Algorithmic Trading
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Contents

Chapter 1

Fundamentals of Stock Markets

1.1 Types of Assets (Asset Classes)

Definition 1.1.1: Asset Class

An asset class is a category of investment with particular risk and return characteristics. The following are some of the popular asset classes:

- Fixed income instruments
- Equity
- Real estate
- Commodities (e.g. precious metals)

1.1.1 Fixed Income Instruments

These carry very limited risk to the principle and the return is paid as an interest based on the particular fixed income instrument.
Interest paid could be at quarterly, semi-annual or annual intervals. The capital is returned to the investor at the end of the term of the deposit.
Typical fixed income investments include:

- Fixed deposits
- Bonds issued by the government and its agencies
- Bonds issued by corporates

1.1.2 Equity

Investment in equities involve buying shares of publicly listed companies.
The shares are traded both on the Bombay Stock Exchange (BSE) and the National Stock Exchange (NSE).
Unlike fixed income securities, these offer no guarantee against the capital. However, as a trade off, these investments can yield very attractive returns. Indian equities have generated returns close to 14%-15% CAGR (compound annual growth rate).

1.1.3 Real Estate

Real estate investment involves transacting commercial and non-commercial land (e.g. sites, apartments, commercial buildings, etc.).

> **Note 1.1** There is no official metric to measure the returns generated by real estate.

1.1.4 Commodity

Investments in precious metals such as gold and silver is considered one of the most popular investment avenues. Gold and silver over a long-term period have yielded a CAGR return of approximately 8% over the last 20 years.

1.2 Financial Intermediaries

1.2.1 The Regulator

In India, the stock market is regulated by the **The Securities and Exchange Board of India** also referred to as **SEBI**. The main objective of SEBI is to promote the development of stock exchanges, protect the interests of retail investors, regulate the activates of market participants and financial intermediaries.

1.2.2 The Stock Broker

Definition 1.2.1: Stock Broker

A stock broker is a private entity, registers as a trading member with the stock exchange and a stock broking license. They are a gateway to the stock exchanges. An individual must go through a stock broker to buy/sell stocks.

An individual who wishes to trade in the stock market must open a "Trading Account" with a broker through which they can then trade at the stock exchanges.

1.2.3 Depository and Depository Participants

Earlier, when you bought stocks, the only way to identify that you owned the stock was a piece of paper called the share certificate. Hence it became extremely important to store the property papers in a safe and secure place.
Seeing the obvious problem of storing the certificates, after 1996, the share certificates were converted to a digital format.

Definition 1.2.2: Dematerialization

The process of converting paper format share certificates to digital format is called dematerialization and is often abbreviated as **DEMAT**

The share certificate, though in digital form, still needs to be stored securely. This is done through DEMAT accounts.

Definition 1.2.3: Depository

A depository is a financial intermediary which offers the service of a DEMAT account.

DEMAT accounts act as a digital vault for your shares.

1.2.4 Banks

Banks help in facilitating the fund transfer from your bank account to your trading account.

1.2.5 Clearing Corporations

National Security Clearing Corporation Ltd (NSCCL) and Indian Clearing Corporation Ltd (ICCL) are wholly owned subsidiaries of NSE and BSE respectively.
The job of the clearing corporation is to ensure guaranteed settlement of your trades/transactions.
The typical roles of the clearing corporation is to ensure the following:

- Identify the buyer and seller and match the debit and credit process
- Ensure no defaults - The clearing corporation also ensures there are no defaults by either party.

1.3 Calculating Returns

1.3.1 Absolute Return

This is the return that your investment has generated in absolute terms.

$$\left(\frac{\text{Ending Period Value}}{\text{Starting Period Value}} - 1\right) \times 100$$

Example 1.3.1 (Calculating absolute return)

Let's say that you bought a stock at 3030 and sold it at 3550. What absolute return did you generate?

$$\begin{aligned}\text{absolute return} &= \left(\frac{3550}{3030} - 1\right) \times 100 \\ &= 0.1716 \times 100 \\ &= 17.16\%\end{aligned}$$

1.3.2 Compound Annual Growth Rate (CAGR)

The formula to calculate CAGR is:

$$\text{CAGR} = \left(\frac{\text{Ending Value}}{\text{Beginning Value}}\right)^{\left(\frac{1}{\text{No. of years}}\right)} - 1$$

Example 1.3.2 (Calculating CAGR)

Let's say that you bought a stock at 3030 and sold it at 3550. What CAGR did you generate?

$$\begin{aligned}\text{CAGR} &= \left(\frac{3550}{3030}\right)^{\frac{1}{2}} - 1 \\ &= 9.2 - 1 \\ &= 8.2\%\end{aligned}$$

1.4 Index

There are two main market indices in India. The **S&P Sensex** representing the BSE and **CNX Nifty** representing the NSE.

1.4.1 Practical Uses of the Index

- **Information**: The index reflects the general market trend for a period of time.
- **Benchmarking**: The index can be used to judge whether the returns you got over a period of time by comparing the returns to the increase in the index.
- **Trading**: Majority of the traders in the market trade the index.
- **Portfolio Hedging**: Investors usually build their own portfolio which typically contains 10-12 stocks which they would have bought from a long term perspective. If they can foresee a prolonged adverse movement in the market (such as in 2008) which could potentially erode the capital in the portfolio, the investors can use the index to hedge the portfolio.

1.4.2 Index Construction Methodology

Every stock in the index is assigned a certain weightage. There are many ways to calculate these weights but the Indian stock exchange follows a method called **free float market capitalization**. In the method, the larger the market capitalization of the company, higher its weight.

$$\text{Free float market capitalization} = \text{total number of shares outstanding in the market} \times \text{price of the stock}$$

1.4.3 Sector Specific Indices

While the Sensex and Nifty represent the broader markets, there are certain indices that represent specific sectors. These are called **sectoral indices**. For example, Bank Nifty on NSE represents mood specific to the banking industry.

1.5 Clearing & Settlement Process

1.5.1 What happens when you buy a stock?

Day 1 - The trade (T Day)

The day one makes a trade is referred to as the trade date (represented as 'T Day').
By the end of the day, your broker will debit the amount required for the trade and other applicable charges towards the purchase.
An important point to note is that the money is debited from your account but the stock does not come into your DEMAT account yet.
The same day, the broker generates a 'contract note'. A contract note typically shows the break up of all transactions done during the day along with the trade reference number as well as the charges charged by the broker.

Day 2 - Trade Day + 1 (T+ Day)

One can sell the stock that they bought on the trade day on this day.

> **Important 1.1** This does involve a slight risk since you do not own the stock that you bought the previous day yet i.e. that stock hasn't been deposited into your DEMAT account.

From the point of view of the user, nothing happens on this day. However, in the background the money required to purchase the shares is collected by the exchange along with other charges.

Day 3 - Trade Day + 2 (T+2 Day)

On this day, around 11 AM, the shares are debited from the person who sold the shares and credited to the brokerage with whom the person is trading, who will in turn credit it to your DEMAT account by end of day. Similarly, money which was debited from your account is credited to the person who sold the shares.

1.5.2 What happens when you sell a stock?

Similar to the process which takes play when you buy a stock, the day when you sold the stock is called the 'trade day'. The moment you sell the stock, the stock gets blocked in your DEMAT account. On the T+1 day, the blocked shares are given to the exchange. On T+2 day, you would receive the funds from the sale which will be credited to your trading account.

1.6 Orders in the Market

1.6.1 Types of Orders

- **Market Order**: A market order is *buying or selling a stock at the best price available.* Generally, this type of order will be *executed immediately.* However, the price at which the market order will be executed is not guaranteed. The *last traded price* (LTP) need not be the price at which the order is executed.
- **Limit Order**: A limit order is an *order to buy or sell a stock at a specific price or better.* A limit order is not guaranteed to be executed. But they do help ensure the investor does not pay more than a predetermined price for a stock.
- **Stop-Loss Order**: A stop order, also referred to as stop-loss order, is an *order to buy or sell a stock once the price reaches a specified price*, also known as the stop price. When the stop price is reached, a stop order becomes a market order. A buy-stop order is entered at a stop price which is above the current market price. Investors generally use a buy-stop order to limit a loss or to protect a profit on a stock that they have sold short. A sell-stop order is entered at a stop price below the current market price. Investors generally use a sell-stop order to limit a loss or to protect a profit on a stock that they own.
- **Stop-Limit Order**: A stop-limit order is an *order to buy or sell a stock that combines the features of a stop order and a limit order.* Once the stop price is reached, a stop-limit order becomes a limit order that will be executed at specified price or better. The benefit of a stop-limit order is that the investor can control the price at which the order can be executed.
- **Take Profit Order**: A take-profit order (sometimes called a profit target) is *intended to close out the trade at a profit once it has reached a certain level.* Execution of a take-profit order closes the position. This type of order is always connected to an open position of a pending order.

1.6.2 Slippage

Definition 1.6.1: Slippage

Slippage refers to the difference between the expected price of a trade and the price at which the trade is executed.

Slippage can occur at any time but is most prevalent during periods of higher volatility when market orders are used. It can also occur when a large order is executed but there isn't enough volume at the chosen price to maintain the current bid/ask spread.
An $x\%$ of slippage means the order was executed $x\%$ below or above the expected price.
Disadvantages of high slippage include:

- Increased trading costs
- Reduced profitability
- Inaccurate risk management
- Difficulty in entering and exiting positions

1.6.3 Risk-Reward Ratio

This ratio is used to assess the potential profitability and risk of a trade or investment opportunity. It is a way to evaluate the relationship between the potential reward of a trade and the amount of risk taken.

The risk-reward ratio is calculated by dividing the potential reward (or profit) of a trade by the potential risk (or loss). The resulting ratio provides an indication of how much profit is expected for each unit of risk assumed.

Chapter 2

Fundamental Analysis

2.1 Overview

Fundamental Analysis (FA) is a holistic approach to study a business. When an investor wishes to invest in a business for the long term(say 3 - 5 years) it becomes extremely essential to understand the business from various perspectives. It is essential for the investor to separate the daily short term noise in the stock prices and concentrate on the underlying business performance. Over the long term, the stock prices of a fundamentally string companies tend to appreciate.

2.2 Investible Grade Attributes

An investible grade company has a few distinguishable characteristics. These characteristics can be classified user two heads namely the 'Qualitative aspect' and the 'Quantitative aspects'.

2.2.1 Qualitative Aspects

These mainly involve understanding the non-numeric aspects of the business. It includes many factors such as:

- Management's background
- Business ethics - is the managements involved in scams, bribery, unfair business practices, etc.
- Corporate governance - appointments of directors, organization structure, transparency, etc.
- Minority shareholders - how does the management treat its minority shareholders, do they consider their interests while taking corporate actions
- Related party transactions - Is the company tendering financial favors to known entities such as promoter's relatives, friends, vendors, etc. at the cost of the shareholders funds?
- Salaries paid to promoters - Is the management paying themselves a hefty salary, usually a percentage of profits
- Operator activity in stocks - Does the stock price display unusual price behavior especially at the time when the promoter is transacting in the shares.
- Shareholders - Who are the significant shareholders in the firm
- Political affiliation
- Promoter lifestyle - Are the promoters too flamboyant and loud about their lifestyle?

2.2.2 Quantitative Aspects

These are matters related to financial numbers. These include many things, to name a few:

- Profitability and its growth
- Margins and its growth
- Earnings and its growth
- Matters related to expenses
- Operating efficiency
- Pricing power
- Matters related to taxes
- Dividends payout
- Cash flow from various activities
- Debt – both short term and long term
- Working capital management
- Asset growth
- Investments
- Financial Ratios

Note 2.1 The list is actually endless. In fact, each sector has many different metrics which are relevant to that sector only.

For example, in the retail industry, the following metrics are used:

- Total number of stores
- Average sales per store
- Total sales per square foot
- Merchandise margins
- Owned store to franchisee ratio

2.3 Annual Report

The annual report (AR) is a yearly publication by the company and is sent to the shareholders and other interested parties. The annual report is published by the end of the Financial Year, and all the data made available in the annual report is dated to 31st March.

Important 2.1 No two annual reports are the same; they are all made to suite the company's requirement keeping in perspective the industry they operate in. However, some sections are common across all annual reports.

The annual report also contains three important financial statements namely:

- Profit and Loss Statement
- Balance Sheet
- Cash Flow Statement

2.4 The Profit and Loss Statement

2.4.1 Overview

The Profit and Loss statement is also popularly referred to as the P&L statement, Income Statement, Statement of Operations, and Statement of Earnings.
The P&L statement reports information on:

- The revenue of the company for the given period (yearly or quarterly)
- The expenses incurred to generate the revenues
- The tax and depreciation
- The earnings per share number

2.4.2 Some Jargon Used in these Statements

- **Top Line**: The top line of the company is the revenue generated by the company.
- **Net Sales**: The revenue adjusted after the excise duty is the net sales of the company.
- **Total Operating Revenue**: Revenue from sales of products + sale if services + other operating revenues sums up to give the total operating revenue of the company.
- **Bottom Line**:
- **Tangible asset**: This asset is one which has a physical form and provides an economic value to the company.
- **Intangible asset**: This asset is one which does not have any physical form but still provides an economic value to the company such as brand value, trademarks, etc.
- **Deprecation and Amortization**: An asset (tangible or intangible) has to be depreciated over its useful life. Useful life is defined as the period during which the asset can provide economic benefit to the company. Since an asset would continue to provide economic benefits over its useful life, it makes sense to spread the cost of acquiring the asset over its useful life. This is called depreciation. The deprecation equivalent for intangible assets is called amortization.
- **Profit After Tax (PAT)**
- **Earnings Per Share (EPS)**: EPS reflects the earning capacity of a company on a per share basis. EPS = $\frac{\text{PAT}}{\text{Total number of outstanding ordinary shares}}$

2.5 The Balance Sheet

Definition 2.5.1: Asset

An asset is a resource controlled by the company, and is expected to have an economic value in the future. Typical examples of assets include plants, machinery, cash, brands, patents etc. Assets are of two types, current and non-current.

Definition 2.5.2: Liability

A liability represents the company's obligation. The obligation is taken up by the company because the company believes these obligations will provide economic value in the long run. Liability in simple words is the loan that the company has taken and it is therefore obligated to repay back.

Note 2.2 In a typical balance sheet, the total assets of a company should be equal to the total liabilities of the company.

Definition 2.5.3: Owners Capital

It is the difference between the assets and the liabilities.
It is also called the 'Shareholders Equity' or the 'Net Worth'

2.5.1 Types of Assets & Liabilities

Current Assets

Current assets are assets that can be easily converted to cash and the company foresees a situation of consuming these assets within 365 days. Current assets are the assets that a company uses to fund its day to day operations and ongoing expenses.

Non-Current Assets (Fixed Assets)

Non-current assets are the assets that the company owns, the economic benefit of which is enjoyed over a long period (beyond 365 days)

Current Liabilities

Current liabilities are a company's obligations which are expected to be settled within 365 days (less than 1 year). The term 'Current' is used to indicate that the obligation is going to be settled soon, within a year.

Non-Current Liabilities

Non-current liabilities represent the long term obligations, which the company intends to settle/pay off not within 365 days/ 12 months of the balance sheet date. These obligations stay on the books for few years. Non-current liabilities are generally settled after 12 months after the reporting period.

2.6 The Cash Flow Statement

Overview

The cash flow statement provides information to the users of the financial statements about the entity's ability to generate cash and cash equivalents as well as indicates the cash needs of a company.

2.6.1 Activities Undertaken by a Company

Any legitimate company has three main activities:

- **Operational activities (OA)**: Activities that are directly related to the daily core business operations are called operational activities. Typical operating activities include sales, marketing, manufacturing, technology upgrade, resource hiring etc.
- **Investing activities (IA)**: Activities pertaining to investments that the company makes with an intention of reaping benefits at a later stage. Examples include parking money in interest bearing instruments, investing in equity shares, investing in land, property, plant and equipment, intangibles and other non current assets etc.
- **Financing activities (FA)**: Activities pertaining to all financial transactions of the company such as distributing dividends, paying interest to service debt, raising fresh debt, issuing corporate bonds etc.

2.7 Financial Ratios

2.7.1 Profitability Ratios

The Profitability ratios help the analyst measure the profitability of the company. The ratios convey how well the company is able to perform in terms of generating profits.

EBITDA Margin

The Earnings before Interest Tax Depreciation & Amortization (EBITDA) Margin tells us how profitable (in percentage terms)the company is at an operating level.

$$\text{EBITDA} = \text{Operating Revenues} - \text{Operating Expenses}$$
$$\text{Operating Revenues} = \text{Total Revenue} - \text{Other Income}$$
$$\text{Operating Expenses} = \text{Total Expense} - \text{Finance Cost} - \text{Depreciation \& Amortization}$$
$$\text{EBITDA Margin} = \frac{\text{EBITDA}}{\text{Total Revenue} - \text{Other Income}}$$

PAT Margin

While the EBITDA margin is calculated at the operating level, the Profit After Tax (PAT) margin is calculated at the final profitability level. At the operating level we consider only the operating expenses however there are other expenses such as depreciation and finance costs which are not considered. Along with these expenses there are tax expenses as well. When we calculate the PAT margin, all expenses are deducted from the Total Revenues of the company to identify the overall profitability of the company.

$$\text{PAT Margin} = \frac{\text{PAT}}{\text{Total Revenue}}$$

Return on Equity (RoE)

It is the return the shareholder earns for every unit of capital invested. RoE measures the entity's ability to generate profits from the shareholders investments.

$$\text{RoE} = \frac{\text{Net Profit}}{\text{Shareholders Equity}} \times 100$$

Important 2.2 DuPont Model

Inspecting the RoE closely is very important because as the company takes on more debt instead of investment through equity, the RoE shoots up but that debt is not good for the company!
To combat this, *DuPont* came up with another way of writing the RoE:

$$\text{RoE} = \frac{\text{Net Profit}}{\text{Net Sales}} \times \frac{\text{Net Sales}}{\text{Avg. Total Assets}} \times \frac{\text{Avg. Total Assets}}{\text{Shareholder Equity}}$$

If you notice, the terms cancel out to give the original formula back. However, in this process of decomposing the formula, one gained insights into three distinct aspects of the company's business.

2.7.2 Leverage Ratios

The Leverage ratios also referred to as solvency ratios/ gearing ratios measures the company's ability (in the long term) to sustain its day to day operations. Leverage ratios measure the extent to which the company uses the debt to finance growth.

Interest Coverage Ration

The interest coverage ratio, also referred to as the debt service ratio or the debt service coverage ratio, helps us understand how much the company is earning relative to the interest burden on the company. Hence, it helps us interpret how easily can the company pay its interest payments.

$$\text{Interest Coverage Ration} = \frac{\text{Earnings before interest and tax}}{\text{Interest Payment}}$$

Debt to Equity Ratio

It measures the amount of total debt capital with respect to the total equity capital.

$$\text{Debt to Equity Ratio} = \frac{\text{Total Debt}}{\text{Total Equity}}$$

Debt to Asset Ratio

It measures the amount of total debt capital with respect to the total equity capital.

$$\text{Debt to Asset Ratio} = \frac{\text{Total Debt}}{\text{Total Assets}}$$

Financial Leverage Ratio

The financial leverage ratio gives us an indication to what extent the assets are supported by equity.

$$\text{Financial Leverage Ratio} = \frac{\text{Average Total Asset}}{\text{Average Total Equity}}$$

2.7.3 Valuation Ratios

The Valuation ratios compare the stock price of the company with either the profitability of the company or the overall value of company to get a sense of how cheap or expensive the stock is trading.

Price to Sales Ratio

In many cases, investors may use sales instead of earnings to value their investments. The earnings figure may not be true as some companies might be experiencing a cyclical low in their earning cycle.

$$\text{P/S Ratio} = \frac{\text{Current Share Price}}{\text{Sales per share}}$$

Price to Book Value Ratio

Definition 2.7.1: Book Value

It is simply the amount of money left on the table after the company pays off all of its obligations. This is the amount of money the company can expect to receive after it sells all of its assets and settles its debts.

$$\text{BV} = \frac{\text{Share Capital} + \text{Reserves}}{\text{Total Number of Shares}}$$

Many investors may choose to value a company based on how much its book value is because that is a guaranteed amount that the company will get for sure even in the worst case scenarios.

$$\text{P/BV Ratio} = \frac{\text{Current Share Price}}{\text{Book Value per share}}$$

Price to Earning Ratio

We know that the *EPS* measures the profitability of a company on a per share basis. Dividing the current market price by the *EPS* gives us the *Price to Earnings ratio* of the firm. It measures the willingness of the market participants to pay for the stock, for every rupee of profit that the company generates.

$$\text{P/E Ratio} = \frac{\text{Current Share Price}}{\text{Earnings per share}}$$

2.7.4 Operating Ratios

The Operating Ratios, also called the 'Activity Ratios' measures the efficiency at which a business can convert its assets (both current and non-current) into revenues. This ratio helps us understand how efficient the management of the company is.

Fixed Assets Turnover

The ratio measures the extent of the revenue generated in comparison to its investment in fixed assets. It tells us how effectively the company uses its assets. Fixed assets include the property, plant and equipment. Higher the ratio, it means the company is effectively and efficiently managing its fixed assets.

$$\text{Fixed Assets Turnover} = \frac{\text{Operating Revenues}}{\text{Total Average Asset}}$$

Working Capital Turnover

Definition 2.7.2: Working Capital

Working capital refers to the capital required by the firm to run its day to day operations.

$$\text{Working Capital} = \text{Current Assets} - \text{Current Liabilities}$$

The working capital turnover, also referred to as net sales to working capital, indicates how much revenue the company generates for every unit of working capital. Higher the number, the better it is.

$$\text{Working Capital Turnover} = \frac{\text{Revenue}}{\text{Average Working Capital}}$$

Total Assets Turnover

The ratio measures the extent of the revenue generated in comparison to its investment in fixed assets. It tells us how effectively the company uses its assets. Fixed assets include the property, plant and equipment. Higher the ratio, it means the company is effectively and efficiently managing its fixed assets.

$$\text{Fixed Assets Turnover} = \frac{\text{Operating Revenues}}{\text{Total Average Asset}}$$

Receivables Turnover Ratio

The receivable turnover ratio indicates how many times in a given period the company receives money/cash from its debtors and customers. Naturally a high number indicates that the company collects cash more frequently.

$$\text{Receivables Turnover Ratio} = \frac{\text{Revenue}}{\text{Average Receivables}}$$

Days Sales Outstanding (DSO) / Average Collection Period

The days sales outstanding ratio illustrates the average cash collection period i.e the time lag between billing and collection.

$$\text{DSO} = \frac{365}{\text{Receivables Turnover Ratio}}$$

2.8 Valuation of a Company using Discounted Cash Flow (DCF) Method

Valuation per say helps the individual determine the 'intrinsic value' of the company. We will now look at a valuation technique called the **Discounted Cash Flow (DCF)** analysis to calculate the intrinsic value of the company.

2.8.1 Time Value of Money

If we have to evaluate, what would be the value of money that we have today sometime in the future, then we need to move the 'money today' through the future. This is called the **Future Value (FV)** of the money. Likewise, if we have to evaluate the value of money that we are expected to receive in the future in today's terms, then we have to move the future money back to today's terms. This is called the **Present Value (PV)** of money.

Definition 2.8.1: Compounding and Discounting

This process of adjusting the money we have today to calculate its future value is called **Compounding** and when we have to calculate its present value of some money we are to receive in the future is called **Discounting**

Future value can be calculated using:

$$\text{Future Value} = \text{Amount} \times (1 + \text{opportunity cost rate})^{\text{Number of Years}}$$

Present value can be calculated using:

$$\text{Present Value} = \frac{\text{Amount}}{(1 + \text{Discount Rate})^{\text{Number of Years}}}$$

Definition 2.8.2: Net Present Value

The sum of all present values of the future cash flow is called the **Net Present Value (NPV)**.

2.8.2 The Free Cash Flow (FCF)

Definition 2.8.3: Free Cash Flow (FCF)

The free cash flow is the excess operating cash that the company generates after accounting for capital expenditures such as buying land, building and equipment.

This is the cash that shareholders enjoy after accounting for the capital expenditures. The mark of a healthy business eventually depends on how much free cash it can generate.

Thus, the free cash is the amount of cash the company is left with after it has paid all its expenses including investments.

$$\text{FCF} = \text{Cash from Operating Activities} - \text{Capital Expenditures}$$

2.8.3 Key Steps of DCF Analysis

1. Estimate the average free cash flow
2. Identify the growth rate
3. Estimate the future cash flows

2.8.4 The Terminal Value

Definition 2.8.4: Terminal Growth Rate

The rate at which the company generates free cash flow grows beyond 10 years is called the terminal growth rate.

Note 2.3 Usually, the terminal growth rate is considered to be less than 5%

Definition 2.8.5: Terminal Value

The terminal value is the sum of all the future cash flow, beyond the 10th year, also called the terminal year.

The terminal value can be calculated by taking the cash flow of the 10th year and grow it at the terminal growth rate.

$$\text{Terminal Value} = \text{FCF} \times \frac{(1 + \text{Terminal Growth Rate})}{(\text{Discount Rate} - \text{Terminal Growth Rate})}$$

Note 2.4 The FCF used in the terminal value calculation is that of the 10th year.

2.8.5 The Share Price

The share price we will be talking about here is not the actual share price on the market but the 'intrinsic value' of the share that we wish to find (the valuation of the company).

Net Debt

Definition 2.8.6: Net Debt

$$\text{Net Debt} = \text{Current Year Total Debt} - \text{Cash \& Cash Balance}$$

Note 2.5 A negative sign indicates that the company has more cash than debt.

This value must be subtracted from the free cash flow to yield the **total present value of the free cash flow**.

$$\text{Share Price} = \frac{\text{Total Present Value of Free Cash Flow}}{\text{Total Number of Shares}}$$

2.8.6 Modelling Error & The Intrinsic Value Band

Though quite scientific, the DCF model makes a bunch of assumptions and hence would most likely lead to errors. Hence, we should accommodate for modelling errors.

One may allow ±10% leeway in the price.

Chapter 3

Technical Analysis

3.1 Overview

Technical Analysis is a research technique to identify trading opportunities in market based on the actions of market participants. The actions of markets participants can be visualized by means of a stock chart. Over time, patterns are formed within these charts and each pattern conveys a certain message.

> **Note 3.1** Technical Analysis (TA) is best used to identify short term trades. Do not use TA to identify long term investment opportunities.

3.2 Assumptions in Technical Analysis

1. **Markets discount everything**: All known and unknown information in the public domain is reflected in the latest stock price.
2. **Prices move in trends**: All major moves in the market are outcomes of trends.
3. **History tends to repeat itself**: In the TA context, the price trend tends to repeat itself. This happens because market participants consistently react to price movements in a remarkable similar way, each and every time the price moves in a certain direction.

3.3 Graphs

3.3.1 Line Chart

This is the most basic chart type and it uses only one data point to form the chart.

When it comes to technical analysis, a line chart is formed by plotting the **closing prices** of a stock or an index.

3.3.2 Bar Chart

This is a slightly more comprehensive chart as it display all the four price variables namely open, high, low, and close.

It has three main components:

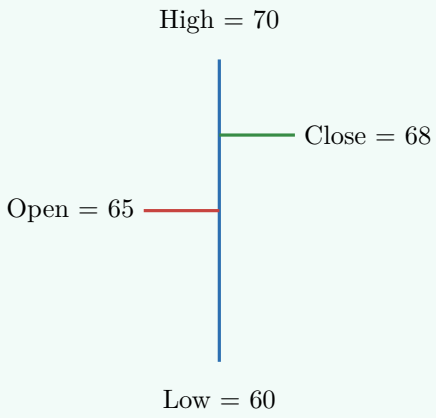
1. **The central line**: The top of this line indicated the highest price the stock had reached while the bottom indicates the lowest price in the same period.
2. **The left mark/tick**: It indicates the open price
3. **The right mark/tick**: It indicates the close price

Example 3.3.1 (Bar Chart)

For example, assume the OHLC data for a stock is as follows:

Open	65
High	70
Low	60
Close	68

The bar chart for this will look like the following:



3.3.3 Candlestick Chart

This chart is very similar to the bar chart with the difference being that the open and close prices are shown using a rectangular body instead of wicks on the left and right.

A candlestick chart is classified as a bullish or bearish candle usually represented by blue/green/white and red/black candles respectively.

It has three main components:

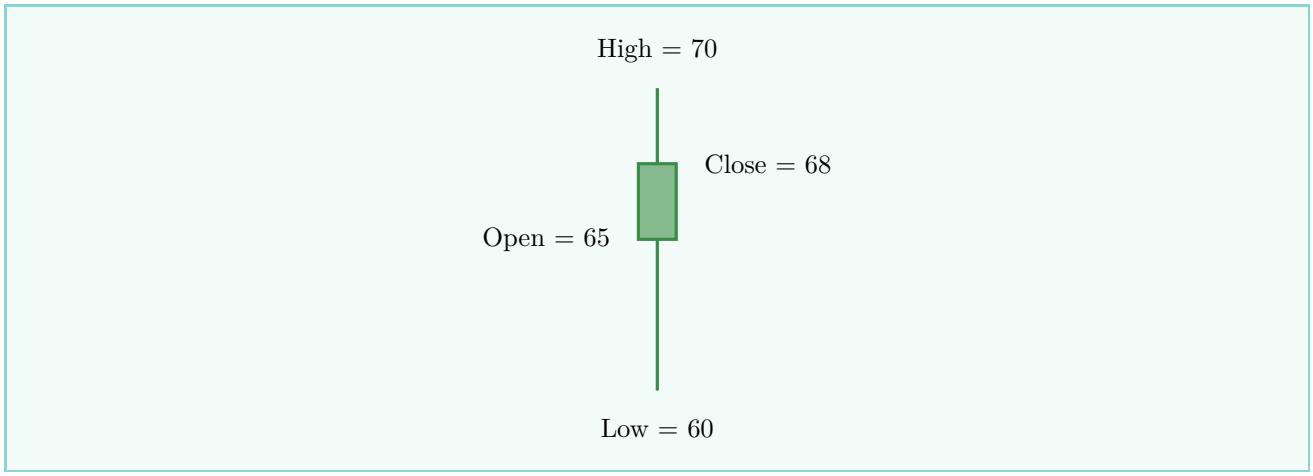
1. **The central real body**: The real body, rectangular in shape, connects the opening and closing price.
2. **Upper shadow**: Connects the high point to the close.
3. **Lower shadow**: Connects the low point to the open.

Example 3.3.2 (Candlestick Chart)

For example, assume the OHLC data for a stock is as follows:

Open	65
High	70
Low	60
Close	68

The candlestick for this will look like the following:



Note 3.2 One needs to pay some attention to the length of the candle while trading based on candlestick patterns. One should avoid trading based on subdued short candles.

3.4 Single Candlestick Patterns

3.4.1 The Marubuzo

Definition 3.4.1: The Marubuzo

It is defined as a candlestick with no upper and lower shadow. It has just the real body.

1. Bullish Marubuzo: Open = Low and Close = High
2. Bearish Marubuzo: Open = High and Close = Low

Figure 3.1: Bullish and Bearish Marubuzo

A **risk taker** would buy the stock in the same time interval in which the marubuzo occurred. Obviously, one needs to validate if the stick will be a marubuzo. This can be easily done by checking if the close price is approximately equal to the high price and the opening price is approximately equal to the low price just a few moments before the interval of the candle stick ends.

While a **risk averse** trader would buy the stock in the next interval right after the marubuzo occurs.

3.4.2 The Spinning Top

The spinning top candlestick can be described as follows:

- These candles have a small real body.
- The upper and lower shadows are almost equal.

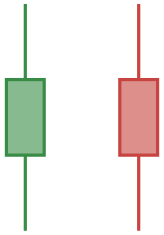


Figure 3.2: Bullish and Bearish Spinning Tops

Significance of the upper and lower shadow

1. The presence of the upper shadow tells us that the bulls did attempt to take the market higher. However, they were not really successful.
2. The presence of the lower shadow tells us that the bears did attempt to take the market lower. However, they were not really successful.

> **Note 3.3** Looking at a spinning top in isolation does not mean much. It just conveys indecision as both bulls and bears were not able to influence the markets. However when you see the spinning top with respect to the trend in the chart it gives out a really powerful message based on which you can position your stance in the markets.

Spinning tops in a downtrend

In a down trend, the bears are in control as they manage to take the price lower. However, with the spinning top in a down trend, the bears cold be consolidating their position before resuming another round of selling or the bulls could have arrested the price fall and have tried to hold onto their position.

Spinning tops in a uptrend

This case is very similar to what happens in a downtrend but reversed. That is, the bulls are in control, however, now they might be going for another buying round or the bears might have entered and are trying to make the prices fall but are unsuccessful.

3.4.3 Paper Umbrella

Definition 3.4.2: Paper Umbrella Candlestick

To qualify a candle as a paper umbrella, the length of the lower shadow should be at least **twice the length of the real body**.

Different types of paper umbrella candlesticks:

1. If the paper umbrella appears at the bottom end of a downward rally, it is called the **Hammer**.
2. If the paper umbrella appears at the top end of a uptrend rally, it is called the **Hanging man**.

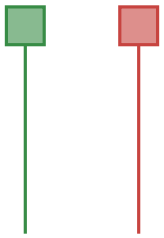


Figure 3.3: Bullish and Bearish Paper Umbrellas

Note 3.4 The hammer or hanging man can be of any color as it does not really matter as long as it qualifies 'the shadow to real body' ratio. However, it is slightly more comfortable to see a green and red colored real body respectively.

3.4.4 The Shooting Star

Definition 3.4.3: Shooting Star

The shooting star looks just like an inverted paper umbrella. Hence, the shooting star does not a long lower shadow. Instead, it has a long upper shadow where the length of the upper shadow is at least twice the length of the real body.

Note 3.5 Just like the paper umbrellas, the color of the shooting star does not matter though the pattern is slightly more reliable if the real body is red.

- The longer the upper wick, the more bearish the pattern is.
- The shooting star is a bearish patter; hence the prior trend should be bullish.

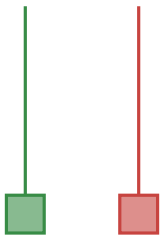


Figure 3.4: Bullish and Bearish Shooting Stars

3.5 Multiple Candlestick Patterns

3.5.1 The Engulfing Pattern

The engulfing pattern need two candlesticks, In a typical engulfing pattern, you will find a small candle followed by a relatively long candle which appears to engulf the smaller one.

- If the engulfing pattern appears at the bottom of the trend, it is called the **Bullish Engulfing**.
- If the engulfing pattern appears at the top of the trend, it is called the **Bearish Engulfing**.

Bullish Engulfing Pattern

The prerequisites for this pattern are as follows:

1. The prior trend must be a downtrend.
2. The first stick of the pattern (P1) should be a red candle reconfirming the bearishness in the market.
3. The 2nd candle of the pattern (P2) should be a green candle, long enough to engulf the red candle.

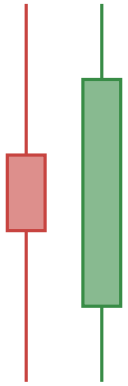


Figure 3.5: Bullish Engulfing Pattern

Bearish Engulfing Pattern

The prerequisites for this pattern are as follows:

1. The prior trend must be a uptrend.
2. The first stick of the pattern (P1) should be a green candle reconfirming the bullishness in the market.
3. The 2nd candle of the pattern (P2) should be a red candle, long enough to engulf the green candle.

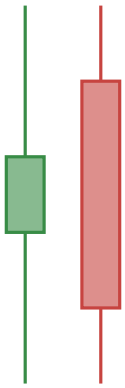


Figure 3.6: Bearish Engulfing Pattern

> **Note 3.6** The bearish engulfing pattern suggests a short trade.

3.5.2 The Piercing Pattern

The piercing pattern is very similar to the bullish engulfing pattern with a very minor variation. In a bullish engulfing pattern the P2's blue candle engulfs P1's red candle completely. However in a piercing pattern P2's blue candle partially engulfs P1's red candle, however the engulfing should be between 50% and less than 100%.

3.5.3 The Dark Cloud Cover

The dark cloud cover is very similar to the bearish engulfing pattern with a minor variation. In a bearish engulfing pattern the red candle on P2 engulfs P1's blue candle completely. However in a dark cloud cover, the red candle on P2 engulfs about 50 to 100% of P1's blue candle. The trade set up is exactly the same as the bearish engulfing pattern.

> **Tip 3.1** Think about the dark cloud cover as the inverse of a piercing pattern.

3.5.4 The Harami Pattern

The Bullish Harami

It is a bullish pattern appearing at the bottom end of the chart. It is similar to the engulfing pattern.

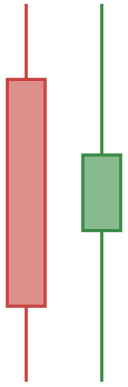


Figure 3.7: Bullish Harami Pattern

The Bearish Harami

It is a bearish pattern appearing at the top end of the chart. It is similar to the engulfing pattern. It presents the trader with a opportunity to initiate a short trade.

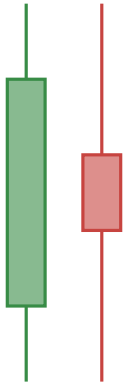


Figure 3.8: Bearish Harami Pattern

3.5.5 The Gaps

Gap Up Opening

It indicated buyer's enthusiasm. Buyers are willing to buy stocks at a price higher than the previous day's close. Hence, because of enthusiastic buyer's outlook, the stock (or the index) opens directly above the previous day's close.

Gap Down Opening

Similar to gap up opening, a gap down opening shows the enthusiasm of the bears. The bears are so eager to sell, that they are willing to sell at a price lower than the previous day's close.

3.5.6 The Morning Star

The morning star is a bullish candlestick pattern which evolves over three periods (i.e. a three candlestick pattern). It is a downtrend reversal pattern. The morning star appears at the bottom of a downtrend.

The conditions for a morning star are:

1. P1 should be a long red candle.
2. With a gap down opening, P2 should be either a doji or a spinning top.
3. P3 opening should be gap up, plus the closing price should be higher than the opening of P1.

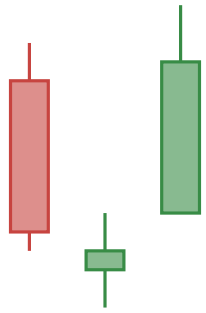


Figure 3.9: The Morning Star Pattern

Note 3.7 A stop loss order for a trade made on the basis of a morning star should be put at the value equal to the lowest price among P1, P2 & P3

3.5.7 The Evening Star

The evening star is a bearish equivalent of the morning star. The evening star appears at the top end of an uptrend. Like the morning star, the evening star is a three candle formation and evolves over three trading sessions.

The conditions for an evening star are:

1. P1 should be a long blue candle.
2. With a up down opening, P2 should be either a doji or a spinning top.
3. P3 opening should be gap down, plus the closing price should be lower than the opening of P1.

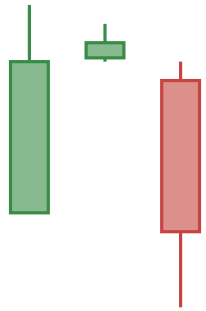


Figure 3.10: The Morning Star Pattern

Note 3.8 A stop loss order for a trade made on the basis of an evening star should be put at the value equal to the highest price among P1, P2 & P3

3.6 The Support and Resistance

Definition 3.6.1: The Resistance

As the name suggests, resistance is something which stops the price from rising further. The resistance level is a price point on the chart where traders expect maximum supply (in terms of selling) for the stock/index. The resistance level is **always above the current market price**.

Definition 3.6.2: The Support

As the name suggests, the support is something that prevents the price from falling further. The support level is a price point on the chart where the trader expects maximum demand (in terms of buying) coming into the stock/index. Whenever the price falls to the support line, it is likely to bounce back. The support level is **always below the current market price**.

3.7 Volume

Definition 3.7.1: Volume

Volumes indicate how many shares are bought and sold over a given period of time. The more active the share, higher would be its volume.

3.7.1 Volume Trends

Price	Volume	Expectation
Increases	Increases	Bullish
Increases	Decreases	Caution - weak hands buying
Decreases	Increases	Bearish
Decreases	Decreases	Caution - weak hands selling

Important 3.1 As a practice, traders usually compare the current session's volume over the average of the last 10 trading sessions.

$$\text{current volume} > \text{average volume} \Rightarrow \text{high volume}$$
$$\text{current volume} = \text{average volume} \Rightarrow \text{average volume}$$
$$\text{current volume} < \text{average volume} \Rightarrow \text{low volume}$$

3.7.2 Thought Process behind Volume Trends

When institutional investors buy or sell they obviously do not transact in small chunks. They buy very huge chunks. Now, if they were to buy a lot of shares from the open market, it will start reflecting in volumes. Besides, because they are buying a large chunk of shares, the share price also tends to go up.

Usually institutional money is referred to as the *smart money*. It is perceived that **smart money always makes wiser moves in the market compared to retail traders**. Hence following the smart money seems like a wise idea.

3.8 Moving Averages

3.8.1 Simple Moving Averages

In this method, we give equal importance to all the data points being considered.

$$\text{SMA} = \sum_{i=0}^{N} \text{value}$$

where N is the number of data points being considered.

3.8.2 Exponential Moving Averages (EMA)

In this method, we give higher importance to the newer data points and lesser to the older ones.

$$\text{EMA}_i = (\text{value} \times K) + (\text{EMA}_{i-1} \times (1 - K))$$

where EMA_0 which is the EMA for the first period is taken to be equal to the SMA for that period and K is multiplier constant which is used to smoothen the curve. It can usually be calculated by the following formula:

$$K = \frac{2}{\text{number of observations} + 1}$$

Example 3.8.1 (Using the SMA/EMA to make trades)

1. Buy (go long) when the current market price turns greater than the 50 day SMA/EMA. Once you go long, you should stay invested till the necessary sell condition is satisfied.
2. Exit the long position (square off) when the current market price turns lesser than the 50 day SMA/EMA.

3.8.3 Moving Average Crossover System

In this system, instead of the usual single moving average, we combine two moving averages. This is referred to as *smoothing*.

Example 3.8.2 (50 Day EMA + 100 Day EMA)

A typical example of this would be to combine a 50 day EMA, with a 100 day EMA. The shorter moving average (50 days in this case) is also referred to as the *faster moving average*. The longer moving average (100 days moving average) is referred to as the *slower moving average*.

Entry and Exit Rules for the Crossover System:

1. Buy long when the short term moving average turns greater than the long term moving average. Stay in the trade as long as this condition is satisfied.
2. Exit the long position when the short term moving average turns lesser than the longer term moving average.

3.9 Indicators

3.9.1 Overview

A technical indicator helps a trader analyze the price movement of a security. Indicators are built on preset logic using which traders can supplement their technical study (candlesticks, volumes, S&R) to arrive at a trading decision. Indicators help in buying, selling, confirming trends, and sometimes predicting trends.

Indicators are of two types namely **leading** and **lagging**.

Leading Indicators

A leading indicator leads the price, meaning it usually signals the occurrence of a reversal or a new trend in advance.

> **Important 3.2** Leading indicators are notorious for giving false signals. Therefore, the trader should be highly alert while using leading indicators.

A majority of leading indicators are called oscillators as they oscillate within a bounded range.

Lagging Indicators

A lagging indicator on the other hand lags the price; meaning it usually signals the occurrence of a reversal or a new trend after it has occurred.

One of the most popular indicators is the moving averages.

3.9.2 Momentum

Definition 3.9.1: Momentum

Momentum is the rate at which the price changes.
For example if stock price is Rs.100 today and it moves to Rs.105 the next day, and Rs.115, the day after, we say the momentum is high as the stock price has changed by 15% in just 3 days. However if the same 15% change happened over let us say 3 months, we can conclude the momentum is low. So the more rapidly the price changes, the higher the momentum.

3.9.3 Relative Strength Index (RSI)

RSI is a leading momentum indicator which helps in **identifying a trend reversal**.

> **Note 3.9** The term *Relative Strength Index* can be a bit misleading as it does not compare the relative strength of two securities, but instead shows the internal strength of the security.

The objective of using RSI is to help the trader identify over sold and overbought price areas. Overbought implies that the positive momentum in the stock is so high that it may not be sustainable for long and hence there could be a correction. Likewise, an oversold position indicates that the negative momentum is high leading to a possible reversal. RSI gives out the strongest signals during the periods of sideways and non-trending ranges.

$$\text{RSI} = 100 - \frac{100}{1 + \text{RS}}$$

$$\text{RS} = \frac{\text{Average Gain}}{\text{Average Loss}}$$

Definition 3.9.2: Look-back Period

The data points used for calculating the RSI determines the *look-back period*.
For example, if one is using daily price data and uses 14 data points for calculating the averages in the RS formula, the look-back period would be 14 days.

Classical Interpretation of RSI

- When the RSI is between 0 and 30, the security is supposed to be oversold and is ready for an upward correction.
- When the RSI is between 70 and 100, it is supposed to be heavily bought and is ready for a downward correction.

Modern Interpretation of RSI

- If the RSI is fixed in an overbought region (0 to 30) for a prolonged period, look for buying opportunities instead of shorting.
-

  > **Note 3.10** The RSI stays in the overbought region for a prolonged period because of an excess positive momentum.

  If the RSI is fixed in an oversold region for a prolonged period, look for selling opportunities rather than buying.

  > **Note 3.11** The RSI stays in the oversold region for a prolonged period because of an excess negative momentum.

  If the RSI value starts moving away from the oversold value after a prolonged period, look for buying opportunities.

  > **Example 3.9.1**
  > The RSI moving above 30 after a long time may mean that the stock may have bottomed out, hence a case for going long

- If the RSI value starts moving away from the overbought value after a prolonged period, look for selling opportunities.

  > **Example 3.9.2**
  > The RSI moving below 70 after a long time may mean the stock has topped out, hence a case for shorting.

3.9.4 Moving Average Convergence and Divergence (MACD)

MACD is all about convergence and divergence of two moving averages. Convergence occurs when the two moving averages move towards each other, and a divergence occurs when the moving averages move away from each other.

A standard MACD is calculated using a 12 day EMA and a 26 day EMA. We subtract the 26 day EMA from the 12 day EMA, to estimate the convergence and divergence (CD) value. A simple line of this graph is often referred to as the *MACD line*.

Significance of Values of MACD

- The sign of the MACD just indicates the direction of the stock's movement.
- The higher the magnitude of the MACD, the higher is the momentum.

Example 3.9.3

For example if the 12 Day EMA is 6380, and 26 Day EMA is 6220 then the MACD value is +160. We also know that the shorter term average will generally be higher than the longer term only when the stock price is trending upwards. Hence **a positive MACD value indicates that the price is moving upwards!**

Point of Convergence and Divergence

- When the MACD Line crosses the center line from the negative territory to positive territory, it means there is divergence between the two averages. This is a sign of increasing bullish momentum; therefore one should look at buying opportunities.
- When the MACD line crosses the center line from positive territory to the negative territory it means there is convergence between the two averages. This is a sign of increasing bearish momentum; therefore one should look at selling opportunities.

The Signal Line

Traders generally argue that while waiting for the MACD line to crossover the center line a bulk of the move would already be done and perhaps it would be late to enter a trade. To overcome this, there is an improvisation over this basic MACD line. The improvisation comes in the form of an additional MACD component which is the *9 day signal line*. **A 9 day signal line is a exponential moving average (EMA) of the MACD line.**

With these two lines (the MACD line and the signal line), a trade can follow a simple 2 line crossover strategy similar to the crossing over of 2 different moving averages and no longer wait for the center line cross over.

- The sentiment is bullish when the MACD line crosses the 9 day EMA wherein MACD line is greater than the 9 day EMA. When this happens, the trader should look at buying opportunities.
- The sentiment is bearish when the MACD line crosses below the 9 day EMA wherein the MACD line is lesser than the 9 day EMA. When this happens, the trader should look at selling opportunities.

3.9.5 The Bollinger Bands (BB)

BBs are used to determine overbought and oversold levels, where a trader can try to sell when the price reaches the top of the band and try to buy when the price reached the bottom of the band.

The BB has 3 components:

1. **The Middle Line**: It is a 20 day SMA of the closing averages.
2. **The Upper Band**: It is a +2 standard deviation of the middle line.
3. **The Lower Band**: It is a -2 standard deviation of the middle line.

Note 3.12 The standard deviation (SD) is a statistical concept; which measures the variance of a particular variable from its average. In finance, the standard deviation of the stock price represents the volatility of a stock.

For example, if the standard deviation of a stock is 12%, it is as good as saying that the volatility of the stock is 12%.

Chapter 4

Future Plan of Action

4.1 Tentative Timeline

- **Week 5:** Learn about managing risks in a portfolio and different mathematical models devised for it.
- **Week 6 & 7:** Learn about different trading algorithms and core ideas behind them.
- **Week 8:** Formulate and implement a trading strategy in Python, evaluate it, and try to figure out ways to improve it.