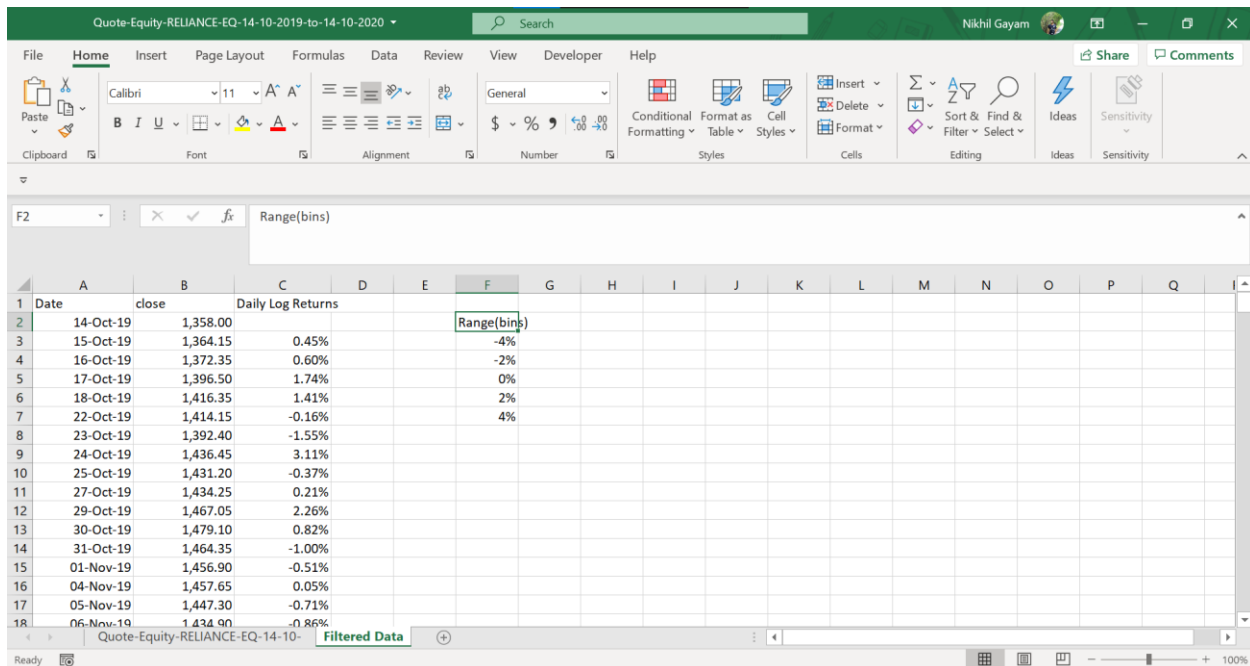
Here, the bins (returns range) is automatically adjusted by excel, you can edit those by double-clicking those bins, you will get a side tab named Format Axis where you can customize the bins according to your needs. You can also customize the color and labels of the chart.

In this way you can customize your histogram according to your needs.

Method 2:

For this method you need Data Analysis Tool pack in your excel which you can add from add-in option in excel. In this method, you can pre define your histogram range. For this Create your own range in excel. I created with 2 % range.

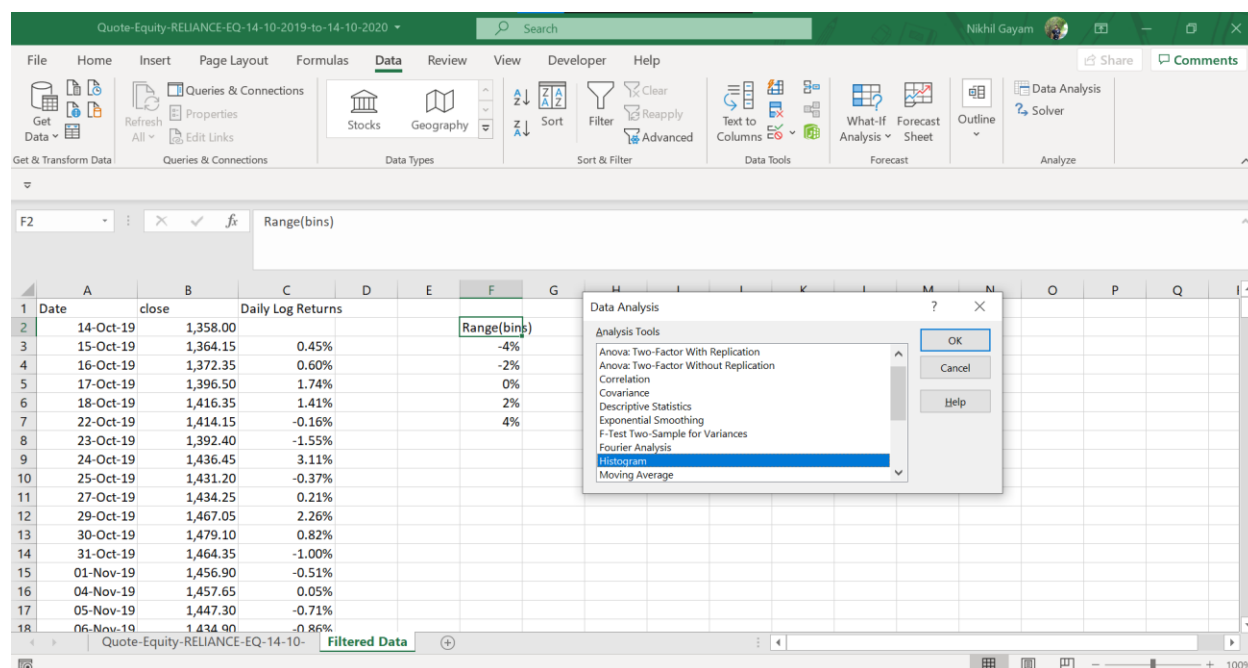
Figure 18 Method 2 Customized Histogram



Source : 18 Author's Compilation

Now select Data Tab in Ribbon and Select Data Analysis tool in that.

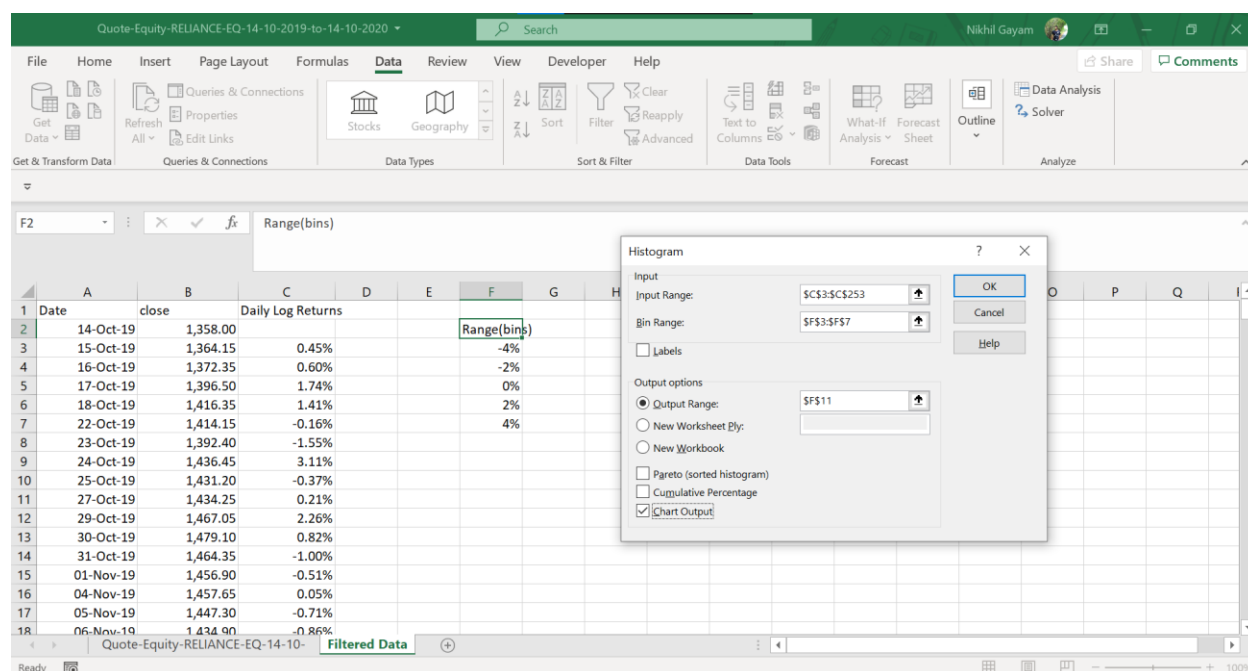
Figure 19 Range of Histogram



Source : 19 Author's Compilation

Once you select the histogram, you will be displayed a new tab asking you to provide details for your histogram.

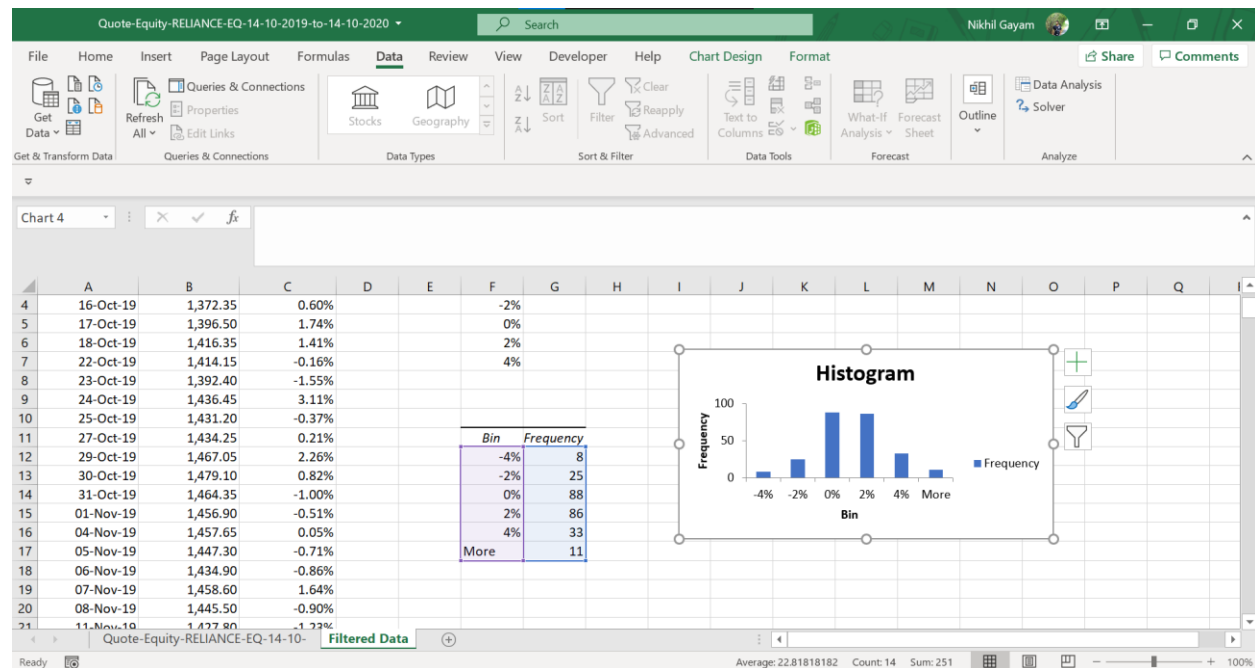
Figure 20 Excel Histogram Toolpak



Source: 20 Author's Compilation

In the input range, select the entire returns data by clicking and dragging the data till end, similarly give the bin range by selecting your customized ranges and in output options you can select a cell where you want to display the data. Don't forget to click on chart output. Once you are done with this click on OK. Once you do this you will get something like this

Figure 21 Customized Histogram



Source: 21 Author's Compilation

Here we got a table according to our bin range it says that there are 8 times where my daily returns are less than -4%, 25 times between the range of -4% to -2%, 88 times between -2% and 0 % etc. and in final 11 times monthly return is greater than 4% for Reliance Industries. You could also see that there is a histogram constructed by excel itself.

In this way you can compile your customized histogram for any security with any frequency, be it daily, weekly, monthly, quarterly or yearly. Method 1 consumes less time and needs little customization, while Method 2 takes a bit more time, but it gives according to your requirements.

Technical Analysis

17. How closely are technical analysis and statistics related?

Ans- Technical analysis is a methodology used by trader or investor to analyze or forecast prices' direction as per behavior of prices and volume of past market data.

Technical analysis is a trading discipline employed to evaluate investments and identify trading opportunities by analyzing **statistical** trends gathered from trading activity, such as price movement and volume. Statistical techniques allow traders to determine if a time series is stationary/non-stationary, independent/dependent, and/or random/non-random. Some famous technical with statistics as base are: SA (simple average), EMA (exponential moving average), MACD (moving average convergence and divergence), RSI (relative strength index), Bollinger bands, Standard deviation.

Technical analysis is a trading discipline applied by evaluating statistical patterns obtained from trading activity, such as price change and volume, to analyze investments and locate trading opportunities. Traders may decide whether a time series is stationary/non-stationary, independent/dependent, and/or random / non-random with statistical techniques. SA (simple average), EMA (exponential moving average), MACD (moving average convergence and diversion) are some popular techniques with statistics as a basis.

18. What are Bollinger bands? How to interpret them?

Bollinger Band is developed by John Bollinger by considering two parameters, standard deviation and moving averages. Bollinger band is a famous technical analysis tool that plot three trend lines, moving average and two standard deviations above and below the moving average of stock market price. The upper and lower bands of standard deviation typically consider as two standard deviations but can be customized as per the user preference.

Upper band=Middle band of simple moving average + 2 standard deviations from Middle band

Lower band = Middle band of simple moving average - 2 standard deviations from Middle band

Figure 22 Bollinger Band



Source : 22 www.chartink.com

Interpretation of Bollinger bands

The width of upper and lower bands of standard deviation is called squeeze. When squeeze length is low or contracting, it indicates low volatility and is considered by traders to be a potential sign for increased volatility and vice versa. As per normal distribution empirical rule, for normally distributed data, most distribution between two standard deviations so movement of stock price action occurs between two standard deviations. The breakout above and below the standard deviation band indicate the major event.

19. What is Simple moving average and Exponential moving average?

When it comes to EMA (exponential moving average) vs. SMA (simple moving average) and its **speed**. The EMA moves much faster and it changes its direction earlier than the SMA because exponential moving average gives more weightage to recent prices as compared to past prices. So when price changes direction, the EMA recognizes this sooner, while the SMA indicates slowly because of equal weight to every data point.

SMA, are generally the choice of the longer-term trader.

EMA, give more weighting to recent prices. They reduce the effect of the lag that comes from using previous price data and can help you identify a trend earlier, so it's a useful indicator for trading short-term

Figure 23 Moving Average



Source : 23 www.chartink.com

contracts.

20. What is an outlier? How does it impact the averages?

The outlier is a data point that differs significantly from other observations and it can be said that it lies outside the overall pattern of distribution. In simple terms it is something that is different from the crowd or data. Outliers can cause an adverse impact on statistical analysis.

An outlier in a data could drag the mean towards the outlier's side and could give the wrong interpretation of the entire data. For example, consider the following data

Ex. 25,27,28,29,32,33

$$25+27+28+29+32+33/6 = 29$$

Here the mean is 29

In the same example if we include an outlier which is completely different from data say 100

$$25+27+28+29+32+33+100/7 = 39.14$$

The mean changed drastically from 29 to 39.14, this is the effect of outlier.

21. Explain the methods to detect outliers from the data, and how to treat an outlier?

There are many methods to detect outliers, some of most widely used methods are:

1. **Box and Whisker:** It is a convenient way to capture the 5 number summary (Minimum Value, Lower Quartile, Median, Upper Quartile, Maximum Value). The points which are away from the box are treated as outliers.

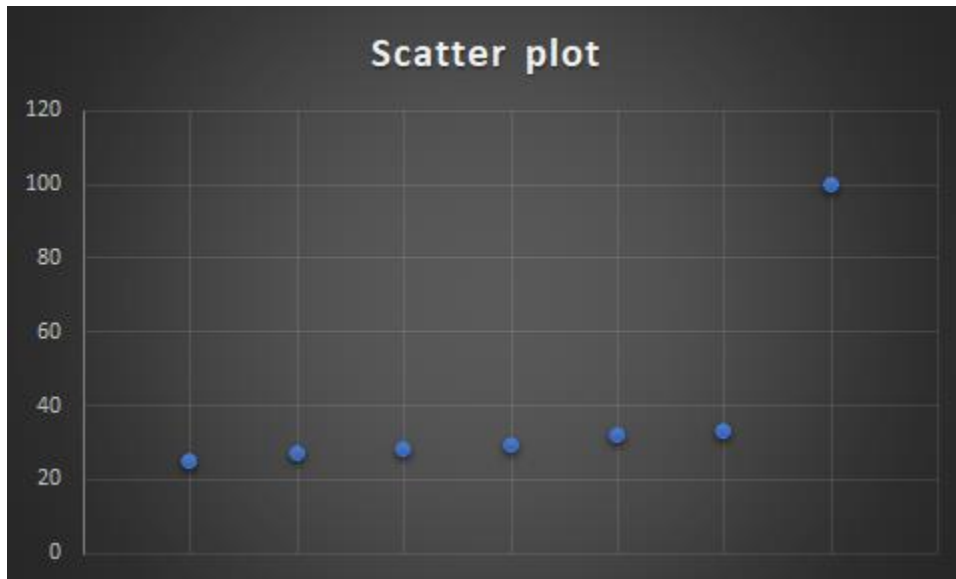
Figure 24 Box and Whisker plot



Source : 24 Author's compilation

2. **Scatter Plot:** Scatter plot gives the visual representation of data points using Cartesian coordinates. By simply looking at the plot we can see that the point 100 is different from others

Figure 25 Scatter Plot



Source : 25 Author's Compilation

- 3. Using Z score:** As we have already seen how to calculate the z score of a data, once we calculate the z scores of observations the one which are above and below the 3 Standard Deviations (in this case with a z-score > +3 or Z score < -3) are treated as outliers.

Once we detect the outliers, we remove them or replace them with random numbers similar to the other data such as mode or median. Removing the outlier can cause the decrease in size of data. So replacing the outlier is more preferred. This method is called Winsorization.

22. If the standard deviation of two variables are in different units or magnitude, then how to compare the standard deviation?

If the standard deviation of two variables are in different units or magnitudes, in order to compare them we convert them into standard form. This is where the concept of Standard Normal Distribution and Z scores comes into play. By converting the observations into standard form we transform the entire distribution to Standard Normal Distribution. In a normal Standard Distribution, the mean value is 0 and Standard Deviation is 1. These Z values have no units, so it is easy to compare them. We do this by using the following formula:

$$z = \frac{x - \mu}{\sigma}$$

μ = Mean

σ = Standard Deviation

So we convert each observation and write in terms of Z. Let's take two observations x_1 and y_1 from different samples with different units or different magnitude and convert them into z values. If we get the z value of x_1 as say 1.3 and z value of y_1 is 1.5 we say that y_1 is more deviated from the mean in the second sample than x_1 from its mean in 1st sample. In the same way now we can compare standard deviations of any variables of any units or magnitudes.

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23. For calculation of average NAV in case of SIP investment of mutual fund which type of average is useful, geometric mean, arithmetic mean or harmonic mean?

- Net Asset Value (NAV) is the price we pay for each unit of a scheme. Since we pay the same SIP every month (like Rs 5000) and the unit prices constantly change we get different numbers of units each month at different prices. So here we can't use simple arithmetic mean or geometric mean. In this case we use a different kind of mean called Harmonic Mean.

Harmonic Mean is the reciprocal of the arithmetic mean of reciprocals of given observations. For example the given observations are 2 and 4, then harmonic mean is calculated by $2 / (\frac{1}{2} + \frac{1}{4})$ which is 2.67

Consider the following mutual fund monthly prices, as you can see that the prices are changing constantly each month, so if you make Rs 1000 SIP each month you would get a different number of units. So what does your average NAV cost?

Figure 26 Harmonic mean in Excel

C27 =HARMEAN(C20:C26)						
	A	B	C	D	E	F
15						
16						
17						
18						
19		Date	Price	Number of units for Rs 1000		
20		01-Jan-20	25.7391	38.85		
21		03-Feb-20	24.9272	40.12		
22		02-Mar-20	24.6526	40.56		
23		01-Apr-20	21.199	47.17		
24		04-May-20	22.6093	44.23		
25		01-Jun-20	23.6825	42.23		
26		01-Jul-20	25.2692	39.57		
27		HARMONIC MEAN	23.91260388			
28						
29						

Source: 26 Author's Compilation

As we have discussed, we use Harmonic Mean to calculate the average NAV, in excel this can be computed with a simple formula HARMEAN (). As you can see in the above figure, HARMEAN is used for the cells containing NAV prices (look in the formula bar). Here the average NAV cost was Rs 23.91

Risk Adjusted Return Ratio

24. What is Sharpe Ratio?

- Sharpe Ratio tells us about the mean return of the portfolio and then compares it with the return of a risk-free asset (a return for virtually zero standard deviation). With a risk-free asset, an investor can choose a risky portfolio and compare it with the risk-free return (to see how better his/her portfolio has performed compared to the risk-free asset). To calculate the risk, we take the standard deviation of the returns because it is commonly used to measure investment risk. We generally consider the risk-free rate to be the 10-year G-Sec rate (available in the RBI website). Sharpe Ratio is generally used to compare the performance of fund managers.

Sharpe ratio formula: The Sharpe ratio for a portfolio p, based on historical returns is defined as

$$Sh = (R_p - R_f) / SD$$

Where, R_p = mean return of portfolio, R_f = Risk-free rate of return, SD = standard deviation of return on the portfolio and Sh = Sharpe ratio. The numerator of the Sharpe ratio is the portfolio's mean return minus the mean return on the risk-free asset over the sample period. The $R_p - R_f$ term measures the extra reward the investors receive for the added risk taken. We call this difference the mean excess return on portfolio p .

Thus the Sharpe ratio calculates a reward, in terms of average excess return to per unit of risk.

Risk averse investors prefer a larger Sharpe ratio to those with smaller Sharpe ratios, as it means greater return per unit of risk.

Let us take an example. Suppose, you have two mutual fund schemes A & B. You want to compare the performance of the fund managers of both the schemes. Scheme A gives a return of 11% pa and has a standard deviation (SD) of 8. Scheme B gives a return of 9% pa with a SD of 4. Which scheme is better?

To find out, we need to calculate the Sharpe ratio of both the schemes.

Table 1 Sharpe ratio

	SCHEME A	SCHEME B
Rate of Return	11%	9%
Risk- free rate of return	5.77%	5.77%
Standard Deviation	8%	4%
Sharpe Ratio	$(11 - 5.77) / 8 = \mathbf{0.65}$	$(9 - 5.77) / 4 = \mathbf{0.81}$

Source : 27 Author's Compilation

We see in the above example that the Sharpe Ratio of Scheme A is higher. We can say Scheme A generates a return of 0.65% above the risk-free return per unit of risk and scheme B generates a return of 0.81% above the risk-free return per unit of risk. Hence, an investor should choose Scheme A instead of Scheme B.

25. Why should interpretation of negative Sharpe Ratio be dealt with extra caution?

- When we deal with negative Sharpe Ratios, we have to deal with extra caution. With positive Sharpe ratios, a portfolio's Sharpe ratio decreases if we increase risk (as the denominator increases). However, with negative Sharpe ratios, increasing risk (SD) results in a numerically larger Sharpe ratio. The Sharpe Ratio increases if we increase the SD (in case of negative Sharpe Ratio). Therefore, in comparing portfolios with negative Sharpe

ratios, we cannot generally interpret the larger Sharpe ratio (the one closer to zero) to mean better risk-adjusted performance. Sometimes, fund managers include riskier assets in their portfolios to increase the Sharpe ratio and make their performance look better (although it is not). This is the reason why negative Sharpe ratios should be dealt with extra caution. Let us understand this with the help of an example.

Suppose, you have a mutual fund scheme. You want to check the performance of the fund manager of the scheme. The scheme gives a return of 5% pa and has a standard deviation(SD) of 8.

Table 2 Sharpe Ratio

Rate of Return	5%
Risk- free rate of return	5.77%
Standard Deviation	8%
Sharpe Ratio	$(5-5.77)/8 = -0.09$

Source: 28 Author's Compilation

Now, in the same scheme, suppose the fund manager has introduced riskier assets in the portfolio.

Table 3 Sharpe Ratio

Rate of Return	5%
Risk- free rate of return	5.77%
Standard Deviation	12%
Sharpe Ratio	$(5-5.77)/12 = -0.06$

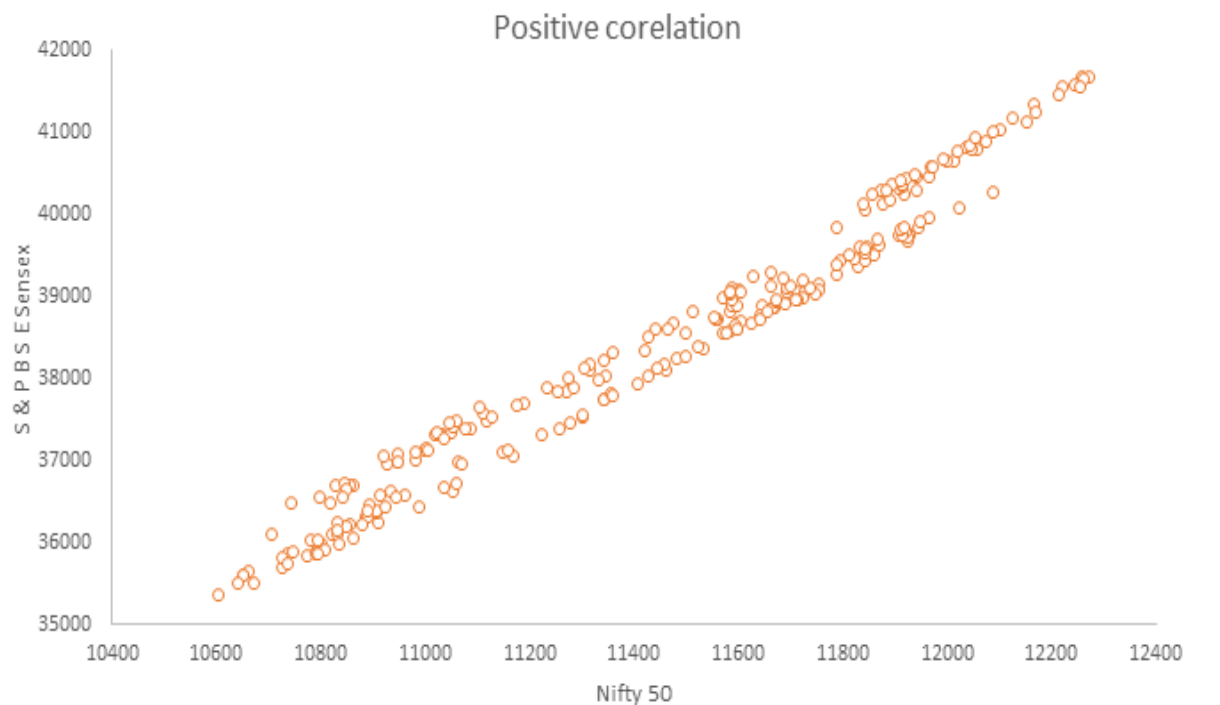
Source : 29 Author's Compilation

You can see in the above example how the Sharpe ratio has increased (From -0.09 to -0.06) just by including some risky assets. This is how fund managers can manipulate the Sharpe ratio. So, we need to remain cautious while interpreting negative Sharpe ratios.

26. What are scatter plots? How can we determine the correlation using scatter plots?

Scatter Plots: Scatter plot is a graphical representation of the relationship between two variables. In other words, Scatter plot is a graph which shows the relationship between two sets of data. Scatter plots use Cartesian coordinates to represent the data. The data is represented as a collection of points but the points are not connected. The position of a point depends on the variables in X-axis and Y-axis. It can be used as a means to know the linear relationship and the slope between the two data sets. Scatter plots are useful to find the correlation between sets of data. Let's see some examples to understand some relationships between two sets of data:

Source 30 Author's Compilation



As the plot starts from the bottom left corner to the top right corner, this means there is a positive correlation between Nifty 50 and S&P BSE Sensex.

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Relationship of variables

27. What is correlation analysis?

- Scatter plot represents the relationship between two data sets graphically. Correlation coefficient conveys the same relationship in a single numerical value. Correlation coefficient measures the direction and the strength of linear relationship between the two data sets.

Correlation coefficient can have a minimum value of -1 and maximum value of +1 ($-1 < r < +1$).

Let's say the correlation between two stocks is +1 then it means historically the stocks have always moved in the same direction.

Generally, a good way to diversify a portfolio is to fill it with securities that have low correlations between all the pairs of stocks.

To calculate correlation, we need another measure of linear relationship which is covariance and individual standard deviations of the variables. We can calculate correlation coefficient by:

$$r = \frac{Cov(x, y)}{\sigma_x \sigma_y}$$

28. What are the limitations of correlation coefficient?

Correlation coefficient measures the linear relationship between two variables. But it may not always be a good measure of a relationship. There are some limitations of correlation coefficient:

-

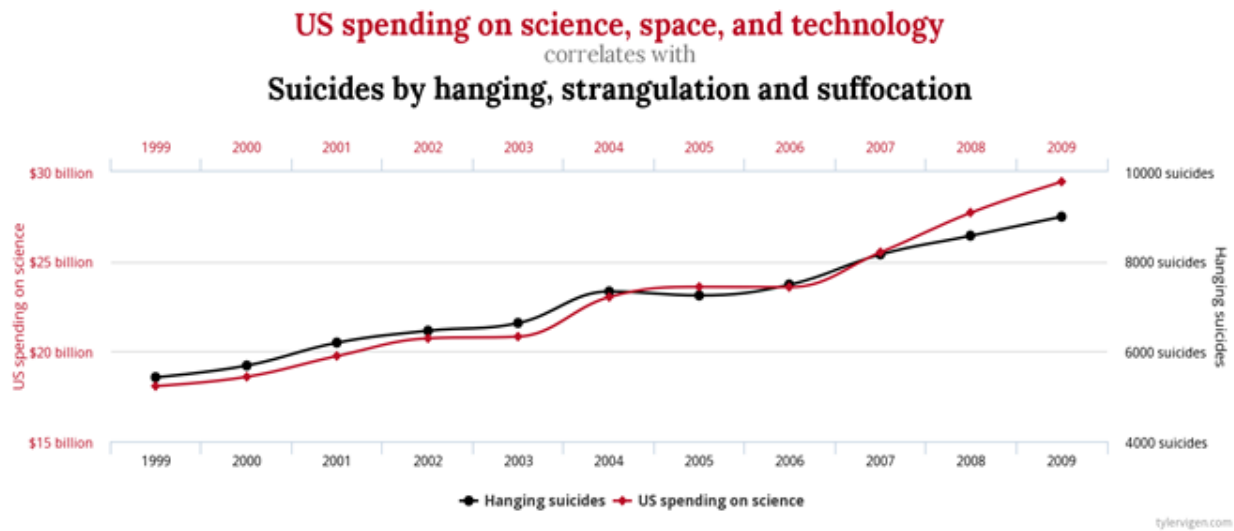
I. The first limitation is that the correlation coefficient only measures a linear relationship between the two variables. The variables may not have a strong linear relationship, but can have a strong nonlinear relationship between them.

For example, $y = (x^2 + 5)$ has a strong nonlinear relationship between variables X and Y.

II. Correlation is an unreliable measure when extreme values or outliers are present in one or both the sets of data.

III. Sometimes, it may be so that there is some correlation between two variables but it may be so by chance, there might be another situation where there can be no logical relationship between the two variables but the correlation coefficient shows there is high correlation. This type of correlation is called spurious correlation. It wrongly implies a cause and effect relationship between two data sets. For Example

Figure 27 Spurious Correlation



Source: 31 www.tylervigen.com

29. How to calculate correlation using excel?

- Let's see how to find the correlation coefficient using excel for ICICI Bank and Nifty Bank Index. Let's see how to do this in excel we the function = correl(array1,array2)

Figure 28 Correlation of ICICI Bank and Nifty Return

ICICI Bank			NIFTY Bank				
Date	Closing price		Date	Closing Price			
20-Jul-15	315.8		20-Jul-15	19032.7			
21-Jul-15	311.45		21-Jul-15	18723.4			
22-Jul-15	316.8		22-Jul-15	18997	Correlation coefficient	To find correlation use	
23-Jul-15	312.9		23-Jul-15	18865	0.781877174	=CORREL(B3:B62,D3:D62)	
24-Jul-15	300.6		24-Jul-15	18635.85			
27-Jul-15	291.1		27-Jul-15	18213.05	Number of observation		60
28-Jul-15	285		28-Jul-15	18282.8			
29-Jul-15	289.25		29-Jul-15	18323.4			
30-Jul-15	291		30-Jul-15	18440.4			
31-Jul-15	302.4		31-Jul-15	18729.85			
01-Aug-16	249.5		01-Aug-16	18740.6			
02-Aug-16	245.3		02-Aug-16	18708.25			
03-Aug-16	242.1		03-Aug-16	18602			
04-Aug-16	240.35		04-Aug-16	18571.7			
05-Aug-16	245.95		05-Aug-16	18925.95			
08-Aug-16	245.25		08-Aug-16	18939.45			
09-Aug-16	245.35		09-Aug-16	18933.3			
10-Aug-16	239.35		10-Aug-16	18647.8			
11-Aug-16	242.7		11-Aug-16	18640.4			
12-Aug-16	245.95		12-Aug-16	18963.7			
05-May-17	298.55		05-May-17	22604.95			
08-May-17	302.95		08-May-17	22767.35			
09-May-17	300.6		09-May-17	22707.3			
10-May-17	298.65		10-May-17	22830.35			
11-May-17	300.2		11-May-17	22818.45			
12-May-17	296.55		12-May-17	22671.7			
15-May-17	301.8		15-May-17	22821.5			
16-May-17	302.65		16-May-17	22928.6			
17-May-17	309.75		17-May-17	22935.95			
18-May-17	307.95		18-May-17	22698.6			
29-Nov-18	362.2		29-Nov-18	26939.6			
30-Nov-18	355.15		30-Nov-18	26862.95			
03-Dec-18	355.5		03-Dec-18	26857.55			
04-Dec-18	357.95		04-Dec-18	26693.8			
05-Dec-18	351.4		05-Dec-18	26519.6			
06-Dec-18	347.65		06-Dec-18	26198.3			
07-Dec-18	352.2		07-Dec-18	26594.3			
10-Dec-18	346.35		10-Dec-18	26102.65			
11-Dec-18	342.8		11-Dec-18	26163.4			
12-Dec-18	349.95		12-Dec-18	26643.85			
23-Aug-19	395.4		23-Aug-19	26958.65			
26-Aug-19	411.65		26-Aug-19	27951.35			
27-Aug-19	418.6		27-Aug-19	28126.15			
28-Aug-19	412.95		28-Aug-19	27804.3			
29-Aug-19	404.4		29-Aug-19	27305.2			
30-Aug-19	409.65		30-Aug-19	27427.85			
03-Sep-19	392.15		03-Sep-19	26824.15			
04-Sep-19	397.5		04-Sep-19	27123.85			
05-Sep-19	389		05-Sep-19	26919.7			
06-Sep-19	391.35		06-Sep-19	27247.9			
07-Apr-20	326.1		07-Apr-20	19062.5			
08-Apr-20	318.95		08-Apr-20	18946.45			
09-Apr-20	342.7		09-Apr-20	19913.6			
13-Apr-20	330.65		13-Apr-20	19488			
15-Apr-20	327.35		15-Apr-20	19057.05			
16-Apr-20	342		16-Apr-20	19400			
17-Apr-20	375.55		17-Apr-20	20681.45			
20-Apr-20	361.3		20-Apr-20	20522.65			
21-Apr-20	331.85		21-Apr-20	19409.35			
22-Apr-20	335.95		22-Apr-20	19701.85			

Source : 32 Author's Compilation

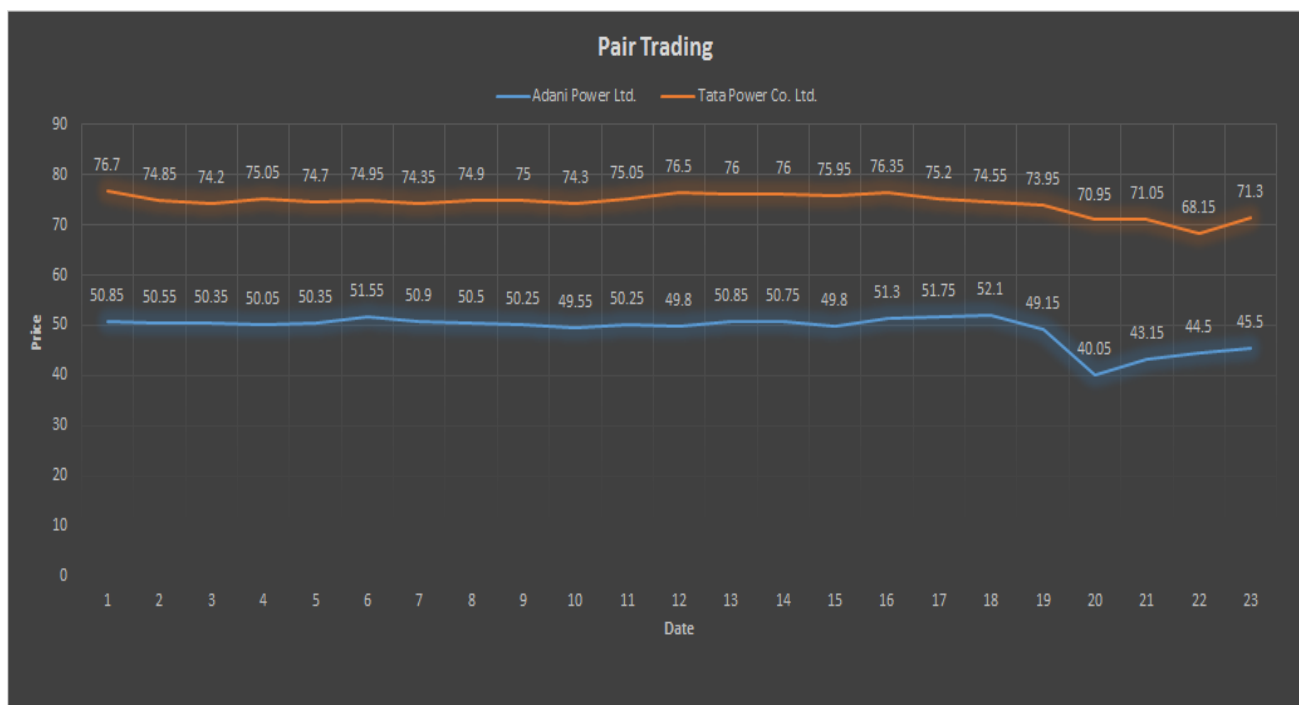
30. How can we use correlation coefficient in Securities markets?

- NISM being an Institute which has an objective of raising the awareness about the securities markets in India, how can we not discuss the use of Correlation in Securities markets. Correlation is a widely used tool in the securities markets.

Here we will discuss a trading strategy which uses correlation, it is known as Pair Trading.

In pair trading we find stocks which have a high positive correlation and the company's business model and the business structure is similar. In such a situation the stock's price movement should also be similar. But sometimes there are situations when one stock goes out of track. This leads to a trading opportunity. Let's look at an example to understand.

Figure 29 Correlation and Pair Trading



Source: 33 Author's Compilation

Here the prices are for January 2019 But the dates are not exact.

In the above example we'll be discussing Adani Power and TATA power during the month of January 2019. The correlation coefficient was 0.83 (January 2019- January 2020), i.e. high positive correlation.

In pair trading the concept is a simple one, with respect to the trend we short or buy the stock which deviates from its normal track and take the opposite position in the other stock. In the above pairs on 22th Jan closing price of Adani power's was Rs 44.5 and Tata power's was Rs 68.15.

We can see that Tata power is out of track, with respect to the trend we are going to buy Tata power and sell Adani power. We bought 100 shares of Tata and short 100 shares of Adani. For simplicity, we assume the trades take place at closing prices. We make a net profit of Rs 1800 $[100\{71.30-68.15\} - (44.5-43.15)]$ from the trade.

You might be wondering since we know that Tata is out of a track, let's just take a position in that, but what if we are wrong and trade is not in our favor we are going to lose money, but if we take the opposite trade in Adani we will minimize our losses.

This is one of the uses of correlation in trading.

Evaluation of Investment Risk

31. What is Standard Deviation of stock return?

The standard deviation measures the volatility of stock return. It is the square root of the sum squared of deviation from mean return. It helps to understand how asset price return spread from their average return.

Standard deviation is one of the important concepts to understand the investment risk.

Following formula is used to calculate the standard deviation,

$$\text{Standard deviation of population} = \sqrt{\frac{(x_i - \underline{x})^2}{n}}$$

Where, x_i = securities return for given time i ,

\underline{x} = mean return

n = number of observation of population

32. What is Downside Standard Deviation? How is it computed?

Downside Deviation is similar to standard deviation except that we only find the deviations of values which are either negative or below a minimum threshold return. This can be either risk free rate or can be specific to the investor. Major drawback of Standard deviation is it averages both positive and negative returns. But in the field of investing, investors are always happy with extreme positive returns. So Downside deviation overcomes this drawback by only considering the returns which are below minimum acceptable return. This is used in calculating Sortino Ratio.

Let's see how Deviation is calculated in excel, I have downloaded 1-year Reliance Data from NSE website and calculated the daily returns using $\text{LN}(P1/P0)$. In this case I took the minimum

