

# Technical Analysis

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# Technical analysis

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In finance, **technical analysis** is a security analysis discipline for forecasting the direction of prices through the study of past market data, primarily price and volume.<sup>[1]</sup> Behavioral economics and quantitative analysis incorporate substantial aspects of technical analysis,<sup>[2]</sup> which being an aspect of active management stands in contradiction to much of modern portfolio theory. According to the weak-form efficient-market hypothesis, such forecasting methods are valueless, since prices follow a random walk or are otherwise essentially unpredictable.

## History

The principles of technical analysis derive from the observation of financial markets over hundreds of years.<sup>[3]</sup> The oldest known hints of technical analysis appear in Joseph de la Vega's accounts of the Dutch markets in the 17th century. In Asia, the oldest example of technical analysis is thought to be a method developed by Homma Munehisa during early 18th century which evolved into the use of candlestick techniques, and is today a main charting tool.<sup>[4]</sup> <sup>[5]</sup> In the 1920s and 1930s Richard W. Schabacker published several books which continued the work of Dow and William Peter Hamilton in his books *Stock Market Theory and Practice* and *Technical Market Analysis*. At the end of his life he was joined by his brother in law, Robert D. Edwards who finished his last book. In 1948 Edwards and John Magee published *Technical Analysis of Stock Trends* which is widely considered to be one of the seminal works of the discipline. It is exclusively concerned with trend analysis and chart patterns and remains in use to the present. It is now in its 9th edition. As is obvious, early technical analysis was almost exclusively the analysis of charts, because the processing power of computers was not available for statistical analysis. Charles Dow reportedly originated a form of chart analysis used by technicians—point and figure analysis.

Dow Theory is based on the collected writings of Dow Jones co-founder and editor Charles Dow, and inspired the use and development of modern technical analysis from the end of the 19th century. Other pioneers of analysis techniques include Ralph Nelson Elliott, William Delbert Gann and Richard Wyckoff who developed their respective techniques in the early 20th century.

Many more technical tools and theories have been developed and enhanced in recent decades, with an increasing emphasis on computer-assisted techniques.

## General description

While fundamental analysts examine earnings, dividends, new products, research and the like, technical analysts examine what investors fear or think about those developments and whether or not investors have the wherewithal to back up their opinions; these two concepts are called psych (psychology) and supply/demand. Technicians employ many techniques, one of which is the use of charts. Using charts, technical analysts seek to identify price patterns and market trends in financial markets and attempt to exploit those patterns.<sup>[6]</sup> Technicians use various methods and tools, the study of price charts is but one.

Supply/demand indicators monitor investors' liquidity; margin levels, short interest, cash in brokerage accounts, etc., in an attempt to determine whether they have any money left. Other indicators monitor the state of psych - are investors bullish or bearish? - and are they willing to spend money to back up their beliefs. A spent-out bull cannot move the market higher, and a well heeled bear won't!; investors need to know which they are facing. In the end, stock prices are only what investors think; therefore determining what they think is every bit as critical as an earnings estimate.

Technicians using charts search for archetypal price chart patterns, such as the well-known head and shoulders or double top/bottom reversal patterns, study technical indicators, moving averages, and look for forms such as lines of support, resistance, channels, and more obscure formations such as flags, pennants, balance days and cup and handle patterns.

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Technical analysts also widely use market indicators of many sorts, some of which are mathematical transformations of price, often including up and down volume, advance/decline data and other inputs. These indicators are used to help access whether an asset is trending, and if it is, its probability of its direction and of continuation. Technicians also look for relationships between price/volume indices and market indicators. Examples include the relative strength index, and MACD. Other avenues of study include correlations between changes in options (implied volatility) and put/call ratios with price. Also important are sentiment indicators such as Put/Call ratios, bull/bear ratios, short interest and Implied Volatility, etc.

There are many techniques in technical analysis. Adherents of different techniques (for example, candlestick charting, Dow Theory, and Elliott wave theory) may ignore the other approaches, yet many traders combine elements from more than one technique. Some technical analysts use subjective judgment to decide which pattern(s) a particular instrument reflects at a given time, and what the interpretation of that pattern should be. Others employ a strictly mechanical or systematic approach to pattern identification and interpretation.

Technical analysis is frequently contrasted with *fundamental analysis*, the study of economic factors that influence the way investors price financial markets. Technical analysis holds that prices already reflect all such trends before investors are aware of them. Uncovering those trends is what technical indicators are designed to do, imperfect as they may be. Fundamental indicators are subject to the same limitations, naturally. Some traders use technical or fundamental analysis exclusively, while others use both types to make trading decisions which conceivably is the most rational approach.

Users of technical analysis are often called technicians or market technicians. Some prefer the term technical market analyst or simply market analyst. An older term, chartist, is sometimes used, but as the discipline has expanded and modernized, the use of the term chartist has become less popular, as it is only one aspect of technical analysis.

## Characteristics

Technical analysis employs models and trading rules based on price and volume transformations, such as the relative strength index, moving averages, regressions, inter-market and intra-market price correlations, cycles or, classically, through recognition of chart patterns.

Technical analysis stands in contrast to the fundamental analysis approach to security and stock analysis. Technical analysis analyses price, volume and other market information, whereas fundamental analysis looks at the actual facts of the company, market, currency or commodity. Most large brokerage, trading group, or financial institution will typically have both a technical analysis and fundamental analysis team.

Technical analysis is widely used among traders and financial professionals, and is very often used by active day traders, market makers, and pit traders. In the 1960s and 1970s it was widely dismissed by academics. In a recent review, Irwin and Park<sup>[7]</sup> reported that 56 of 95 modern studies found it produces positive results, but noted that many of the positive results were rendered dubious by issues such as data snooping so that the evidence in support of technical analysis was inconclusive; it is still considered by many academics to be pseudoscience.<sup>[8]</sup> Academics such as Eugene Fama say the evidence for technical analysis is sparse and is inconsistent with the *weak form* of the efficient-market hypothesis.<sup>[9] [10]</sup> Users hold that even if technical analysis cannot predict the future, it helps to identify trading opportunities.<sup>[11]</sup>

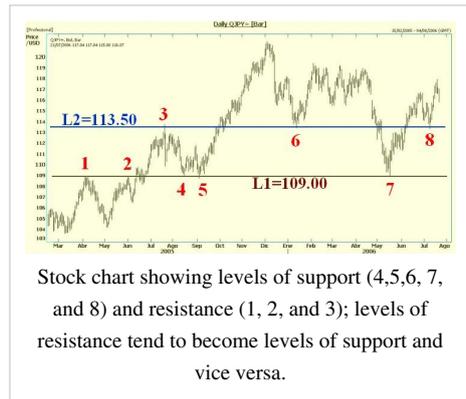
In the foreign exchange markets, its use may be more widespread than fundamental analysis.<sup>[12] [13]</sup> This does not mean technical analysis is more applicable to foreign markets, but that technical analysis is more recognized there as to its efficacy there than elsewhere. While some isolated studies have indicated that technical trading rules might lead to consistent returns in the period prior to 1987,<sup>[14] [15] [16] [17]</sup> most academic work has focused on the nature of the anomalous position of the foreign exchange market.<sup>[18]</sup> It is speculated that this anomaly is due to central bank intervention, which obviously technical analysis is not designed to predict.<sup>[19]</sup> Recent research suggests that combining various trading signals into a Combined Signal Approach may be able to increase profitability and reduce dependence on any single rule.<sup>[20]</sup>

## Principles

Technicians say that a market's price reflects all relevant information, so their analysis looks at the history of a security's trading pattern rather than external drivers such as economic, fundamental and news events. Price action also tends to repeat itself because investors collectively tend toward patterned behavior – hence technicians' focus on identifiable trends and conditions.

### Market action discounts everything

Based on the premise that all relevant information is already reflected by prices, technical analysts believe it is important to understand what investors think of that information, known and perceived; studies such as by Cutler, Poterba, and Summers titled "What Moves Stock Prices?" do not cover this aspect of investing.



Stock chart showing levels of support (4,5,6, 7, and 8) and resistance (1, 2, and 3); levels of resistance tend to become levels of support and vice versa.

### Prices move in trends

Technical analysts believe that prices trend directionally, i.e., up, down, or sideways (flat) or some combination. The basic definition of a price trend was originally put forward by Dow Theory.<sup>[6]</sup>

An example of a security that had an apparent trend is AOL from November 2001 through August 2002. A technical analyst or trend follower recognizing this trend would look for opportunities to sell this security. AOL consistently moves downward in price. Each time the stock rose, sellers would enter the market and sell the stock; hence the "zig-zag" movement in the price. The series of "lower highs" and "lower lows" is a tell tale sign of a stock in a down trend.<sup>[21]</sup> In other words, each time the stock moved lower, it fell below its previous relative low price. Each time the stock moved higher, it could not reach the level of its previous relative high price.

Note that the sequence of lower lows and lower highs did not begin until August. Then AOL makes a low price that doesn't pierce the relative low set earlier in the month. Later in the same month, the stock makes a relative high equal to the most recent relative high. In this a technician sees strong indications that the down trend is at least pausing and possibly ending, and would likely stop actively selling the stock at that point.

### History tends to repeat itself

Technical analysts believe that investors collectively repeat the behavior of the investors that preceded them. "Everyone wants in on the next Microsoft," "If this stock ever gets to \$50 again, I will buy it," "This company's technology will revolutionize its industry, therefore this stock will skyrocket" – these are all examples of investor sentiment repeating itself. To a technician, the emotions in the market may be irrational, but they exist. Because investor behavior repeats itself so often, technicians believe that recognizable (and predictable) price patterns will develop on a chart.<sup>[6]</sup>

Technical analysis is not limited to charting, but it always considers price trends. For example, many technicians monitor surveys of investor sentiment. These surveys gauge the attitude of market participants, specifically whether they are bearish or bullish. Technicians use these surveys to help determine whether a trend will continue or if a reversal could develop; they are most likely to anticipate a change when the surveys report extreme investor sentiment. Surveys that show overwhelming bullishness, for example, are evidence that an uptrend may reverse – the premise being that if most investors are bullish they have already bought the market (anticipating higher prices). And because most investors *are* bullish and invested, one assumes that few buyers remain. This leaves more potential sellers than buyers, despite the bullish sentiment. This suggests that prices will trend down, and is an example of contrarian trading.

## Industry

The industry is globally represented by the International Federation of Technical Analysts (IFTA), which is a Federation of regional and national organizations and the Market Technicians Association (MTA). In the United States, the industry is represented by both the Market Technicians Association (MTA) and the American Association of Professional Technical Analysts (AAPTA). The United States is also represented by the Technical Security Analysts Association of San Francisco (TSAASF). In the United Kingdom, the industry is represented by the Society of Technical Analysts (STA). In Canada the industry is represented by the Canadian Society of Technical Analysts. Some other national professional technical analysis organizations are noted in the external links section below.

Professional technical analysis societies have worked on creating a body of knowledge that describes the field of Technical Analysis. A body of knowledge is central to the field as a way of defining how and why technical analysis may work. It can then be used by academia, as well as regulatory bodies, in developing proper research and standards for the field. The Market Technicians Association (MTA) has published a body of knowledge, which is the structure for the MTA's Chartered Market Technician (CMT) exam.

## Use

Traders generally share the view that trading in the direction of the trend is the most effective means to be profitable in financial or commodities markets. John W. Henry, Larry Hite, Ed Seykota, Richard Dennis, William Eckhardt, Victor Sperandeo, Michael Marcus and Paul Tudor Jones (some of the so-called wizards in the popular book, *Market Wizards* by Jack D. Schwager) have each amassed massive fortunes via the use of technical analysis and its concepts. George Lane, a technical analyst, coined one of the most popular phrases on Wall Street, "The trend is your friend!"

Many non-arbitrage algorithmic trading systems rely on the idea of trend-following, as do many hedge funds. A relatively recent trend, both in research and industrial practice, has been the development of increasingly sophisticated automated trading strategies. These often rely on underlying technical analysis principles (see algorithmic trading article for an overview).

## Systematic trading

### Neural networks

Since the early 1990s when the first practically usable types emerged, artificial neural networks (ANNs) have rapidly grown in popularity. They are artificial intelligence adaptive software systems that have been inspired by how biological neural networks work. They are used because they can learn to detect complex patterns in data. In mathematical terms, they are universal function approximators,<sup>[22] [23]</sup> meaning that given the right data and configured correctly, they can capture and model any input-output relationships. This not only removes the need for human interpretation of charts or the series of rules for generating entry/exit signals, but also provides a bridge to fundamental analysis, as the variables used in fundamental analysis can be used as input.

As ANNs are essentially non-linear statistical models, their accuracy and prediction capabilities can be both mathematically and empirically tested. In various studies, authors have claimed that neural networks used for generating trading signals given various technical and fundamental inputs have significantly outperformed buy-and-hold strategies as well as traditional linear technical analysis methods when combined with rule-based expert systems.<sup>[24] [25] [26]</sup>

While the advanced mathematical nature of such adaptive systems has kept neural networks for financial analysis mostly within academic research circles, in recent years more user friendly neural network software has made the technology more accessible to traders. However, large-scale application is problematic because of the problem of matching the correct neural topology to the market being studied.

## Rule-based trading

Rule-based trading is an approach intended to create trading plans using strict and clear-cut rules. Unlike some other technical methods and the approach of fundamental analysis, it defines a set of rules that determine all trades, leaving minimal discretion. The theory behind this approach is that by following a distinct set of trading rules you will reduce the number of poor decisions, which are often emotion based.

For instance, a trader might make a set of rules stating that he will take a long position whenever the price of a particular instrument closes above its 50-day moving average, and shorting it whenever it drops below.

## Combination with other market forecast methods

John Murphy states that the principal sources of information available to technicians are price, volume and open interest.<sup>[27]</sup> Other data, such as indicators and sentiment analysis, are considered secondary.

However, many technical analysts reach outside pure technical analysis, combining other market forecast methods with their technical work. One advocate for this approach is John Bollinger, who coined the term *rational analysis* in the middle 1980s for the intersection of technical analysis and fundamental analysis.<sup>[28]</sup> Another such approach, fusion analysis,<sup>[29]</sup> overlays fundamental analysis with technical, in an attempt to improve portfolio manager performance.

Technical analysis is also often combined with quantitative analysis and economics. For example, neural networks may be used to help identify intermarket relationships.<sup>[30]</sup> A few market forecasters combine financial astrology with technical analysis. Chris Carolan's article "Autumn Panics and Calendar Phenomenon", which won the Market Technicians Association Dow Award for best technical analysis paper in 1998, demonstrates how technical analysis and lunar cycles can be combined.<sup>[31]</sup> Calendar phenomena, such as the January effect in the stock market, are generally believed to be caused by tax and accounting related transactions, and are not related to the subject of financial astrology.

Investor and newsletter polls, and magazine cover sentiment indicators, are also used by technical analysts.<sup>[32]</sup>

## Empirical evidence

Whether technical analysis actually works is a matter of controversy. Methods vary greatly, and different technical analysts can sometimes make contradictory predictions from the same data. Many investors claim that they experience positive returns, but academic appraisals often find that it has little predictive power.<sup>[33]</sup> Modern studies may be more positive: of 95 modern studies, 56 concluded that technical analysis had positive results, although data-snooping bias and other problems make the analysis difficult.<sup>[7]</sup> Nonlinear prediction using neural networks occasionally produces statistically significant prediction results.<sup>[34]</sup> A Federal Reserve working paper<sup>[15]</sup> regarding support and resistance levels in short-term foreign exchange rates "offers strong evidence that the levels help to predict intraday trend interruptions," although the "predictive power" of those levels was "found to vary across the exchange rates and firms examined".

Technical trading strategies were found to be effective in the Chinese marketplace by a recent study that states, "Finally, we find significant positive returns on buy trades generated by the contrarian version of the moving average crossover rule, the channel breakout rule, and the Bollinger band trading rule, after accounting for transaction costs of 0.50 percent."<sup>[35]</sup>

An influential 1992 study by Brock et al. which appeared to find support for technical trading rules was tested for data snooping and other problems in 1999;<sup>[36]</sup> the sample covered by Brock et al. was robust to data snooping.

Subsequently, a comprehensive study of the question by Amsterdam economist Gerwin Griffioen concludes that: "for the U.S., Japanese and most Western European stock market indices the recursive out-of-sample forecasting procedure does not show to be profitable, after implementing little transaction costs. Moreover, for sufficiently high

transaction costs it is found, by estimating CAPMs, that technical trading shows no statistically significant risk-corrected out-of-sample forecasting power for almost all of the stock market indices."<sup>[10]</sup> Transaction costs are particularly applicable to "momentum strategies"; a comprehensive 1996 review of the data and studies concluded that even small transaction costs would lead to an inability to capture any excess from such strategies.<sup>[37]</sup>

In a paper published in the *Journal of Finance*, Dr. Andrew W. Lo, director MIT Laboratory for Financial Engineering, working with Harry Mamaysky and Jiang Wang found that "Technical analysis, also known as "charting," has been a part of financial practice for many decades, but this discipline has not received the same level of academic scrutiny and acceptance as more traditional approaches such as fundamental analysis. One of the main obstacles is the highly subjective nature of technical analysis—the presence of geometric shapes in historical price charts is often in the eyes of the beholder. In this paper, we propose a systematic and automatic approach to technical pattern recognition using nonparametric kernel regression, and apply this method to a large number of U.S. stocks from 1962 to 1996 to evaluate the effectiveness of technical analysis. By comparing the unconditional empirical distribution of daily stock returns to the conditional distribution—conditioned on specific technical indicators such as head-and-shoulders or double-bottoms—we find that over the 31-year sample period, several technical indicators do provide incremental information and may have some practical value."<sup>[38]</sup> In that same paper Dr. Lo wrote that "several academic studies suggest that ... technical analysis may well be an effective means for extracting useful information from market prices."<sup>[39]</sup> Some techniques such as Drummond Geometry attempt to overcome the past data bias by projecting support and resistance levels from differing time frames into the near-term future and combining that with reversion to the mean techniques.<sup>[40]</sup>

## Efficient market hypothesis

The efficient-market hypothesis (EMH) contradicts the basic tenets of technical analysis by stating that past prices cannot be used to profitably predict future prices. Thus it holds that technical analysis cannot be effective. Economist Eugene Fama published the seminal paper on the EMH in the *Journal of Finance* in 1970, and said "In short, the evidence in support of the efficient markets model is extensive, and (somewhat uniquely in economics) contradictory evidence is sparse."<sup>[41]</sup> EMH advocates say that if prices quickly reflect all relevant information, no method (including technical analysis) can "beat the market." Developments which influence prices occur randomly and are unknowable in advance.

Technicians say that EMH ignores the way markets work, in that many investors base their expectations on past earnings or track record, for example. Because future stock prices can be strongly influenced by investor expectations, technicians claim it only follows that past prices influence future prices.<sup>[42]</sup> They also point to research in the field of behavioral finance, specifically that people are not the rational participants EMH makes them out to be. Technicians have long said that irrational human behavior influences stock prices, and that this behavior leads to predictable outcomes.<sup>[43]</sup> Author David Aronson says that the theory of behavioral finance blends with the practice of technical analysis:

By considering the impact of emotions, cognitive errors, irrational preferences, and the dynamics of group behavior, behavioral finance offers succinct explanations of excess market volatility as well as the excess returns earned by stale information strategies.... cognitive errors may also explain the existence of market inefficiencies that spawn the systematic price movements that allow objective TA [technical analysis] methods to work.<sup>[42]</sup>

EMH advocates reply that while individual market participants do not always act rationally (or have complete information), their aggregate decisions balance each other, resulting in a rational outcome (optimists who buy stock and bid the price higher are countered by pessimists who sell their stock, which keeps the price in equilibrium).<sup>[44]</sup> Likewise, complete information is reflected in the price because all market participants bring their own individual, but incomplete, knowledge together in the market.<sup>[44]</sup>

### Random walk hypothesis

The random walk hypothesis may be derived from the weak-form efficient markets hypothesis, which is based on the assumption that market participants take full account of any information contained in past price movements (but not necessarily other public information). In his book *A Random Walk Down Wall Street*, Princeton economist Burton Malkiel said that technical forecasting tools such as pattern analysis must ultimately be self-defeating: "The problem is that once such a regularity is known to market participants, people will act in such a way that prevents it from happening in the future."<sup>[45]</sup>

In the late 1980s, professors Andrew Lo and Craig McKinlay published a paper which casts doubt on the random walk hypothesis. In a 1999 response to Malkiel, Lo and McKinlay collected empirical papers that questioned the hypothesis' applicability<sup>[46]</sup> that suggested a non-random and possibly predictive component to stock price movement, though they were careful to point out that rejecting random walk does not necessarily invalidate EMH, an entirely separate concept from RWH.

Technicians say that the EMH and random walk theories both ignore the realities of markets, in that participants are not completely rational and that current price moves are not independent of previous moves.<sup>[21] [47]</sup>

## Charting terms and indicators

### Concepts

- Resistance — a price level that may prompt a net increase of selling activity
- Support — a price level that may prompt a net increase of buying activity
- Breakout — the concept whereby prices forcefully penetrate an area of prior support or resistance, usually, but not always, accompanied by an increase in volume.
- Trending — the phenomenon by which price movement tends to persist in one direction for an extended period of time
- Average true range — averaged daily trading range, adjusted for price gaps
- Chart pattern — distinctive pattern created by the movement of security prices on a chart
- Dead cat bounce — the phenomenon whereby a spectacular decline in the price of a stock is immediately followed by a moderate and temporary rise before resuming its downward movement
- Elliott wave principle and the golden ratio to calculate successive price movements and retracements
- Fibonacci ratios — used as a guide to determine support and resistance
- Momentum — the rate of price change
- Point and figure analysis — A priced-based analytical approach employing numerical filters which may incorporate time references, though ignores time entirely in its construction.
- Cycles - time targets for potential change in price action (price only moves up, down, or sideways)

### Types of charts

- Open-high-low-close chart — OHLC charts, also known as bar charts, plot the span between the high and low prices of a trading period as a vertical line segment at the trading time, and the open and close prices with horizontal tick marks on the range line, usually a tick to the left for the open price and a tick to the right for the closing price.
- Candlestick chart — Of Japanese origin and similar to OHLC, candlesticks widen and fill the interval between the open and close prices to emphasize the open/close relationship. In the West, often black or red candle bodies represent a close lower than the open, while white, green or blue candles represent a close higher than the open price.
- Line chart — Connects the closing price values with line segments.

- Point and figure chart — a chart type employing numerical filters with only passing references to time, and which ignores time entirely in its construction.

## Overlays

Overlays are generally superimposed over the main price chart.

- Resistance — a price level that may act as a ceiling above price
- Support — a price level that may act as a floor below price
- Trend line — a sloping line described by at least two peaks or two troughs
- Channel — a pair of parallel trend lines
- Moving average — the last n-bars of price divided by "n" -- where "n" is the number of bars specified by the length of the average. A moving average can be thought of as a kind of dynamic trend-line.
- Bollinger bands — a range of price volatility
- Parabolic SAR — Wilder's trailing stop based on prices tending to stay within a parabolic curve during a strong trend
- Pivot point — derived by calculating the numerical average of a particular currency's or stock's high, low and closing prices
- Ichimoku kinko hyo — a moving average-based system that factors in time and the average point between a candle's high and low

## Price-based indicators

These indicators are generally shown below or above the main price chart.

- Advance decline line — a popular indicator of market breadth
- Average Directional Index — a widely used indicator of trend strength
- Commodity Channel Index — identifies cyclical trends
- MACD — moving average convergence/divergence
- Relative Strength Index (RSI) — oscillator showing price strength
- Stochastic oscillator — close position within recent trading range
- Trix — an oscillator showing the slope of a triple-smoothed exponential moving average
- Momentum — the rate of price change

## Volume-based indicators

- Accumulation/distribution index — based on the close within the day's range
- Money Flow — the amount of stock traded on days the price went up
- On-balance volume — the momentum of buying and selling stocks

## Notes

- [1] See e.g. Kirkpatrick and Dahlquist *Technical Analysis: The Complete Resource for Financial Market Technicians* (Financial Times Press, 2006), page 3.
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## External links

International and national organizations

- International Federation of Technical Analysts (<http://www.ifta.org>)
- Market Technicians Association (<http://www.mta.org>)
- New Zealand: Society of Technical Analysts of New Zealand (<http://www.stanz.co.nz>)
- Singapore: Technical Analysts Society (Singapore) (<http://www.tass.org.sg>)

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# CONCEPTS

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## Support and resistance

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**Support and resistance** is a concept in technical analysis that the movement of the price of a security will tend to stop and reverse at certain predetermined price levels.

### Support

A **support level** is a price level where the price tends to find support as it is going down. This means the price is more likely to "bounce" off this level rather than break through it. However, once the price has passed this level, by an amount exceeding some noise, it is likely to continue dropping until it finds another support level.

### Resistance

A **resistance level** is the opposite of a support level. It is where the price tends to find resistance as it is going up. This means the price is more likely to "bounce" off this level rather than break through it. However, once the price has passed this level, by an amount exceeding some noise, it is likely that it will continue rising until it finds another resistance level.

### Reactive vs Proactive support and resistance

Most Traders will be aware of the many different types of Support and Resistance methods used by traders

Proactive Support and Resistance methods are 'predictive' they often outline areas where price has not actually been. They are formed based upon current price action that through analysis has been shown to be predictive of future price action. Proactive Support and Resistance methods include Elliot Wave, Fibonacci, Calculated Pivots, Trendlines and Moving averages. VWAP, Market Profile (VAH, VAL and POC)

Reactive Support and Resistance are the opposite they are formed directly as a result of price action or volume behaviour. They include Volume Profile, Price Swing lows/highs, Initial Balance, Open Gaps and OHLC.

Both Proactive and Reactive Support and Resistance methods have merit and form a staple part of any Support and Resistance based trading strategy

### Identifying support and resistance levels

Support and resistance levels can be identified by trend lines. Some traders believe in using pivot point calculations.

The more often a support/resistance level is "tested" (touched and bounced off by price), the more significance given to that specific level.

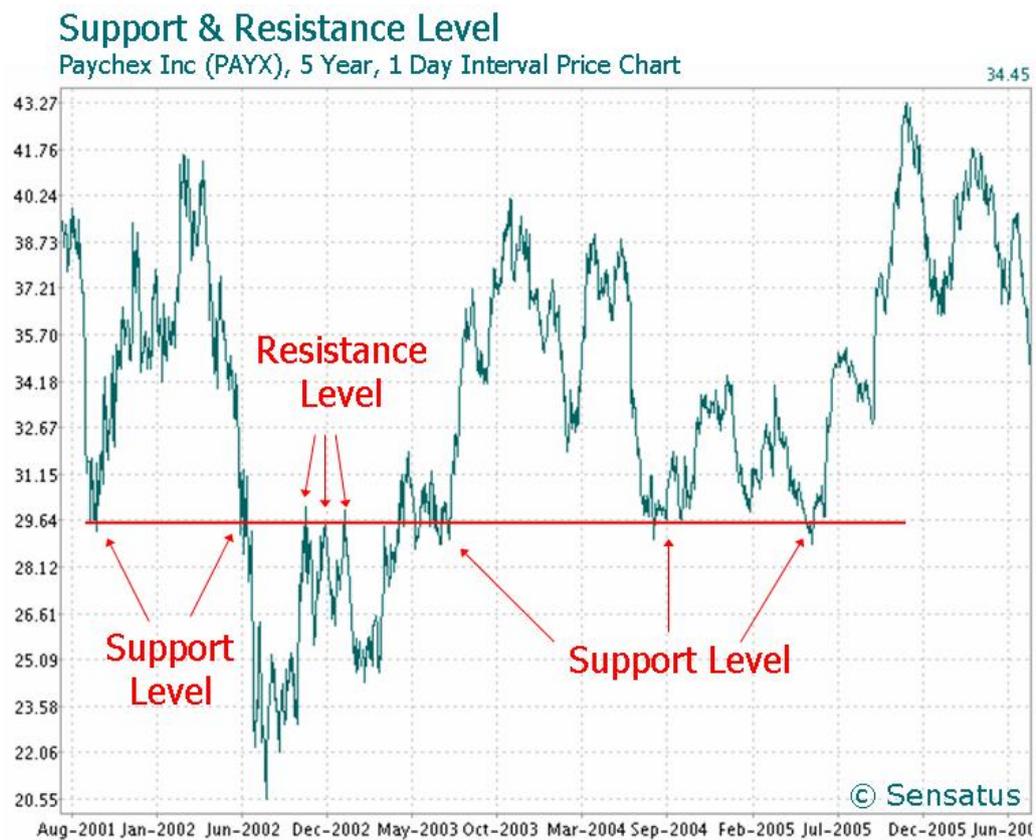
If a price breaks past a support level, that support level often becomes a new resistance level. The opposite is true as well, if price breaks a resistance level, it will often find support at that level in the future.

Various methods of determining support and resistance exist. A price histogram is useful in showing at what price a market has spent more relative time. Psychological levels near round numbers often serve as support and resistance. More recently, volatility has been used to calculate potential support and resistance.

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## Using support and resistance levels

This is an example of support switching roles with resistance, and vice versa:



If a stock price is moving between support and resistance levels, then a basic investment strategy commonly used by traders, is to buy a stock at support and sell at resistance, then short at resistance and cover the short at support as per the following example:

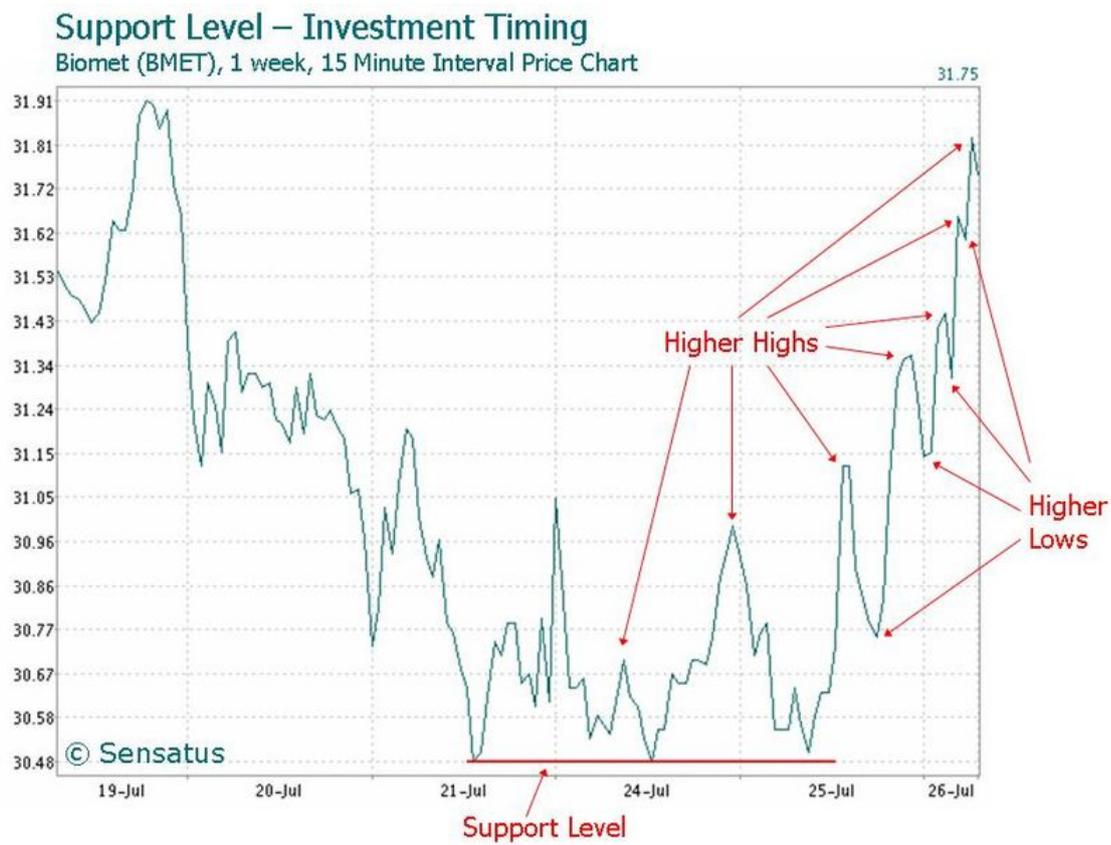
## Support and Resistance Trading Channel

Microsoft (MSFT), 5 Year, 1 Week Interval Price Chart

22.52



When judging entry and exit investment timing using support or resistance levels it is important to choose a chart based on a price interval period that aligns with your trading strategy timeframe. Short term traders tend to use charts based on interval periods, such as 1 minute (i.e. the price of the security is plotted on the chart every 1 minute), with longer term traders using price charts based on hourly, daily, weekly or monthly interval periods. Typically traders use shorter term interval charts when making a final decisions on when to invest, such as the following example based on 1 week of historical data with price plotted every 15 minutes. In this example the early signs that the stock was coming out of a downtrend was when it started to form support at \$30.48 and then started to form higher highs and higher lows signalling a change from negative to positive trending.



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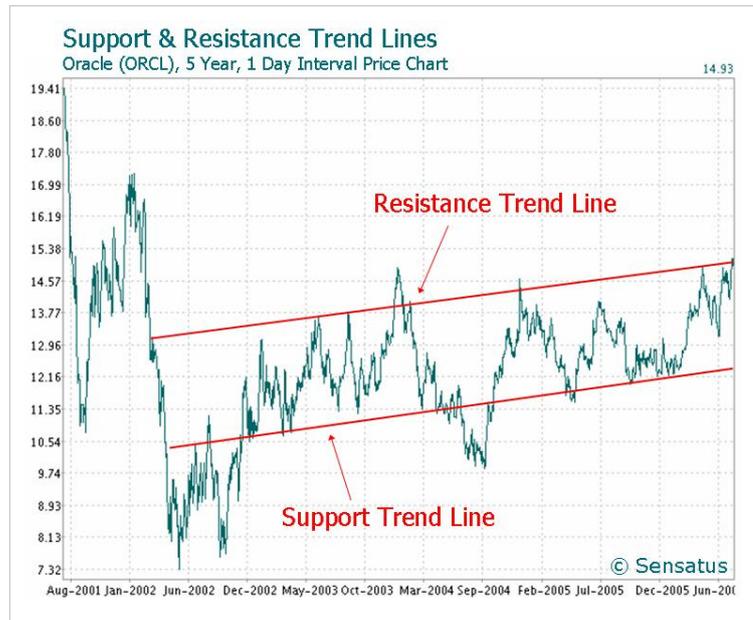
- John Murphy, Technical Analysis of the Financial Markets, ISBN 978-0735200661

# Trend line (technical analysis)

A **trend line** is formed when you can draw a diagonal line between two or more price pivot points. They are commonly used to judge entry and exit investment timing when trading securities. It can also be referred to a **dutch line** as it was first used in Holland

A trend line is a bounding line for the price movement of a security. A **support trend line** is formed when a securities price decreases and then rebounds at a pivot point that aligns with at least two previous support pivot points. Similarly a **resistance trend line** is formed when a securities price increases and then rebounds at a pivot point that aligns with at least two previous resistance pivot points. The following chart provides an example of support and resistance trend lines:

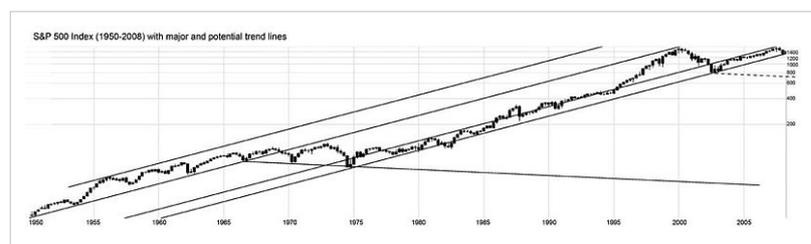
Trend lines are a simple and widely used technical analysis approach to judging entry and exit investment timing. To establish a trend line historical data, typically presented in the format of a chart such as the above price chart, is required. Historically, trend lines have been drawn by hand on paper charts, but it is now more common to use charting software that enables trend lines to be drawn on computer based charts. There are some charting software that will automatically generate trend lines, however most traders prefer to draw their own trend lines.



When establishing trend lines it is important to choose a chart based on a price interval period that aligns with your trading strategy. Short term traders tend to use charts based on interval periods, such as 1 minute (i.e. the price of the security is plotted on the chart every 1 minute), with longer term traders using price charts based on hourly, daily, weekly and monthly interval periods.

However, time periods can also be viewed in terms of years. For example, below is a chart of the S&P 500 since the earliest data point until April 2008. Please note that while the Oracle example above uses a linear scale of price changes, long term data is more often viewed as logarithmic: e.g. the changes are really an attempt to approximate percentage changes than pure numerical value. If we were to view this same chart linearly, we would not be able to see any detail from 1950 to about 1990 simply because all the data would be compressed to the bottom.

Trend lines are typically used with price charts, however they can also be used with a range of technical analysis charts such as MACD and RSI. Trend lines can be used to identify positive and negative trending charts, whereby a positive trending chart forms an



upsloping line when the support and the resistance pivot points are aligned, and a negative trending chart forms a downsloping line when the support and resistance pivot points are aligned.

Trend lines are used in many ways by traders. If a stock price is moving between support and resistance trend lines, then a basic investment strategy commonly used by traders, is to buy a stock at support and sell at resistance, then

short at resistance and cover the short at support. The logic behind this, is that when the price returns to an existing principal trend line it may be an opportunity to open new positions in the direction of the trend, in the belief that the trend line will hold and the trend will continue further. A second way is that when price action breaks through the principal trend line of an existing trend, it is evidence that the trend may be going to fail, and a trader may consider trading in the opposite direction to the existing trend, or exiting positions in the direction of the trend.

## External links

- Identifying and Trading Trend Lines <sup>[1]</sup>

## References

[1] <http://www.chartsecret.com/content/identifying-and-trading-trend-lines>

# Breakout (technical analysis)

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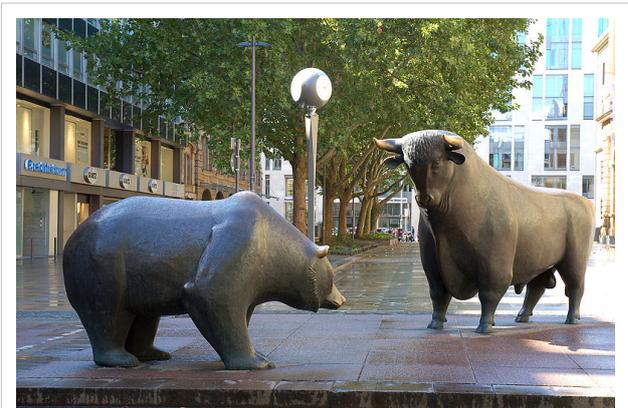
A **breakout** is when prices pass through and stay through an area of support or resistance. On the technical analysis chart a *break out* occurs when price of a stock or commodity exits an area pattern.

## Market trend

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A **market trend** is a putative tendency of a financial market to move in a particular direction over time.<sup>[1]</sup> These trends are classified as *secular* for long time frames, *primary* for medium time frames, and *secondary* lasting short times.<sup>[2]</sup> Traders identify market trends using technical analysis, a framework which characterizes market trends as a predictable price response of the market at levels of price support and price resistance, varying over time.

The terms bull market and bear market describe upward and downward market trends, respectively, and can be used to describe either the market as a whole or specific sectors and securities.<sup>[3]</sup>



Statues of the two symbolic beasts of finance, the bear and the bull, in front of the Frankfurt Stock Exchange.

## Secular market trend

A secular market trend is a long-term trend that lasts 5 to 25 years and consists of a series of sequential primary trends. A secular bear market consists of smaller bull markets and larger bear markets; a secular bull market consists of larger bull markets and smaller bear markets.

In a secular bull market the prevailing trend is "bullish" or upward moving. The United States stock market was described as being in a secular bull market from about 1983 to 2000 (or 2007), with brief upsets including the crash of 1987 and the dot-com bust of 2000–2002.

In a secular bear market, the prevailing trend is "bearish" or downward moving. An example of a secular bear market was seen in gold during the period between January 1980 to June 1999, culminating with the Brown Bottom. During this period the nominal gold price fell from a high of \$850/oz (\$30/g) to a low of \$253/oz (\$9/g),<sup>[4]</sup> and became part

of the Great Commodities Depression.

## Secondary market trend

Secondary trends are short-term changes in price direction within a primary trend. The duration is a few weeks or a few months.

One type of secondary market trend is called a market **correction**. A correction is a short term price decline of 5% to 20% or so.<sup>[5]</sup> A correction is a downward movement that is not large enough to be a bear market (ex post).

Another type of secondary trend is called a **bear market rally** (or "sucker's rally") which consist of a market price increase of 10% to 20%. A bear market rally is an upward movement that is not large enough to be a bull market (ex post). Bear market rallies occurred in the Dow Jones index after the 1929 stock market crash leading down to the market bottom in 1932, and throughout the late 1960s and early 1970s. The Japanese Nikkei 225 has been typified by a number of bear market rallies since the late 1980s while experiencing an overall long-term downward trend.

## Primary market trend

A primary trend has broad support throughout the entire market (most sectors) and lasts for a year or more.

### Bull market

A bull market is associated with increasing investor confidence, and increased investing in anticipation of future price increases (capital gains). A bullish trend in the stock market often begins before the general economy shows clear signs of recovery. It is a win-win situation for the investors.

### Examples

India's Bombay Stock Exchange Index, SENSEX, was in a bull market trend for about five years from April 2003 to January 2008 as it increased from 2,900 points to 21,000 points. A notable bull market was in the 1990s and most of the 1980s when the U.S. and many other stock markets rose; the end of this time period sees the dot-com bubble.

### Bear market

A bear market is a general decline in the stock market over a period of time.<sup>[6]</sup> It is a transition from high investor optimism to widespread investor fear and pessimism. According to The Vanguard Group, "While there's no agreed-upon definition of a bear market, one generally accepted measure is a price decline of 20% or more over at least a two-month period."<sup>[7]</sup> It is sometimes referred to as "The Heifer Market" due to the paradox with the above subject.

### Examples

A bear market followed the Wall Street Crash of 1929 and erased 89% (from 386 to 40) of the Dow Jones Industrial Average's market capitalization by July 1932, marking the start of the Great Depression. After regaining nearly 50% of its losses, a longer bear market from 1937 to 1942 occurred in which the market was again cut in half. Another long-term bear market occurred from about 1973 to 1982, encompassing the 1970s energy crisis and the high unemployment of the early 1980s. Yet another bear market occurred between March 2000 and October 2002. The most recent example occurred between October 2007 and March 2009.

## Market top

A market top (or market high) is usually not a dramatic event. The market has simply reached the highest point that it will, for some time (usually a few years). It is retroactively defined as market participants are not aware of it as it happens. A decline then follows, usually gradually at first and later with more rapidity. William J. O'Neil and company report that since the 1950s a market top is characterized by three to five distribution days in a major market index occurring within a relatively short period of time. Distribution is a decline in price with higher volume than the preceding session.

### Examples

The peak of the dot-com bubble (as measured by the NASDAQ-100) occurred on March 24, 2000. The index closed at 4,704.73 and has not since returned to that level. The Nasdaq peaked at 5,132.50 and the S&P 500 at 1525.20.

A recent peak for the broad U.S. market was October 9, 2007. The S&P 500 index closed at 1,576 and the Nasdaq at 2861.50.

## Market bottom

A market bottom is a trend reversal, the end of a market downturn, and precedes the beginning of an upward moving trend (bull market).

It is very difficult to identify a bottom (referred to by investors as "bottom picking") while it is occurring. The upturn following a decline is often short-lived and prices might resume their decline. This would bring a loss for the investor who purchased stock(s) during a misperceived or "false" market bottom.

Baron Rothschild is said to have advised that the best time to buy is when there is "blood in the streets", i.e., when the markets have fallen drastically and investor sentiment is extremely negative.<sup>[8]</sup>

### Examples

Some examples of market bottoms, in terms of the closing values of the Dow Jones Industrial Average (DJIA) include:

- The Dow Jones Industrial Average hit a bottom at 1738.74 on 19 October 1987, as a result of the decline from 2722.41 on 25 August 1987. This day was called Black Monday (chart<sup>[9]</sup>).
- A bottom of 7286.27 was reached on the DJIA on 9 October 2002 as a result of the decline from 11722.98 on 14 January 2000. This included an intermediate bottom of 8235.81 on 21 September 2001 (a 14% change from 10 September) which led to an intermediate top of 10635.25 on 19 March 2002 (chart<sup>[10]</sup>). The "tech-heavy" Nasdaq fell a more precipitous 79% from its 5132 peak (10 March 2000) to its 1108 bottom (10 October 2002).
- A decline associated with the subprime mortgage crisis starting at 14164.41 on 9 October 2007 (DJIA) and caused a bottom of 6,440.08 on 9 March 2009 (chart<sup>[11]</sup>).

## Investor sentiment

Investor sentiment is a contrarian stock market indicator.

By definition, the market balances buyers and sellers, so it's impossible to literally have 'more buyers than sellers' or vice versa, although that is a common expression. The market comprises investors and traders. The investors may own a stock for many years; traders put on a position for several weeks down to seconds.

Generally, the investors follow a buy low sell high strategy.<sup>[12]</sup> Traders attempt to "fade" the investors' actions (buy when they are selling, sell when they are buying). A surge in demand from investors lifts the traders' asks, while a surge in supply hits the traders' bids.

When a high proportion of investors express a bearish (negative) sentiment, some analysts consider it to be a strong signal that a market bottom may be near. The predictive capability of such a signal (see also market sentiment) is

thought to be highest when investor sentiment reaches extreme values.<sup>[13]</sup> Indicators that measure investor sentiment may include:

- Investor Intelligence Sentiment Index: If the Bull-Bear spread (% of Bulls - % of Bears) is close to a historic low, it may signal a bottom. Typically, the number of bears surveyed would exceed the number of bulls. However, if the number of bulls is at an extreme high and the number of bears is at an extreme low, historically, a market top may have occurred or is close to occurring. This contrarian measure is more reliable for its coincidental timing at market lows than tops.
- American Association of Individual Investors (AAII) sentiment indicator: Many feel that the majority of the decline has already occurred once this indicator gives a reading of minus 15% or below.
- Other sentiment indicators include the Nova-Ursa ratio, the Short Interest/Total Market Float, and the Put/Call ratio.

## Market capitulation

Market capitulation refers to the threshold reached after a severe fall in the market, when large numbers of investors can no longer tolerate the financial losses incurred.<sup>[14]</sup> These investors then capitulate (give up) and sell in panic, or find that their pre-set sell stops have been triggered, thereby automatically liquidating their holdings in a given stock. This may trigger a further decline in the stock's price, if not already anticipated by the market. Margin calls and mutual fund and hedge fund redemptions significantly contribute to capitulations.

The contrarians consider a capitulation a sign of a possible bottom in prices. This is because almost everyone who wanted (or was forced) to sell stock has already done so, leaving the buyers in the market, and they are expected to drive the prices up.

The peak in volume may precede an actual bottom.

## Changes with consumer behavior

Market trends are fluctuated on the demographics and technology. In a micro economical view, the current state of consumer trust in spending will vary the circulation of currency. In a micro economical view, demographics within a market will change the advancement of businesses and companies. With the introduction of the internet, consumers have access to different vendors as well as substitute products and services changing the direction of which a market will go.

Despite that it is believed that market trends follow one direction over a matter of time, there are many different factors that change can change this idea. Technology s-curves, explained in the book *The Innovator's Dilemma*, states that technology will start slow then increase in users once better understood but level off once another technology replaces it, proving that change in the market is actually consistent.

## Etymology

The precise origin of the phrases "bull market" and "bear market" are obscure. The *Oxford English Dictionary* cites an 1891 use of the term "bull market". In French "bulle spéculative" refers to a speculative market bubble. The Online Etymology Dictionary relates the word "bull" to "inflate, swell", and dates its stock market connotation to 1714.<sup>[15]</sup>

One hypothetical etymology points to London bearskin "jobbers" (market makers), who would sell bearskins before the bears had actually been caught in contradiction of the proverb *ne vendez pas la peau de l'ours avant de l'avoir tué* ("don't sell the bearskin before you've killed the bear")—an admonition against over-optimism. By the time of the South Sea Bubble of 1721, the bear was also associated with short selling; jobbers would sell bearskins they did not own in anticipation of falling prices, which would enable them to buy them later for an additional profit.

Another plausible origin is from the word "bulla" which means bill, or contract. When a market is rising, holders of contracts for future delivery of a commodity see the value of their contract increase. However in a falling market, the counterparties—the "bearers" of the commodity to be delivered—win because they have locked in a future delivery price that is higher than the current price.

Some analogies that have been used as mnemonic devices:

- Bull is short for 'bully', in its now mostly obsolete meaning of 'excellent'.
- It relates to the common use of these animals in blood sport, i.e. bear-baiting and bull-baiting.
- It refers to the way that the animals attack: a bull attacks upwards with its horns, while a bear swipes downwards with its paws.
- It relates to the speed of the animals: bulls usually charge at very high speed whereas bears normally are thought of as lazy and cautious movers—a misconception because a bear, under the right conditions, can outrun a horse.<sup>[16]</sup>
- They were originally used in reference to two old merchant banking families, the Barings and the Bulstrodes.
- Bears hibernate, while bulls do not.
- The word "bull" plays off the market's returns being "full" whereas "bear" alludes to the market's returns being "bare".

In describing financial market behavior, the largest group of market participants is often referred to, metaphorically, as the herd. This is especially relevant to participants in bull markets since bulls are herding animals. A bull market is also sometimes described as a bull run. Dow Theory attempts to describe the character of these market movements.<sup>[17]</sup>

International sculpture team Mark and Diane Weisbeck were chosen to re-design Wall Street's Bull Market. Their winning sculpture, the "Bull Market Rocket" was chosen as the modern, 21st century symbol of the up-trending Bull Market.

## Criticism

The concept of market trends is inconsistent with the standard academic view of the price movement of the financial markets, the efficient-market hypothesis.<sup>[18] [19]</sup>

## References

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## External links

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# Dead cat bounce

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**Dead cat bounce** is a Wall Street term that refers to a small, brief recovery in the price of a declining stock.<sup>[1]</sup>

## History

The term "dead cat bounce" is derived from the idea that "even a dead cat will bounce if it falls from a great height".<sup>[2]</sup> The phrase has been used on Wall Street for many years. The earliest use of the phrase dates from 1985 when the Singaporean and Malaysian stock markets bounced back after a hard fall during the recession of that year. Journalist Christopher Sherwell of the *Financial Times* reported a stock broker as saying the market rise was a "dead cat bounce". A similar expression has an older history in Cantonese and this may be the origin of the term.

## Variations and usage

A short rise in price followed by a price decline of a stock is the standard usage of the term. In other instances the term is used exclusively to refer to securities or stocks that are considered to be of low value. First, the securities have poor past performance. Second, there is no indication of an impending rise in price. Lastly, there is no indication that sustained growth is imminent should a major upward shift occur in the market.<sup>[2]</sup>

Some variations on the definition of the term include:

- A stock in a severe decline has a sharp bounce off the lows.<sup>[3]</sup>
- A small upward price movement in a bear market after which the market continues to fall.<sup>[4] [5] [6]</sup>

## Technical analysis

A "dead cat bounce" price pattern may be considered part of the technical analysis method of stock trading. Price patterns such as the dead cat bounce are recognized only with hindsight. Technical analysis describes a dead cat bounce as a continuation pattern that looks in the beginning like a reversal pattern. It begins with a downward move followed by a significant price retracement. The price fails to continue upward and instead falls again downwards, and exceeds the prior low.<sup>[7]</sup>

## Alternate meanings

The term has also been used in reference to political polling numbers.<sup>[8]</sup>

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## External links

- Investopedia.com (<http://www.investopedia.com/terms/d/deadcatbounce.asp>)

# Elliott wave principle

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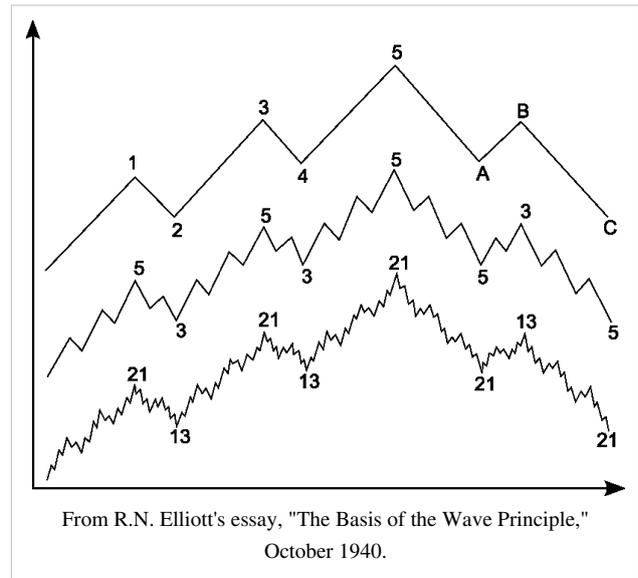
Economic Waves series (see Business cycles)	
Cycle/Wave Name	Years
Kitchin inventory	3–5
Juglar fixed investment	7–11
Kuznets infrastructural investment	15–25
Kondratiev wave	45–60

The **Elliott Wave Principle** is a form of technical analysis that traders use to analyze financial market cycles and forecast market trends by identifying extremes in investor psychology, highs and lows in prices, and other collective factors. Ralph Nelson Elliott (1871–1948), a professional accountant, discovered the underlying social principles and developed the analytical tools in the 1930s. He proposed that market prices unfold in specific patterns, which practitioners today call Elliott waves, or simply waves. Elliott published his theory of market behavior in the book *The Wave Principle* in 1938, summarized it in a series of articles in *Financial World* magazine in 1939, and covered it most comprehensively in his final major work, *Nature's Laws: The Secret of the Universe* in 1946. Elliott stated that "because man is subject to rhythmical procedure, calculations having to do with his activities can be projected far into the future with a justification and certainty heretofore unattainable."<sup>[1]</sup>

## Overall design

The Elliott Wave Principle posits that collective investor psychology, or crowd psychology, moves between optimism and pessimism in natural sequences. These mood swings create patterns evidenced in the price movements of markets at every degree of trend or time scale.

In Elliott's model, market prices alternate between an impulsive, or *motive* phase, and a corrective phase on all time scales of trend, as the illustration shows. Impulses are always subdivided into a set of 5 lower-degree waves, alternating again between motive and corrective character, so that waves 1, 3, and 5 are impulses, and waves 2 and 4 are smaller retraces of waves 1 and 3. Corrective waves subdivide into 3 smaller-degree waves starting with a five-wave counter-trend impulse, a retrace, and another impulse. In a bear market the dominant trend is downward, so the pattern is reversed—five waves down and three up. Motive waves always move with the trend, while corrective waves move against it.



## Degree

The patterns link to form five and three-wave structures which themselves underlie self-similar wave structures of increasing size or higher degree. Note the lower most of the three idealized cycles. In the first small five-wave sequence, waves 1, 3 and 5 are motive, while waves 2 and 4 are corrective. This signals that the movement of the wave one degree higher is upward. It also signals the start of the first small three-wave corrective sequence. After the initial five waves up and three waves down, the sequence begins again and the self-similar fractal geometry begins to unfold according to the five and three-wave structure which it underlies one degree higher. The completed motive pattern includes 89 waves, followed by a completed corrective pattern of 55 waves.<sup>[2]</sup>

Each degree of a pattern in a financial market has a name. Practitioners use symbols for each wave to indicate both function and degree—numbers for motive waves, letters for corrective waves (shown in the highest of the three idealized series of wave structures or degrees). Degrees are relative; they are defined by form, not by absolute size or duration. Waves of the same degree may be of very different size and/or duration.<sup>[2]</sup>

The classification of a wave at any particular degree can vary, though practitioners generally agree on the standard order of degrees (approximate durations given):

- Grand supercycle: multi-century
- Supercycle: multi-decade (about 40-70 years)
- Cycle: one year to several years (or even several decades under an Elliott Extension)
- Primary: a few months to a couple of years
- Intermediate: weeks to months
- Minor: weeks
- Minute: days
- Minuette: hours
- Subminuette: minutes

## Elliott Wave personality and characteristics

Elliott wave analysts (or *Elliotticians*) hold that each individual wave has its own *signature* or characteristic, which typically reflects the psychology of the moment.<sup>[2] [3]</sup> Understanding those personalities is key to the application of the Wave Principle; they are defined below. (Definitions assume a bull market in equities; the characteristics apply in reverse in bear markets.)

Five wave pattern (dominant trend)	Three wave pattern (corrective trend)	
<p><b>Wave 1:</b> Wave one is rarely obvious at its inception. When the first wave of a new bull market begins, the fundamental news is almost universally negative. The previous trend is considered still strongly in force. Fundamental analysts continue to revise their earnings estimates lower; the economy probably does not look strong. Sentiment surveys are decidedly bearish, put options are in vogue, and implied volatility in the options market is high. Volume might increase a bit as prices rise, but not by enough to alert many technical analysts.</p>	<p><b>Wave A:</b> Corrections are typically harder to identify than impulse moves. In wave A of a bear market, the fundamental news is usually still positive. Most analysts see the drop as a correction in a still-active bull market. Some technical indicators that accompany wave A include increased volume, rising implied volatility in the options markets and possibly a turn higher in open interest in related futures markets.</p>	
<p><b>Wave 2:</b> Wave two corrects wave one, but can never extend beyond the starting point of wave one. Typically, the news is still bad. As prices retest the prior low, bearish sentiment quickly builds, and "the crowd" haughtily reminds all that the bear market is still deeply ensconced. Still, some positive signs appear for those who are looking: volume should be lower during wave two than during wave one, prices usually do not retrace more than 61.8% (see Fibonacci section below) of the wave one gains, and prices should fall in a three wave pattern.</p>	<p><b>Wave B:</b> Prices reverse higher, which many see as a resumption of the now long-gone bull market. Those familiar with classical technical analysis may see the peak as the right shoulder of a head and shoulders reversal pattern. The volume during wave B should be lower than in wave A. By this point, fundamentals are probably no longer improving, but they most likely have not yet turned negative.</p>	
<p><b>Wave 3:</b> Wave three is usually the largest and most powerful wave in a trend (although some research suggests that in commodity markets, wave five is the largest). The news is now positive and fundamental analysts start to raise earnings estimates. Prices rise quickly, corrections are short-lived and shallow. Anyone looking to "get in on a pullback" will likely miss the boat. As wave three starts, the news is probably still bearish, and most market players remain negative; but by wave three's midpoint, "the crowd" will often join the new bullish trend. Wave three often extends wave one by a ratio of 1.618:1.</p>	<p><b>Wave C:</b> Prices move impulsively lower in five waves. Volume picks up, and by the third leg of wave C, almost everyone realizes that a bear market is firmly entrenched. Wave C is typically at least as large as wave A and often extends to 1.618 times wave A or beyond.</p>	
<p><b>Wave 4:</b> Wave four is typically clearly corrective. Prices may meander sideways for an extended period, and wave four typically retraces less than 38.2% of wave three (see Fibonacci relationships below). Volume is well below than that of wave three. This is a good place to buy a pull back if you understand the potential ahead for wave 5. Still, fourth waves are often frustrating because of their lack of progress in the larger trend.</p>		
<p><b>Wave 5:</b> Wave five is the final leg in the direction of the dominant trend. The news is almost universally positive and everyone is bullish. Unfortunately, this is when many average investors finally buy in, right before the top. Volume is often lower in wave five than in wave three, and many momentum indicators start to show divergences (prices reach a new high but the indicators do not reach a new peak). At the end of a major bull market, bears may very well be ridiculed (recall how forecasts for a top in the stock market during 2000 were received).</p>		

## Pattern recognition and fractals

Elliott's market model relies heavily on looking at price charts. Practitioners study developing trends to distinguish the waves and wave structures, and discern what prices may do next; thus the application of the wave principle is a form of pattern recognition.

The structures Elliott described also meet the common definition of a fractal (self-similar patterns appearing at every degree of trend). Elliott wave practitioners say that just as naturally-occurring fractals often expand and grow more complex over time, the model shows that collective human psychology develops in natural patterns, via buying and selling decisions reflected in market prices: "It's as though we are somehow programmed by mathematics. Seashell, galaxy, snowflake or human: we're all bound by the same order."<sup>[4]</sup>

## Elliott wave rules and guidelines

A correct Elliott wave "count" must observe three rules: 1) Wave 2 always retraces less than 100% of wave 1; 2) Wave 3 cannot be the shortest of the three impulse waves, namely waves 1, 3 and 5; 3) Wave 4 does not overlap with the price territory of wave 1, except in the rare case of a diagonal triangle. A common guideline observes that in a five-wave pattern, waves 2 and 4 will often take alternate forms; a sharp move in wave 2, for example, will suggest a mild move in wave 4. Corrective wave patterns unfold in forms known as zigzags, flats, or triangles. In turn these corrective patterns can come together to form more complex corrections.<sup>[3]</sup>

## Fibonacci relationships

R. N. Elliott's analysis of the mathematical properties of waves and patterns eventually led him to conclude that "The Fibonacci Summation Series is the basis of The Wave Principle".<sup>[1]</sup> Numbers from the Fibonacci sequence surface repeatedly in Elliott wave structures, including motive waves (1, 3, 5), a single full cycle (5 up, 3 down = 8 waves), and the completed motive (89 waves) and corrective (55 waves) patterns. Elliott developed his market model before he realized that it reflects the Fibonacci sequence. "When I discovered The Wave Principle action of market trends, I had never heard of either the Fibonacci Series or the Pythagorean Diagram".<sup>[1]</sup>

The Fibonacci sequence is also closely connected to the Golden ratio (1.618). Practitioners commonly use this ratio and related ratios to establish support and resistance levels for market waves, namely the price points which help define the parameters of a trend.<sup>[5]</sup> See Fibonacci retracement.

Finance professor Roy Batchelor and researcher Richard Ramyar, a former Director of the United Kingdom Society of Technical Analysts and Head of UK Asset Management Research at Reuters Lipper, studied whether Fibonacci ratios appear non-randomly in the stock market, as Elliott's model predicts. The researchers said the "idea that prices retrace to a Fibonacci ratio or round fraction of the previous trend clearly lacks any scientific rationale". They also said "there is no significant difference between the frequencies with which price and time ratios occur in cycles in the Dow Jones Industrial Average, and frequencies which we would expect to occur at random in such a time series".<sup>[6]</sup>

Robert Prechter replied to the Batchelor–Ramyar study, saying that it "does not challenge the validity of any aspect of the Wave Principle...it supports wave theorists' observations," and that because the authors had examined ratios between prices achieved in filtered trends rather than Elliott waves, "their method does not address actual claims by wave theorists".<sup>[7]</sup> The Socionomics Institute also reviewed data in the Batchelor–Ramyar study, and said these data show "Fibonacci ratios do occur more often in the stock market than would be expected in a random environment".<sup>[8]</sup>

Example of the Elliott Wave Principle and the Fibonacci relationship

The GBP/JPY currency chart gives an example of a fourth wave retracement apparently halting between the 38.2% and 50.0% Fibonacci retracements of a completed third wave. The chart also highlights how the Elliott Wave Principle works well with other technical analysis tendencies as prior support (the bottom of wave-1) acts as resistance to wave-4. The wave count depicted in the chart would be invalidated if GBP/JPY moves above the wave-1 low.

## After Elliott

Following Elliott's death in 1948, other market technicians and financial professionals continued to use the wave principle and provide forecasts to investors. Charles Collins, who had published Elliott's "Wave Principle" and helped introduce Elliott's theory to Wall Street, ranked Elliott's contributions to technical analysis on a level with Charles Dow. Hamilton Bolton, founder of *The Bank Credit Analyst*, provided wave analysis to a wide readership in the 1950s and 1960s. Bolton introduced Elliott's wave principle to A.J. Frost, who provided weekly financial commentary on the Financial News Network in the 1980s. Frost co-authored *Elliott Wave Principle* with Robert Prechter in 1978.



## Rediscovery and current use

Robert Prechter came across Elliott's works while working as a market technician at Merrill Lynch. His prominence as a forecaster during the bull market of the 1980s brought the greatest exposure to date to Elliott's work, and today Prechter remains the most widely known Elliott analyst.<sup>[9]</sup>

Among market technicians, wave analysis is widely accepted as a component of their trade. Elliott's Wave principle is among the methods included on the exam that analysts must pass to earn the Chartered Market Technician (CMT) designation, the professional accreditation developed by the Market Technicians Association (MTA).

Robin Wilkin, Ex-Global Head of FX and Commodity Technical Strategy at JPMorgan Chase, says "the Elliott Wave principle ... provides a probability framework as to when to enter a particular market and where to get out, whether for a profit or a loss."<sup>[10]</sup>

Jordan Kotick, Global Head of Technical Strategy at Barclays Capital and past President of the Market Technicians Association, has said that R. N. Elliott's "discovery was well ahead of its time. In fact, over the last decade or two, many prominent academics have embraced Elliott's idea and have been aggressively advocating the existence of financial market fractals."<sup>[11]</sup>

One such academic is the physicist Didier Sornette, visiting professor at the Department of Earth and Space Science and the Institute of Geophysics and Planetary Physics at UCLA. In a paper he co-authored in 1996 ("Stock Market Crashes, Precursors and Replicas") Sornette said,

It is intriguing that the log-periodic structures documented here bear some similarity with the "Elliott waves" of technical analysis ... A lot of effort has been developed in finance both by academic and trading institutions and more recently by physicists (using some of their statistical tools developed to deal with complex times series) to analyze past data to get information on the future. The 'Elliott wave' technique is probably the most famous in this field. We speculate that the "Elliott waves", so strongly rooted in the financial analysts'

folklore, could be a signature of an underlying critical structure of the stock market.<sup>[12]</sup>

Paul Tudor Jones, the billionaire commodity trader, calls Prechter and Frost's standard text on Elliott "a classic," and one of "the four Bibles of the business":

[Magee and Edwards'] *Technical Analysis of Stock Trends* and *The Elliott Wave Theorist* both give very specific and systematic ways to approach developing great reward/risk ratios for entering into a business contract with the marketplace, which is what every trade should be if properly and thoughtfully executed.<sup>[13]</sup>

## Criticism

The premise that markets unfold in recognizable patterns contradicts the efficient market hypothesis, which states that prices cannot be predicted from market data such as moving averages and volume. By this reasoning, if successful market forecasts were possible, investors would buy (or sell) when the method predicted a price increase (or decrease), to the point that prices would rise (or fall) immediately, thus destroying the profitability and predictive power of the method. In efficient markets, knowledge of the Elliott Wave Principle among traders would lead to the disappearance of the very patterns they tried to anticipate, rendering the method, and all forms of technical analysis, useless.

Benoit Mandelbrot has questioned whether Elliott waves can predict financial markets:

But Wave prediction is a very uncertain business. It is an art to which the subjective judgement of the chartists matters more than the objective, replicable verdict of the numbers. The record of this, as of most technical analysis, is at best mixed.<sup>[14]</sup>

Robert Prechter had previously stated that ideas in an article by Mandelbrot<sup>[15]</sup> "originated with Ralph Nelson Elliott, who put them forth more comprehensively and more accurately with respect to real-world markets in his 1938 book *The Wave Principle*."<sup>[16]</sup>

Critics also warn the wave principle is too vague to be useful, since it cannot consistently identify when a wave begins or ends, and that Elliott wave forecasts are prone to subjective revision. Some who advocate technical analysis of markets have questioned the value of Elliott wave analysis. Technical analyst David Aronson wrote:<sup>[17]</sup>

The Elliott Wave Principle, as popularly practiced, is not a legitimate theory, but a story, and a compelling one that is eloquently told by Robert Prechter. The account is especially persuasive because EWP has the seemingly remarkable ability to fit any segment of market history down to its most minute fluctuations. I contend this is made possible by the method's loosely defined rules and the ability to postulate a large number of nested waves of varying magnitude. This gives the Elliott analyst the same freedom and flexibility that allowed pre-Copernican astronomers to explain all observed planet movements even though their underlying theory of an Earth-centered universe was wrong.

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## External links

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- Elliott Wave International - What Is the Wave Principle? (<http://www.elliottwave.com/education/welcome/1.htm>)

# Fibonacci retracement

**Fibonacci retracements** are a method of technical analysis for determining support and resistance levels. They are named after their use of the Fibonacci sequence. Fibonacci retracement is based on the idea that markets will retrace a predictable portion of a move, after which they will continue to move in the original direction.

Fibonacci retracement is created by taking two extreme points on a chart and dividing the vertical distance by the key Fibonacci ratios. 0.0% is considered to be the start of the retracement, while 100.0% is a complete reversal to the original part of the move. Once these levels are identified, horizontal lines are drawn and used to identify possible support and resistance levels



## Fibonacci ratios

Fibonacci ratios are mathematical relationships, expressed as ratios, derived from the Fibonacci sequence. The key Fibonacci ratios are 0%, 23.6%, 38.2%, 50%, 61.8% and 100%.

$$F_{100\%} = \left( \frac{1 + \sqrt{5}}{2} \right)^0 = 1$$

The key Fibonacci ratio of 0.618 is derived by dividing any number in the sequence by the number that immediately follows it. *For example: 8/13 is approximately 0.6154, and 55/89 is approximately 0.6180.*

$$F_{61.8\%} = \left( \frac{1 + \sqrt{5}}{2} \right)^{-1} \approx 0.618034$$

The 0.382 ratio is found by dividing any number in the sequence by the number that is found two places to the right. *For example: 34/89 is approximately 0.3820.*

$$F_{38.2\%} = \left( \frac{1 + \sqrt{5}}{2} \right)^{-2} \approx 0.381966$$

The 0.236 ratio is found by dividing any number in the sequence by the number that is three places to the right. *For example: 55/233 is approximately 0.2361.*

$$F_{23.6\%} = \left( \frac{1 + \sqrt{5}}{2} \right)^{-3} \approx 0.236068$$

The 0 ratio is :

$$F_{0\%} = \left( \frac{1 + \sqrt{5}}{2} \right)^{-\infty} = 0$$

### Other ratios

The 0.764 ratio is the result of subtracting 0.236 from the number 1.

$$F_{76.4\%} = 1 - \left( \frac{1 + \sqrt{5}}{2} \right)^{-3} \approx 0.763932$$

The 0.786 ratio is :

$$F_{78.6\%} = \left( \frac{1 + \sqrt{5}}{2} \right)^{-\frac{1}{2}} \approx 0.786151$$

The 0.500 ratio is derived from dividing the number 1 (third number in the sequence) by the number 2 (forth number in the sequence).

$$F_{50\%} = \frac{1}{2} = 0.500000$$

### Further reading

- Stevens, Leigh (2002). *Essential technical analysis: tools and techniques to spot market trends*. New York: Wiley. ISBN 047115279X. OCLC 48532501.
- Brown, Constance M. (2008). *Fibonacci analysis*. New York: Bloomberg Press. ISBN 1576602613.
- Posamentier, Alfred S.; Lehmann, Ingmar (2007). *The fabulous Fibonacci numbers*. Amherst, NY: Prometheus Books. ISBN 1591024757.

### External links

- *What is Fibonacci retracement, and where do the ratios that are used come from?* <sup>[1]</sup> at investopedia.com
- Fibonacci Retracements <sup>[2]</sup> at stockcharts.com
- *How to draw Fibonacci retracement, and how to analyze it?* <sup>[3]</sup> at lollymotion.com

### References

[1] <http://www.investopedia.com/ask/answers/05/FibonacciRetracement.asp>

[2] [http://stockcharts.com/school/doku.php?id=chart\\_school:chart\\_analysis:fibonacci\\_retracemen](http://stockcharts.com/school/doku.php?id=chart_school:chart_analysis:fibonacci_retracemen)

[3] <http://lollymotion.com/fibonacci/fibonacci-retracement>

# Pivot point

A **pivot point** is a price level of significance in technical analysis of a financial market that is used by traders as a predictive indicator of market movement. A pivot point is calculated as an average of significant prices (high, low, close) from the performance of a market in the prior trading period. If the market in the following period trades above the pivot point it is usually evaluated as a bullish sentiment, whereas trading below the pivot point is seen as bearish.

It is customary to calculate additional levels of support and resistance, below and above the pivot point, respectively, by subtracting or adding price differentials calculated from previous trading ranges of the market.

A pivot point and the associated support and resistance levels are often turning points for the direction of price movement in a market. In an up-trending market, the pivot point and the resistance levels may represent a ceiling level in price above which the uptrend is no longer sustainable and a reversal may occur. In a declining market, a pivot point and the support levels may represent a low price level of stability or a resistance to further decline.



Monthly pivot point chart of the Dow Jones Industrials average for the first 8 months of 2009, showing sets of first and second levels of resistance (green) and support (red). The pivot point levels are highlighted in yellow. Trading below the pivot point, particularly at the beginning of a trading period sets a bearish market sentiment and often results in further price decline, while trading above it, bullish price action may continue for some time.

## Calculation

Several methods exist for calculating the pivot point ( $P$ ) of a market. Most commonly, it is the arithmetic average of the high ( $H$ ), low ( $L$ ), and closing ( $C$ ) prices of the market in the prior trading period:

$$P = (H + L + C) / 3.$$

Sometimes, the average also includes the previous period's or the current period's opening price ( $O$ ):

$$P = (O + H + L + C) / 4.$$

In other cases, traders like to emphasize the closing price,  $P = (H + L + C + C) / 4$ , or the current periods opening price,  $P = (H + L + O + O) / 4$ .

## Support and resistance levels

Price support and resistance levels are key trading tools in any market. Their roles may be interchangeable, depending on whether the price level is approached in an up-trending or a down-trending market. These price levels may be derived from many market assumptions and conventions. In pivot point analysis, several levels, usually three, are commonly recognized below and above the pivot point. These are calculated from the range of price movement in the previous trading period, added to the pivot point for resistances and subtracted from it for support levels.

The first and most significant level of support ( $S_1$ ) and resistance ( $R_1$ ) is obtained by recognition of the upper and the lower halves of the prior trading range, defined by the trading above the pivot point ( $H - P$ ), and below it ( $P - L$ ). The first resistance on the up-side of the market is given by the lower width of prior trading added to the pivot point price and the first support on the down-side is the width of the upper part of the prior trading range below the pivot point.

- $R_1 = P + (P - L) = 2 \times P - L$
- $S_1 = P - (H - P) = 2 \times P - H$

Thus, these levels may simply be calculated by subtracting the previous low ( $L$ ) and high ( $H$ ) price, respectively, from twice the pivot point value.<sup>[1]</sup>

The second set of resistance ( $R_2$ ) and support ( $S_2$ ) levels are above and below, respectively, the first set. They are simply determined from the full width of the prior trading range ( $H - L$ ), added to and subtracted from the pivot point, respectively:

- $R_2 = P + (H - L)$
- $S_2 = P - (H - L)$

Commonly a third set is also calculated, again representing another higher resistance level ( $R_3$ ) and a yet lower support level ( $S_3$ ). The method of the second set is continued by doubling the range added and subtracted from the pivot point:

- $R_3 = P + 2 \times (H - L)$
- $S_3 = P - 2 \times (H - L)$

This concept is sometimes, albeit rarely, extended to a fourth set in which the tripled value of the trading range is used in the calculation.

Qualitatively, the second and higher support and resistance levels are always located symmetrically around the pivot point, whereas this is not the case for the first levels, unless the pivot point happens to divide the prior trading range exactly in half.

## Trading tool

The pivot point itself represents a level of highest resistance or support, depending on the overall market condition. If the market is directionless (*undecided*), prices will often fluctuate greatly around this level until a price breakout develops. Trading above or below the pivot point indicates the overall market sentiment. It is a leading indicator providing advanced signaling of potentially new market highs or lows within a given time frame.<sup>[1]</sup>

The support and resistance levels calculated from the pivot point and the previous market width may be used as exit points of trades, but are rarely used as entry signals. For example, if the market is up-trending and breaks through the pivot point, the first resistance level is often a good target to close a position, as the probability of resistance and reversal increases greatly.



5-day pivot point chart of the SPDR Gold Trust (GLD) for intra-day trading in October 2009

Many traders recognize the half-way levels between any of these levels as additional, but weaker resistance or support areas.<sup>[2]</sup> The half-way (*middle*) point between the pivot point and  $R_1$  is designated  $M+$ , between  $R_1$  and  $R_2$  is  $M++$ , and below the pivot point the middle points are labeled as  $M-$  and  $M--$ . In the 5-day intra-day chart of the SPDR Gold Trust (above) the middle points can clearly be identified as support in days 1, 3, and 4, and as resistance in days 2 and 3.

## References

- [1] John L. Person, *Candlestick and Pivot Point Trading Triggers*, John Wiley & Sons (2007), ISBN 978-0-471-98022-3  
 [2] "Pivot points with half-way levels" (<http://www.stockstoshop.com/pivots.htm>). .

# Dow Theory

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**Dow Theory** on stock price movement is a form of technical analysis that includes some aspects of sector rotation. The theory was derived from 255 Wall Street Journal editorials written by Charles H. Dow (1851–1902), journalist, founder and first editor of the Wall Street Journal and co-founder of Dow Jones and Company. Following Dow's death, William Peter Hamilton, Robert Rhea and E. George Schaefer organized and collectively represented "Dow Theory," based on Dow's editorials. Dow himself never used the term "Dow Theory," nor presented it as a trading system.

The six basic tenets of Dow Theory as summarized by Hamilton, Rhea, and Schaefer are described below.

## Six basic tenets of Dow Theory

### 1. The market has three movements

(1) The "main movement", primary movement or major trend may last from less than a year to several years. It can be bullish or bearish. (2) The "medium swing", secondary reaction or intermediate reaction may last from ten days to three months and generally retraces from 33% to 66% of the primary price change since the previous medium swing or start of the main movement. (3) The "short swing" or minor movement varies with opinion from hours to a month or more. The three movements may be simultaneous, for instance, a daily minor movement in a bearish secondary reaction in a bullish primary movement.

### 2. Market trends have three phases

Dow Theory asserts that major market trends are composed of three phases: an accumulation phase, a public participation phase, and a distribution phase. The accumulation phase (*phase 1*) is a period when investors "in the know" are actively buying (selling) stock against the general opinion of the market. During this phase, the stock price does not change much because these investors are in the minority absorbing (releasing) stock that the market at large is supplying (demanding). Eventually, the market catches on to these astute investors and a rapid price change occurs (*phase 2*). This occurs when trend followers and other technically oriented investors participate. This phase continues until rampant speculation occurs. At this point, the astute investors begin to distribute their holdings to the market (*phase 3*).

### 3. The stock market discounts all news

Stock prices quickly incorporate new information as soon as it becomes available. Once news is released, stock prices will change to reflect this new information. On this point, Dow Theory agrees with one of the premises of the efficient market hypothesis.

### 4. Stock market averages must confirm each other

In Dow's time, the US was a growing industrial power. The US had population centers but factories were scattered throughout the country. Factories had to ship their goods to market, usually by rail. Dow's first stock averages were an index of industrial (manufacturing) companies and rail companies. To Dow, a bull market in industrials could not occur unless the railway average rallied as well, usually first. According to this logic, if manufacturers' profits are rising, it follows that they are producing more. If they produce more, then they have to ship more goods to consumers. Hence, if an investor is looking for signs of health in manufacturers, he or she should look at the performance of the companies that ship the output of them to market, the railroads. The two averages should be moving in the same direction. When the performance of the averages diverge, it is a warning that change is in the air.

Both Barron's Magazine and the Wall Street Journal still publish the daily performance of the Dow Jones Transportation Index in chart form. The index contains major railroads, shipping companies, and air freight carriers in the US.

### 5. Trends are confirmed by volume

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Dow believed that volume confirmed price trends. When prices move on low volume, there could be many different explanations why. An overly aggressive seller could be present for example. But when price movements are accompanied by high volume, Dow believed this represented the "true" market view. If many participants are active in a particular security, and the price moves significantly in one direction, Dow maintained that this was the direction in which the market anticipated continued movement. To him, it was a signal that a trend is developing.

#### 6. Trends exist until definitive signals prove that they have ended

Dow believed that trends existed despite "market noise". Markets might temporarily move in the direction opposite to the trend, but they will soon resume the prior move. The trend should be given the benefit of the doubt during these reversals. Determining whether a reversal is the start of a new trend or a temporary movement in the current trend is not easy. Dow Theorists often disagree in this determination. Technical analysis tools attempt to clarify this but they can be interpreted differently by different investors.

## Analysis

There is little academic support for the profitability of the Dow Theory. Alfred Cowles in a study in *Econometrica* in 1934 showed that trading based upon the editorial advice would have resulted in earning less than a buy-and-hold strategy using a well diversified portfolio. Cowles concluded that a buy-and-hold strategy produced 15.5% annualized returns from 1902-1929 while the Dow Theory strategy produced annualized returns of 12%. After numerous studies supported Cowles over the following years, many academics stopped studying Dow Theory believing Cowles's results were conclusive.

In recent years however, Cowles' conclusions have been revisited. William Goetzmann, Stephen Brown, and Alok Kumar believe that Cowles' study was incomplete [1] and that Dow Theory produces excess risk-adjusted returns.<sup>[2]</sup> Specifically, the return of a buy-and-hold strategy was higher than that of a Dow Theory portfolio by 2%, but the riskiness and volatility of the Dow Theory portfolio was lower, so that the Dow Theory portfolio produced higher risk-adjusted returns according to their study. Nevertheless, adjusting returns for risk is controversial in the context of the Dow Theory. One key problem with any analysis of Dow Theory is that the editorials of Charles Dow did not contain explicitly defined investing "rules" so some assumptions and interpretations are necessary.

Many technical analysts consider Dow Theory's definition of a trend and its insistence on studying price action as the main premises of modern technical analysis.

## References

- [1] <http://viking.som.yale.edu/will/newsclips/newsclip.html#The%20New%20York%20Times%209/6/98>
- [2] The Dow Theory: William Peter Hamilton's Record Reconsidered (<http://viking.som.yale.edu/will/dow/dowpaper.htm>)

## Further reading

- Scott Peterson: The Wall Street Journal, *Technically, A Challenge for Blue Chips*, Vol. 250, No. 122, November 23, 2007.

## External links

- Goetzmann's Dow Page (<http://viking.som.yale.edu/will/dow/dowpage.html>) Includes a link to Dow's editorials and links to numerous articles describing support of Dow Theory.
- Alfred Cowles's Yale Page with selected publications (<http://cowles.econ.yale.edu/archive/people/directors/cowles.htm>)
- Richard Russell's Dow Theory letters (<http://www.dowtheoryletters.com/>) weekly newsletter and charts.
- John Hussman discusses Dow Theory (<http://www.hussmanfunds.com/wmc/wmc080211.htm>)

- Record of Dow Theory Signals (<http://www.thedowtheory.com/Description&results.html>)

### **Classic Books by Dow Theorists**

- Dow Theory for the 21st Century, by Jack Schanep (<http://www.amazon.com/dp/0470240598>)
  - Dow Theory Today, by Richard Russell (<http://www.amazon.com/dp/0870340611>)
  - The Dow Theory, by Robert Rhea (<http://www.amazon.com/dp/0870341103>)
  - The Stock Market Barometer, by William Hamilton (<http://www.amazon.com/dp/1602060061>)
  - The ABC of Stock Speculation, by S.A. Nelson (<http://www.amazon.com/dp/1602069921>)
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# CHARTS

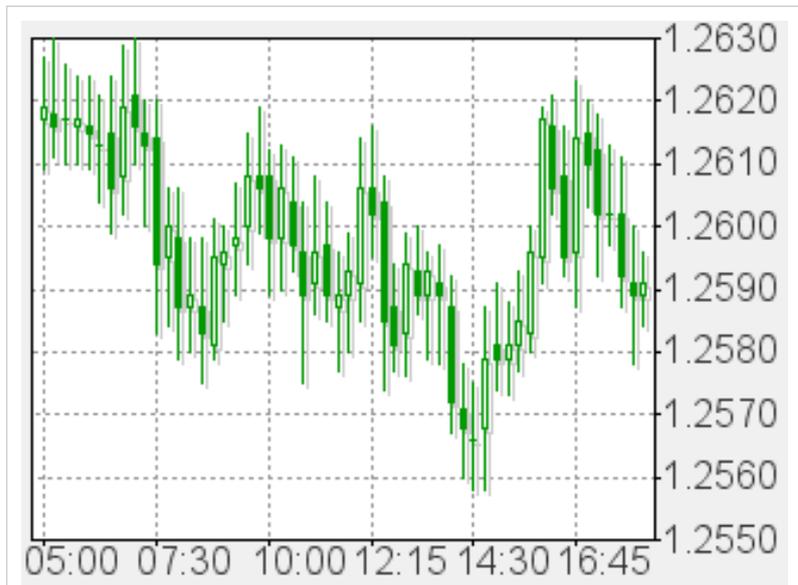
## Candlestick chart

A **candlestick chart** is a style of bar-chart used primarily to describe price movements of a security, derivative, or currency over time.

It is a combination of a line-chart and a bar-chart, in that each bar represents the range of price movement over a given time interval. It is most often used in technical analysis of equity and currency price patterns. They appear superficially similar to error bars, but are unrelated.

### History

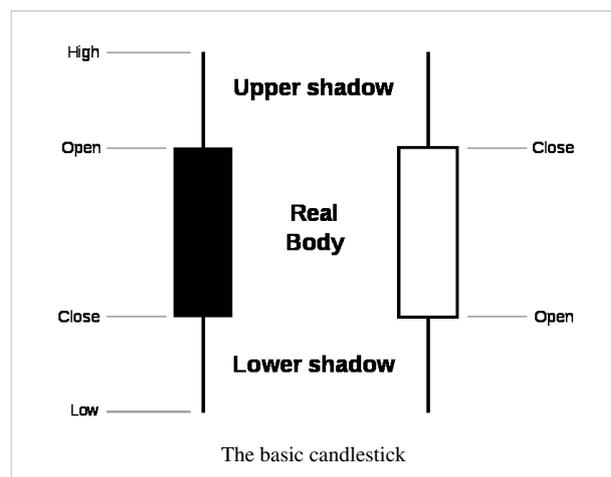
Candlestick charts are thought to have been developed in the 18th century by Japanese rice trader of financial instruments.



Candlestick chart of EURUSD

### Candlestick chart topics

Candlesticks are usually composed of the body (black or white), and an upper and a lower shadow (wick): the area between the open and the close is called the *real body*, price excursions above and below the real body are called *shadows*. The wick illustrates the highest and lowest traded prices of a security during the time interval represented. The body illustrates the opening and closing trades. If the security closed higher than it opened, the body is white or unfilled, with the opening price at the bottom of the body and the closing price at the top. If the security closed lower than it opened, the body is black, with the opening price at the top and the closing price at the bottom. A candlestick need not have either a body or a wick.



The basic candlestick

To better highlight price movements, modern candlestick charts (especially those displayed digitally) often replace the black or white of the candlestick body with colors such as red (for a lower closing) and blue or green (for a higher closing).

## Candlestick simple patterns

There are multiple forms of candlestick chart patterns

## Complex Patterns

In addition to the rather simple patterns depicted in the section above, there are more complex and difficult patterns which have been identified since the charting method's inception. Complex patterns can be colored or highlighted for better visualization.

Candlestick charts also convey more information than other forms of charts, such as bar charts. Just as with bar charts, they display the absolute values of the open, high, low, and closing price for a given period. But they also show how those prices are relative to the prior periods' prices, so one can tell by looking at one bar if the price action is higher or lower than the prior one. They are also visually easier to look at, and can be coloured for even better definition. Rather than using the open-high-low-close for a given time period (for example, 5 minute, 1 hour, 1 day, 1 month), candlesticks can also be constructed using the open-high-low-close of a specified volume range (for example, 1,000; 100,000; 1 million shares per candlestick).

## Use of candlestick charts

Candlestick charts are a visual aid for decision making in stock, forex, commodity, and options trading. For example, when the bar is white and high relative to other time periods, it means buyers are very bullish. The opposite is true for a black bar.

## Heikin-Ashi candlesticks

Heikin-Ashi (Japanese for 'average bar') candlesticks are a weighted version of candlesticks calculated with the following formula:

- $\text{Open} = (\text{open of previous bar} + \text{close of previous bar}) / 2$
- $\text{Close} = (\text{open} + \text{high} + \text{low} + \text{close}) / 4$
- $\text{High} = \text{maximum of high, open, or close (whichever is highest)}$
- $\text{Low} = \text{minimum of low, open, or close (whichever is lowest)}$

Heikin-Ashi candlesticks must be used with caution with regards to the price as the body doesn't necessarily sync up with the actual open/close. Unlike with regular candlesticks, a long wick shows more strength, whereas the same period on a standard chart might show a long body with little or no wick. Depending on the software or user preference, Heikin-Ashi may be used to chart the price (instead of line, bar, or candlestick), as an indicator overlaid on a regular chart, or as an indicator plotted on a separate window.

## See also

- Kagi chart
  - Pivot point calculations
  - Chart pattern
  - Open-high-low-close chart
  - Hikkake Pattern
-

## External links

- Tutorial of 16 Candlestick patterns with charts and explanations <sup>[1]</sup>

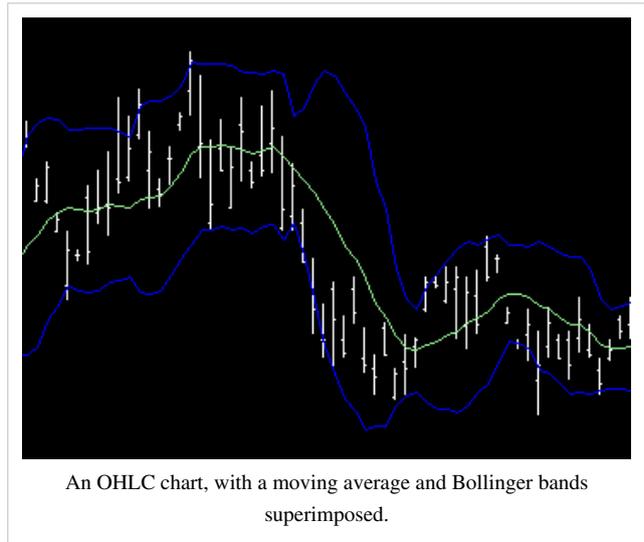
## References

[1] <http://www.onlinetradingconcepts.com/TechnicalAnalysis/Candlesticks/CandlestickBasics.html>

# Open-high-low-close chart

An **open-high-low-close chart** (also **OHLC chart**, or simply **bar chart**) is a type of chart typically used to illustrate movements in the price of a financial instrument over time. Each vertical line on the chart shows the price range (the highest and lowest prices) over one unit of time, e.g. one day or one hour. Tick marks project from each side of the line indicating the opening price (e.g. for a daily bar chart this would be the starting price for that day) on the left, and the closing price for that time period on the right. The bars may be shown in different hues depending on whether prices rose or fell in that period.

The Japanese candlestick chart is another way of displaying market price data, with the opening and closing prices defining a rectangle within the range for each time unit. Both charts show exactly the same data, i.e. the opening, high, low, and closing prices during a particular time frame. Some traders find the candlestick chart easier to read.



## External links

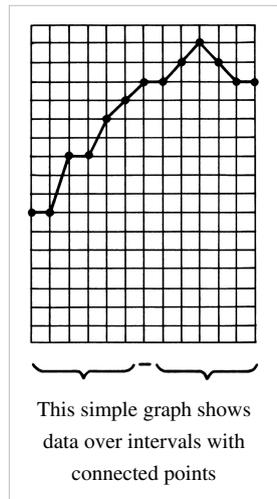
- <http://www.investopedia.com/terms/o/ohlcchart.asp>

# Line chart

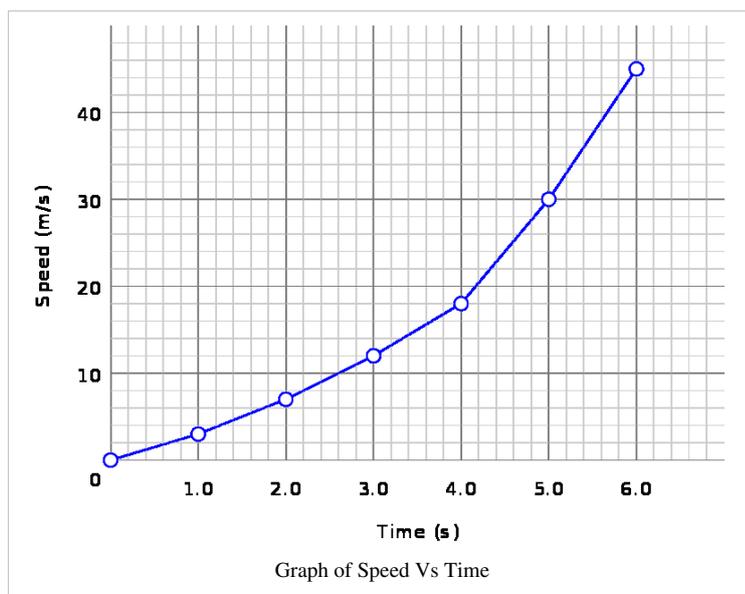
A **line chart** or **line graph** is a type of graph, which displays information as a series of data points connected by straight line segments.<sup>[1]</sup> It is a basic type of chart common in many fields. It is an extension of a scatter graph, and is created by connecting a series of points that represent individual measurements with line segments. A line chart is often used to visualize a trend in data over intervals of time – a time series – thus the line is often drawn chronologically.<sup>[2]</sup>

## Example

In the experimental sciences, data collected from experiments are often visualized by a graph that includes an overlaid mathematical function depicting the best-fit trend of the scattered data. This layer is referred to as a best-fit layer and the graph containing this layer is often referred to as a line graph.



For example, if one were to collect data on the speed of a body at certain points in time, one could visualize the data by a data table such as the following:



Elapsed Time (s)	Speed ( $\text{ms}^{-1}$ )
0	0
1	3
2	7
3	12
4	20
5	30
6	45

The table "visualization" is a great way of displaying exact values, but a very bad way of understanding the underlying patterns that those values represent. Because of these qualities, the table display is often erroneously

conflated with the data itself; whereas it is just another visualization of the data.

Understanding the process described by the data in the table is aided by producing a graph or line chart of *Speed versus Time*. In this context, Versus (or the abbreviations vs and VS), separates the parameters appearing in an X-Y (two-dimensional) graph. The first argument indicates the dependent variable, usually appearing on the Y-axis, while the second argument indicates the independent variable, usually appearing on the X-axis. So, the graph of *Speed versus Time* would plot time along the x-axis and speed up the y-axis. Mathematically, if we denote time by the variable  $t$ , and speed by  $v$ , then the function plotted in the graph would be denoted  $v(t)$  indicating that  $v$  (the dependent variable) is a function of  $t$ .

It is simple to construct a "best-fit" layer consisting of a set of line segments connecting adjacent data points; however, such a "best-fit" is usually not an ideal representation of the trend of the underlying scatter data for the following reasons:

1. It is highly improbable that the discontinuities in the slope of the best-fit would correspond exactly with the positions of the measurement values.
2. It is highly unlikely that the experimental error in the data is negligible, yet the curve falls exactly through each of the data points.

A true best-fit layer should depict a continuous mathematical function whose parameters are determined by using a suitable error-minimization scheme, which appropriately weights the error in the data values.

In either case, the best-fit layer can reveal trends in the data. Further, measurements such as the gradient or the area under the curve can be made visually, leading to more conclusions or results from the data.

## References

- [1] Burton G. Andreas (1965). *Experimental psychology*. p.186
- [2] Neil J. Salkind (2006). *Statistics for People who (think They) Hate Statistics: The Excel Edition*. page 106.

# Point and figure chart

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**Point and figure** is a charting technique used in technical analysis, used to attempt to predict financial market prices. Point and figure charting is unique in that it does not plot price against time as all other techniques do. Instead it plots price against changes in direction by plotting a column of Xs as the price rises and a column of Os as the price falls.

## History

The technique is over 100 years old. "Hoyle" was the first to write about it and showed charts in his 1898 book, *The Game in Wall Street*.<sup>[1]</sup> Richard Wyckoff also described the technique with charts in his 1910 classic, *Studies in Tape Reading*. The first book/manual dedicated to Point and Figure was written by Victor Devilliers in 1933. Chartcraft Inc, in the USA, popularized the system in the 1940s. Cohen founded Chartcraft and wrote on point and figure charting in 1947. Chartcraft published further pioneering books on P&F charting, namely those by Burke, Aby and Zieg. Chartcraft Inc is still running today, providing daily point and figure services for the US market under the name of Investors Intelligence. Veteran Mike Burke still works for Chartcraft, having started back in 1962 under the guidance of Cohen. Burke went on to train other point and figure gurus, such as Dorsey.

A detailed history can be found in Jeremy du Plessis' 'The Definitive Guide to Point and Figure' where many references and examples are cited.

Du Plessis describes their development from a price recording system to a charting method. Traders kept track of prices by writing them down in columns. They noticed patterns in their price record and started referring to them first as 'fluctuation charts' and then as 'figure charts'. They started using Xs instead of numbers and these charts became known as 'point charts'. Traders used both point charts and figure charts together and referred to them as their point and figure charts, which is where Du Plessis suggests the name point and figure came from. Modern point and figure charts are drawn with Xs and Os where columns of Xs are rising prices and columns of Os are falling prices, although many traditionalists such as David Fuller and Louise Yamada still use the Xs only point method of plotting.

## How to draw

The correct way to draw a point and figure chart is to plot every price change but practicality has rendered this difficult to do for a large quantity of stocks so many point and figure chartists use the summary prices at the end of each day. Some prefer to use the day's closing price and some prefer to use the day's high or low depending on the direction of the last column. The high/low method was invented by A.W. Cohen in his 1947 book, 'How to Use the Three-Point Reversal Method of Point & Figure Stock Market Timing' and has a large following.

The charts are constructed by deciding on the value represented by each X and O. Any price change below this value is ignored so point and figure acts as a filter to filter out the smaller price changes. The charts change column when the price changes direction by the value of a certain number of Xs or Os. Traditionally this was one and is called a 1 box reversal chart. More common is three, called a 3 box reversal chart.



## 45 Degree Trend lines

Because point and figure charts are plotted on squared paper, 45 degree lines may be used to define up trends and down trends from important highs and lows on the chart allowing objective analysis of trends.

## Price Targets

Also in common usage are two methods of obtaining price targets from point and figure charts. The vertical method measures the length of the thrust off a high or low and projects the thrust to obtain a target. The horizontal method measures the width of a congestion pattern and uses that to obtain a target.

## Computerization

In the US, Chartcraft used an IBM S/360 in the 1960s to produce point and figure charts.

Point and Figure charts were automated in the UK in the early 1980s by the Indexia company run by Jeremy Du Plessis. This automation increased the popularity and usage of point and figure charts because hundreds of charts could be viewed and altered quickly and easily. At the same time a method of log scaling point and figure charts was devised, where the value of the Xs and Os was set to a percentage rather than a price. This allowed the sensitivity of Point and Figure charts to remain constant no matter what the price level.

Kaufman, in *New Trading Systems and Methods*, 2005, documents research he and Kermit Zeig performed over many years computerizing point and figure charting. LeBeau and Lucas also developed computerized point and figure charts in *Technical Traders Guide to Computer Analysis of the Futures Markets*.

## External links

- Sample P&F chart of gold, circa January 2009 [2]

## Further reading

- Aby, Carroll D.Jr. *Point & Figure Charting: The Complete Guide*, ISBN 0-934380-30-9
- Anderson, J.A. and Faff, R. "Point and Figure Charting: A Computational Methodology and Trading Performance in the S&P 500 Futures Market", *International Review of Financial Analysis* (Forthcoming, 2006)
- Anderson, J.A., 2004. "P&F Charting - Computational Method and Distributional Forms", chapter in *Computational Finance & Its Applications*, Witpress, UK
- Burke, Michael L. *All New Guide to the Three-Point Reversal Method of Point and Figure*, 116 pages, ringbound, ISBN 99931-2-861-9.
- Cohen, A.W. *How to Use the Three-Point Reversal Method of Point & Figure Stock Market Timing* first edition 1947 - Out Of Print
- Cohen, A.W. *The Chartcraft method of point and figure trading - A technical approach to stock market trading*
- Cohen, A.W. *Technical indicator analysis by point & figure technique*
- De Villiers, Victor and Owen Taylor. *The Point and Figure Method - of anticipating Stock Price Movements*, ISBN 1-883272-83-1
- De Villiers, Victor *The Point and Figure Method - of anticipating Stock Price Movements - A reprint of the 1933 edition including a chart on the 1929 crash*, ISBN 0-930233-64-6
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- Dorsey, Thomas J. *Point and Figure Charting - The Essential Application for Forecasting and Tracking Market Prices*, 2nd Edition, ISBN 0-471-41292-9 - PDF <sup>[3]</sup>
- Dorsey, Thomas J. *Tom Dorsey's Trading Tips - A Playbook for Stock Market Success*, ISBN 1-57660-077-7
- Dorsey, Thomas J. *Sicher anlegen mit Point und Figure. Klare Signale mit einfachen Methoden*, ISBN 3-932114-38-8
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- [1] [http://books.google.com/books?id=EPMpAAAAYAAJ&printsec=frontcover&source=gbs\\_atb#v=onepage&q&f=false](http://books.google.com/books?id=EPMpAAAAYAAJ&printsec=frontcover&source=gbs_atb#v=onepage&q&f=false)
- [2] <http://caseyresearch.com/dImage.php?i=1232818310-SharpChartv05.ServletDriver.png>
- [3] [http://www.stockvision.org/books/Thomas\\_Dorsey-Point\\_and\\_Figure\\_Charting-EN.pdf](http://www.stockvision.org/books/Thomas_Dorsey-Point_and_Figure_Charting-EN.pdf)

## Kagi chart

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The **Kagi chart** is a chart used for tracking price movements and to make decisions on purchasing stock. It differs from traditional stock charts, such as the Candlestick chart by being mostly independent of time. This feature aids in producing a chart that reduces random noise.

Due to its effectiveness in showing a clear path of price movements, the Kagi chart is one of the various charts that investors use to make better decisions about stocks. The most important benefit of this chart is that it is independent of time and change of direction occurs only when a specific amount is reached.

The Kagi chart was originally developed in Japan during the 1870s when the Japanese stock market started trading.<sup>[1]</sup> It was used for tracking the price movement of rice and found use in determining the general levels of supply and demand for certain assets.

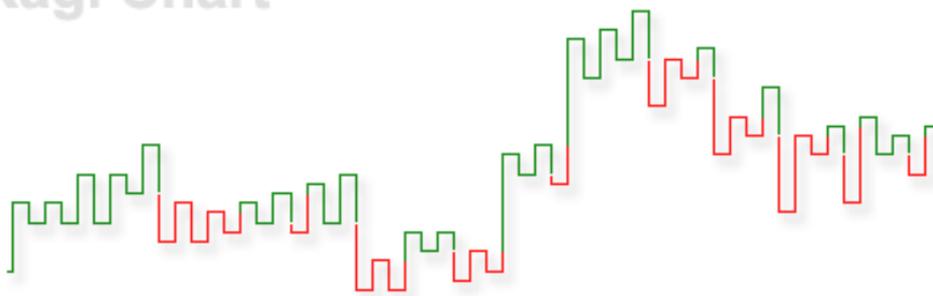
### Construction

Kagi charts look similar to swing charts and do not have a time axis.<sup>[2]</sup> A Kagi chart is created with a series of vertical lines connected by short horizontal lines. The thickness and direction of the lines is based on the price of the underlying stock or asset, as follows:

- The thickness of the line changes when the price reaches the high or low of the previous vertical line.
- The direction of the line changes when the price reaches a preset reversal amount, which is usually set at 4%.  
When a direction change occurs, a short horizontal line is drawn between the lines of opposite direction.

Alternatively, thin and thick lines can be replaced with lines of different colours, such as the green/red example in the figure.

### Kagi Chart



Changes in line thickness are used to generate transaction signals. Buy signals are generated when the Kagi line goes from thin to thick and sell signals are generated when the line turns from thick to thin.

## How to plot a Kagi chart

1. Find the starting point. The starting point is generally considered the first closing price. From this point forward, you compare each day's closing price with the starting price.
2. Draw a thin vertical line from the starting price to each day's closing price, while the trend does not reverse.
3. If a day's closing price moves in the opposite direction to the trend by more than the reversal amount, draw a short horizontal line and a new vertical line, beginning from the horizontal line to the new closing price.
4. If the price on a day is greater than or equal to the previous high, change to a thick line and continue the vertical line. If the price on that day is less than or equal to the previous low, then change to a thin line.

## References

- [1] Kagi Chart, Investopedia (<http://www.investopedia.com/terms/k/kagichart.asp>). Retrieved 16 Oct 2008.
- [2] A Look At Kagi Charts, Investopedia ([http://www.investopedia.com/articles/trading/07/kagi\\_chart.asp](http://www.investopedia.com/articles/trading/07/kagi_chart.asp)). Retrieved 16 Oct 2008.

## External links

- Kagi Chart, Investopedia (<http://www.investopedia.com/terms/k/kagichart.asp>)
- A Look At Kagi Charts, Investopedia ([http://www.investopedia.com/articles/trading/07/kagi\\_chart.asp](http://www.investopedia.com/articles/trading/07/kagi_chart.asp))

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# PATTERNS: Chart Pattern

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## Chart pattern

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A **chart pattern** is a pattern that is formed within a chart when prices are graphed. In stock and commodity markets trading, chart pattern studies play a large role during technical analysis. When data is plotted there is usually a pattern which naturally occurs and repeats over a period of time. Chart patterns are used as either reversal or continuation signals.

Some people claim that by recognizing chart patterns they are able to predict future stock prices and profit by this prediction; other people respond by quoting "past performance is no guarantee of future results" and argue that chart patterns are merely illusions created by people's subconscious. Certain theories of economics hold that if there were a way to predict future stock prices and profit by it then when enough people used these techniques they would become ineffective and cease to be profitable. On the other hand, if you can predict what other people will predict the market to do then that would be valuable information.

## Patterns

Examples of "classical" chart patterns as popularized by Edwards and Magee and used widely by traders and investors include:

- Head and shoulders
- Trend lines
- Cup and handle
- Double top and double bottom
- Triple top and triple bottom
- Broadening top
- Price channels
- Wedge pattern
- Triangle (technical analysis)
- Flag and pennant patterns
- Elite patterns

## External links

- Chart Patterns for Institutional Portfolio Managers/Michael Lowrey/Rodney Fragodt <sup>[1]</sup>

## References

[1] <http://www.mtresearchcorp.com/>

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# Head and shoulders (chart pattern)

The **Head and Shoulders** formation is one of the most well known reversal patterns.

On the technical analysis chart, when a price trend is in the process of reversal either from a bullish or bearish trend, a characteristic pattern takes shape and is recognized as reversal formation.

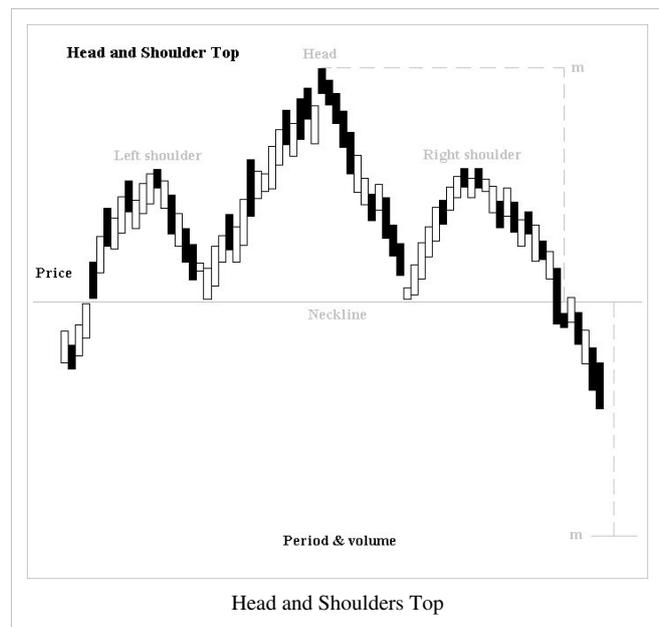
## Formations

Head and Shoulders Top and Head and Shoulders Bottom is discussed below.

### Head and shoulders top

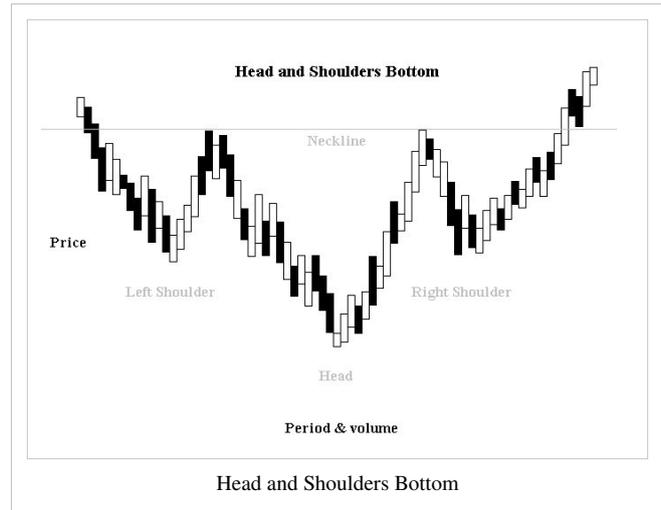
Head and Shoulders formation consists of a left shoulder, a head, and a right shoulder and a line drawn as the neckline. The left shoulder is formed at the end of an extensive move during which volume is noticeably high. After the peak of the left shoulder is formed, there is a subsequent reaction and prices slide down up to a certain extent which generally occurs on low volume. The prices rally up to form the head with normal or heavy volume and subsequent reaction downward is accompanied with lesser volume. The right shoulder is formed when prices move up again but remain below the central peak called the Head and fall down nearly equal to the first valley between the left shoulder and the head or at least below the peak of the left shoulder. Volume is lesser in the right shoulder formation compared to the left shoulder and the head formation.

A neckline is drawn across the bottoms of the left shoulder, the head and the right shoulder. When prices break through this neckline and keep on falling after forming the right shoulder, it is the ultimate confirmation of the completion of the Head and Shoulders Top formation. It is quite possible that prices pull back to touch the neckline before continuing their declining trend.



## Head and shoulders bottom

This formation is simply the inverse of a Head and Shoulders Top and often indicates a change in the trend and the sentiment. The formation is upside down in which volume pattern is different than a Head and Shoulder Top. Prices move up from first low with increase volume up to a level to complete the left shoulder formation and then falls down to a new low. It follows by a recovery move that is marked by somewhat more volume than seen before to complete the head formation. A corrective reaction on low volume occurs to start formation of the right shoulder and then a sharp move up that must be on quite heavy volume breaks through the neckline.



Another difference between the Head and Shoulders

Top and Bottom is that the Top Formations are completed in a few weeks, whereas a Major Bottom (Left, right shoulder or the head) usually takes a longer, and as observed, may prolong for a period of several months or sometimes more than a year.

## Importance of neckline

The drawn neckline of the pattern represents a support level, and assumption cannot be taken that the Head and Shoulder formation is completed unless it is broken and such breakthrough may happen to be on more volume or may not be. The breakthrough should not be observed carelessly. A serious situation can occur if such a break is more than three to four percent.

When a stock drifts through the neckline on small volume, there may be a *wave up*, although it is not certain, but it is observed, the rally normally does not cross the general level of the Neckline and before selling pressure increases, the steep decline occurs and prices tumble with greater volume.

## Characteristics

- Most of the time Head and Shoulders are not perfectly shaped. This formation is slightly tilted upward or downward.
- One shoulder may appear to droop.
- On many chart patterns, any one of the two shoulders may appear broader than the other which is caused by the time involved in the formation of the valleys.
- The neckline may not be perfectly horizontal; it may be ascending or descending.
- If the neckline is ascending then the only qualification of the formation lies in the fact that the lowest point of the right shoulder must be noticeably lower than the peak of the left shoulder.

## Usage as a tool

Head and Shoulders is an extremely useful tool after its confirmation to estimate and measure the minimum probable extent of the subsequent move from the neckline. To find the distance of subsequent move, measure the distance from the peak of the head to the neckline. Then measure the same distance down from the neckline to the point where prices penetrate the neckline after the completion of the right shoulder. This gives the minimum objective of how far prices can decline after the completion of this top formation.

In case, if the price advance preceding the Head and Shoulders top is not long, the subsequent price fall after its completion may be small as well.

## External links

- *Analyzing Chart Patterns: Head And Shoulders* <sup>[1]</sup> at investopedia.com
- Head and shoulders <sup>[2]</sup> at onlinetradingconcepts.com

## References

[1] <http://www.investopedia.com/university/charts/charts2.asp>

[2] <http://www.onlinetradingconcepts.com/TechnicalAnalysis/ClassicCharting/HeadShoulders.html>

# Cup and handle

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The **cup and handle** formation (also called the **cup with handle** formation) is a bullish chart pattern that is defined by a chart where a stock drops in value, then rises back up to the original value, then drops a small amount in value, and then rises a small amount in value.

## Important characteristics

- **Trend:** A cup and handle formation should follow an increase trend, ideally one that is only a few months old. The older the increase trend, the less likely it is that the cup and handle will be an accurate indicator.
- **Shape:** In a cup and handle formation, the cup must always precede the handle. The cup should form a rounded bowl shape, with an obvious bottom. A V-shaped bowl is said to be avoided. The cup should be fairly shallow, and ideally should retrace about 30% to 50% of the previous increase.<sup>[1]</sup> The perfect pattern would have equal highs on either side of the cup, but this is not always the case.
- **Duration:** The cup should last 1 to 6 months, while the handle should only last for 1 to 4 weeks.<sup>[1]</sup> These are only approximate values, however; a cup may last anywhere from a few weeks to a few years.
- **Volume:** The volume of the stock should decrease along with the price during the cup and should increase rapidly near the end of the handle when the price begins to rise.<sup>[1]</sup>

## Significance for traders

A cup and handle formation is considered to be a bullish signal, and is usually followed by a sharp rise in value. A rather accurate estimation of the expected price rise is found by measuring the price rise from the bottom of the cup to the right side.<sup>[1]</sup> The reason for a price rise following a cup and handle formation is largely unknown. Likely because many traders know about this signal and buy when they see it forming thus artificially creating the bullish uptrend.

## References

[1] Cup and handle at stockcharts.com ([http://stockcharts.com/school/doku.php?id=chart\\_school:chart\\_analysis:chart\\_patterns:cup\\_with\\_handle](http://stockcharts.com/school/doku.php?id=chart_school:chart_analysis:chart_patterns:cup_with_handle))

## External links

- *Analyzing Chart Patterns: Cup And Handle* (<http://www.investopedia.com/university/charts/charts3.asp>) at investopedia.com

# Double top and double bottom

**Double top and double bottom** are reversal chart patterns observed in the technical analysis of financial trading markets of stocks, commodities, currencies, and other assets.

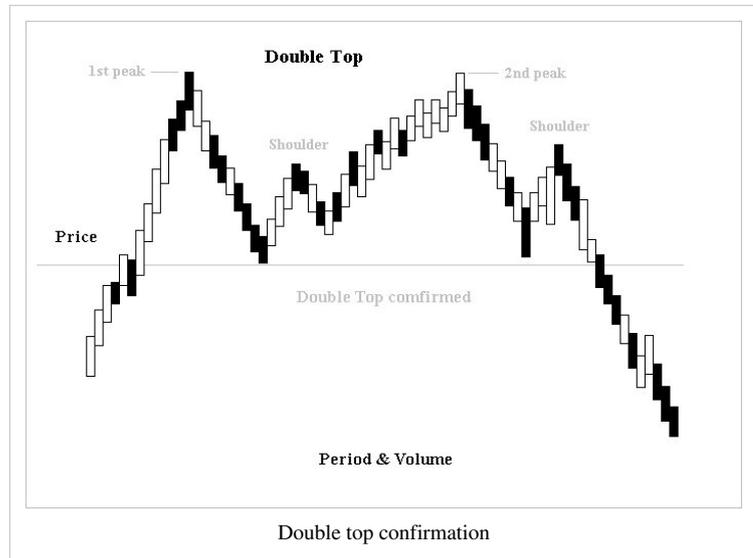
## Double top

The double top is a frequent price formation at the end of a bull market. It appears as two consecutive peaks of approximately the same price on a price-versus-time chart of a market. The two peaks are separated by a minimum in price, a *valley*. The price level of this minimum is called the neck line of the formation. The formation is completed and confirmed when the price falls below the neck line, indicating that further price decline is imminent or highly likely.

The double top pattern shows that demand is outpacing supply (buyers predominate) up to the first top, causing prices to rise. The supply-demand balance then reverses; supply outpaces demand (sellers predominate), causing prices to fall. After a price valley, buyers again predominate and prices rise. If traders see that prices are not pushing past their level at the first top, sellers may again prevail, lowering prices and causing a double top to form. It is generally regarded as a bearish signal if prices drop below the neck line.

The time between the two peaks is also a determining factor for the existence of a double top pattern. If the tops appear at the same level but are very close in time, then the probability is high that they are part of the consolidation and the trend will resume.

Volume is another indicator for interpreting this formation. Price reaches the first peak on increased volume then falls down the valley with low volume. Another attempt on the rally up to the second peak should be on a lower volume.

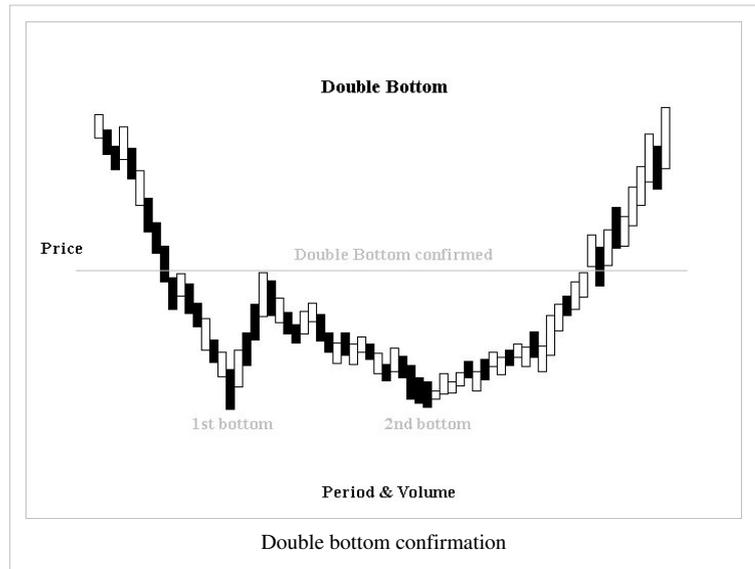


## Double bottom

A double bottom is the end formation in a declining market. It is identical to the double top, except for the inverse relationship in price. The pattern is formed by two price minima separated by local peak defining the neck line.

Most of the rules that are associated with double top formation also apply to the double bottom pattern.

Volume should show a marked increase on the rally up while prices are flat at the second bottom.



## External links

- *Analyzing Chart Patterns: Double Top And Double Bottom* <sup>[1]</sup> at investopedia.com

## References

- [1] <http://www.investopedia.com/university/charts/charts4.asp>

# Triple top and triple bottom

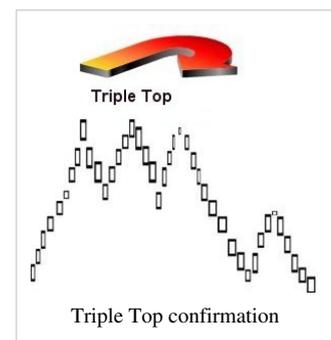
**Triple top and triple bottom** are reversal chart patterns used in the technical analysis of stocks, commodities, currencies, and other assets.

## Triple top

### Formation

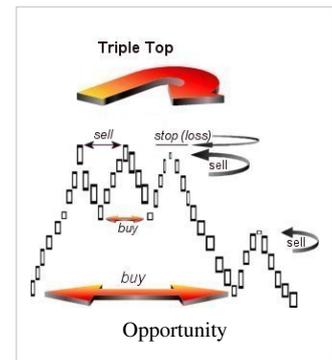
The formation of triple tops is rarer than that of double tops in the rising market trend. The volume is usually low during the second rally up and lesser during the formation of the *third top*. The peaks may not necessarily be spaced evenly like those which constitute a Double top. The intervening valleys may not bottom out at exactly the same level, i.e. either the first or second may be lower. The *triple top* is confirmed when the price decline from the *third top* falls below the *bottom* of the lowest valley between the three peaks.

### Selling Strategy



There are several different trading strategies that can be employed to take advantage of this formation. Of course, first and second peaks are perfect point to place sell orders. After the Double top has been confirmed and if prices are moving up again with low volume, it is an opportune point to sell. One can sell short with a stop (calculated loss) above the highest peak of the Double Top. The next opportune point to sell would be after a Triple top has formed and a fourth top is being formed at the lower level.

**Notes** Observation shows that it is rare to see four tops or bottoms at equal levels. In case prices continue to rally up to the level of the three previous tops, there is a good chance that they will rally up higher. If they come down to the same level a fourth time, they usually decline.



## Triple bottom

Most of the rules that are applied in the formation of the Triple top can be reversed in the formation of *triple bottom*. As far as volume is concerned, the third low bottom should be on low volume and the rally up from that bottom should show a marked increase in activity.

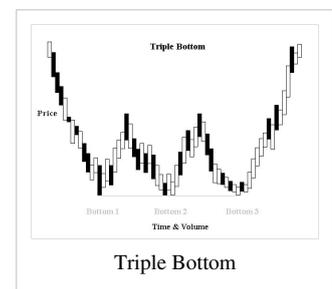
The formation of Triple Bottom occurs during the period of accumulation.

## External links

- *Analyzing Chart Patterns: Triple Tops And Bottoms* <sup>[1]</sup> at investopedia.com

## References

[1] <http://www.investopedia.com/university/charts/charts9.asp>



# Broadening top

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**Broadening top** is technical analysis chart pattern describing trends of stocks, commodities, currencies, and other assets.

## Point of Formation

Broadening Top formation appears much more frequently at tops than at bottoms. It is a difficult formation to trade in. Its formation usually has *bearish* implications.

## Role of Big Players

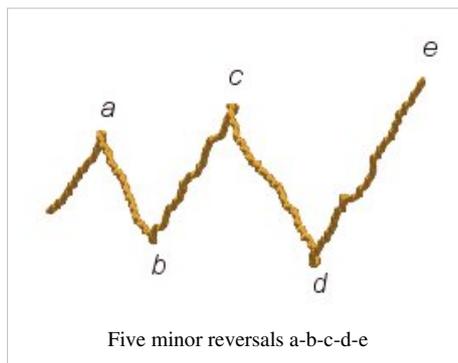
It is a common saying that *smart money* is out of market in such formation and market is out of control. In its formation, most of the selling is completed in the early stage by big players and the participation is from general public in the later stage.

## Price & Volume

Price keeps on swinging unpredictably and one can't be sure where the next swing will end. Regarding the *shares volume*, it is very irregular and leaves no clue to the direction of the next move.

## How Broadening Top is formed

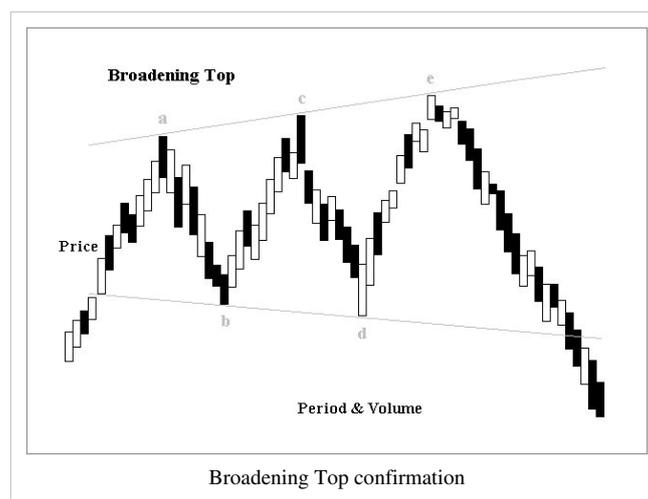
In the broadening top formation *five minor reversals* are followed by a substantial decline.



In the figure above, price of the share reverses five times, reversal point *d* is made at a lower point than reversal point *b* and reversal point *c* and *e* occur successively higher than reversal point *a*.

One can't be sure of the trend unless price breaks down the lower of the two points (*b* & *d*) and keeps on falling. In the figure below, *Broadening Top is confirmed*.

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## Other Chart Patterns

- Candlestick pattern
- Double Top & Double Bottom
- Gaps (Technical analysis)
- Head and Shoulders Top & Bottom
- The Island Reversal
- Triple Top & Triple Bottom
- Wedge Formations

## Price channels

A **price channel** is a pair of parallel trend lines that form a chart pattern for a stock or commodity.<sup>[1]</sup> Channels may be horizontal, ascending or descending. When prices pass through and stay through a trendline representing support or resistance, the trend is said to be broken and there is a "breakout".<sup>[2]</sup>

## References

[1] Murphy, pages 80-85

[2] Murphy, pages 400-401

- John J. Murphy, *Technical Analysis of the Financial Markets*, New York Institute of Finance, 1999, ISBN 0-7352-0066-1

# Wedge pattern

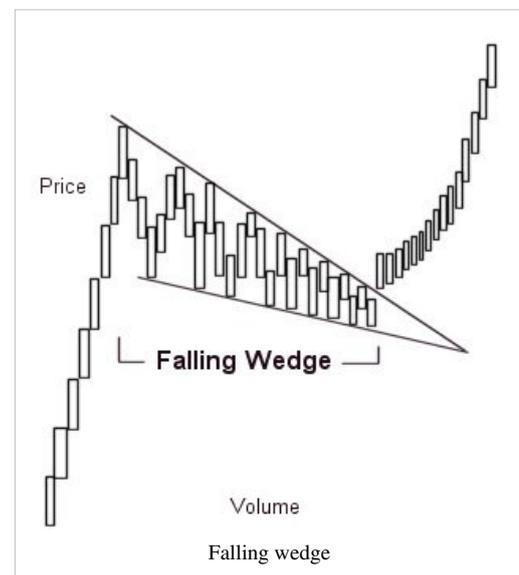
The **wedge pattern** is a commonly found pattern in the price charts of financially traded assets (stocks, bonds, futures, etc.). The pattern is characterized by a contracting range in prices coupled with an upward trend in prices (known as a rising wedge) or a downward trend in prices (known as a falling wedge).

A wedge pattern is considered to be a temporary halt of primary trend. It is a type of formation in which trading activities are confined within converging straight lines which form a pattern. It should take about 3 to 4 weeks to complete the wedge. This pattern has a rising or falling slant pointing in the same direction. It differs from the triangle in the sense that both boundary lines either slope up or down. Price breaking out point creates another difference from the triangle. Falling and rising wedges are a small part of intermediate or major trend. As they are reserved for minor trends, they are not considered to be major patterns. Once that basic or primary trend resumes itself, the wedge pattern loses its effectiveness as a technical indicator.

## Falling wedge

The falling wedge pattern is characterized by a chart pattern which forms when the market makes lower lows and lower highs with a contracting range. When this pattern is found in a downward trend, it is considered a reversal pattern, as the contraction of the range indicates the downtrend is losing steam. When this pattern is found in an uptrend, it is considered a bullish pattern, as the market range becomes narrower into the correction, indicating that the downward trend is losing strength and the resumption of the uptrend is in the making.

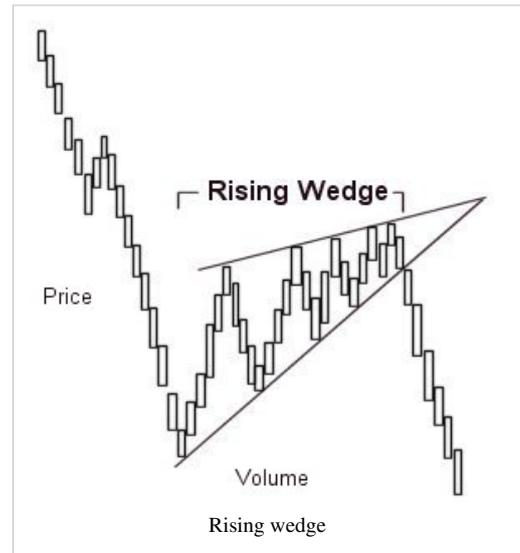
In a falling wedge, both boundary lines slant down from left to right. The upper descends at a steeper angle than the lower line. Volume keeps on diminishing and trading activity slows down due to narrowing prices. There comes the breaking point, and trading activity after the breakout differs. Once prices move out of the specific boundary lines of a falling wedge, they are more likely to move sideways and saucer-out before they resume the basic trend.



## Rising wedge

The rising wedge pattern is characterized by a chart pattern which forms when the market makes higher highs and higher lows with a contracting range. When this pattern is found in an uptrend, it is considered a reversal pattern, as the contraction of the range indicates that the uptrend is losing strength. When this pattern is found in a downtrend, it is considered a bearish pattern, as the market range becomes narrower into the correction, indicating that the correction is losing strength, and that the resumption of the downtrend is in the making.

In a rising wedge, both boundary lines slant up from left to right. Although both lines point in the same direction, the lower line rises at a steeper angle than the upper one. Prices usually decline after breaking through the lower boundary line. As far as volumes are concerned, they keep on declining with each new price advance or wave up, indicating that the demand is weakening at the higher price level. A rising wedge is more reliable when found in a bearish market. In a bullish trend what seems to be a Rising Wedge may actually be a Flag or a Pennant (stepbrother of a wedge) requiring about 4 weeks to complete.



## External links

- *Analyzing Chart Patterns: The Wedge*<sup>[1]</sup> at investopedia.com

## References

- [1] <http://www.investopedia.com/university/charts/charts7.asp>

# Triangle (chart pattern)

**Triangles** are a commonly found in the price charts of financially traded assets (stocks, bonds, futures, etc). The pattern derives its name from the fact that it is characterized by a contraction in price range and converging trendlines, thus giving it a triangular shape.

Triangle Patterns can be broken down into three categories: the ascending triangle, the descending triangle, and the symmetrical triangle. While the shape of the triangle is significant, of more importance is the direction that the market moves when it breaks out of the triangle. Lastly, while triangles can sometimes be reversal patterns—meaning a reversal of the prior trend—they are normally seen as continuation patterns (meaning a continuation of the prior trend).

## The Ascending Triangle

The ascending triangle is formed when the market makes higher lows and the same level highs. These patterns are normally seen in an uptrend and viewed as a continuation pattern as buying demand gain more and more control, running up to the top resistance line of the pattern. While you normally will see this pattern form in an uptrend, if you do see it in a downtrend it should be paid attention to as it can act as a powerful reversal signal.

The chart below offers an example of an ascending triangle.



## The Descending Triangle

The descending triangle is formed when the market makes lower highs and the same level lows. These patterns are normally seen in a downtrend and viewed as a continuation pattern as the bears gain more and more control running down to the bottom support line of the pattern. While you normally will see this pattern form in a downtrend, if you do see it in an uptrend it should be paid attention to as it can act as a powerful reversal signal.

The image below illustrates.



## The Symmetrical Triangle

The symmetrical triangle is formed when the market makes lower highs and higher lows and is commonly associated with directionless markets as the contraction of the market range indicates that neither the bulls nor the bears are in control. If this pattern forms in an uptrend then it is considered a continuation pattern if the market breaks out to the upside and a reversal pattern if the market breaks to the downside. Similarly if the pattern forms in a downtrend it is considered a continuation pattern if the market breaks out to the downside and a reversal pattern if the market breaks to the upside.

The image below illustrates.



## Flag and pennant patterns

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The **flag and pennant patterns** are commonly found patterns in the price charts of financially traded assets (stocks, bonds, futures, etc). The patterns are characterized by a clear direction of the price trend, followed by a consolidation and rangebound movement, which is then followed by a resumption of the trend.

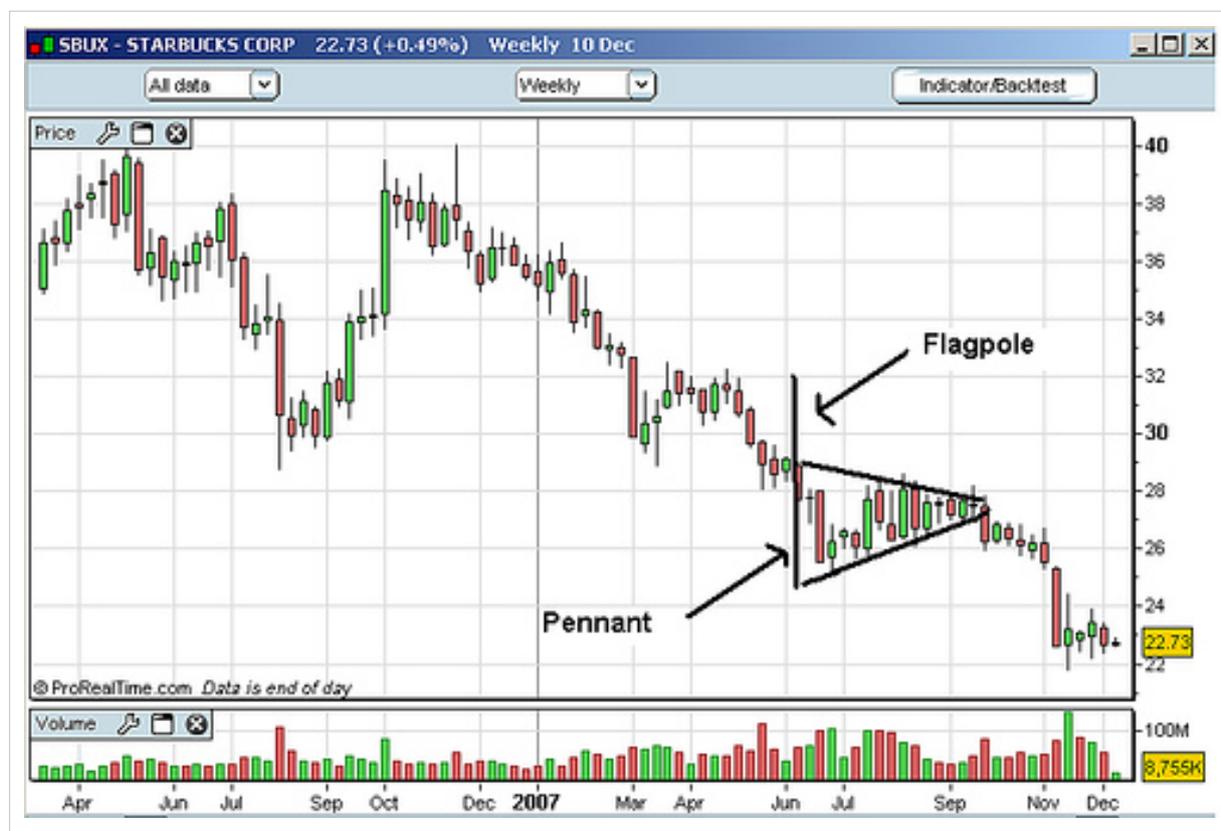
### Flag pattern

The flag pattern is encompassed by two parallel lines. These lines can be either flat or pointed in the opposite direction of the primary market trend. The pole is then formed by a line which represents the primary trend in the market. The pattern is seen as the market potentially just taking a “breather” after a big move before continuing its primary trend. The chart below illustrates.



## Pennant pattern

The pennant pattern is identical to the flag pattern in its setup and implications; the only difference is that the consolidation phase of a pennant pattern is characterized by converging trendlines rather than parallel trendlines. The image below illustrates.



## External links

- *Analyzing Chart Patterns: Flags And Pennants*<sup>[1]</sup> at investopedia.com

## References

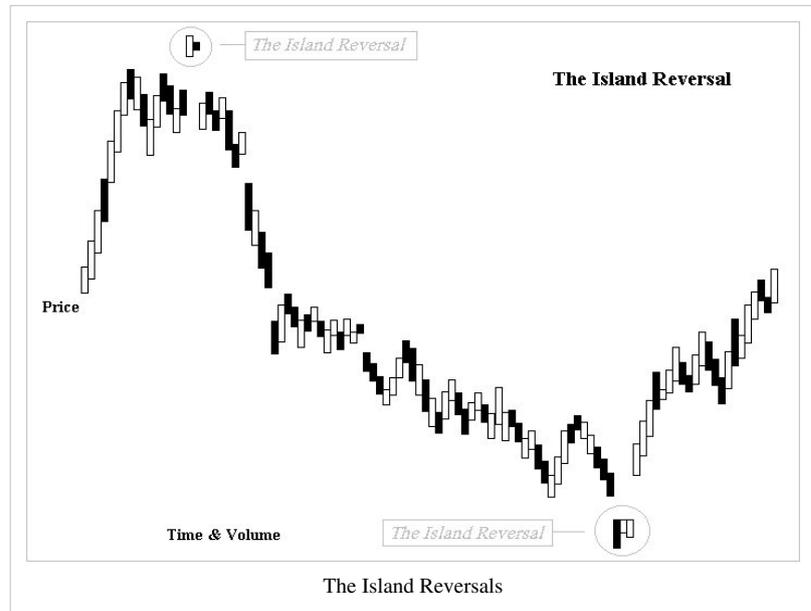
- [1] <http://www.investopedia.com/university/charts/charts6.asp>

# The Island Reversal

In general terms, **The Island Reversal** can be defined as a compact trading activity within a range of prices, separated from the move preceding it; this separation is caused by an Exhaustion Gap and the subsequent move in the opposite direction occurs as a result of a Breakaway Gap.

## Formation

Close scrutiny of Island Reversal formations shows that the Island Reversal consists of an Exhaustion Gap and the subsequent move is followed by a Breakaway Gap.



Uncommonly, the Breakaway Gap that completes the Island is filled in a few days by a pull back as a result of the reaction. The Island Reversal can occur at the peak or the reverse of Head and Shoulders formations.

For example, assume that the price in a rising trend closes at its high of \$84.00 and opens at \$91.00 the following day and then does not fall below its opening. Near the end of the day, it moves up further and touches \$97.00 but closes at \$96.00 however. Observation thus shows a gap of \$7.00 which is not filled. On the following day market price open at \$94.00, touches high of \$96.00 and closes at \$90.00. A few days later or the very next day, market price opens at \$84.00 and closes at \$83.00, keeping itself below the area of \$91.00 and \$84.00. All the trading above \$91.00 will appear on the Technical analysis chart to be isolated and is known as, "The Island Reversal."

## Characteristics

- The occurrence of The Island Reversal is rather rare.
- It consists of a minor move.
- It is not, in itself of major significance.
- It can occur at the Top as well as at the Bottom.
- The Gaps at either end occur at almost the same price level.
- It has a compact trading activity that is separated from the subsequent move which is in the opposite direction.
- It is an extremely good indicator of a reversal of primary or intermediate trend.
- As soon as it appears, it indicates that an extreme change in the sentiment has occurred.
- High volume is expected in that compact trading area.
- The trading activity may last for only a single day or a couple of days. When this arrangement occurs for only a single day, it is known as One Day Reversal.

## Caution

This can be compared with the scenario that on reaching an island, a boat will leave it immediately after unloading some of its load. This entire process is very rapid. A crew member engaged in trading onshore if left behind in the frenzy will be subject to mental stress on how to transport his bargained goods. Even if he manages to swim against the waves of worries and reaches the boat along with his purchases, he shall incur losses by damage to the items.

Hence, caution should be exercised in taking a step on the island at top level with a bullish attitude.

## Gap (chart pattern)

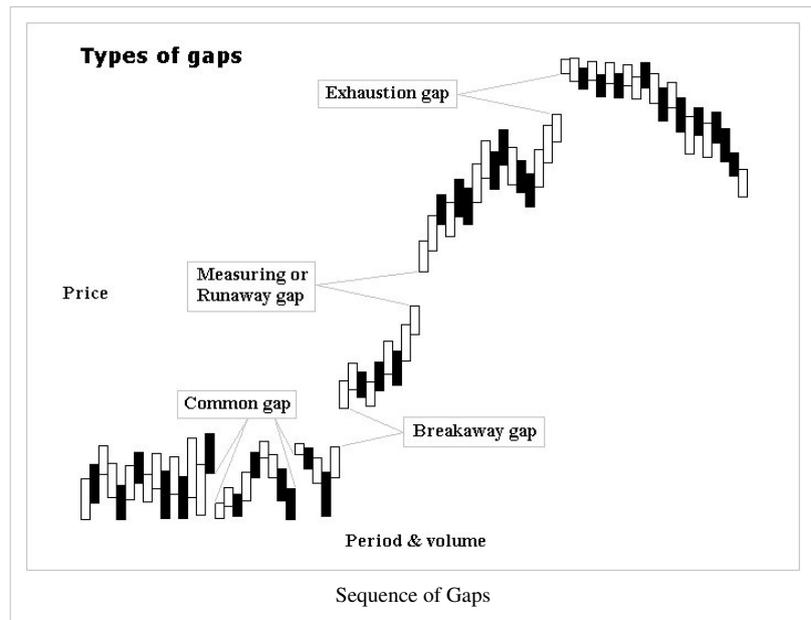
A **gap** is defined as an unfilled space or interval. On a technical analysis chart, a gap represents an area where no trading takes place. On the Japanese candlestick chart, a window is interpreted as a gap.

In an upward trend, a gap is produced when the highest price of one day is lower than the lowest price of the following day. Thus, in a downward trend, a gap occurs when the lowest price of any one day is higher than the highest price of the next day.

For example, the price of a share reaches a high of \$30.00 on Wednesday, and opens at \$36.00 on

Thursday, falls down to \$35.00 in the early hour, moves straight up again to \$37.00, and no trading occurs in between \$30.00 and \$35.00 area. This no-trading zone appears on the chart as a *gap*.

Gaps can play an important role when spotted before the beginning of a move.



## Types of gaps

There are four different types of gaps, excluding the gap that occurs as a result of a stock going ex-dividend. Since each type of gap has its own distinctive implication, it is very important to be able to distinguish between such gaps.

- **Breakaway gap** : It occurs when prices break away from an area of congestion. When the price is breaking away from a triangle (Ascending or Descending) with a gap then it can be implied that change in sentiment is strong and coming move will be powerful. One must keep an eye on the volume. If it is heavy after the gap is formed then there is a good chance that market does not return to *fill the gap*. When the price is breaking away on a low volume, there is a possibility that the gap will be filled before prices resume their trend.
- **Common gap** : It is also known as *area gap*, *pattern gap* or *temporary gap*. They tend to occur when trading is bound between support and resistance level on a short span of time and market price is moving sideways. One can also see them in price congestion area. Usually, the price moves back or goes up in order to *fill the gaps* in the coming days. If the gap is filled, then they offer, not much in the way of forecasting significance.
- **Exhaustion gap** signals end of a move. These gaps are associated with a rapid, straight-line advance or decline. When they are formed at the top with heavy volume, there are significant chances that the market is exhausted

and reversal is ahead. A reversal day can easily differentiate between the Measuring gap and the Exhaustion gap.

- **Measuring Gap** : Also known as Runaway Gap, a Measuring gap is formed usually in the half way of a price move. It is not associated with the congestion area, it is more likely to occur approximately in the middle of rapid advance or decline. It can be used to measure how much further ahead a move will go.

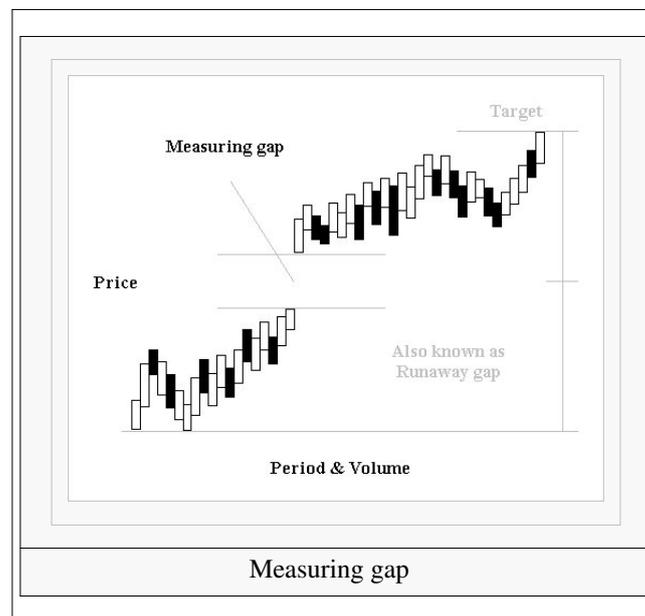
## Caution

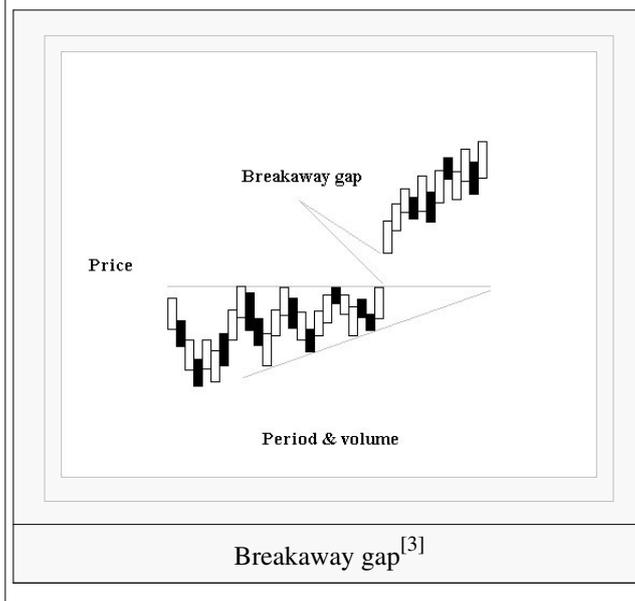
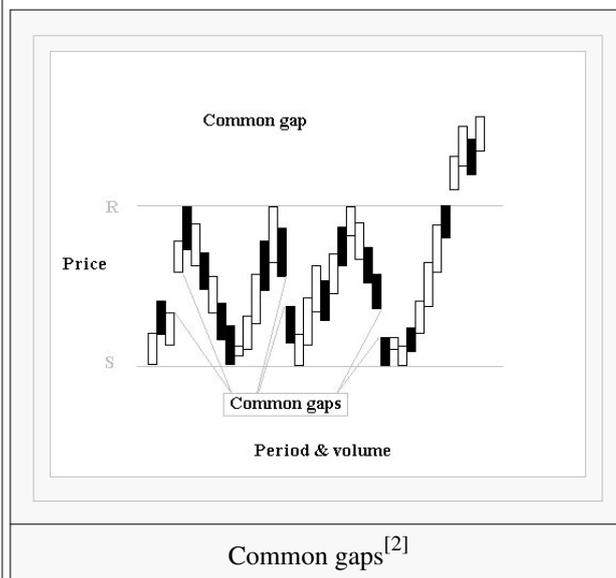
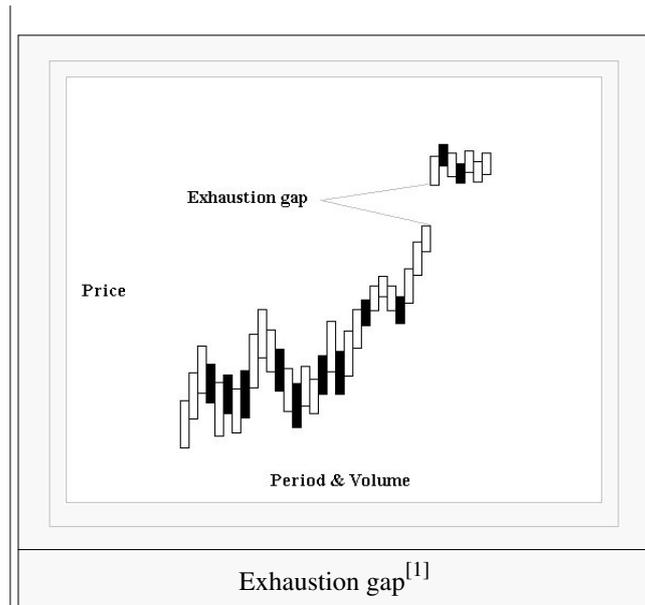
It is quite possible that confusion between *measuring gap* and *exhaustion gap* can cause an investor to position himself incorrectly and to miss significant gains during the last half of a major uptrend. Keeping an eye on the volume can help to find the clue between *measuring gap* and *exhaustion gap*. Normally, noticeable heavy volume accompanies the arrival of *exhaustion gap*.

## Trading gaps for profit

Some market speculators "Fade" the gap on the opening of a market. This means for example that if the S&P 500 closed the day before at 1150 (16:15 EST) and opens today at 1160 (09:30 EST), they will short the market expecting this "upgap" to close. A "downgap" would mean today opens at for example 1140, and the speculator buys the market at the open expecting the "downgap to close". The probability of this happening on any given day is around 70%, depending on which market you look at. Once the probability of "gap fill" on any given day or technical position is established, then the best setups for this trade can be identified. Some days have such a low probability of the gap filling that speculators will trade in the direction of the gap.

## Examples





## References

- [1] Exhaustion gap - investopedia.com (<http://www.investopedia.com/terms/e/exhaustiongap.asp>)
- [2] Common gap - investopedia.com (<http://www.investopedia.com/terms/c/commongap.asp>)
- [3] Breakaway gap - investopedia.com (<http://www.investopedia.com/terms/b/breakawaygap.asp>)

## External links

- *Analyzing Chart Patterns: Gaps* (<http://www.investopedia.com/university/charts/charts8.asp>) at investopedia.com
  - *Playing The Gap* (<http://www.investopedia.com/articles/trading/05/playinggaps.asp>) at investopedia.com
  - Windows (Gaps) (<http://www.onlinetradingconcepts.com/TechnicalAnalysis/Candlesticks/Windows.html>) at onlinetradingconcepts.com
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# PATTERNS: Candlestick pattern

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## Candlestick pattern

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This page provides brief introduction to the patterns of Japanese Candlesticks Chart. Please note that **candlestick pattern** recognition is subjective and programs that are used for charting technique must rely on predefined rules.

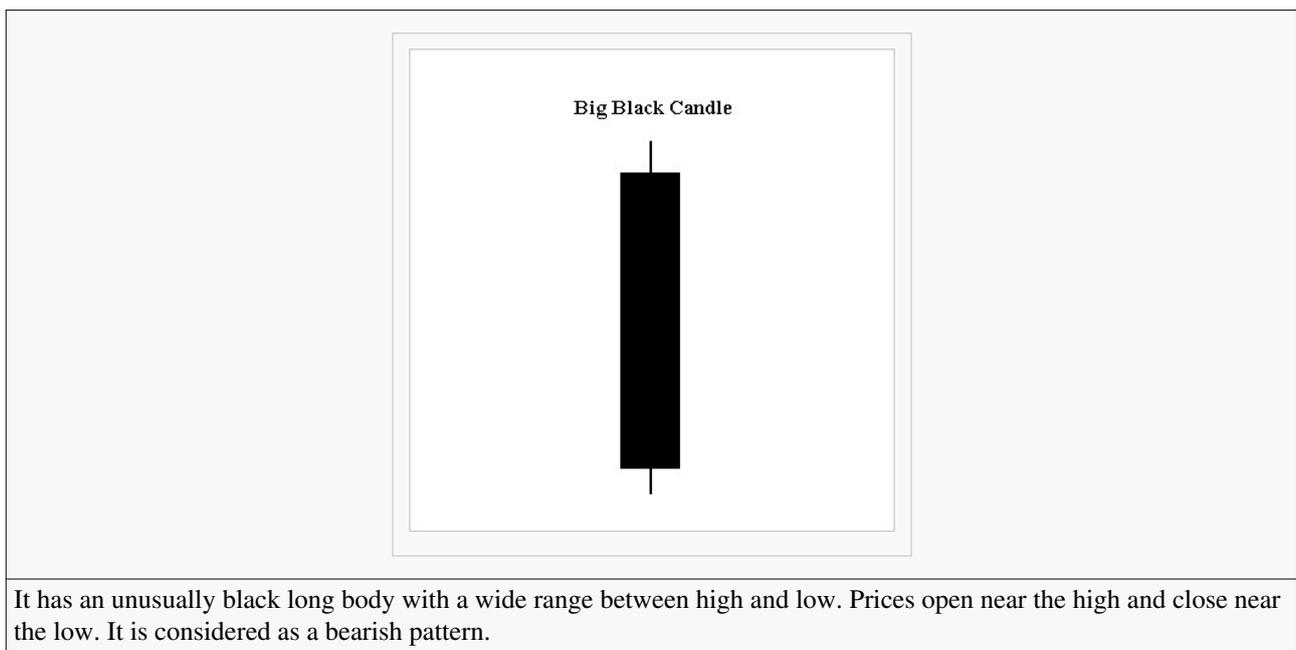
### History

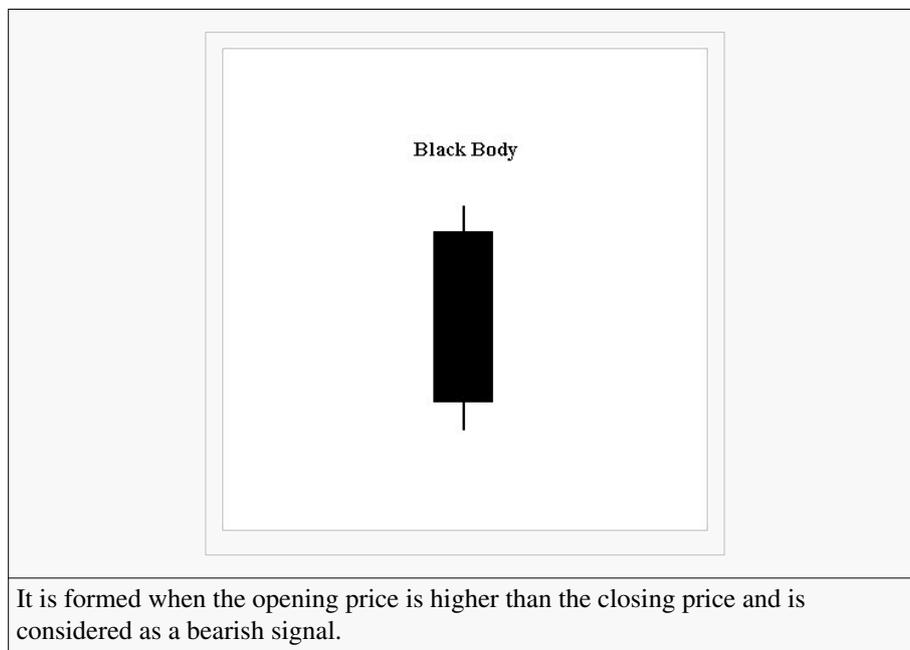
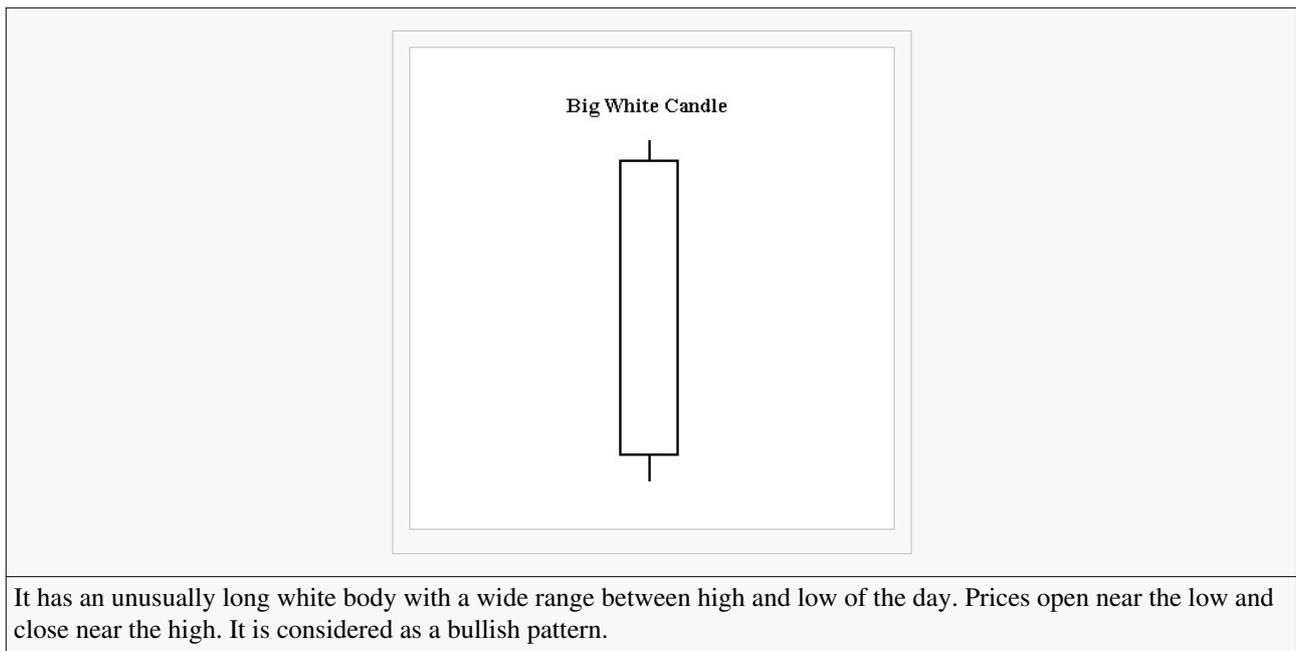
It is said that Japanese used technical analysis to trade rice in the 17th century. But according to Steve Nison, candlestick charting came later and probably began sometime after 1850. Much of the credit for candlestick charting goes to Munehisa Homma who was a rice trader from Sakata.

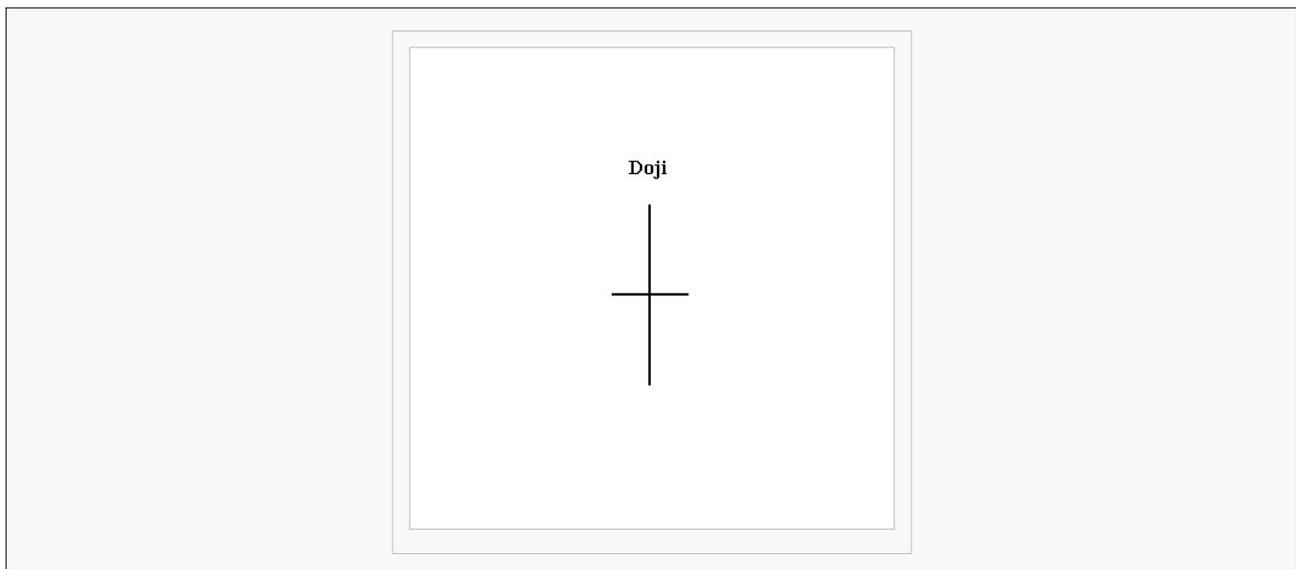
### Formation of candlestick

Candlestick is formed with the help of opening, high, low and closing price of the day. If the opening price is above the closing price then a filled candlestick is drawn. Normally, black colour is used for filling the candle. If the closing price is above the opening price, then a hollow candlestick (normally displayed in white with black border) is drawn. The filled or the hollow portion of the candle is known as body or real body which can be long, normal or short with proportionate to the line above or below it. The lines (long or short) above and below the body or real body represent the high or low price range and these lines are known as shadows, tails or wicks. For the particular day, the highest price is declared by the top of the upper shadow and the lowest price is marked by the bottom of the lower tail. Please note that the body may or may not have shadows, tails or wicks.

### Simple patterns



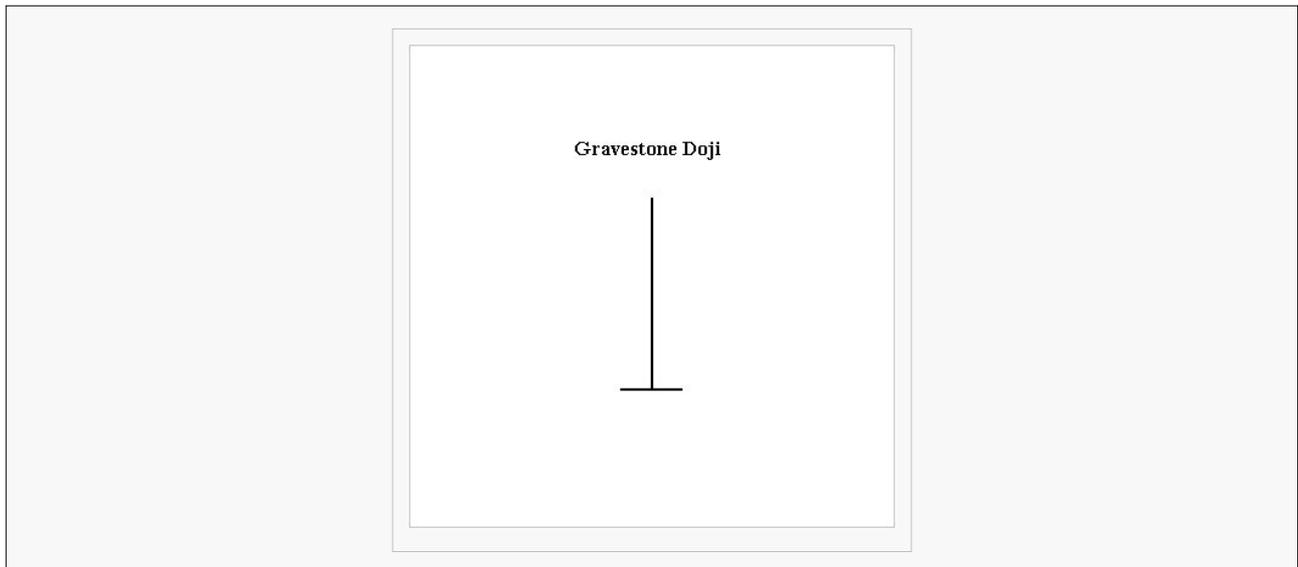




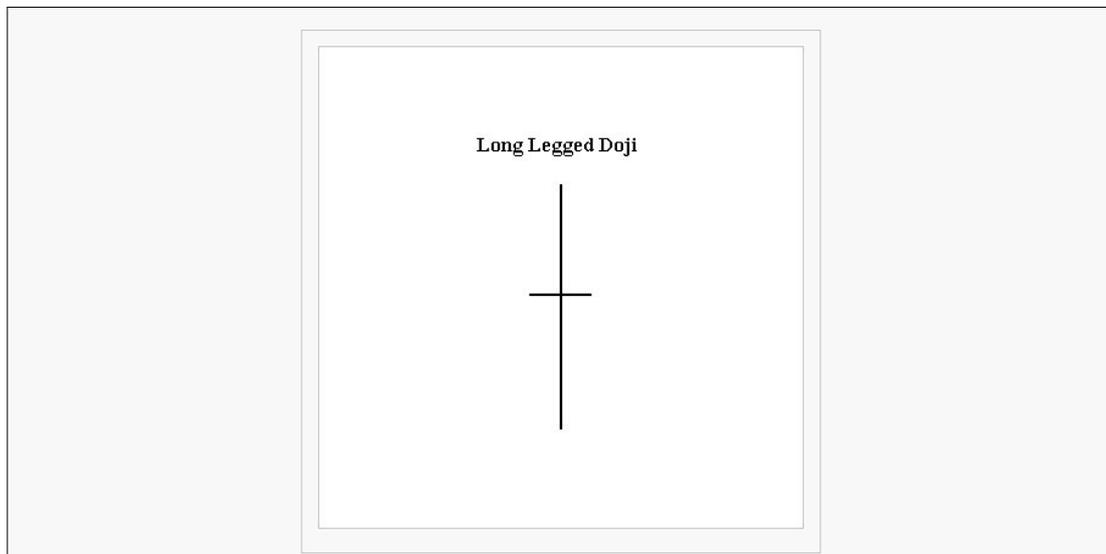
It is formed when opening and closing prices are *virtually* the same. The length of shadows can vary. It is considered that doji candlesticks are usually components of many candlestick pattern.



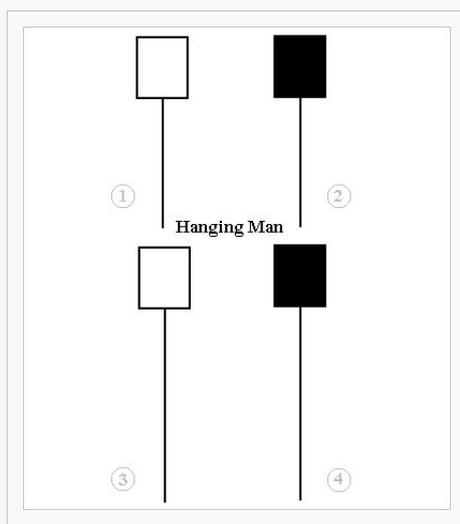
It is formed when the opening and the closing prices are at the highest of the day. If it has a longer lower shadow it signals more bullish trend. When it appears at market bottom it is considered as a reversal signal.



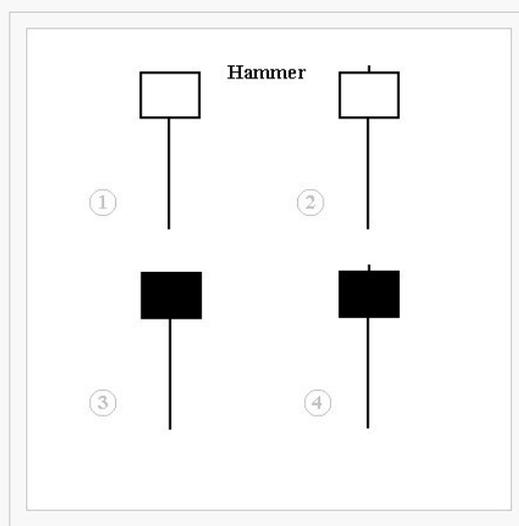
It is formed when the opening and closing prices are at the lowest of the day. If it has a longer upper shadow it signals more bearish trend. When it appears at market top it is considered as a reversal signal.



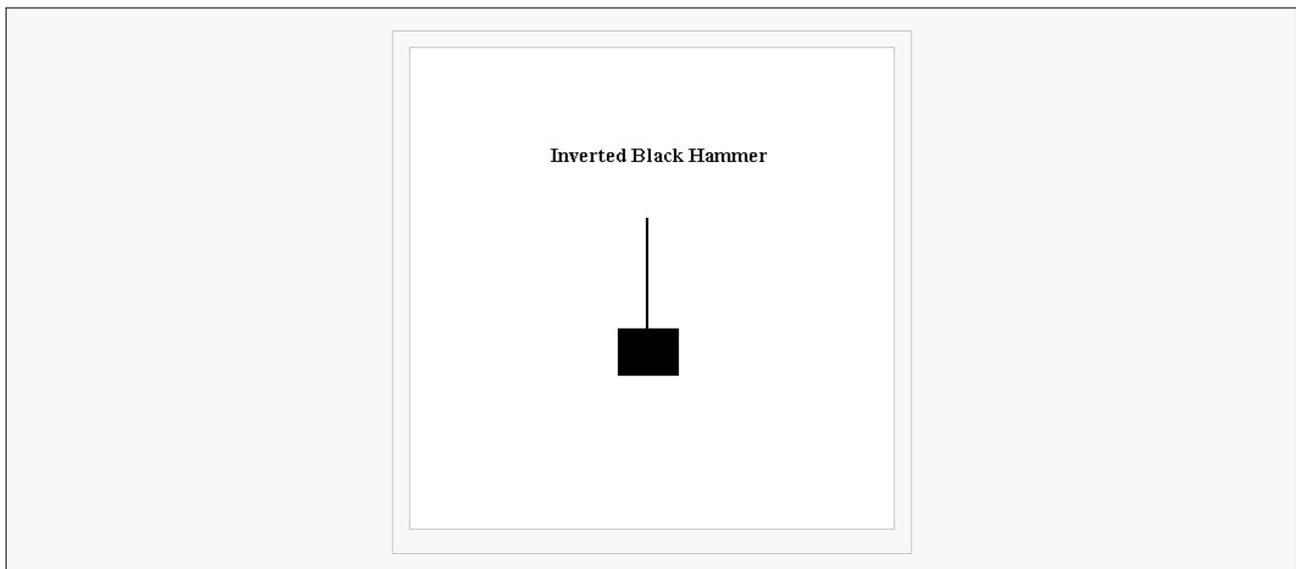
It consists of a Doji with very long upper and lower shadow. When it appears at market top it is considered as a reversal signal.



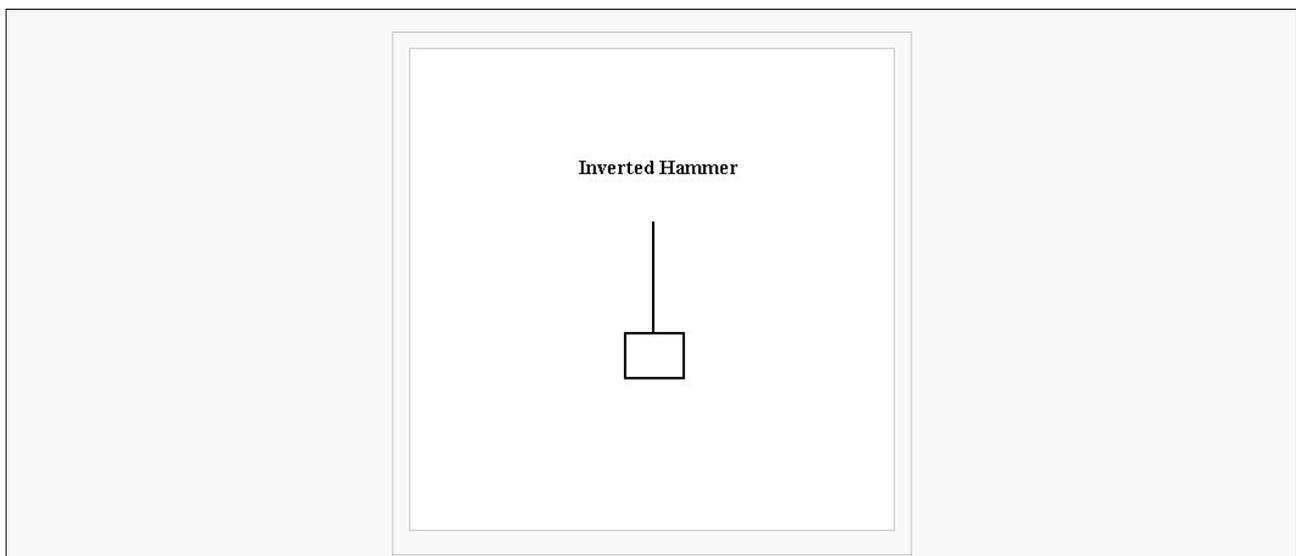
A black or a white candlestick that consists of a small body near the high with a little or no upper shadow and a long lower tail. The lower tail should be two or three times the height of the body. It is considered as a bearish pattern during an uptrend.



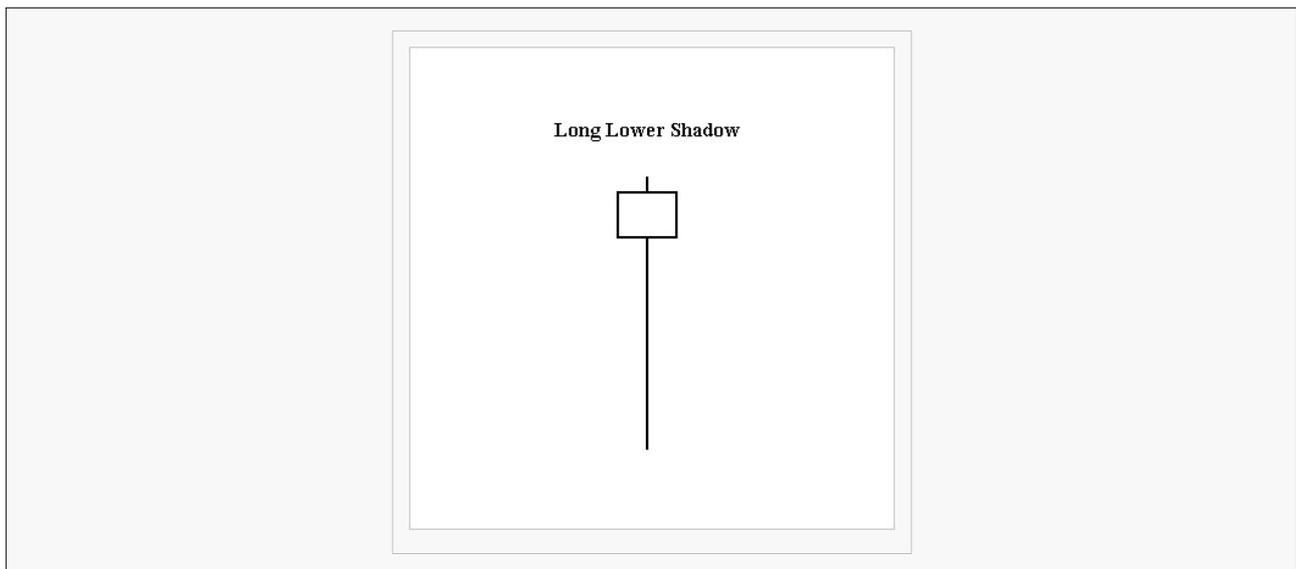
A black or a white candlestick that consists of a small body near the high with a little or no upper shadow and a long lower tail. It is considered as a bullish pattern during a downtrend.



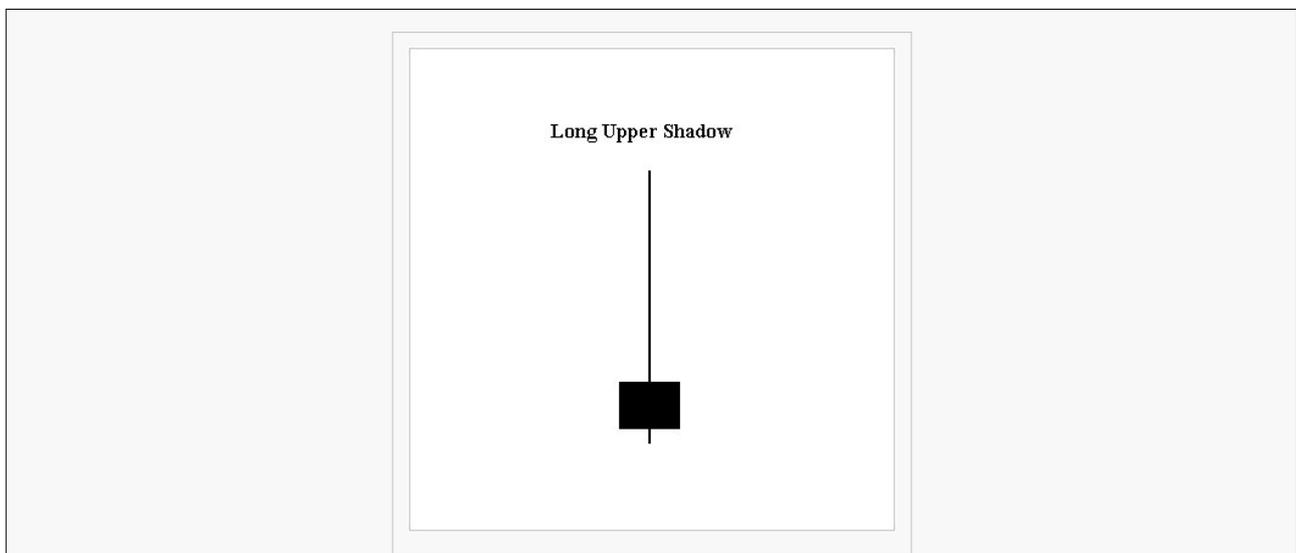
A black body is formed in an upside-down hammer position. It is considered as a bottom reversal signal that needs confirmation on the next trading day.



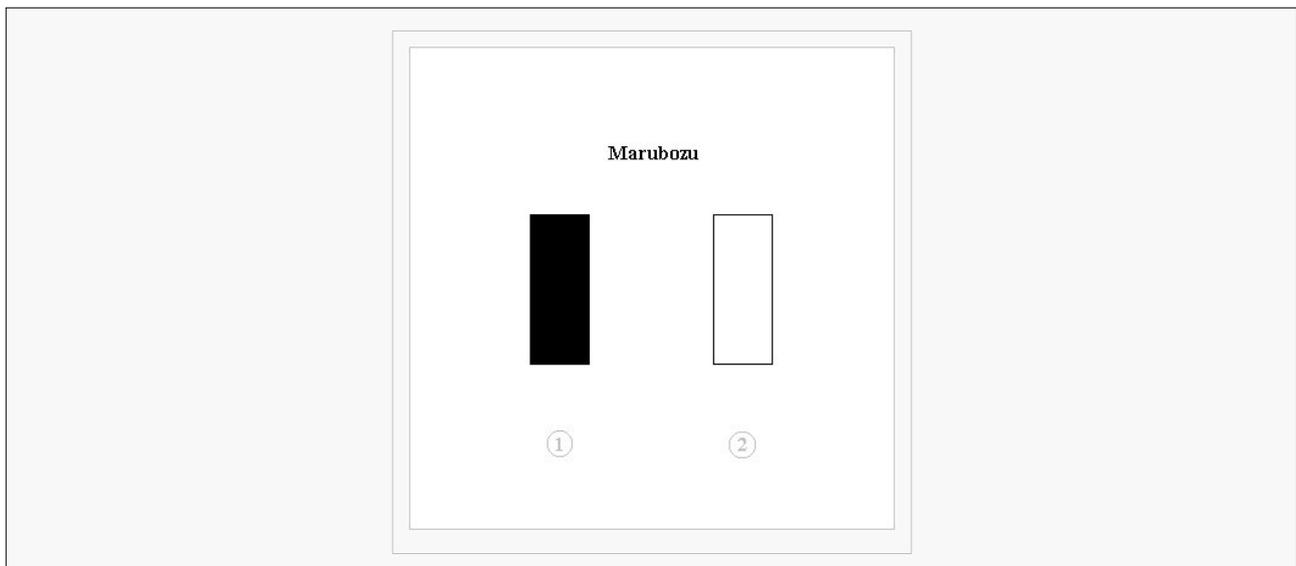
It consists of black or a white candlestick in an upside-down hammer position. It is considered as a bottom reversal signal that needs confirmation on the next trading day.



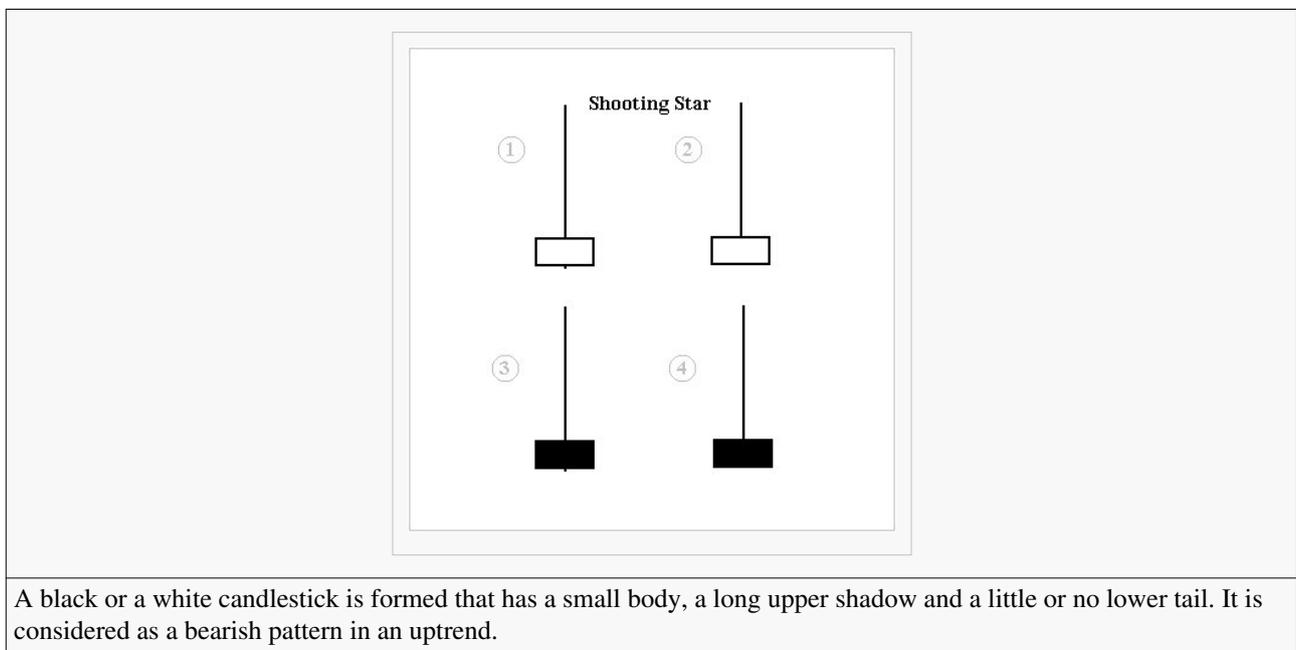
A black or a white candlestick is formed with a lower tail that has a length of  $2/3$  or more of the total range of the candlestick. Normally, it is considered as a bullish signal when it appears around price support levels.



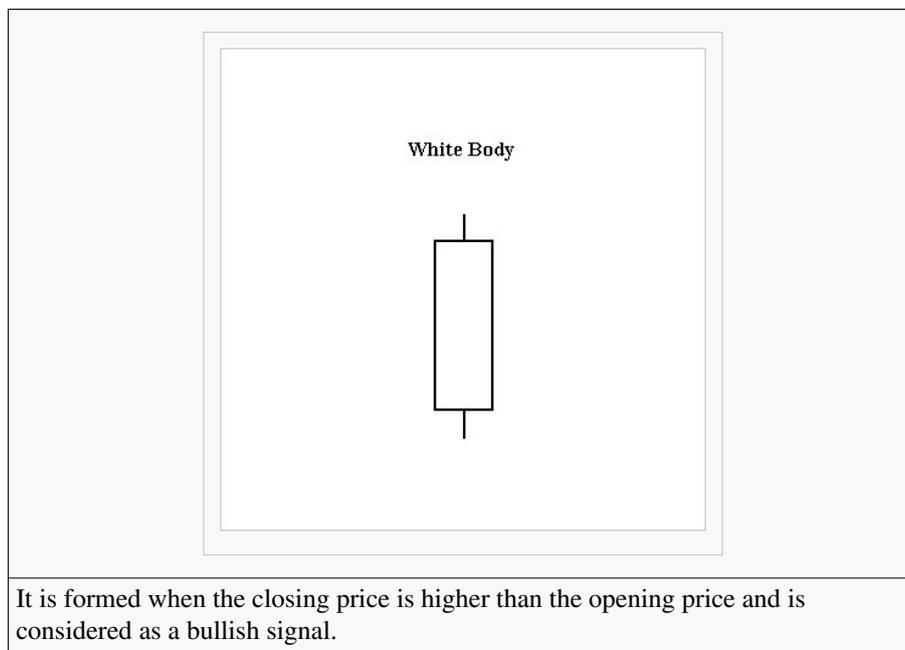
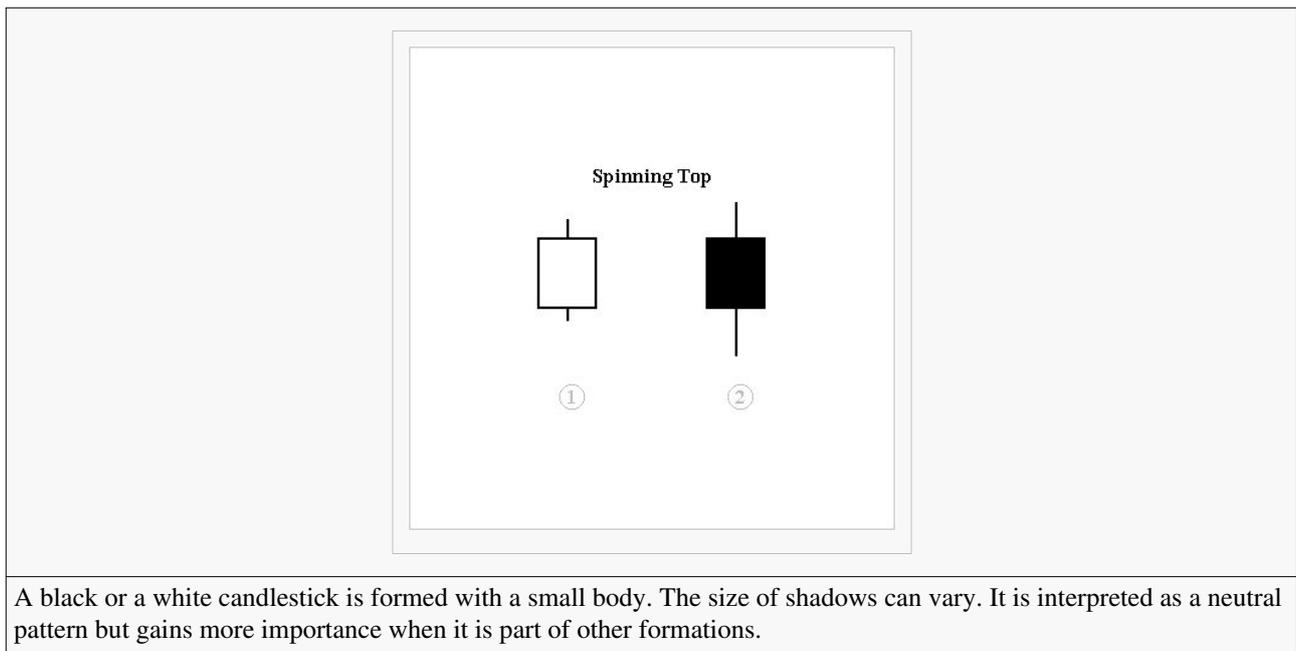
A black or a white candlestick with a upper shadow that has a length of  $2/3$  or more of the total range of the candlestick. Normally, It is considered as a bearish signal, when it appears around price resistance levels.

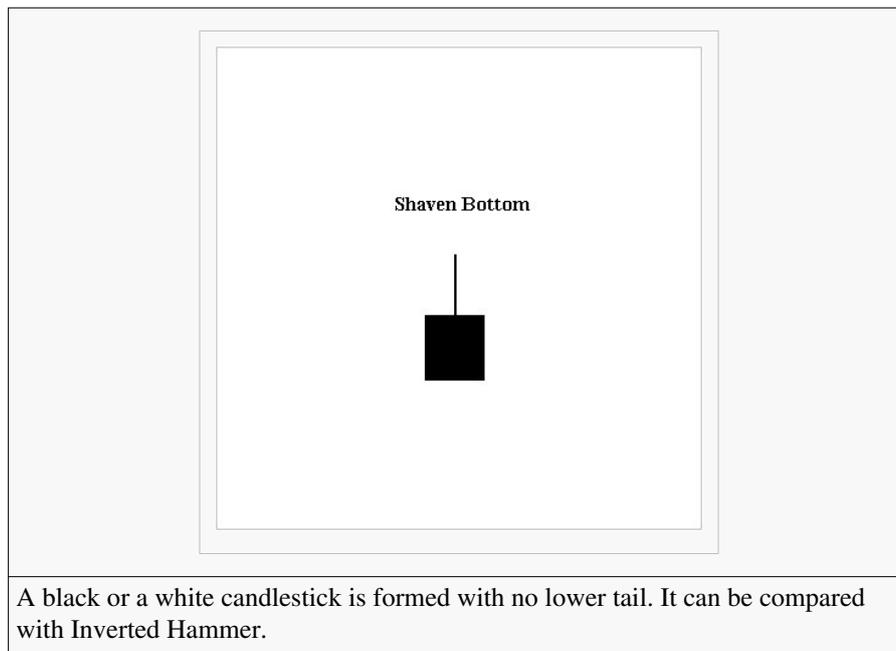


A long or a normal candlestick (black or white) is formed with no shadow or tail. The high and the low is consisted of the opening and the closing prices. It is considered as a continuation pattern.

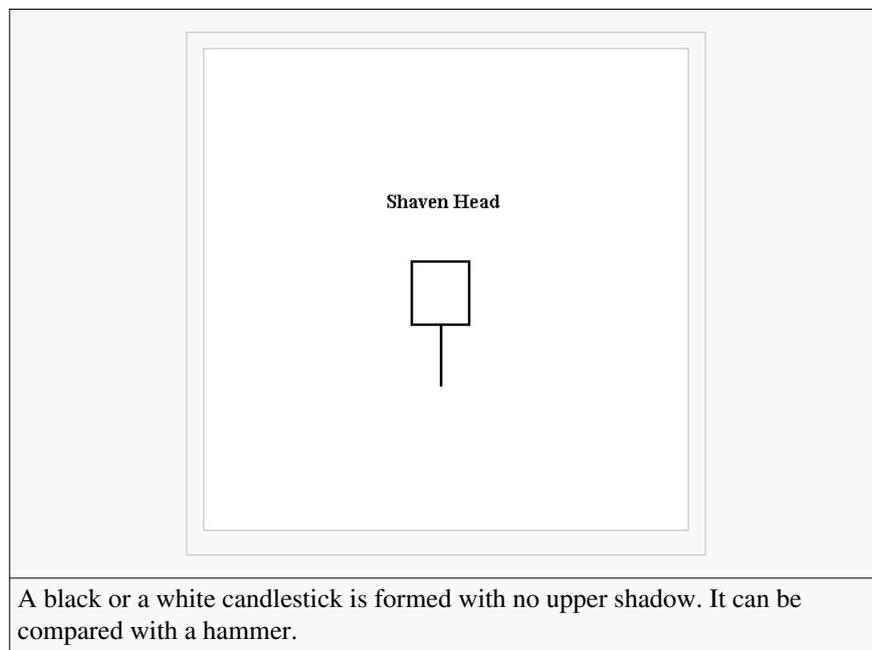


A black or a white candlestick is formed that has a small body, a long upper shadow and a little or no lower tail. It is considered as a bearish pattern in an uptrend.



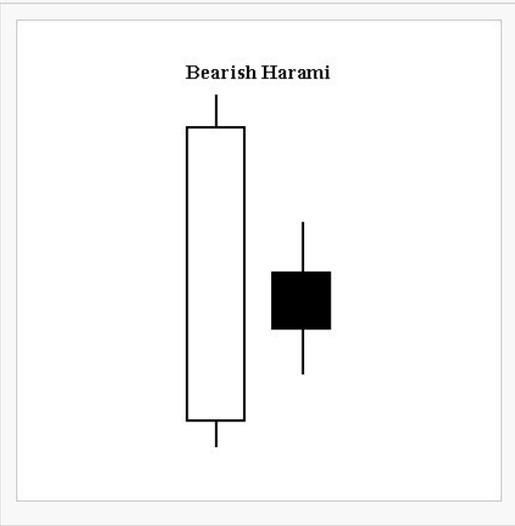


A black or a white candlestick is formed with no lower tail. It can be compared with Inverted Hammer.



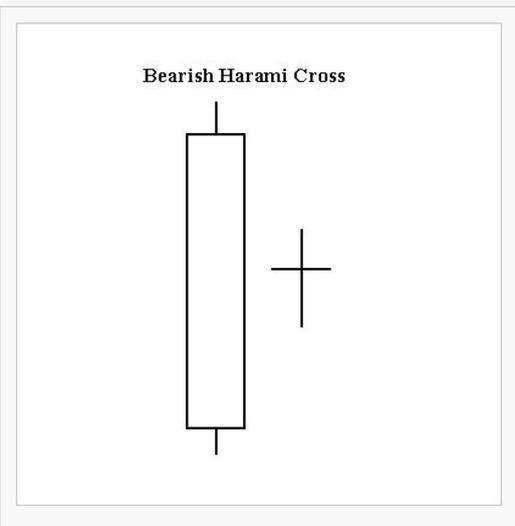
A black or a white candlestick is formed with no upper shadow. It can be compared with a hammer.

## Complex patterns



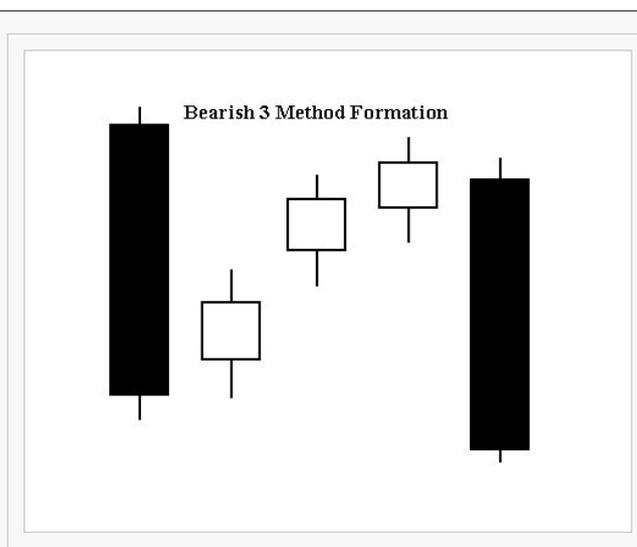
The diagram shows a candlestick pattern labeled "Bearish Harami". It consists of two candlesticks. The first is a large white candlestick with a long upper shadow and a short lower shadow. The second is a small black candlestick with a short upper shadow and a long lower shadow, positioned to the right of the first candlestick. The body of the second candlestick is entirely contained within the body of the first candlestick.

It consists of an unusually large white body followed by a small back body (contained within large white body). It is considered as a bearish pattern when preceded by an uptrend.

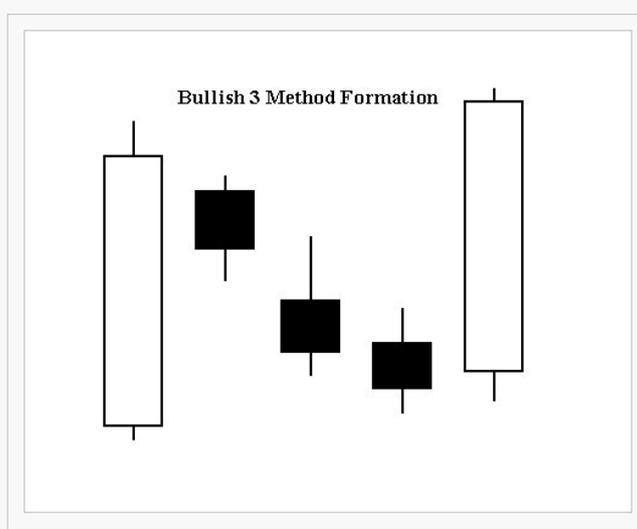


The diagram shows a candlestick pattern labeled "Bearish Harami Cross". It consists of two candlesticks. The first is a large white candlestick with a long upper shadow and a short lower shadow. The second is a Doji candlestick, represented by a cross with a vertical line and a horizontal line, positioned to the right of the first candlestick. The vertical line of the Doji is centered within the body of the first candlestick.

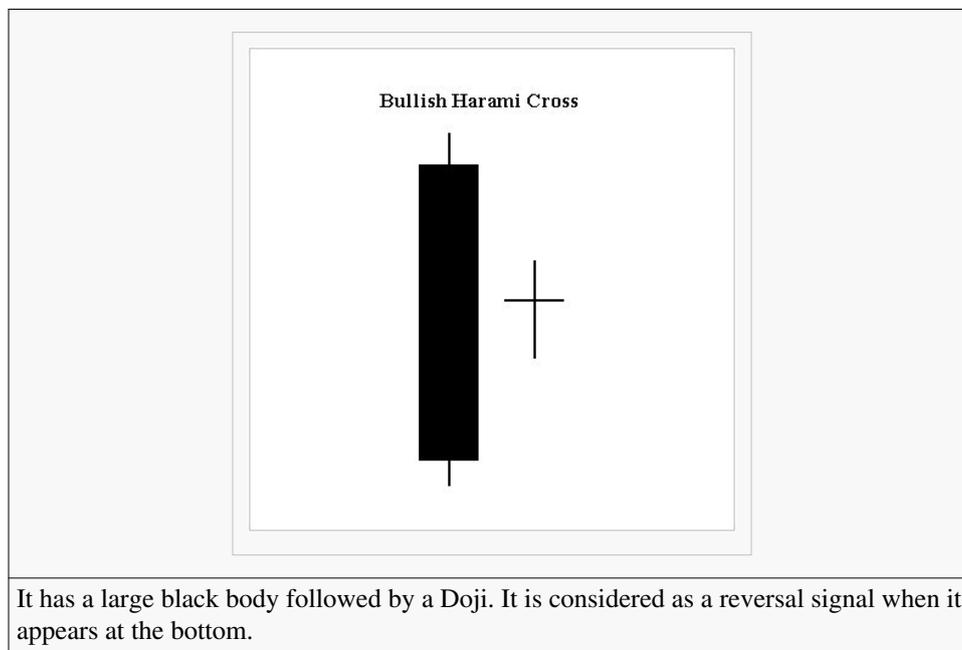
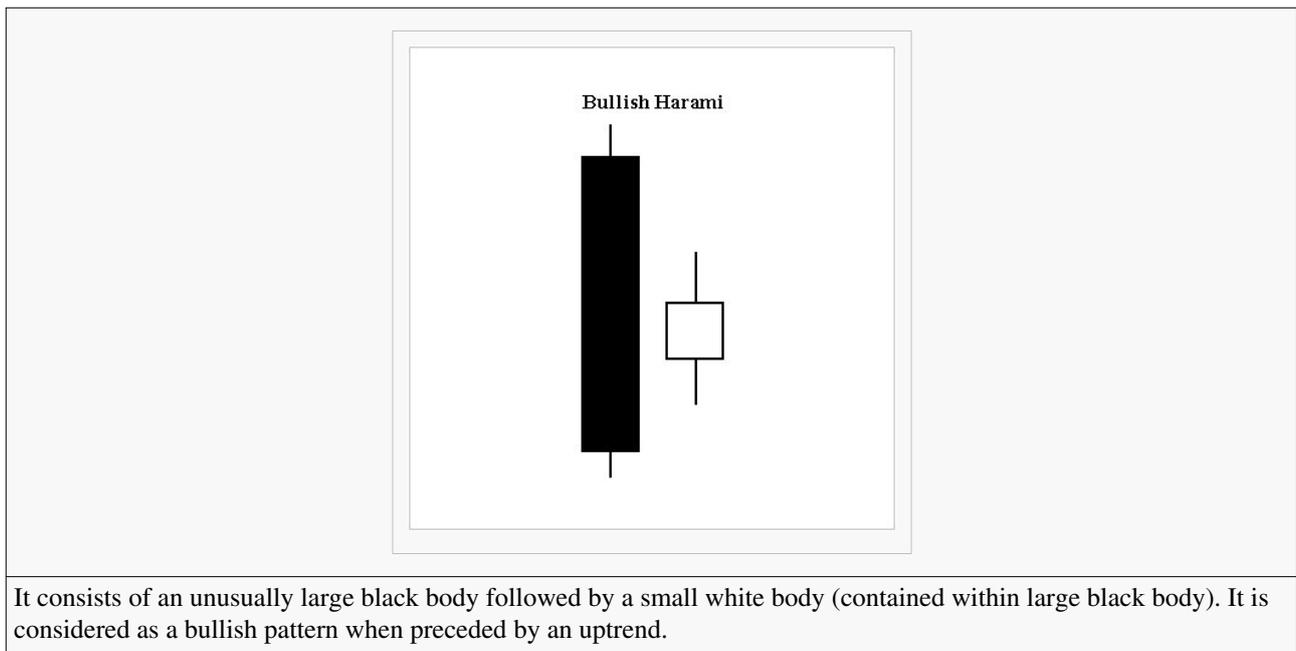
It has a large white body followed by a Doji. It is considered as a reversal signal when it appears at the top.

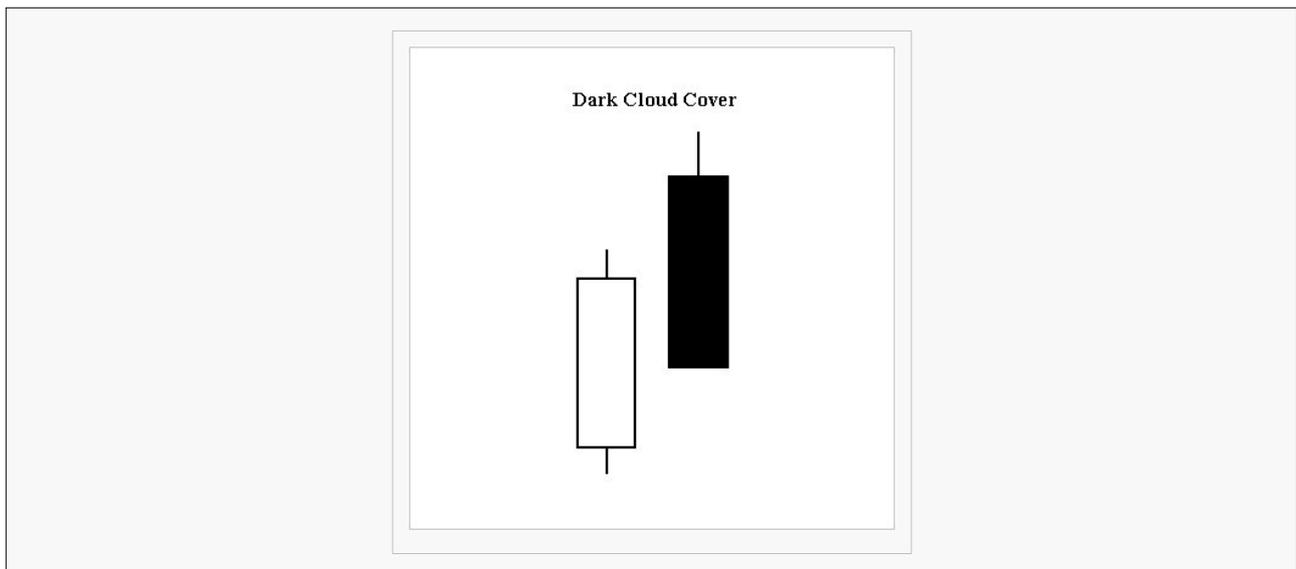


It has a long black body followed by three small bodies (normally white) and a long black body. The three white bodies are contained within the range of first black body. This is considered as a bearish continuation pattern.

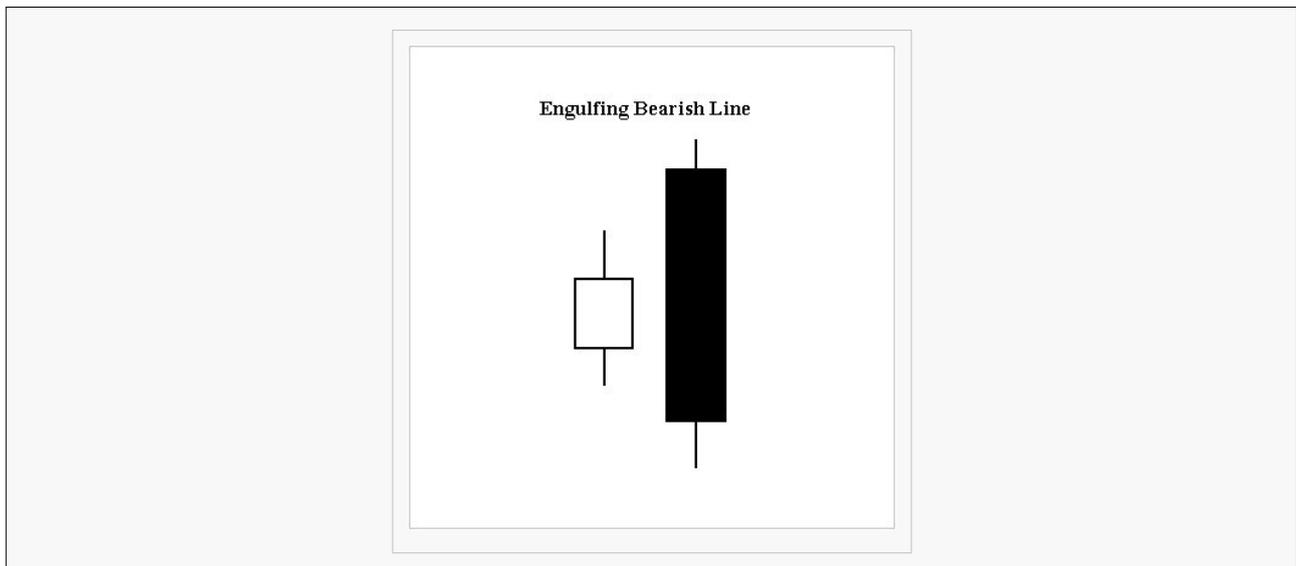


It consists of a long white body followed by three small bodies (normally black) and a long white body. The three black bodies are contained within the range of first white body. This is considered as a bullish continuation pattern.

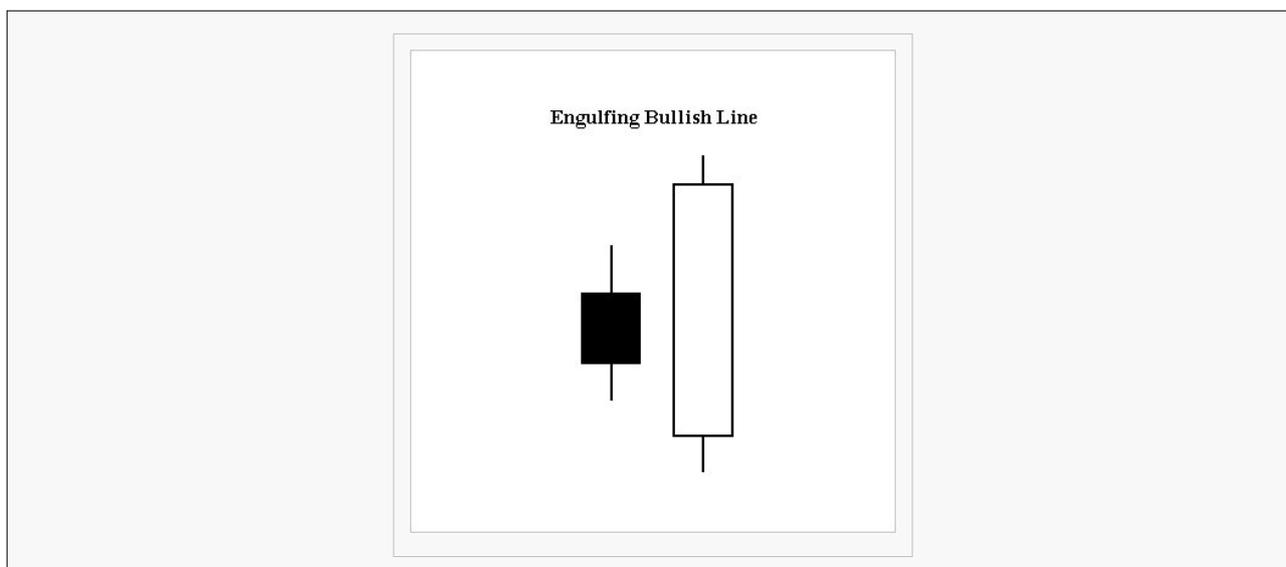




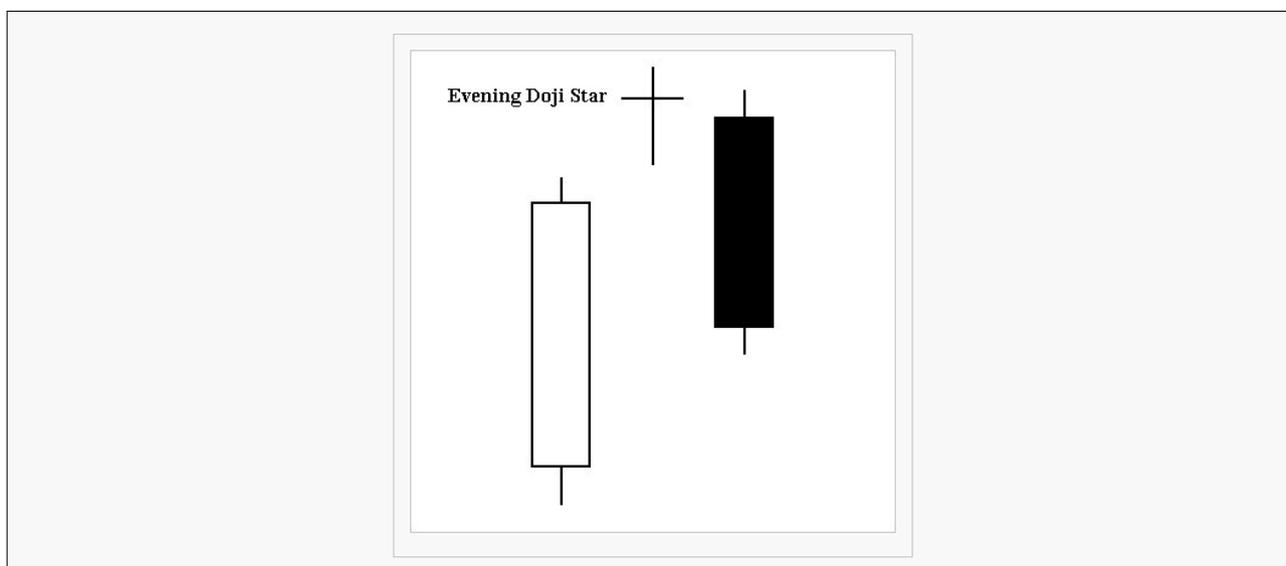
It consists of a long white candlestick followed by a black candlestick that opens above the high of the white candlestick and closes well into the body of the white candlestick. It is considered as a bearish reversal signal during an uptrend.



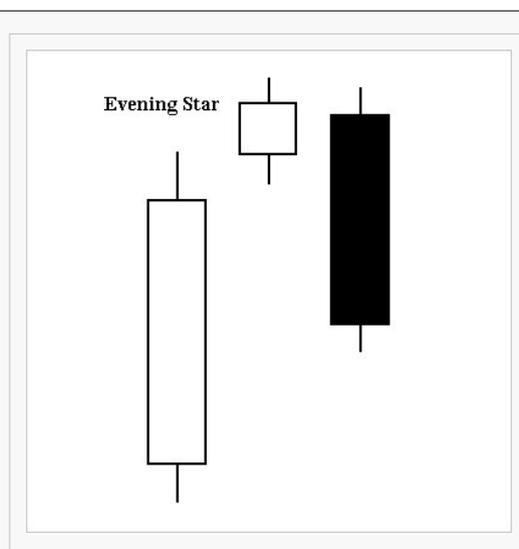
It consists of a small white body that is contained within the followed large black candlestick. When it appears at top it is considered as a major reversal signal.



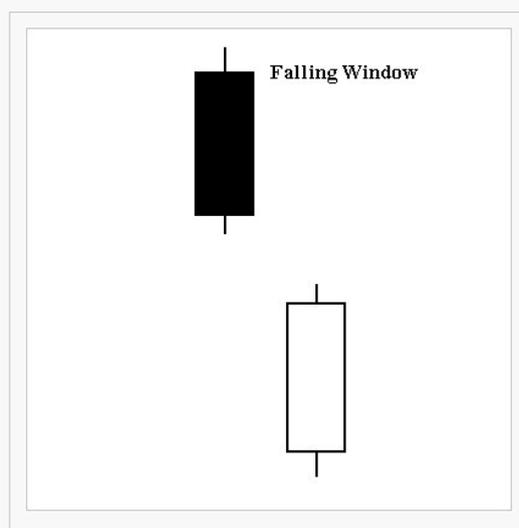
It consists of a small black body that is contained within the followed large white candlestick. When it appears at bottom it is interpreted as a major reversal signal.



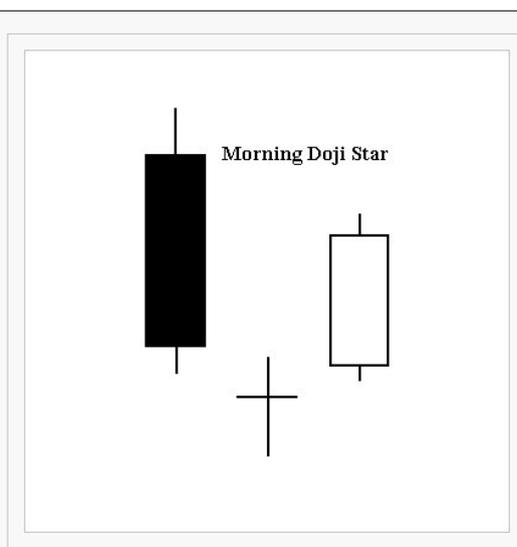
It consists of three candlesticks. First is a large white body candlestick followed by a Doji that gap above the white body. The third candlestick is a black body that closes well into the white body. When it appears at the top it is considered as a reversal signal. It signals more bearish trend than the evening star pattern because of the doji that has appeared between the two bodies.



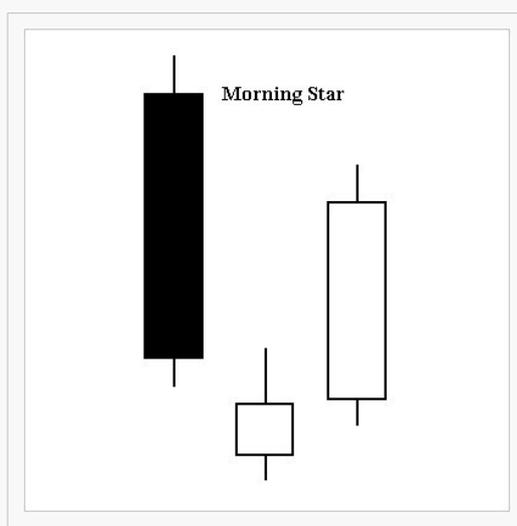
It consists of a large white body candlestick followed by a small body candlestick (black or white) that gaps above the previous. The third is a black body candlestick that closes well within the large white body. It is considered as a reversal signal when it appears at top level.



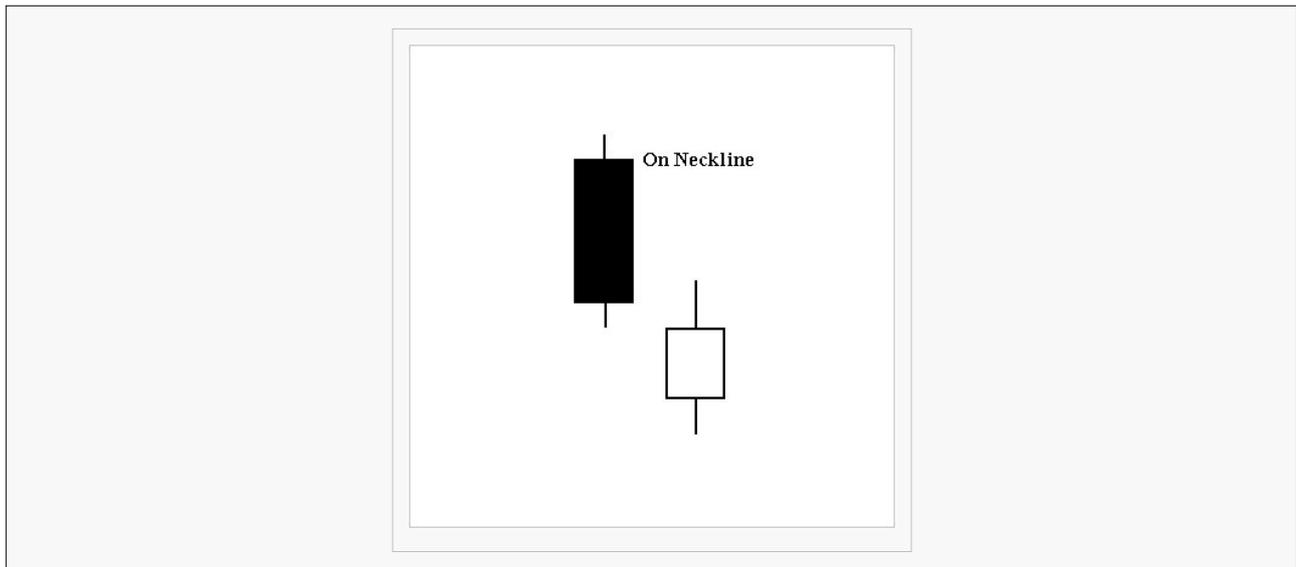
A window (gap) is created when the high of the second candlestick is below the low of the preceding candlestick. It is considered that the window should be filled with a probable resistance.



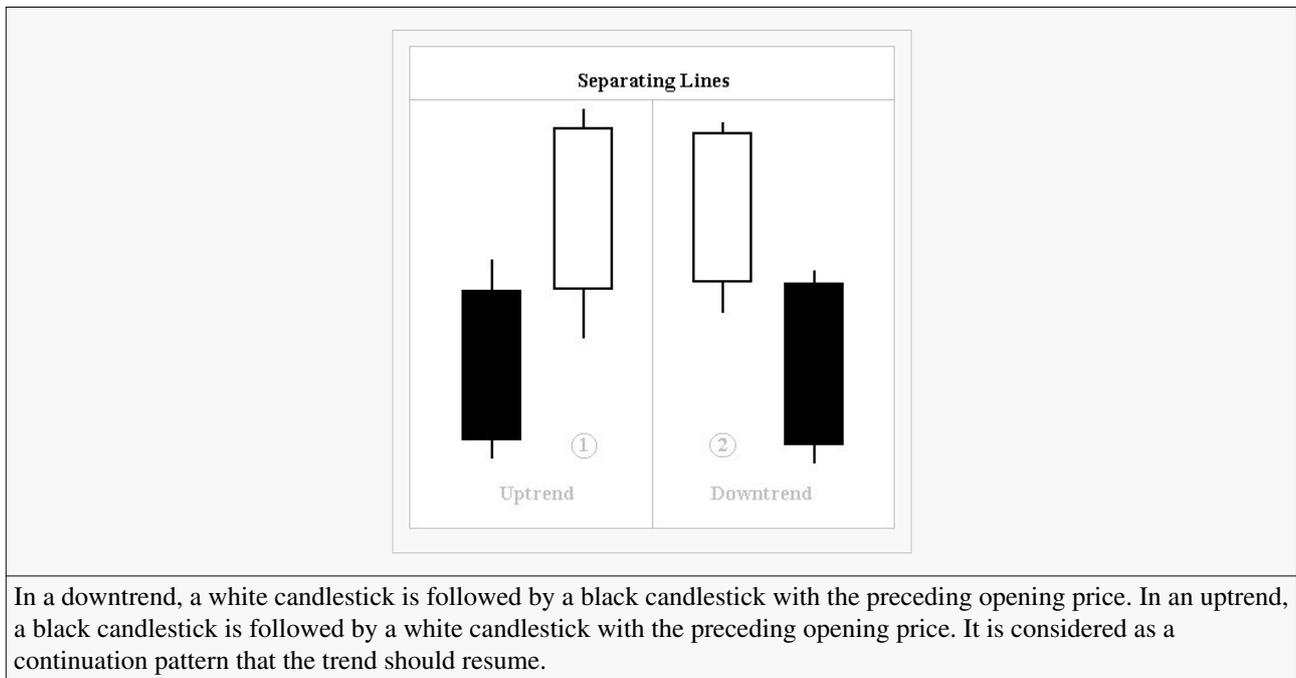
It consists of a large black body candlestick followed by a Doji that occurred below the preceding candlestick. On the following day, a third white body candlestick is formed that closed well into the black body candlestick which appeared before the Doji. It is considered as a major reversal signal that is more bullish than the regular morning star pattern because of the existence of the Doji.



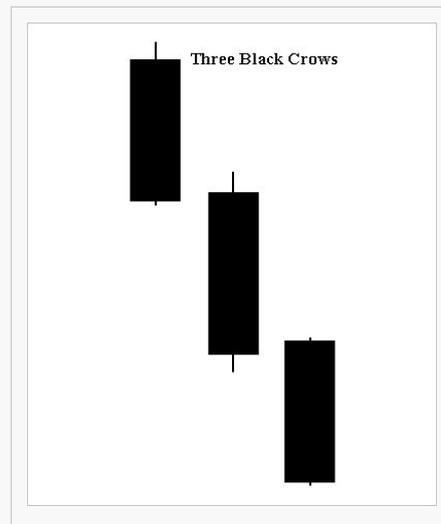
It consists of a large black body candlestick followed by a small body (black or white) that occurred below the large black body candlestick. On the following day, a third white body candlestick is formed that closed well into the black body candlestick. It is considered as a major reversal signal when it appears at bottom.



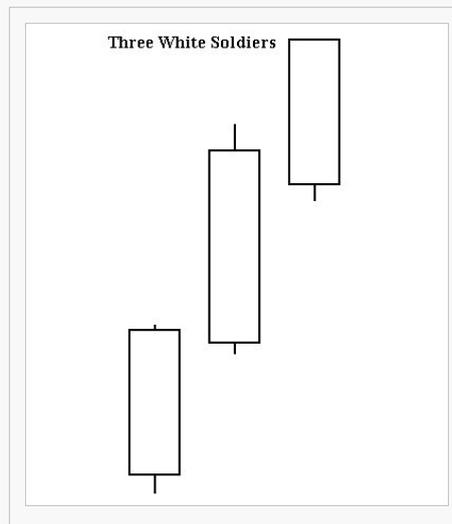
In a downtrend, it consists of a black candlestick followed by a small body white candlestick with its close near the low of the preceding black candlestick. It is considered as a bearish pattern when the low of the white candlestick is penetrated.



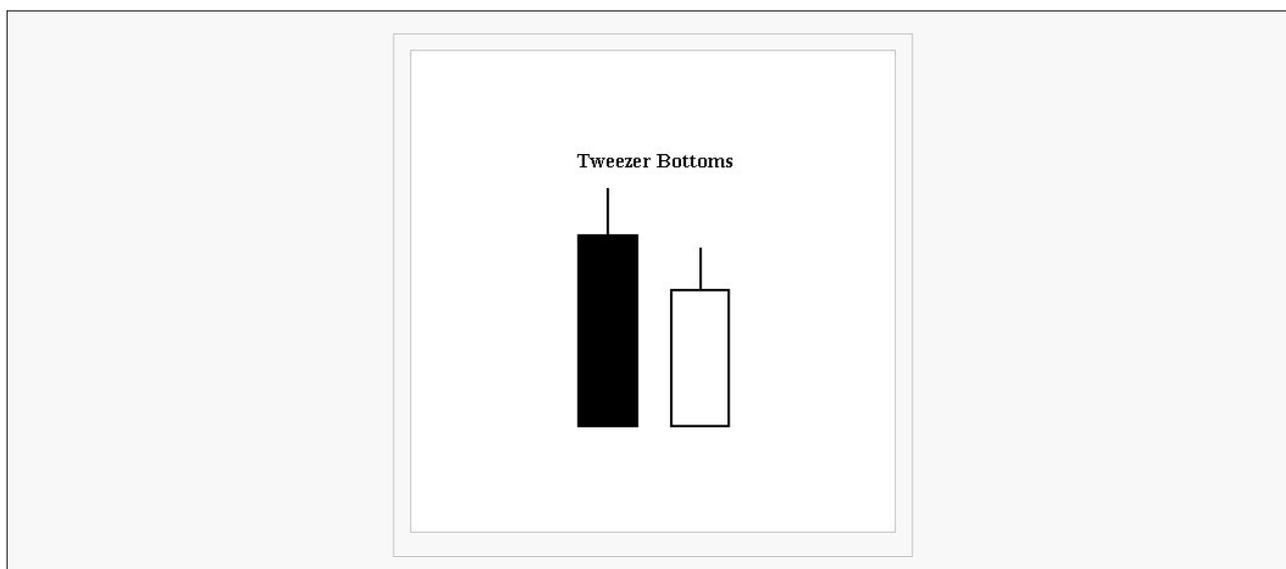
In a downtrend, a white candlestick is followed by a black candlestick with the preceding opening price. In an uptrend, a black candlestick is followed by a white candlestick with the preceding opening price. It is considered as a continuation pattern that the trend should resume.



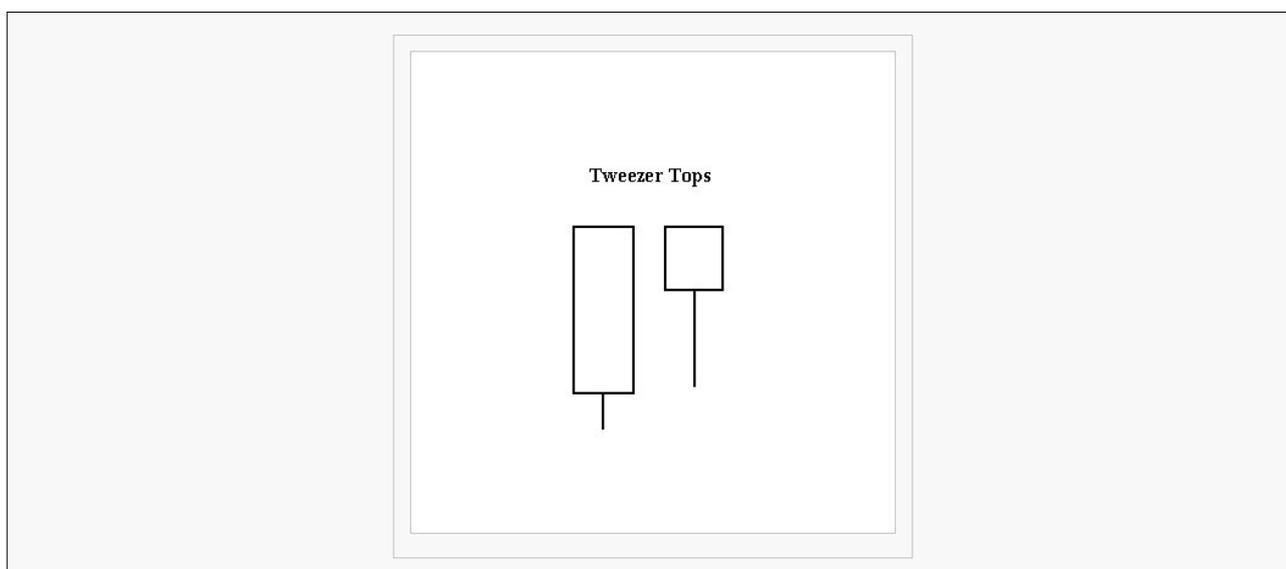
It consists of three long black candlesticks with consecutively lower closes. The closing prices are near to or at their lows. When it appears at top it is considered as a top reversal signal.



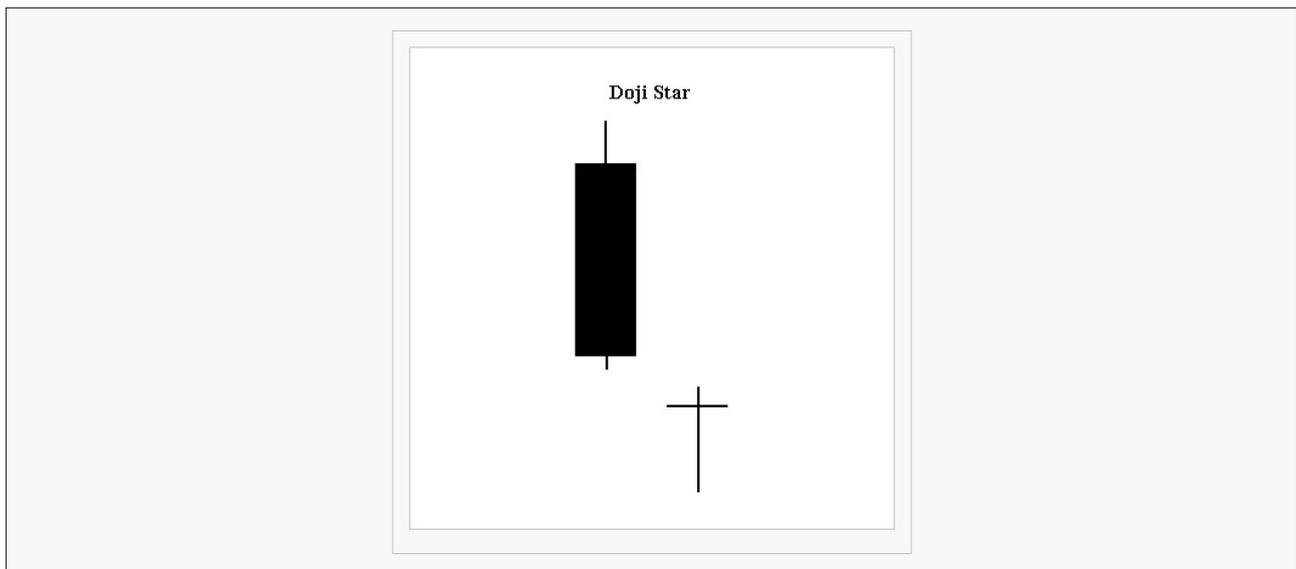
It consists of three long white candlesticks with consecutively higher closes. The closing prices are near to or at their highs. When it appears at bottom it is interpreted as a bottom reversal signal.



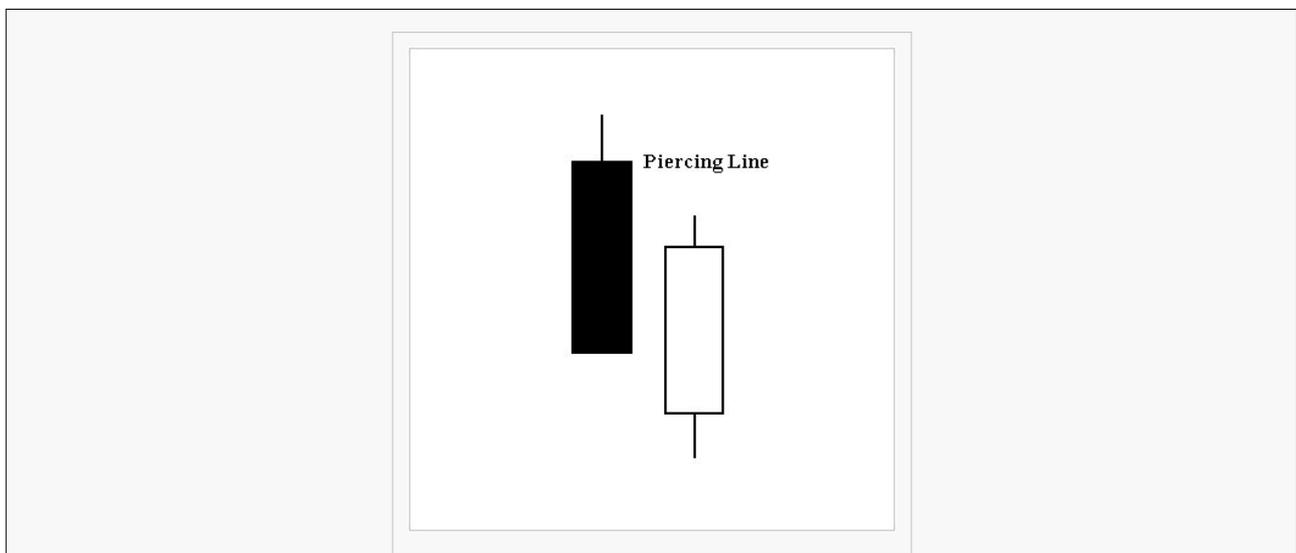
It consists of two or more candlesticks with matching bottoms. The candlesticks may or may not be consecutive and the sizes or the colours can vary. It is considered as a minor reversal signal that becomes more important when the candlesticks form another pattern.



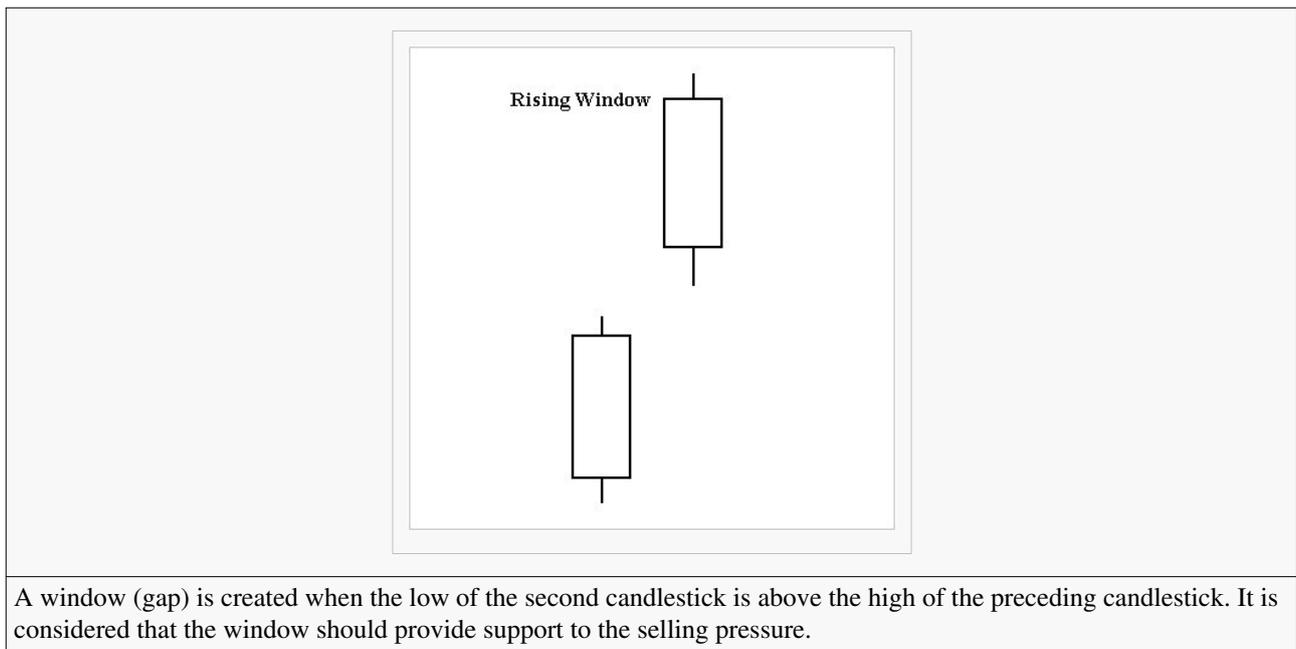
It consists of two or more candlesticks with matching tops. The candlesticks may or may not be consecutive and the sizes or the colours can vary. It is considered as a minor reversal signal that becomes more important when the candlesticks form another pattern.



It consists of a black or a white candlestick followed by a Doji that gap above or below these. It is considered as a reversal signal with confirmation during the next trading day.



It consists of a black candlestick followed by a white candlestick that opens lower than the low of preceding but closes more than halfway into black body candlestick. It is considered as reversal signal when it appears at bottom.



## See also

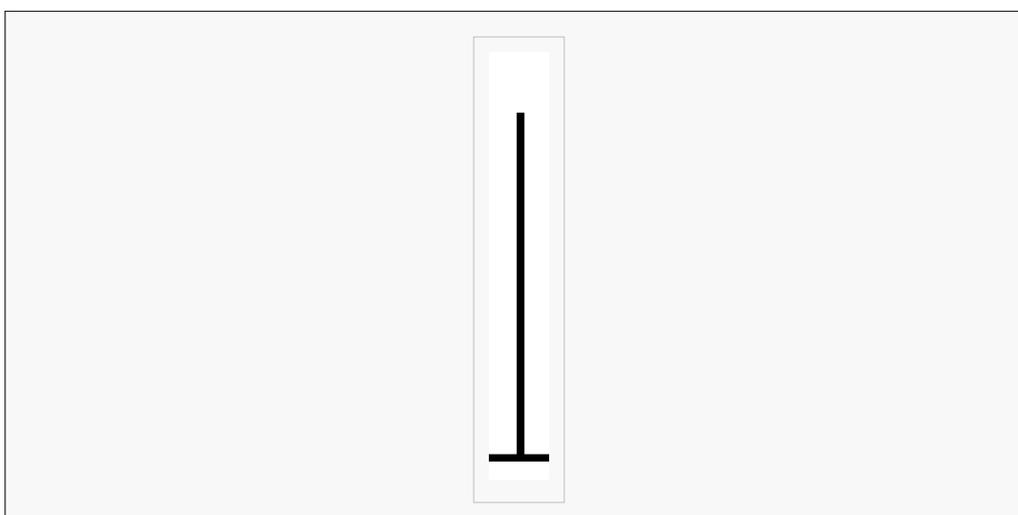
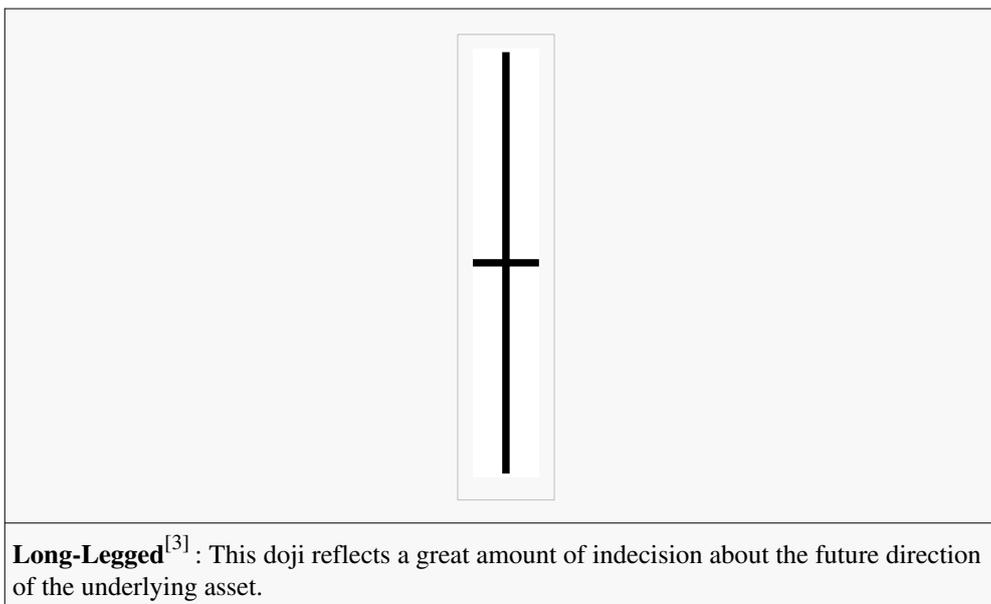
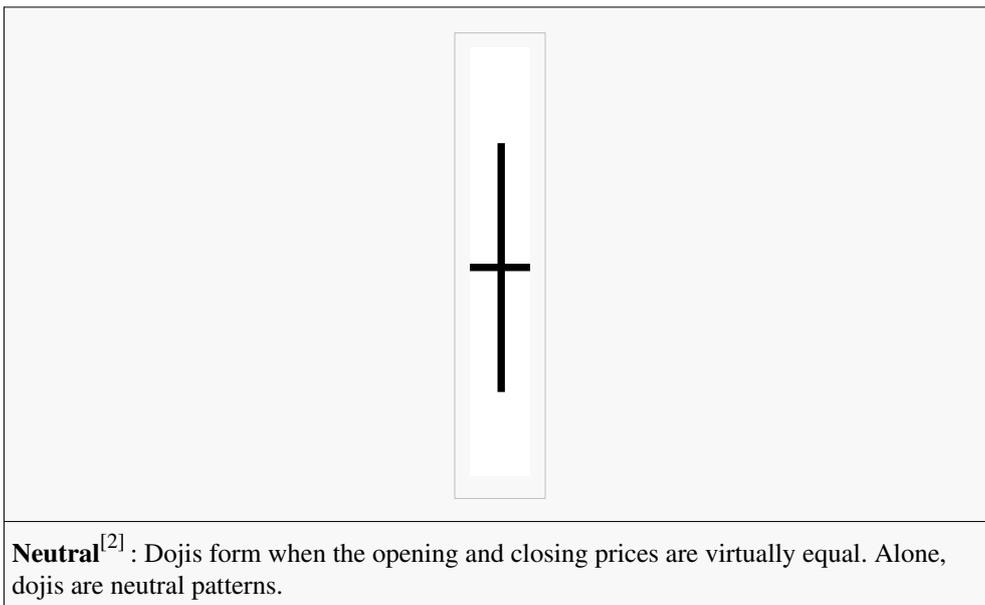
- A brief introduction of the terms used in acquisitions, mergers and takeovers
- The Island Reversal

## Doji

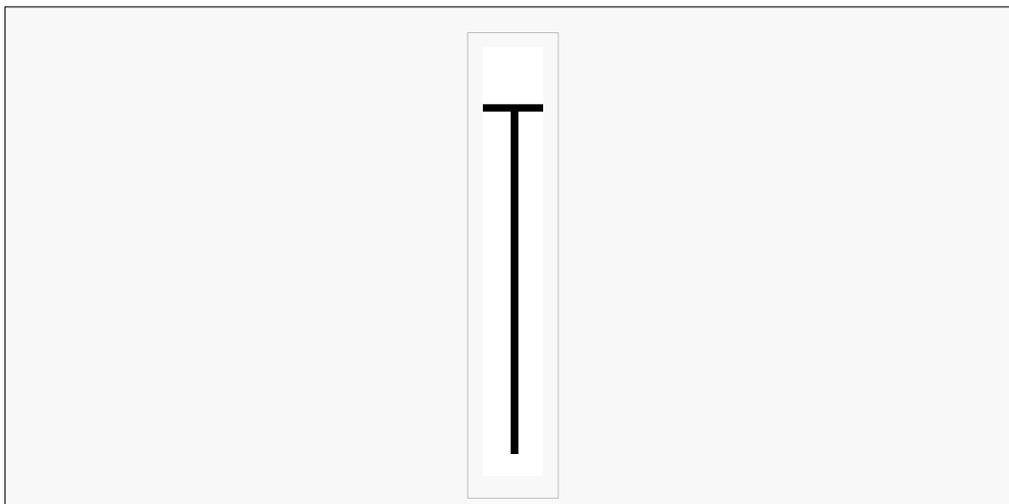
The **doji** is a commonly found pattern in a candlestick chart of financially traded assets (stocks, bonds, futures, etc). It is characterized by being small in length—meaning a small trading range—with an opening and closing price that are virtually equal<sup>[1]</sup>.

The doji represents indecision in the market. A doji is not as significant if the market is not clearly trending, as non-trending markets are inherently indicative of indecision. If the doji forms in an uptrend or downtrend, this is normally seen as significant, as it is a signal that the buyers are losing conviction when formed in an uptrend and a signal that sellers are losing conviction if seen in a downtrend.

## Types of Doji



**Gravestone**<sup>[4]</sup> : The long upper shadow suggests that the direction of the trend may be nearing a major turning point.



**Dragonfly**<sup>[5]</sup> : The long lower shadow suggests that the direction of the trend may be nearing a major turning point.

## References

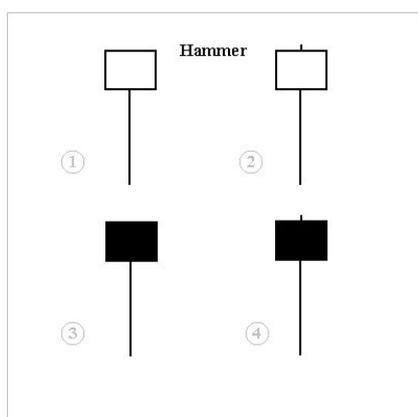
- [1] Doji - stockcharts.com ([http://stockcharts.com/school/doku.php?id=chart\\_school:chart\\_analysis:introduction\\_to\\_candlesticks#doji](http://stockcharts.com/school/doku.php?id=chart_school:chart_analysis:introduction_to_candlesticks#doji))
- [2] Neutral Doji - investopedia.com (<http://www.investopedia.com/terms/d/doji.asp>)
- [3] Long-Legged Doji - investopedia.com (<http://www.investopedia.com/terms/l/long-legged-doji.asp>)
- [4] Gravestone Doji - investopedia.com (<http://www.investopedia.com/terms/g/gravestone-doji.asp>)
- [5] Dragonfly Doji - investopedia.com (<http://www.investopedia.com/terms/d/dragonfly-doji.asp>)

## See also

- Candlestick chart
- Harami cross
- Doji star

# Hammer (candlestick pattern)

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Hammers are found in downtrends

A **hammer** is a type of **bullish reversal** candlestick pattern, made up of just one candle, found in price charts of financial assets. The candle looks like a hammer, as it has a long lower wick and a short body at the top of the candlestick with little or no upper wick. In order for a candle to be a valid hammer most traders say the lower wick must be two times greater than the size of the body portion of the candle, and the body of the candle must be at the upper end of the trading range.

When you see the hammer form in a **downtrend** this is a sign of a potential reversal in the market as the long lower wick represents a period of trading where the sellers were initially in control but the buyers were able to reverse that control and drive prices back up to close near the high for the day, thus the short body at the top of the candle.

After seeing this chart pattern form in the market most traders will wait for the next period to open higher than the close of the previous period to confirm that the buyers are actually in control.

Two additional things that traders will look for to place more significance on the pattern are a long lower wick and an increase in volume for the time period that formed the hammer.

## External links

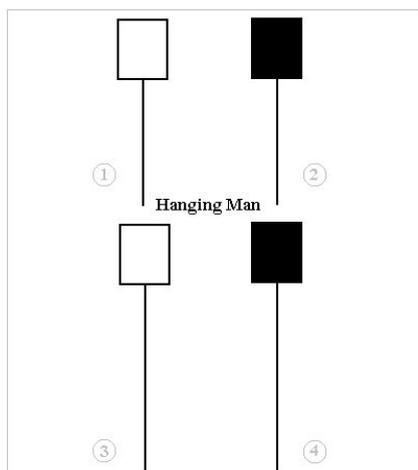
- Hammer pattern <sup>[1]</sup> at [onlinetradingconcepts.com](http://onlinetradingconcepts.com)
- Bullish Hammer <sup>[2]</sup> at [candlesticker.com](http://candlesticker.com)
- Hammer definition <sup>[3]</sup> at [investopedia.com](http://investopedia.com)

## References

- [1] <http://www.onlinetradingconcepts.com/TechnicalAnalysis/Candlesticks/Hammer.html>  
[2] <http://www.candlesticker.com/Cs18.asp>  
[3] <http://www.investopedia.com/terms/h/hammer.asp>

# Hanging man (candlestick pattern)

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Hanging man patterns are found in uptrends

A **hanging man** is a type of **bearish reversal** pattern, made up of just one candle, found in price charts of financial assets. It has a long lower wick and a short body at the top of the candlestick with little or no upper wick. In order for a candle to be a valid hanging man most traders say the lower wick must be two times greater than the size of the body portion of the candle, and the body of the candle must be at the upper end of the trading range.

## External links

- Hanging man pattern <sup>[1]</sup> at [onlinetradingconcepts.com](http://onlinetradingconcepts.com)
- Bearish Hanging man <sup>[2]</sup> at [candlesticker.com](http://candlesticker.com)
- Hanging man definition <sup>[3]</sup> at [investopedia.com](http://investopedia.com)

## References

- [1] <http://www.onlinetradingconcepts.com/TechnicalAnalysis/Candlesticks/HangingMan.html>  
[2] <http://www.candlesticker.com/Cs26.asp>  
[3] <http://www.investopedia.com/terms/h/hangingman.asp>

# Inverted hammer

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The **Inverted Hammer** is a type of **bullish reversal** pattern. As its name implies, the inverted Hammer looks like an upside down version of the hammer candlestick pattern. Like the hammer candlestick pattern, the Inverted Hammer consists of one candle and when found in a **downtrend** is considered a potential reversal pattern.

The pattern is made up of a candle with a small lower body and a long upper wick which is at least two times as large as the short lower body. The body of the candle should be at the low end of the trading range and there should be little or no lower wick in the candle.

The long upper wick of the candlestick pattern indicates that the buyers drove prices up at some point during the period in which the candle was formed but encountered selling pressure which drove prices back down for the period to close near to where they opened. As this occurred in an uptrend the selling pressure is seen as a potential reversal sign. When encountering this pattern traders will look for a lower open on the next period before considering the pattern valid and potentially including it in their trading strategy

## External links

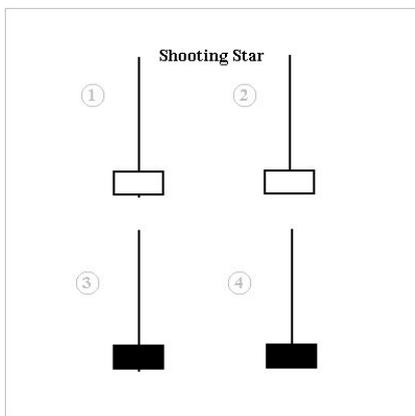
- Inverted hammer <sup>[1]</sup> at onlinetradingconcepts.com

## References

- [1] <http://www.onlinetradingconcepts.com/TechnicalAnalysis/Candlesticks/InvertedHammer.html>

# Shooting star (candlestick pattern)

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Shooting star patterns are found in uptrends

The **shooting star** is a type of **bearish reversal** pattern. The Shooting Star looks exactly the same as the Inverted hammer, but instead of being found in a downtrend it is found in an **uptrend** and thus has different implications. Like the Inverted hammer it is made up of a candle with a small lower body, little or no lower wick, and a long upper wick that is at least two times the size of the lower body.

The long upper wick of the candlestick pattern indicates that the buyers drove prices up at some point during the period in which the candle was formed but encountered selling pressure which drove prices back down for the period to close near to where they opened. As this occurred in an uptrend the selling pressure is seen as a potential reversal sign. When encountering this pattern traders will look for a lower open on the next period before considering the pattern valid and potentially including it in their trading strategy.

As with the Inverted hammer most traders will see a longer wick as a sign of a greater potential reversal and like to see an increase in volume on the day the Shooting Star forms.

## External links

- Shooting star pattern <sup>[1]</sup> at onlinetradingconcepts.com
- Bearish Shooting star <sup>[2]</sup> at candlesticker.com
- Shooting star definition <sup>[3]</sup> at investopedia.com

## References

[1] <http://www.onlinetradingconcepts.com/TechnicalAnalysis/Candlesticks/ShootingStar.html>

[2] <http://www.candlesticker.com/Cs42.asp>

[3] <http://www.investopedia.com/terms/s/shootingstar.asp>

# Marubozu

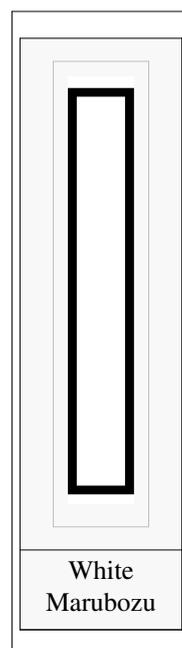
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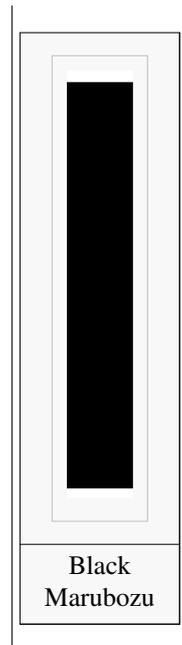
**Marubozu** is the name of Japanese candlesticks formation used in technical analysis to indicate a stock has traded strongly in one direction throughout the session and closed at its high or low price of the day. A marubozu candle is represented only by a body; it has no wicks or shadows extending from the top or bottom of the candle. A white marubozu candle has a long white body and is formed when the open equals the low and the close equals the high.

The white marubozu candle indicates that buyers controlled the price of the stock from the opening bell to the close of the day, and is considered very bullish.

A black marubozu candle has a long black body and is formed when the open equals the high and the close equals the low. A black marubozu indicates that sellers controlled the price from the opening bell to the close of the day, and is considered very bearish.

## Examples



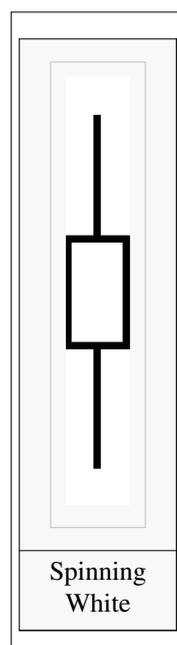


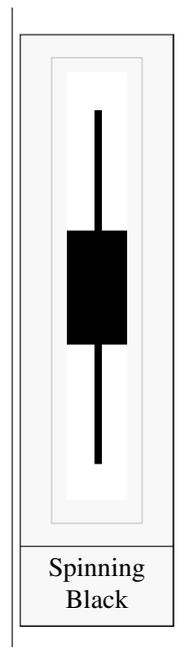
## Spinning top (candlestick pattern)

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**Spinning top** is a Japanese candlesticks pattern with a short body found in the middle of two long wicks. A spinning top is indicative of a situation where neither the buyers nor the sellers have won for that time period, as the market has closed relatively unchanged from where it opened; the market is indecisive regarding its trend. The upper and lower long wicks, however, tell us that both the buyers and the sellers had the upper hand at some point during the time period the candle represents. When a spinning top forms after a run up or run down in the market, it can be an indication of a pending reversal, as the indecision in the market is representative of the buyers losing momentum when this occurs after an uptrend and the sellers losing momentum after a downtrend.

### Examples



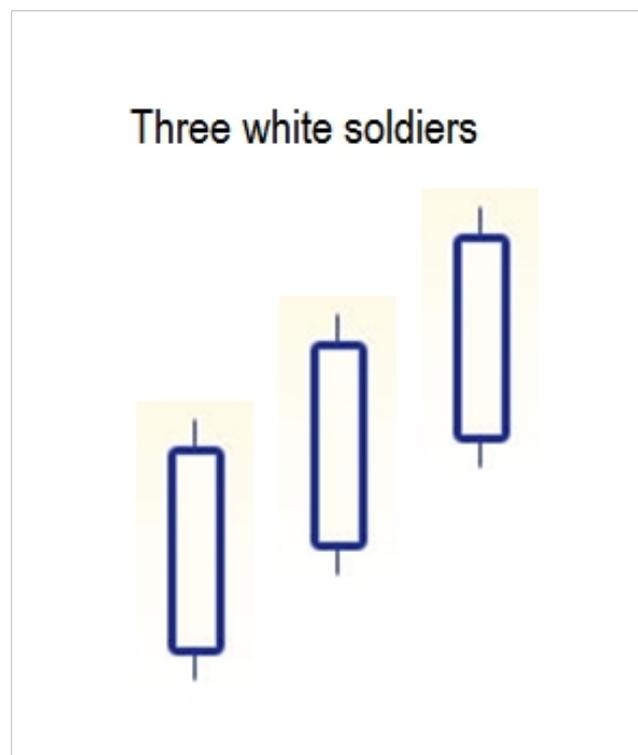


## Three white soldiers

**Three white soldiers** is a candlestick chart pattern in the financial markets. It unfolds across three trading sessions and suggests a strong price reversal from a bear market to a bull market. The pattern consists of three long candlesticks that trend upward like a staircase; each should open above the previous day's open, ideally in the middle price range of that previous day. Each candlestick should also close progressively upward to establish a new near-term high.<sup>[1]</sup>

The three white soldiers help to confirm that a bear market has ended and market sentiment has turned positive. In *Candlestick Charting Explained*, technical analyst Gregory L. Morris says "This type of price action is very bullish and should never be ignored."<sup>[2]</sup>

This candlestick pattern has an opposite known as the Three Black Crows, which shares the same attributes in reverse.



### Notes

[1] "Japanese Candlesticks" ([http://www.ejapanesecandles.com/three\\_white\\_soldiers.php](http://www.ejapanesecandles.com/three_white_soldiers.php)). . Retrieved 15 June 2010.

[2] Morris, Gregory L.; Litchfield, Ryan (2005). *Candlestick Charting Explained* (3rd ed.). New York, NY: McGraw-Hill. p. 126. ISBN 0-07-146154-X.

## References

- *Candlestick Charting Explained* by Gregory L. Morris. Published by McGraw-Hill. ISBN 0-07-146154-X
- *Japanese Candlestick Charting Techniques* by Steve Nison. Published by New York Institute of Finance. ISBN 0-7352-0181-1

## External links

- Stock Charts - Glossary ([http://stockcharts.com/school/doku.php?id=chart\\_school:glossary\\_t](http://stockcharts.com/school/doku.php?id=chart_school:glossary_t))
- Investopedia - Dictionary ([http://www.investopedia.com/terms/t/three\\_white\\_soldiers.asp](http://www.investopedia.com/terms/t/three_white_soldiers.asp))
- Prosticks - Chart Patterns ([http://www.prosticks.com/education/candlestick\\_patterns/three\\_white\\_soldiers.php](http://www.prosticks.com/education/candlestick_patterns/three_white_soldiers.php))

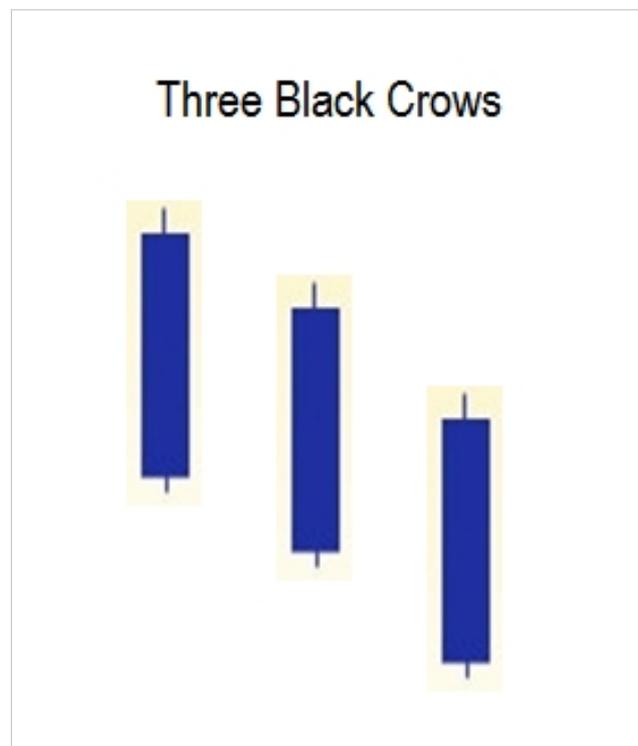
# Three Black Crows

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**Three black crows** is a term used by stock market analysts to describe a market downturn. It appears on a candlestick chart in the financial markets. It unfolds across three trading sessions, and consists of three long candlesticks that trend downward like a staircase. Each candle should open below the previous day's open, ideally in the middle price range of that previous day. Each candlestick should also close progressively downward to establish a new near-term low. The pattern indicates a strong price reversal from a bull market to a bear market.<sup>[1]</sup>

The three black crows help to confirm that a bull market has ended and market sentiment has turned negative. In *Japanese Candlestick Charting Techniques*, technical analyst Steve Nison says "The three black crows would likely be useful for longer-term traders."<sup>[2]</sup>

This candlestick pattern has a counterpart known as the Three white soldiers, whose attributes help identify a bullish reversal or market upswing.



## References

- [1] "Stock market investing 101 - Simplified utilizing candlestick signals" ([http://www.candlestickforum.com/PPF/Parameters/16\\_597\\_/candlestick.asp](http://www.candlestickforum.com/PPF/Parameters/16_597_/candlestick.asp)). . Retrieved 16 June 2010.
  - [2] Nison, Steve (2001). *Candlestick Charting Explained* (2nd ed.). Paramus, New Jersey: New York Institute of Finance. p. 97. ISBN 0-7352-0181-1.
  - *Japanese Candlestick Charting Techniques* by Steve Nison. Published by New York Institute of Finance. ISBN 0-7352-0181-1
  - *Candlestick Charting Explained* by Gregory L. Morris. Published by McGraw-Hill. ISBN 0-07-146154-X
-

## External links

- Stock Charts - Glossary ([http://stockcharts.com/school/doku.php?id=chart\\_school:glossary\\_t](http://stockcharts.com/school/doku.php?id=chart_school:glossary_t))
- Investopedia - Dictionary ([http://www.investopedia.com/terms/t/three\\_black\\_crows.asp](http://www.investopedia.com/terms/t/three_black_crows.asp))
- Prosticks - Chart Patterns ([http://www.prosticks.com/education/candlestick\\_patterns/three\\_black\\_crows.php](http://www.prosticks.com/education/candlestick_patterns/three_black_crows.php))

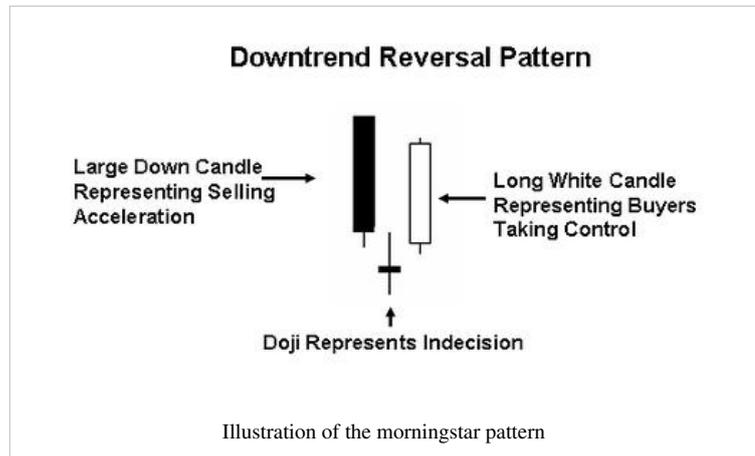
## Morning star (candlestick pattern)

The **Morning Star** is a pattern seen in a candlestick chart, a type of chart used by stock analysts to describe and predict price movements of a security, derivative, or currency over time.

### Description

The pattern is made up of three candles: normally a long bearish candle, followed by a short bullish or bearish doji, which is then followed by a long bullish candle. In order to have a valid Morning Star formation,

most traders will look for the top of the third candle to be at least half way up the body of the first candle in the pattern. Black candles indicate falling prices, and white candles indicate rising prices.



### Interpretation

When found in a downtrend, this pattern can be an indication that a reversal in the price trend is going to take place. What the pattern represents from a supply and demand point of view is a lot of selling in the period which forms the first black candle; then, a period of lower trading but with a reduced range, which indicates indecision in the market; this forms the second candle. This is followed by a large white candle, representing buyers taking control of the market. As the Morning Star is a three-candle pattern, traders oftentimes will not wait for confirmation from a fourth candle before buying the stock. High volumes on the third trading day confirm the pattern. Traders will look at the size of the candles for an indication of the size of the potential reversal. The larger the white and black candle, and the higher the white candle moves in relation to the black candle, the larger the potential reversal.

The chart below illustrates.



The opposite occurring at the top of an uptrend is called an evening star.

## Hikkake Pattern

The **Hikkake Pattern** (also known simply as **Hikkake** or an **inside day false breakout**), is a technical analysis pattern used for determining market turning-points and continuations. It is a simple pattern that can be observed in market price data, using traditional bar charts, or Japanese candlestick charts.

### Description

The pattern consists of a measurable period of rest and volatility contraction in the market, followed by a relatively brief price move that encourages unsuspecting traders and investors to adopt a false assumption regarding the likely future direction of price. The pattern, once formed, yields its own set of trading parameters for the time and price of market entry, the dollar risk amount (i.e., where to place protective stops), and the expected profit target. The pattern is not meant as a stand alone "system" for market speculation, but rather as an ancillary technique to traditional technical and fundamental market analysis methods.

The pattern is recognised in two variants, one bearish and one bullish. In both variants, the first bar of the pattern is an inside bar (i.e., one which has both a higher low and a lower high, compared with the previous bar). This is then followed by either a bar with both higher low and higher high for the bearish variant, or with lower low and lower high for the bullish variant. Before the pattern produces a trading signal it must be confirmed; this happens when the price passes below the low of the first bar of the pattern (in the bearish variant) or above the high of the first bar (in the bullish variant). Confirmation must occur within three periods of the last bar of the signal for the signal to be considered valid.

## Origin

The hikkake pattern was first discovered and introduced to the financial community through a series of published articles written by technical analyst.<sup>[1]</sup> The phrase "Hikkake" is a Japanese verb which means to "trick" or "ensnare."

## Notable uses

Due to its popularity among institutional traders, the hikkake pattern has been adopted for use by INSTREAM,<sup>[2]</sup> the Nordic power trading software company, in their E2 Energy Market Analysis Platform.

Growing interest in the hikkake pattern among traders and investors has also spawned attention from various book authors. See: "Technical Analysis: The Complete Resource for Financial Market Technicians" by Charles D. Kirkpatrick and Julie R. Dahlquist, and "Long/Short Market Dynamics: Trading Strategies for Today's Markets" by Clive M. Corcoran.

## References

[1] Daniel L. Chesler, CMT (<http://www.chesler.us>)

[2] INTSTREAM (<http://www.intstream.com/>)

## External links

- Trading False Moves with the Hikkake Pattern - PDF file (<http://www.chesler.us/resources/articles/chesler0404.pdf>)
- Quantifying Market Deception with The Hikkake Pattern - PDF file ([http://www.chesler.us/resources/articles/TechAnalyst\\_Nov04.pdf](http://www.chesler.us/resources/articles/TechAnalyst_Nov04.pdf))
- Noted technical analysis authority Thomas Bulkowski considers in detail the historical performance record of the Hikkake pattern (<http://thepatternsite.com/HikkakeBull.html>)

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# INDICATORS: Trend

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## Average Directional Index

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The **Average Directional Index (ADX)** was developed in 1978 by J. Welles Wilder as an indicator of trend strength in a series of prices of a financial instrument. ADX has become a widely used indicator for technical analysts, and is provided as a standard in collections of indicators offered by various trading platforms.

### Calculation

The ADX is a combination of two other indicators developed by Wilder, the positive directional indicator (abbreviated +DI) and negative directional indicator (-DI). The ADX combines them and smooths the result with an exponential moving average.

To calculate +DI and -DI, one needs price data consisting of high, low, and closing prices each period (typically each day). One first calculates the Directional Movement (+DM and -DM):

$$\text{UpMove} = \text{Today's High} - \text{Yesterday's High}$$

$$\text{DownMove} = \text{Yesterday's Low} - \text{Today's Low}$$

$$\text{if } \text{UpMove} > \text{DownMove} \text{ and } \text{UpMove} > 0, \text{ then } +\text{DM} = \text{UpMove}, \text{ else } +\text{DM} = 0$$

$$\text{if } \text{DownMove} > \text{UpMove} \text{ and } \text{DownMove} > 0, \text{ then } -\text{DM} = \text{DownMove}, \text{ else } -\text{DM} = 0$$

After selecting the number of periods (Wilder used 14 days originally), +DI and -DI are:

$$+\text{DI} = 100 \text{ times exponential moving average of } +\text{DM} \text{ divided by Average True Range}$$

$$-\text{DI} = 100 \text{ times exponential moving average of } -\text{DM} \text{ divided by Average True Range}$$

The exponential moving average is calculated over the number of periods selected, and the average true range is an exponential average of the true ranges. Then:

$$\text{ADX} = 100 \text{ times the exponential moving average of the Absolute value of } (+\text{DI} - -\text{DI}) \text{ divided by } (+\text{DI} + -\text{DI})$$

Variations of this calculation typically involve using different types of moving averages, such as a weighted moving average or an adaptive moving average.

### Interpretation

The ADX does not indicate trend direction, only trend strength. It is a lagging indicator; that is, a trend must have established itself before the ADX will generate a signal that a trend is underway. ADX will range between 0 and 100. Generally, ADX readings below 20 indicate trend weakness, and readings above 40 indicate trend strength. An extremely strong trend is indicated by readings above 50.

### References

- J. Welles Wilder, Jr. (June 1978). *New Concepts in Technical Trading Systems*. Greensboro, NC: Trend Research. ISBN 978-0894590276.
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# Ichimoku Kinkō Hyō

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**Ichimoku Kinko Hyo** (一目均衡表 *Ichimoku Kinkō Hyō*) usually just called *ichimoku* is a technical analysis method that builds on candlestick charting to improve the accuracy of forecasted price moves. It was developed in the late 1930s by Goichi Hosoda (細田悟一 *Hosoda Goichi*), a Japanese journalist who used to be known as Ichimoku Sanjin, which can be translated as "What a man in the mountain sees". He spent thirty years perfecting the technique before releasing his findings to the general public in the late 1960s.<sup>[1]</sup>

Ichimoku Kinko Hyo translates to 'one glance equilibrium chart' or 'instant look at the balance chart' and is sometimes referred to as 'one glance cloud chart' based on the unique 'clouds' that feature in ichimoku charting.<sup>[2]</sup>

Ichimoku is a moving average-based trend identification system and because it contains more data points than standard candlestick charts, provides a clearer picture of potential price action.<sup>[3]</sup> The main difference between how moving averages are plotted in ichimoku as opposed to other methods is that ichimoku's lines are constructed using the 50% point of the highs and lows as opposed to the candle's closing price.

Ichimoku factors in time as an additional element along with the price action, similar to William Delbert Gann's trading ideas.

Popular in Japan, ichimoku is gaining traction in the west through proponents of its charting accuracy such as Lincoln FX and Ichi360.

## The key elements of the ichimoku chart

### Tenkan-sen

Tenkan-sen (転換線) calculation:  $(\text{highest high} + \text{lowest low})/2$  for the last 9 periods.

It is primarily used as a signal line and a minor support/resistance line.

### Kijun-sen

Kijun-sen (基準線) calculation:  $(\text{highest high} + \text{lowest low})/2$  for the past 26 periods.

This is a confirmation line, a support/resistance line, and can be used as a trailing stop line.

### Senkou span A

Senkou (先行) span A calculation:  $(\text{Tenkan-sen} + \text{kijun-sen})/2$  plotted 26 periods ahead.

Also called leading span 1, this line forms one edge of the kumo, or cloud

### Senkou span B

Senkou span B calculation:  $(\text{highest high} + \text{lowest low})/2$  calculated over the past 52 time periods and plotted 26 periods ahead.

Also called leading span 2, this line forms the other edge of the kumo.

### Kumo

Kumo (雲, cloud) is the space between senkou span A and B. The cloud edges identify current and potential future support and resistance points.

## Chikou span

Chikou (遅行) span calculation: today's closing price projected back 26 days on the chart.

Also called the lagging span it is used as a support/resistance aid.

## References

- [1] Kumotrader Ichimoku Wiki ([http://www.kumotrader.com/ichimoku\\_wiki/index.php?title=Main\\_Page](http://www.kumotrader.com/ichimoku_wiki/index.php?title=Main_Page))
- [2] Example ichimoku chart showing all the elements (<http://www.lincolnfx.com/forex-forecasts/2010/01/24/ichimoku-elements-2/>)
- [3] Ichimoku Cloud Filters Information Storm (<http://www.investopedia.com/articles/forex/06/ichimoku.asp>)

# MACD

**MACD** (Moving Average Convergence/Divergence) is a technical analysis indicator created by Gerald Appel in the late 1970s.<sup>[1]</sup> It is used to spot changes in the strength, direction, momentum, and duration of a trend in a stock's price.

The MACD is a computation of the difference between two exponential moving averages (EMAs) of closing prices. This difference is charted over time, alongside a moving average of the difference. The divergence between the two is shown as a histogram or bar graph.

Exponential moving averages highlight recent changes in a stock's price. By comparing EMAs of different periods, the MACD line illustrates changes in the trend of a stock. Then by comparing that difference to an average, an analyst can chart subtle shifts in the stock's trend.

Since the MACD is based on moving averages, it is inherently a lagging indicator. As a metric of price trends, the MACD is less useful for stocks that are not trending or are trading erratically.

Note that the term "MACD" is used both generally, to refer to the indicator as a whole, and specifically, to the MACD line itself.

## Basic components



The graph above shows a stock with a MACD indicator underneath it. The indicator shows a blue line, a red line, and a histogram or bar chart which calculates the difference between the two lines. Values are calculated from the price of the stock in the main part of the graph.

For the example above this means:

- MACD line (blue line): difference between the 12 and 26 days EMAs
- signal (red line): 9 day EMA of the blue line
- histogram (bar graph): difference between the blue and red lines

Mathematically:

- $MACD = EMA[fast, 12] - EMA[slow, 26]$
- $signal = EMA[period, 9] \text{ of } MACD$
- $histogram = MACD - signal$

The period for the moving averages on which an MACD is based can vary, but the most commonly used parameters involve a faster EMA of 12 days, a slower EMA of 26 days, and the signal line as a 9 day EMA of the difference between the two. It is written in the form, MACD(faster, slower, signal) or in this case, MACD(12,26,9).

## Interpretation

Exponential moving averages highlight recent changes in a stock's price. By comparing EMAs of different lengths, the MACD line gauges changes in the trend of a stock. By then comparing differences in the change of that line to an average, an analyst can identify subtle shifts in the strength and direction of a stock's trend.

Traders recognize three meaningful signals generated by the MACD indicator.

When:

- the MACD line crosses the signal line
- the MACD line crosses zero
- there is a divergence between the MACD line and the price of the stock or between the histogram and the price of the stock

Graphically this corresponds to:

- the blue line crossing the red line
- the blue line crossing the x-axis (the straight black line in the middle of the indicator)
- higher highs (lower lows) on the price graph but not on the blue line, or higher highs (lower lows) on the price graph but not on the bar graph

And mathematically:

- $MACD - signal = 0$
- $EMA[fast, 12] - EMA[slow, 26] = 0$
- $Sign(\text{relative price extremum}_{final} - \text{relative price extremum}_{initial}) \neq Sign(\text{relative MACD extremum}_{final} - \text{MACD extremum}_{initial})$

## Signal line crossover

Signal line crossovers are the primary cues provided by the MACD. The standard interpretation is to buy when the MACD line crosses up through the signal line, or sell when it crosses down through the signal line.

The upwards move is called a bullish crossover and the downwards move a bearish crossover. Respectively, they indicate that the trend in the stock is about to accelerate in the direction of the crossover.

The histogram shows when a crossing occurs. Since the histogram is the difference between the MACD line and the signal line, when they cross there is no difference between them.

The histogram can also help in visualizing when the two lines are approaching a crossover. Though it may show a difference, the changing size of the difference can indicate the acceleration of a trend. A narrowing histogram suggests a crossover may be approaching, and a widening histogram suggests that an ongoing trend is likely to get even stronger.

While it is theoretically possible for a trend to increase indefinitely, under normal circumstances, even stocks moving drastically will eventually slow down, lest they go up to infinity or down to nothing.

## Zero crossover

A crossing of the MACD line through zero happens when there is no difference between the fast and slow EMAs. A move from positive to negative is bearish and from negative to positive, bullish. Zero crossovers provide evidence of a change in the direction of a trend but less confirmation of its momentum than a signal line crossover.

## Divergence

The third cue, divergence, refers to a discrepancy between the MACD line and the graph of the stock price. Positive divergence between the MACD and price arises when price hits a new low, but the MACD doesn't. This is interpreted as bullish, suggesting the downtrend may be nearly over. Negative divergence is when the stock price hits a new high but the MACD does not. This is interpreted as bearish, suggesting that recent price increases will not continue.

Divergence may also occur between the stock price and the histogram. If new high price levels are not confirmed by new high histogram levels, it is considered bearish; alternately, if new low price levels are not confirmed by new low histogram levels, it is considered bullish.

Longer and sharper divergences—distinct peaks or troughs—are regarded as more significant than small, shallow patterns.

## Timing

The MACD is only as useful as the context in which it is applied. An analyst might apply the MACD to a weekly scale before looking at a daily scale, in order to avoid making short term trades against the direction of the intermediate trend.<sup>[2]</sup> Analysts will also vary the parameters of the MACD to track trends of varying duration. One popular short-term set-up, for example, is the (5,35,5).

## False signals

Like any indicator, the MACD can generate false signals. A false positive, for example, would be a bullish crossover followed by a sudden decline in a stock. A false negative would be a situation where there was no bullish crossover, yet the stock accelerated suddenly upwards.

A prudent strategy would be to apply a filter to signal line crossovers to ensure that they will hold. An example of a price filter would be to buy if the MACD line breaks above the signal line and then remains above it for three days. As with any filtering strategy, this reduces both the probability of false signals as well as the frequency of missed profit.

Analysts use a variety of approaches to filter out false signals and confirm true ones. As a lagging indicator, the MACD is often paired with a leading indicator, like the Relative Strength Index (RSI). Historical comparisons to similar stocks as well as a careful investigation of past price movements provide added information about how a stock tends to move.

## Limitations

The MACD has often been criticized for failing to respond in very low or alternately very high volatility market conditions.<sup>[3]</sup> Since the MACD measures the divergence between averages, it can give meaningful feedback only as trends change. Thus, the MACD is less useful if the market is not trending, that is, if it is trading sideways, or if the market is trading erratically, making sudden, dramatic, or countervailing moves.

In a sideways market, the divergence between averages will not have a trend to illuminate. In an erratic market, the changes will happen too quickly to be picked up by moving averages or will cancel each other out, diminishing the MACDs usefulness. A partial caveat to this criticism is that whether a market is trending or volatile is always relative to a particular timeframe, and the MACD can be adjusted to shorter or longer spans.

Finally, though some analysts trade on technical indicators alone, the abundance of experts recommend a complete work-up of a company's business sectors, financial strength, past earnings, new products, management, and institutional buying. For more traditional investors, an indicator like the MACD may be used only to support a previously determined stock choice, or to select an ideal entry-point into a fundamentally sound stock.

## Oscillator classification

The MACD is an absolute price oscillator (APO), because it deals with the actual prices of moving averages rather than percentage changes. A percentage price oscillator (PPO), on the other hand, computes the difference between two moving averages of price divided by the longer moving average value.

While an APO will show greater levels for higher priced securities and smaller levels for lower priced securities, a PPO calculates changes relative to price. Subsequently, a PPO is preferred when: comparing oscillator values between different securities, especially those with substantially different prices; or comparing oscillator values for the same security at significantly different times, especially a security whose value has changed greatly.

A third member of the price oscillator family is the detrended price oscillator (DPO), which ignores long term trends while emphasizing short term patterns.

## Signal processing theory

In signal processing terms, the MACD is a filtered measure of velocity. The velocity has been passed through two first-order linear low pass filters. The "signal line" is that resulting velocity, filtered again. The difference between those two, the histogram, is a measure of the acceleration, with all three filters applied. An MACD crossover of the signal line indicates that the direction of the acceleration is changing. The MACD line crossing zero suggests that the average velocity is changing direction.

## History

The MACD was invented by Gerald Appel in the 1970's. Thomas Aspray added a histogram to the MACD in 1986, as a means to anticipate MACD crossovers, an indicator of important moves in the underlying security.

## References

- [1] Appel, Gerald (1999). *Technical Analysis Power Tools for Active Investors*. Financial Times Prentice Hall. pp. 166. ISBN 0131479024.
- [2] Murphy, John (1999). *Technical Analysis of the Financial Markets*. Prentice Hall Press. pp. 252–255. ISBN 0735200661.
- [3] Fidelity Trend Trading with Short-Term Patterns (<http://personal.fidelity.com/myfidelity/atn/archives/august2003.html>) Retrieved on May 12, 2007

## External links

- Interpreting MACD Crossovers, Histograms, and Divergences (<http://www.onlinetradingconcepts.com/TechnicalAnalysis/MACD.html>)
- MACD page (<http://www.investopedia.com/terms/m/macd.asp>), at Investopedia.com
- MACD page ([http://stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators:moving\\_average\\_conve](http://stockcharts.com/school/doku.php?id=chart_school:technical_indicators:moving_average_conve)), at Stockcharts.com

## Mass index

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The **mass index** is an indicator, developed by Donald Dorsey, used in technical analysis to predict trend reversals. It is based on the notion that there is a tendency for reversal when the price range widens, and therefore compares previous trading ranges (highs minus lows).

Mass index for a commodity is obtained<sup>[1]</sup> by calculating its exponential moving average over a 9 day period and the exponential moving average of this average (a "double" average), and summing the ratio of these two over a given amount of days (usually 25).

$$Mass = Sum[25] \text{ of } \frac{EMA[9] \text{ of } (high - low)}{EMA[9] \text{ of } EMA[9] \text{ of } (high - low)}$$

Generally the EMA and the re-smoothed EMA of EMA are fairly close, making their ratio is roughly 1 and the sum around 25.

According to Dorsey, a so-called "reversal bulge" is a probable signal of trend reversal (regardless of the trend's direction).<sup>[2]</sup> Such a bulge takes place when a 25-day mass index reaches 27.0 and then falls to below 26 (or 26.5). A 9-day prime moving average is usually used to determine whether the bulge is a buy or sell signal.

This formula uses intraday range values: not the "true range," which adjusts for full and partial gaps. Also, the "bulge" does not indicate direction.

## References

- [1] Mass Index construction ([http://www.incrediblecharts.com/technical/mi\\_construction.htm](http://www.incrediblecharts.com/technical/mi_construction.htm)) at IncredibleCharts.com
- [2] Mass Index ([http://www.incrediblecharts.com/technical/mass\\_index.htm](http://www.incrediblecharts.com/technical/mass_index.htm)) at IncredibleCharts.com
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# Moving average

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In statistics, a **moving average**, also called **rolling average**, **rolling mean** or **running average**, is a type of finite impulse response filter used to analyze a set of data points by creating a series of averages of different subsets of the full data set.

Given a series of numbers and a fixed subset size, the moving average can be obtained by first taking the average of the first subset. The fixed subset size is then shifted forward, creating a new subset of numbers, which is averaged. This process is repeated over the entire data series. The plot line connecting all the (fixed) averages is the moving average. Thus, a moving average is not a single number, but it is a set of numbers, each of which is the average of the corresponding subset of a larger set of data points. A moving average may also use unequal weights for each data value in the subset to emphasize particular values in the subset.

A moving average is commonly used with time series data to smooth out short-term fluctuations and highlight longer-term trends or cycles. The threshold between short-term and long-term depends on the application, and the parameters of the moving average will be set accordingly. For example, it is often used in technical analysis of financial data, like stock prices, returns or trading volumes. It is also used in economics to examine gross domestic product, employment or other macroeconomic time series. Mathematically, a moving average is a type of convolution and so it is also similar to the low-pass filter used in signal processing. When used with non-time series data, a moving average simply acts as a generic smoothing operation without any specific connection to time, although typically some kind of ordering is implied.

## Simple moving average

A **simple moving average** (SMA) is the unweighted mean of the previous  $n$  data points. For example, a 10-day simple moving average of closing price is the mean of the previous 10 days' closing prices. If those prices are  $P_M, P_{M-1}, \dots, P_{M-9}$  then the formula is

$$SMA = \frac{P_M + P_{M-1} + \dots + P_{M-9}}{10}$$

When calculating successive values, a new value comes into the sum and an old value drops out, meaning a full summation each time is unnecessary,

$$SMA_{\text{today}} = SMA_{\text{yesterday}} - \frac{P_{M-n}}{n} + \frac{P_M}{n}$$

In technical analysis there are various popular values for  $n$ , like 10 days, 40 days, or 200 days. The period selected depends on the kind of movement one is concentrating on, such as short, intermediate, or long term. In any case moving average levels are interpreted as support in a rising market, or resistance in a falling market.

In all cases a moving average lags behind the latest data point, simply from the nature of its smoothing. An SMA can lag to an undesirable extent, and can be disproportionately influenced by old data points dropping out of the average. This is addressed by giving extra weight to more recent data points, as in the weighted and exponential moving averages.

One characteristic of the SMA is that if the data have a periodic fluctuation, then applying an SMA of that period will eliminate that variation (the average always containing one complete cycle). But a perfectly regular cycle is rarely encountered in economics or finance.<sup>[1]</sup>

For a number of applications it is advantageous to avoid the shifting induced by using only 'past' data. Hence a **central moving average** can be computed, using both 'past' and 'future' data. The 'future' data in this case are *not* predictions, but merely data obtained after the time at which the average is to be computed.

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## Cumulative moving average

The **cumulative moving average** is also frequently called a *running average* or a *long running average* although the term *running average* is also used as synonym for a *moving average*. This article uses the term **cumulative moving average** or simply **cumulative average** since this term is more descriptive and unambiguous.

In some data acquisition systems, the data arrives in an ordered data stream and the statistician would like to get the average of all of the data up until the current data point. For example, an investor may want the average price of all of the stock transactions for a particular stock up until the current time. As each new transaction occurs, the average price at the time of the transaction can be calculated for all of the transactions up to that point using the cumulative average. This is the cumulative average, which is typically an unweighted average of the sequence of  $i$  values  $x_1, \dots, x_i$  up to the current time:

$$CA_i = \frac{x_1 + \dots + x_i}{i}.$$

The brute force method to calculate this would be to store all of the data and calculate the sum and divide by the number of data points every time a new data point arrived. However, it is possible to simply update cumulative average as a new value  $x_{i+1}$  becomes available, using the formula:

$$CA_{i+1} = \frac{x_{i+1} + iCA_i}{i + 1},$$

where  $CA_0$  can be taken to be equal to 0.

Thus the current cumulative average for a new data point is equal to the previous cumulative average plus the difference between the latest data point and the previous average divided by the number of points received so far. When all of the data points arrive ( $i = N$ ), the cumulative average will equal the final average.

The derivation of the cumulative average formula is straightforward. Using

$$x_1 + \dots + x_i = iCA_i,$$

and similarly for  $i + 1$ , it is seen that

$$x_{i+1} = (x_1 + \dots + x_{i+1}) - (x_1 + \dots + x_i) = (i + 1)CA_{i+1} - iCA_i.$$

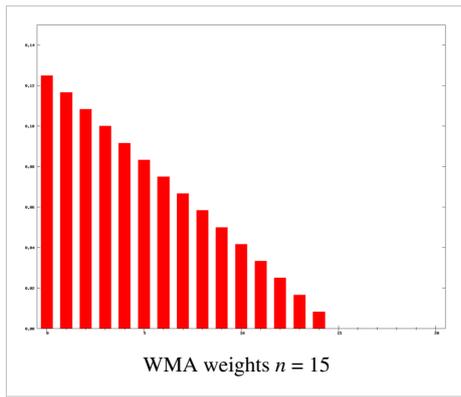
Solving this equation for  $CA_{i+1}$  results in:

$$CA_{i+1} = \frac{(x_{i+1} + iCA_i)}{i + 1} = CA_i + \frac{x_{i+1} - CA_i}{i + 1}.$$

## Weighted moving average

A weighted average is any average that has multiplying factors to give different weights to different data points. Mathematically, the moving average is the convolution of the data points with a moving average function; in technical analysis, a **weighted moving average** (WMA) has the specific meaning of weights that decrease arithmetically. In an  $n$ -day WMA the latest day has weight  $n$ , the second latest  $n - 1$ , etc, down to one.

$$WMA_M = \frac{np_M + (n - 1)p_{M-1} + \dots + 2p_{(M-n+2)} + p_{(M-n+1)}}{n + (n - 1) + \dots + 2 + 1}$$



The denominator is a triangle number, and can be easily computed as  $\frac{n(n + 1)}{2}$ .

When calculating the WMA across successive values, it can be noted the difference between the numerators of  $WMA_{M+1}$  and  $WMA_M$  is  $np_{M+1} - p_M - \dots - p_{M-n+1}$ . If we denote the sum  $p_M + \dots + p_{M-n+1}$  by  $Total_M$ , then

$$Total_{M+1} = Total_M + p_{M+1} - p_{M-n+1}$$

$$Numerator_{M+1} = Numerator_M + np_{M+1} - Total_M$$

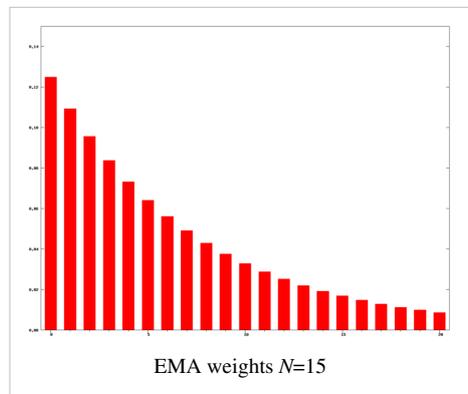
$$WMA_{M+1} = \frac{Numerator_{M+1}}{n + (n - 1) + \dots + 2 + 1}$$

The graph at the right shows how the weights decrease, from highest weight for the most recent data points, down to zero. It can be compared to the weights in the exponential moving average which follows.

### Exponential moving average

An **exponential moving average** (EMA), also known as an **exponentially weighted moving average** (EWMA),<sup>[2]</sup> is a type of infinite impulse response filter that applies weighting factors which decrease exponentially. The weighting for each older data point decreases exponentially, never reaching zero. The graph at right shows an example of the weight decrease.

The formula for calculating the EMA at time periods  $t > 2$  is



$$S_t = \alpha \times Y_t + (1 - \alpha) \times S_{t-1}$$

Where:

- The coefficient  $\alpha$  represents the degree of weighting decrease, a constant smoothing factor between 0 and 1. A higher  $\alpha$  discounts older observations faster. Alternatively,  $\alpha$  may be expressed in terms of  $N$  time periods, where  $\alpha = 2/(N+1)$ . For example,  $N = 19$  is equivalent to  $\alpha = 0.1$ . The half-life of the weights (the interval over which the weights decrease by a factor of two) is approximately  $N/2.8854$  (within 1% if  $N > 5$ ).
- $Y_t$  is the observation at a time period  $t$ .
- $S_t$  is the value of the EMA at any time period  $t$ .

$S_1$  is undefined.  $S_2$  may be initialized in a number of different ways, most commonly by setting  $S_2$  to  $Y_1$ , though other techniques exist, such as setting  $S_2$  to an average of the first 4 or 5 observations. The prominence of the  $S_2$  initialization's effect on the resultant moving average depends on  $\alpha$ ; smaller  $\alpha$  values make the choice of  $S_2$  relatively

more important than larger  $\alpha$  values, since a higher  $\alpha$  discounts older observations faster.

This formulation is according to Hunter (1986)<sup>[3]</sup>. By repeated application of this formula for different times, we can eventually write  $S_t$  as a weighted sum of the data points  $Y_i$ , as:

$$S_t = \alpha \times (Y_{t-1} + (1-\alpha) \times Y_{t-2} + (1-\alpha)^2 \times Y_{t-3} + \dots + (1-\alpha)^k \times Y_{t-(k+1)}) + (1-\alpha)^{k+1} \times S_{t-(k+1)}$$

for any suitable  $k = 0, 1, 2, \dots$ . The weight of the general data point  $Y_{t-i}$  is  $\alpha(1-\alpha)^{i-1}$ .

An alternate approach by Roberts (1959) uses  $Y_t$  in lieu of  $Y_{t-1}$ <sup>[4]</sup>:

$$S_{t, \text{alternate}} = \alpha \times Y_t + (1-\alpha) \times S_{t-1}$$

This formula can also be expressed in technical analysis terms as follows, showing how the EMA steps towards the latest data point, but only by a proportion of the difference (each time):<sup>[5]</sup>

$$\text{EMA}_{\text{today}} = \text{EMA}_{\text{yesterday}} + \alpha \times (\text{price}_{\text{today}} - \text{EMA}_{\text{yesterday}})$$

Expanding out  $\text{EMA}_{\text{yesterday}}$  each time results in the following power series, showing how the weighting factor on each data point  $p_1, p_2$ , etc, decreases exponentially:

$$\text{EMA} = \alpha \times (p_1 + (1-\alpha)p_2 + (1-\alpha)^2 p_3 + (1-\alpha)^3 p_4 + \dots)$$
<sup>[6]</sup>

This is an infinite sum with decreasing terms.

The  $N$  periods in an  $N$ -day EMA only specify the  $\alpha$  factor.  $N$  is not a stopping point for the calculation in the way it is in an SMA or WMA. For sufficiently large  $N$ , The first  $N$  data points in an EMA represent about 86% of the total weight in the calculation<sup>[7]</sup>:

$$\frac{\alpha \times (1 + (1-\alpha) + (1-\alpha)^2 + \dots + (1-\alpha)^N)}{\alpha \times (1 + (1-\alpha) + (1-\alpha)^2 + \dots + (1-\alpha)^\infty)} = 1 - \left(1 - \frac{2}{N+1}\right)^{N+1}$$

i.e.  $\lim_{N \rightarrow \infty} \left[1 - \left(1 - \frac{2}{N+1}\right)^{N+1}\right]$  simplified<sup>[8]</sup>, tends to  $1 - e^{-2} \approx 0.8647$ .

The power formula above gives a starting value for a particular day, after which the successive days formula shown first can be applied. The question of how far back to go for an initial value depends, in the worst case, on the data. If there are huge  $p$  price values in old data then they'll have an effect on the total even if their weighting is very small. If one assumes prices don't vary too wildly then just the weighting can be considered. The weight omitted by stopping after  $k$  terms is

$$\alpha \times ((1-\alpha)^k + (1-\alpha)^{k+1} + (1-\alpha)^{k+2} + \dots),$$

which is

$$\alpha \times (1-\alpha)^k \times (1 + (1-\alpha) + (1-\alpha)^2 + \dots),$$

i.e. a fraction

$$\begin{aligned} \frac{\text{weight omitted by stopping after } k \text{ terms}}{\text{total weight}} &= \frac{\alpha \times [(1-\alpha)^k + (1-\alpha)^{k+1} + (1-\alpha)^{k+2} + \dots]}{\alpha \times [1 + (1-\alpha) + (1-\alpha)^2 + \dots]} \\ &= \frac{\alpha(1-\alpha)^k \times \frac{1}{1-(1-\alpha)}}{\frac{\alpha}{1-(1-\alpha)}} \\ &= (1-\alpha)^k \end{aligned}$$

out of the total weight.

For example, to have 99.9% of the weight, set above ratio equal to 0.1% and solve for  $k$ :

$$k = \frac{\log(0.001)}{\log(1-\alpha)}$$

terms should be used. Since  $\log(1-\alpha)$  approaches  $\frac{-2}{N+1}$  as  $N$  increases<sup>[9]</sup>, this simplifies to approximately<sup>[10]</sup>

$$k = 3.45(N + 1)$$

for this example (99.9% weight).

### Modified moving average

A **modified moving average** (MMA), **running moving average** (RMA), or **smoothed moving average** is defined as:

$$\text{MMA}_{\text{today}} = \frac{(N - 1) \times \text{MMA}_{\text{yesterday}} + \text{price}}{N}$$

In short, this is exponential moving average, with  $\alpha = 1/N$ .

### Application to measuring computer performance

Some computer performance metrics, e.g. the average process queue length, or the average CPU utilization, use a form of exponential moving average.

$$S_n = \alpha(t_n - t_{n-1}) \times Y_n + (1 - \alpha(t_n - t_{n-1})) \times S_{n-1}.$$

Here  $\alpha$  is defined as a function of time between two readings. An example of a coefficient giving bigger weight to the current reading, and smaller weight to the older readings is

$$\alpha(t_n - t_{n-1}) = 1 - e^{-\frac{t_n - t_{n-1}}{W \times 60}}$$

where time for readings  $t_n$  is expressed in seconds, and  $W$  is the period of time in minutes over which the reading is said to be averaged (the mean lifetime of each reading in the average). Given the above definition of  $\alpha$ , the moving average can be expressed as

$$S_n = (1 - e^{-\frac{t_n - t_{n-1}}{W \times 60}}) \times Y_n + e^{-\frac{t_n - t_{n-1}}{W \times 60}} \times S_{n-1}$$

For example, a 15-minute average  $L$  of a process queue length  $Q$ , measured every 5 seconds (time difference is 5 seconds), is computed as

$$L_n = (1 - e^{-\frac{5}{15 \times 60}}) \times Q_n + e^{-\frac{5}{15 \times 60}} \times L_{n-1} = (1 - e^{-\frac{1}{180}}) \times Q_n + e^{-1/180} \times L_{n-1} = Q_n + e^{-1/180} \times (L_{n-1} - Q_n)$$

### Other weightings

Other weighting systems are used occasionally – for example, in share trading a **volume weighting** will weight each time period in proportion to its trading volume.

A further weighting, used by actuaries, is Spencer's 15-Point Moving Average<sup>[11]</sup> (a central moving average). The symmetric weight coefficients are -3, -6, -5, 3, 21, 46, 67, 74, 67, 46, 21, 3, -5, -6, -3.

### Moving median

From a statistical point of view, the moving average, when used to estimate the underlying trend in a time series, is susceptible to rare events such as rapid shocks or other anomalies. A more robust estimate of the trend is the **simple moving median** over  $n$  time points:

$$\text{SMM} = \text{Median}(p_M, p_{M-1}, \dots, p_{M-n+1})$$

where the median is found by, for example, sorting the values inside the brackets and finding the value in the middle.

Statistically, the moving average is optimal for recovering the underlying trend of the time series when the fluctuations about the trend are normally distributed. However, the normal distribution does not place high probability on very large deviations from the trend which explains why such deviations will have a disproportionately large effect on the trend estimate. It can be shown that if the fluctuations are instead assumed to be Laplace distributed, then the moving median is statistically optimal<sup>[12]</sup>. For a given variance, the Laplace distribution places higher probability on rare events than does the normal, which explains why the moving median

tolerates shocks better than the moving mean.

When the simple moving median above is central, the smoothing is identical to the median filter which has applications in, for example, image signal processing.

## Notes and references

- [1] *Statistical Analysis*, Ya-lun Chou, Holt International, 1975, ISBN 0030894220, section 17.9.  
 [2] <http://lorien.ncl.ac.uk/ming/filter/filewma.htm>  
 [3] NIST/SEMATECH e-Handbook of Statistical Methods: Single Exponential Smoothing (<http://www.itl.nist.gov/div898/handbook/pmc/section4/pmc431.htm>) at the National Institute of Standards and Technology  
 [4] NIST/SEMATECH e-Handbook of Statistical Methods: EWMA Control Charts (<http://www.itl.nist.gov/div898/handbook/pmc/section3/pmc324.htm>) at the National Institute of Standards and Technology  
 [5] Moving Averages page ([http://www.stockcharts.com/education/IndicatorAnalysis/indic\\_movingAvg.html](http://www.stockcharts.com/education/IndicatorAnalysis/indic_movingAvg.html)) at StockCharts.com

$$[6] \text{EMA} = \frac{p_1 + (1 - \alpha)p_2 + (1 - \alpha)^2 p_3 + (1 - \alpha)^3 p_4 + \dots}{1 + (1 - \alpha) + (1 - \alpha)^2 + (1 - \alpha)^3 + \dots},$$

since  $1/\alpha = 1 + (1 - \alpha) + (1 - \alpha)^2 + \dots$ .

- [7] The denominator on the left-hand side should be unity, and the numerator will become the right-hand side (geometric series),

$$\alpha \left( \frac{1 - (1 - \alpha)^{N+1}}{1 - (1 - \alpha)} \right).$$

- [8] Because  $(1+x/n)^n$  becomes  $e^x$  for large  $n$ .

- [9] It means  $\alpha \rightarrow 0$ , and the Taylor series of  $\log(1 - \alpha) = -\alpha - \alpha^2/2 - \dots$  tends to  $-\alpha$ .

- [10]  $\log_e(0.001) / 2 = -3.45$

- [11] Spencer's 15-Point Moving Average — from Wolfram MathWorld (<http://mathworld.wolfram.com/Spencers15-PointMovingAverage.html>)

- [12] G.R. Arce, "Nonlinear Signal Processing: A Statistical Approach", Wiley:New Jersey, USA, 2005.

## External links

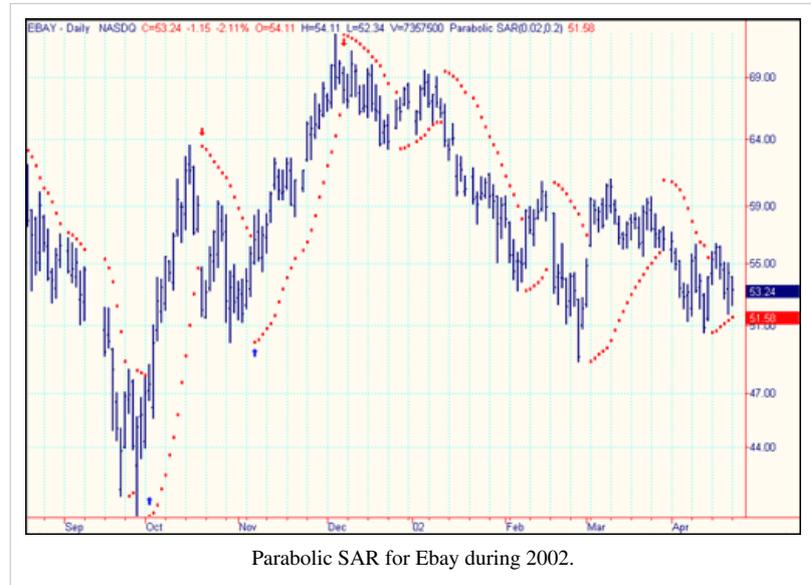
- EWMA in determining network traffic and ethernet (<http://www.think-lamp.com/2009/03/the-hidden-power-of-ping/>)
- FastMedFilt1D: Fast Matlab software for computing the simple moving median of a time series. (<http://www.physics.ox.ac.uk/users/littlem/software/>)

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# Parabolic SAR

In the field of technical analysis, **Parabolic SAR** (SAR - stop and reverse) is a method devised by J. Welles Wilder, Jr., to find trends in market prices or securities. It may be used as a trailing stop loss based on prices tending to stay within a parabolic curve during a strong trend.

The concept draws on the idea that time is the enemy (similar to option theory's concept of time decay), and unless a security can continue to generate more profits over time, it should be liquidated. The indicator generally works well in trending markets, but provides "whipsaws" during non-trending, sideways phases; as such, Wilder recommended establishing the strength and direction of the trend first through the use of things such as the Average Directional Index, and then using the Parabolic SAR to trade that trend.



A parabola below the price is generally bullish, while a parabola above is generally bearish.

A parabola below the price is generally bullish, while a parabola above is generally bearish.

## Construction

The Parabolic SAR is calculated almost independently for each trend in the price. When the price is in an uptrend, the SAR appears below the price and converges upwards towards it. Similarly, on a downtrend, the SAR appears above the price and converges downwards.

At each step within a trend, the SAR is calculated ahead of time. That is, tomorrow's SAR value is built using data available today. The general formula used for this is:

$$SAR_{n+1} = SAR_n + \alpha(EP - SAR_n)$$

Where  $SAR_n$  and  $SAR_{n+1}$  represent today's and tomorrow's SAR values, respectively.

The extreme point,  $EP$ , is a record kept during each trend that represents the highest value reached by the price during the current uptrend — or lowest value during a downtrend. On each period, if a new maximum (or minimum) is observed, the EP is updated with that value.

The  $\alpha$  value represents the acceleration factor. Usually, this is set to a value of 0.02 initially. This factor is increased by 0.02 each time a new EP is recorded. In other words, each time a new EP is observed, it will increase the acceleration factor. This will then quicken the rate at which the SAR converges towards the price. To keep it from getting too large, a maximum value for the acceleration factor is normally set at 0.20, so that it never goes beyond that. For stocks trading, it is preferable to set the acceleration factor to 0.01, in order to be less sensitive to local decreases. For commodity or currency trading, it is preferable to use a value of 0.02.

The SAR is iteratively calculated for each new period using this recursive definition. There are, however, two special cases that will modify the SAR value:

- If tomorrow's SAR value lies within (or beyond) today's or yesterday's price range, the SAR must be set to the closest price bound. For example, if in an uptrend, the new SAR value is calculated and it results to be greater than today's or yesterday's lowest price, the SAR must be set equal to that lower boundary.

- If tomorrow's SAR value lies within (or beyond) tomorrow's price range, a new trend direction is then signaled, and the SAR must "switch sides."

Upon a trend switch, several things happen. The first SAR value for this new trend is set to the last EP recorded on the previous trend. The EP is then reset accordingly to this period's maximum. The acceleration factor is reset to its initial value of 0.02.

## External links

- Using Parabolic SAR for Buy and Sell signals, and placing Stop Loss orders <sup>[1]</sup>
- How to Trade Parabolic SAR - InformedTrades <sup>[2]</sup>
- Yahoo! Finance Charts User Guide <sup>[3]</sup>

## References

- J. Welles Wilder, Jr. (June 1978). *New Concepts in Technical Trading Systems*. Greensboro, NC: Trend Research. ISBN 978-0894590276.

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[1] <http://www.onlinetradingconcepts.com/TechnicalAnalysis/ParabolicSAR.html>

[2] <http://www.informedtrades.com/4559-how-trade-parabolic-sar-forex-futures-stocks.html>

[3] <http://biz.yahoo.com/charts/guide16.html>

# Trix (technical analysis)

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**Trix** (or **TRIX**) is a technical analysis oscillator developed in the 1980s by Jack Hutson, editor of *Technical Analysis of Stocks and Commodities* magazine. It shows the slope (i.e. derivative) of a triple-smoothed exponential moving average. The name Trix is from "triple exponential."

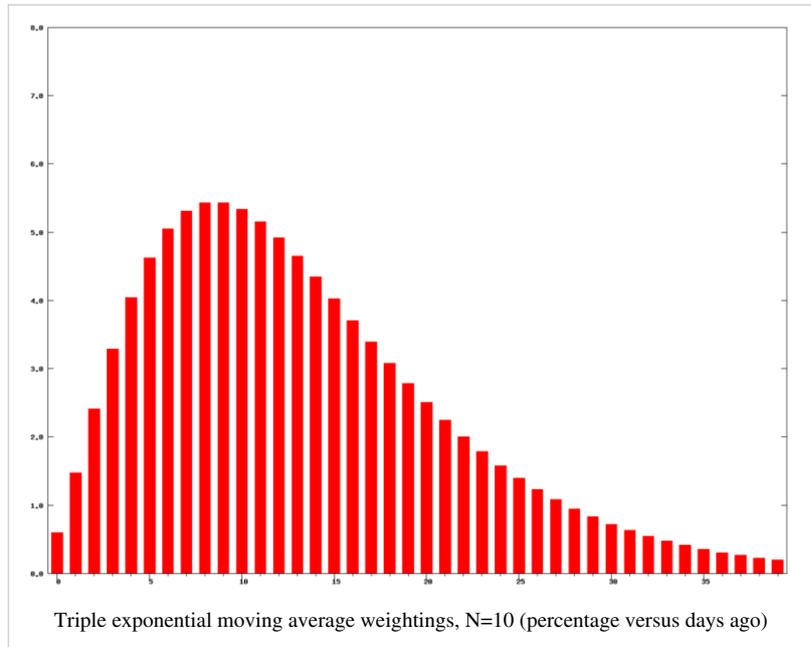
Trix is calculated with a given N-day period as follows:

- Smooth prices (often closing prices) using an N-day exponential moving average (EMA).
- Smooth that series using another N-day EMA.
- Smooth a third time, using a further N-day EMA.
- Calculate the percentage difference between today's and yesterday's value in that final smoothed series.

Like any moving average, the triple EMA is just a smoothing of price data and therefore is trend-following. A rising or falling line is an uptrend or downtrend and Trix shows the slope of that line, so it's positive for a steady uptrend, negative for a downtrend, and a crossing through zero is a trend-change, i.e. a peak or trough in the underlying average.

The triple-smoothed EMA is very different from a plain EMA. In a plain EMA the latest few days dominate and the EMA follows recent prices quite closely; however, applying it three times results in weightings spread much more broadly, and the weights for the latest few days are in fact smaller than those of days further past. The following graph shows the weightings for an N=10 triple EMA (most recent days at the left):

Note that the distribution's mode will lie with  $p_{N-2}$ 's weight, i.e. in the graph above  $p_8$  carries the highest weighting. An N of 1 is invalid.



The easiest way to calculate the triple EMA based on successive values is just to apply the EMA three times, creating single-, then double-, then triple-smoothed series. The triple EMA can also be expressed directly in terms of the prices as below, with  $p_0$  today's close,  $p_1$  yesterday's, etc., and with  $f = 1 - \frac{2}{N + 1} = \frac{N - 1}{N + 1}$  (as for a plain EMA):

$$TripleEMA_0 = (1 - f)^3(p_0 + 3fp_1 + 6f^2p_2 + 10f^3p_3 + \dots)$$

The coefficients are the triangle numbers,  $n(n+1)/2$ . In theory, the sum is infinite, using all past data, but as  $f$  is less than 1 the powers  $f^n$  become smaller as the series progresses, and they decrease faster than the coefficients increase, so beyond a certain point the terms are negligible.

## References

- StockCharts.com article on TRIX <sup>[1]</sup>, by Nicholas Fisher

## References

[1] [http://stockcharts.com/education/IndicatorAnalysis/indic\\_trix.htm](http://stockcharts.com/education/IndicatorAnalysis/indic_trix.htm)

# Vortex Indicator

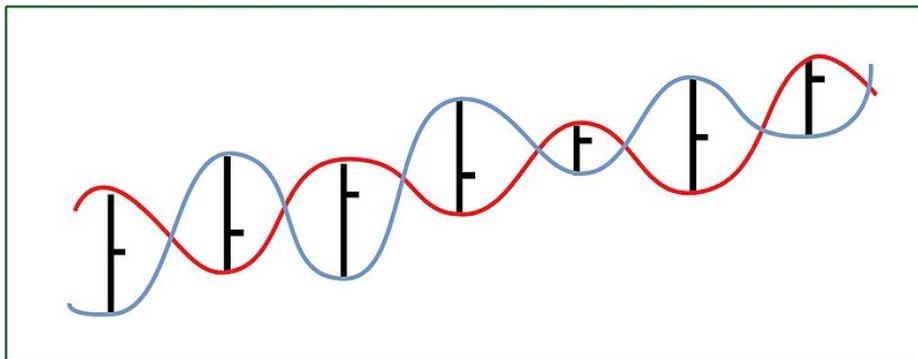
The **Vortex Indicator** is a technical indicator invented by Etienne Botes and Douglas Siepman to identify the start of a new trend or the continuation of an existing trend within financial markets. It was published in the January 2010 edition of *Technical Analysis of Stocks & Commodities*.<sup>[1]</sup>

## Inspiration

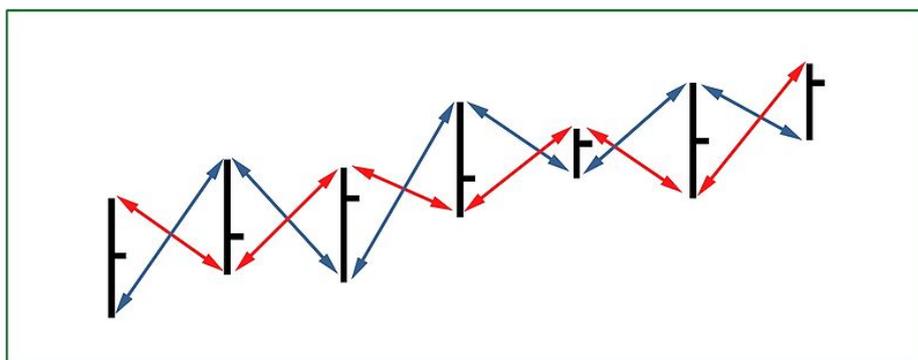
The Vortex Indicator was inspired by the work of an Austrian inventor, Viktor Schaubberger, who studied the flow of water in rivers and turbines. Etienne Botes and Douglas Siepman developed the idea that movements and flows within financial markets are similar to the vortex motions found in water. The Vortex Indicator was also partly inspired by J. Welles Wilder's concept of directional movement, which assumes the relationship between price bars gives clues as to the direction of a market.<sup>[2]</sup>

## Description

A vortex pattern may be observed in any market by connecting the lows of that market's price bars with the consecutive bars' highs, and then price bar highs with consecutive lows. The greater the distance between the low of a price bar and the subsequent bar's high, the greater the upward or positive Vortex movement (VM+). Similarly, the greater the distance between a price bar's high and the subsequent bar's low, the greater the downward or negative Vortex movement (VM-).



**A Vortex Pattern in the Market:** By connecting the lows of price bars with the consecutive bars' highs, and then price bar highs with consecutive lows, one can observe a vortex pattern in the market.



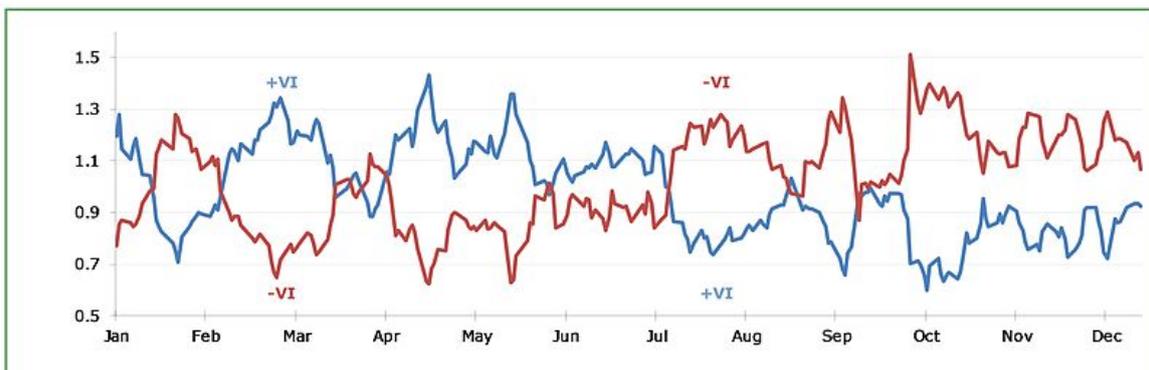
**The Vortex Indicator:** The greater the distance between the low of a price bar and the subsequent bar's high, the stronger the positive Vortex movement (VM+). Similarly, the greater the distance between a price bar's high and the subsequent bar's low, the stronger the negative Vortex movement (VM-).

## Identifying a trend

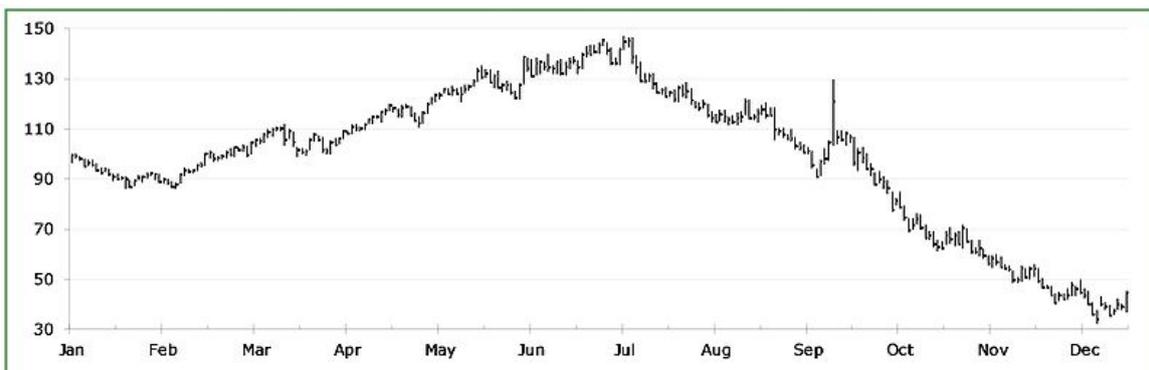
On a chart, VI+ and VI- will be seen to intersect each other at a change of trend, and begin to diverge ever wider as the strength of a trend increases. When VI+ is larger and above VI-, the market is trending up. Conversely, when VI- is bigger and above VI+, the market is trending down.

A trader should focus on the key trend change points of the Vortex Indicator (i.e. the crossing points of VI+ and VI-). When VI+ crosses above VI-, a long (buy) position is indicated. A short or sell position is suggested when VI- crosses above VI+.

The published article also suggested further measures to ensure an effective trading strategy, for example, only entering a trade at the extreme high or low of the price bar that corresponds with a crossing of the Vortex Indicator.<sup>[3]</sup>



**14-Period Daily Vortex Indicator:** When VI+ is greater than VI-, it indicates that the market is trending up. The market is trending down when VI- is above VI+. The potential change of trend points are found where VI+ and VI- intersect one another.



**Price Chart:** As the trend strengthens, notice how the VI+ and VI- lines increasingly diverge. As the trend weakens, you will observe the two lines converging again.

## Calculation

The high, low and close values are required for any chosen stock, future, commodity or currency. These values may be 15-minute, hourly, daily, etc.

- **First, calculate the current True Range:**
  - Current True Range (TR) = Maximum absolute value of either (Current High-Current Low), (Current Low-Previous Close), (Current High-Previous Close)
- **Next, calculate the current upward (positive) and downward (negative) Vortex movements:**
  - Current Vortex Movement Up (VM+) = Absolute value of Current High – Previous Low
  - Current Vortex Movement Down (VM-) = Absolute Value of Current Low – Previous High

- **Decide on a parameter length (21 periods was used for this example). Now, sum the last 21 period's True Range, VM+ and VM-:**
  - Sum of the last 21 periods' True Range = SUM TR21
  - Sum of the last 21 periods' VM+ = SUM VM21+
  - Sum of the last 21 periods' VM- = SUM VM21-
- **Finally, divide SUM VM21+ and SUM VM21- respectively with the SUM TR21 to obtain the Vortex Indicator:**
  - $\text{SUM VM21+} / \text{SUM TR21} = \text{VI21+}$
  - $\text{SUM VM21-} / \text{SUM TR21} = \text{VI21-}$

If this process is repeated, the resulting VI21+ and VI21- can be drawn graphically to represent the two lines of the Vortex Indicator.

## Practical application

The Vortex Indicator is simple to use as the only required inputs are the high, low and close of a price bar. Traders may use the Vortex Indicator on its own, in combination with other technical indicators to confirm a change of trend or as part of a larger trading system.

In addition, the Vortex Indicator may be used for any:

- **market** (such as stocks, futures or currencies)
- **time frame** (for example, 15 minute, hourly or weekly charts)
- **parameter** (such as 13, 21 or 34 periods)

The inventors of the Vortex Indicator recommend using longer time frames and parameters in order to filter out false signals. If a trader does opt to use a very short time frame, such as 5 minutes, this should be combined with a long parameter of 34 or 55 periods.

Because of its universal applicability, the Vortex Indicator is suitable for both short term traders as well as longer term fund managers who may wish to identify larger macro trends within a market.

## Coding and strategies

The Vortex Indicator is available on most charting software.<sup>[4]</sup> Some of these companies have suggested additional trading strategies to use in conjunction with the Vortex Indicator, including the implementation of a trailing stop<sup>[5]</sup> and making use of supporting indicators in order to reduce the number of false signals.<sup>[6]</sup>

## Comparative studies

To test the Vortex Indicator against Welles Wilder's Directional Movement Indicator (DMI), a portfolio of 38 of the most actively traded, full sized, futures contracts was created. These 38 futures included a number of index and financial futures, currencies, metals, energy futures and commodities like grains, oils and foods. The test period was from 3 January 1978 to 6 November 2009, using a 14 day parameter for both indicators. Over the entire test period, and also during the last 10 years, the Vortex Indicator showed a better performance than the DMI.<sup>[7]</sup>

However, using a similar test based on 101 NASDAQ stocks, on a smaller sample (for the period 2 January 1992 to 14 August 2009), the DMI showed a better performance than the Vortex Indicator.<sup>[8]</sup>

## Possible improvement and variation

An alternative version of the indicator was created by Jez Liberty.<sup>[9]</sup> This version enables the calculation to account for gap days which sometimes occur in non-continuous markets such as stocks.<sup>[10]</sup>

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- [10] Liberty, Jez (February 2010). "Vortex indicator" (<http://www.automated-trading-system.com/free-code-improved-vortex/>). Automated Trading System. . Retrieved 11 November 2010.

## External links

- The Vortex Indicator ([http://www.traders.com/Reprints/PDF\\_reprints/VFX\\_VORTEX.PDF](http://www.traders.com/Reprints/PDF_reprints/VFX_VORTEX.PDF))

# Know Sure Thing (KST) Oscillator

Know Sure Thing (KST) Oscillator is a complex, smoothed price velocity indicator developed by Martin J. Pring.<sup>[1]</sup>  
[2]

Rate of Change (ROC) indicator is the foundation of KST indicator. KST indicator is useful to identify major stock market cycle junctures because its formula is weighed to have larger influence by the longer and more dominant time span to better reflecting the primary swings of stock market cycle.<sup>[3]</sup> The concept behind the oscillator is that price trends are determined by the interaction of many different time cycles and that important trend reversals take place when a number of price trends are simultaneously changing direction.

## Formula

Four different rates of change are calculated, smoothed, multiplied by weights and then summed to form one indicator.<sup>[4]</sup>

$$ROC1 = (1 - Price/Price(X1)) * 100;$$

$$ROC2 = (1 - Price/Price(X2)) * 100;$$

$$ROC3 = (1 - Price/Price(X3)) * 100;$$

$$ROC4 = (1 - Price/Price(X4)) * 100;$$

Where Price refers to current closing price and Price(X1) refers to the closing price X1 bars ago.

$$KST = MOV(ROC1, AVG1)*W1+MOV(ROC2, AVG2)*W2+MOV(ROC3, AVG3)*W3+MOV(ROC4, AVG4)*W4$$

Where MOV(ROC1,AVG1) refers to the AVG1 day moving average for ROC1

For Short term trend, Martin J Pring suggest the following parameters:

$$X1 = 10$$

$$X2 = 15$$

$$X3 = 20$$

$$X4 = 30$$

$$AVG1 = 10$$

$$AVG2 = 10$$

$$AVG3 = 10$$

$$AVG4 = 15$$

$$W1 = 1$$

$$W2 = 2$$

$$W3 = 3$$

$$W4 = 4$$

The formula is built into, or can be included into various technical analysis softwares like MetaStock<sup>[5]</sup> or OmniTrader<sup>[6]</sup>.

## Implications

### Entry rules KST Indicator

When KST crosses below its 8 day exponential average, short at the next day opening price.

### Exit rules KST Indicator

When KST crosses above its 8 day exponential average, close short position at the next day opening price.<sup>[4]</sup>

## Variations

It can be calculated on **daily**<sup>[7]</sup> or **long term**<sup>[8]</sup> basis.

The dominant time frame in the Know Sure Thing (KST)'s construction is a 24-month period, which is half of the 4-year business cycle. This means that the Know Sure Thing (KST) will work best when the security in question is experiencing a primary up- and downtrend based on the business cycle.<sup>[4]</sup>

## KST Interpretation

KST can be interpreted in the ways mentioned below.<sup>[7]</sup>

The dominant time frame in the Know Sure Thing (KST)'s construction is a 24-month period, which is half of the 4-year business cycle. This means that the Know Sure Thing (KST) will work best when the security in question is experiencing a primary up- and downtrend based on the business cycle.

## Directional Changes and Moving Average Crossovers

You've discovered how changes in direction are the way the KST triggers signals, but also that moving average crossovers offer less timely, but more reliable signals. The average to use is a simple 10-day moving average. It is possible to anticipate a moving average crossover if the KST has already turned and the price violates a trendline. The KST started to reverse to the downside before the up trendline was violated. Since either a reversal or a trading range follow a valid trendline violation, it's evident that upside momentum has temporarily dissipated, causing the KST to cross below its moving average.

Traditionally, the MACD gives buy and sell signals when it crosses above and below its exponential moving average, known as the "signal line". This approach isn't perfect; the ellipses on the chart highlight all the whipsaws. As said earlier, the KST can also give false or misleading signals, as you can see from the April 2005 buy signal. It comes close to a couple of whipsaws, but by and large, it's more accurate, even though the MACD often turns faster than the KST.

### **Overbought/Oversold and Divergences**

The concept is that when the indicator crosses above and below the overbought/oversold zones, momentum buy and sell signals are triggered. Even so, you must wait for some kind of trend reversal signal in the price, such as a price pattern completion, trendline violation, or similar.

The KST often diverges positively and negatively with the price.

### **Trendline Violations and Price Pattern Completions**

It is possible to construct a trendline on the KST and see when it's been violated, but not very often. When it does though, it usually results in a powerful signal.

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# INDICATORS: Momentum

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## Momentum (finance)

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In finance, **momentum** is the empirically observed tendency for rising asset prices to rise further. For instance, it was shown that stocks with strong past performance continue to outperform stocks with poor past performance in the next period with an average excess return of about 1% per month (Jegadeesh and Titman, 1993, 1999).

The existence of momentum is a market anomaly, which finance theory struggles to explain. The difficulty is that an increase in asset prices, in and of itself, should not warrant further increase. Such increase, according to the efficient-market hypothesis, is warranted only by changes in demand and supply or new information (cf. fundamental analysis). Students of financial economics have largely attributed the appearance of momentum to cognitive biases, which belong in the realm of behavioral economics. The explanation is that investors are irrational (Daniel, Hirshleifer, and Subrahmanyam, 1998 and Barberis, Shleifer, and Vishny, 1998), in that they underreact to new information by failing to incorporate news in their transaction prices. However, much as in the case of price bubbles, recent research has argued that momentum can be observed even with perfectly rational traders (Crombez, 2001).

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# Relative Strength Index

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The **Relative Strength Index (RSI)** is a technical indicator used in the technical analysis of financial markets. It is intended to chart the current and historical strength or weakness of a stock or market based on the closing prices of a recent trading period. The indicator should not be confused with relative strength.

The RSI is classified as a momentum oscillator, measuring the velocity and magnitude of directional price movements. Momentum is the rate of the rise or fall in price. The RSI computes momentum as the ratio of higher closes to lower closes: stocks which have had more or stronger positive changes have a higher RSI than stocks which have had more or stronger negative changes.

The RSI is most typically used on a 14 day timeframe, measured on a scale from 0 to 100, with high and low levels marked at 70 and 30, respectively. Shorter or longer timeframes are used for alternately shorter or longer outlooks. More extreme high and low levels—80 and 20, or 90 and 10—occur less frequently but indicate stronger momentum.

The Relative Strength Index was developed by J. Welles Wilder and published in a 1978 book, *New Concepts in Technical Trading Systems*, and in *Commodities* magazine (now *Futures* magazine) in the June 1978 issue.<sup>[1]</sup>

## Calculation

For each trading period an upward change  $U$  or downward change  $D$  is calculated. Up periods are characterized by the close being higher than the previous close:

$$U = \text{close}_{\text{now}} - \text{close}_{\text{previous}}$$

$$D = 0$$

Conversely, a down period is characterized by the close being lower than the previous period's (note that  $D$  is nonetheless a positive number),

$$U = 0$$

$$D = \text{close}_{\text{previous}} - \text{close}_{\text{now}}$$

If the last close is the same as the previous, both  $U$  and  $D$  are zero. The average  $U$  and  $D$  are calculated using an  $n$ -period exponential moving average (EMA). The ratio of these averages is the *Relative Strength*:

$$RS = \frac{\text{EMA}(U, n)}{\text{EMA}(D, n)}$$

If the average of  $D$  values is zero, then the RSI value is defined as 100.

The Relative Strength is then converted to a Relative Strength Index between 0 and 100:

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

The exponential moving averages should be appropriately initialized with a simple averages using the first  $n$  values in the price series.

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## Interpretation

### Basic configuration

The RSI is presented on a graph above or below the price chart. The indicator has an upper line, typically at 70, a lower line at 30, and a dashed mid-line at 50. Wilder recommended a smoothing period of 14 (see EMA smoothing, i.e.  $\alpha = 1/14$  or  $N = 27$ ).

### Principles

Wilder posited that when price moves up very rapidly, at some point it is considered overbought. Likewise, when price falls very rapidly, at some point it is considered oversold. In either case, Wilder deemed a reaction or reversal imminent.

The level of the RSI is a measure of the stock's recent trading strength. The slope of the RSI is directly proportional to the velocity of a change in the trend. The distance traveled by the RSI is proportional to the magnitude of the move.

Wilder believed that tops and bottoms are indicated when RSI goes above 70 or drops below 30. Traditionally, RSI readings greater than the 70 level are considered to be in overbought territory, and RSI readings lower than the 30 level are considered to be in oversold territory. In between the 30 and 70 level is considered neutral, with the 50 level a sign of no trend.

### Divergence

Wilder further believed that divergence between RSI and price action is a very strong indication that a market turning point is imminent. Bearish divergence occurs when price makes a new high but the RSI makes a lower high, thus failing to confirm. Bullish divergence occurs when price makes a new low but RSI makes a higher low.

### Overbought and oversold conditions

Wilder thought that "failure swings" above 70 and below 30 on the RSI are strong indications of market reversals. For example, assume the RSI hits 76, pulls back to 72, then rises to 77. If it falls below 72, Wilder would consider this a "failure swing" above 70.

Finally, Wilder wrote that chart formations and areas of support and resistance could sometimes be more easily seen on the RSI chart as opposed to the price chart. The center line for the relative strength index is 50, which is often seen as both the support and resistance line for the indicator.

If the relative strength index is below 50, it generally means that the stock's losses are greater than the gains. When the relative strength index is above 50, it generally means that the gains are greater than the losses.



## Uptrends and downtrends

In addition to Wilder's original theories of RSI interpretation, Andrew Cardwell has developed several new interpretations of RSI to help determine and confirm trend. First, Cardwell noticed that uptrends generally traded between RSI 40 and 80, while downtrends usually traded between RSI 60 and 20. Cardwell observed when securities change from uptrend to downtrend and vice versa, the RSI will undergo a "range shift."

Next, Cardwell noted that bearish divergence: 1) only occurs in uptrends, and 2) mostly only leads to a brief correction instead of a reversal in trend. Therefore bearish divergence is a sign confirming an uptrend. Similarly, bullish divergence is a sign confirming a downtrend.

## Reversals

Finally, Cardwell discovered the existence of positive and negative reversals in the RSI. Reversals are the opposite of divergence. For example, a positive reversal occurs when an uptrend price correction results in a higher low compared to the last price correction, while RSI results in a lower low compared to the prior correction. A negative reversal happens when a downtrend rally results in a lower high compared to the last downtrend rally, but RSI makes a higher high compared to the prior rally.

In other words, despite stronger momentum as seen by the higher high or lower low in the RSI, price could not make a higher high or lower low. This is evidence the main trend is about to resume. Cardwell noted that positive reversals only happen in uptrends while negative reversals only occur in downtrends, and therefore their existence confirms the trend.

## Cutler's RSI

A variation called Cutler's RSI is based on a simple moving average of  $U$  and  $D$ ,<sup>[2]</sup> instead of the exponential average above. Cutler had found that since Wilder used an exponential moving average to calculate RSI, the value of Wilder's RSI depended upon where in the data file his calculations started. Cutler termed this Data Length Dependency. Cutler's RSI is not data length dependent, and returns consistent results regardless of the length of, or the starting point within a data file.

$$RS = \frac{SMA(U, n)}{SMA(D, n)}$$

Cutler's RSI generally comes out slightly different from the normal Wilder RSI, but the two are similar, since SMA and EMA are also similar.



## References

- [1] J. Welles Wilder, *New Concepts in Technical Trading Systems*, ISBN 0-89459-027-8  
 [2] Cutler's RSI page (<http://www.aspenres.com/Documents/AspenGraphics4.0/CutlersRSI.htm>) at Aspen Graphics Technical Analysis Software

## External links

- Cardwell Techniques with the RSI (<http://www.optionetics.com/market/articles/19819>)

# Stochastic oscillator

In technical analysis of securities trading, the **stochastics oscillator** is a momentum indicator that uses support and resistance levels. Dr. George Lane promoted this indicator in the 1950s. The term *stochastic* refers to the location of a current price in relation to its price range over a period of time.<sup>[1]</sup> This method attempts to predict price turning points by comparing the closing price of a security to its price range.

The indicator is defined as follows:

$$\%K = 100 \frac{\text{closing price} - L}{H - L},$$

where H and L are respectively the highest and the lowest price over the last  $n$  periods, and

$\%D = 3$  period moving average of  $\%K$ .

In working with  $\%D$  it is important to remember that there is only one valid signal—a divergence between  $\%D$  and the security with which you are working.<sup>[2]</sup>

## Definition

The calculation above finds the range between an asset's high and low price during a given period of time. The current securities price is then expressed as a percentage of this range with 0% indicating the bottom of the range and 100% indicating the upper limits of the range over the time period covered. The idea behind this indicator is that prices tend to close near the extremes of the recent range before turning points. The Stochastic oscillator is calculated:

Where

$Price$  is the last closing price

$LOW_N(Price)$  is the lowest price over the last N periods

$HIGH_N(Price)$  is the highest price over the last N periods

$EMA_3(\%D)$  is a 3-period exponential moving average of  $\%K$ .

$EMA_3(\%D - Slow)$  is a 3-period exponential moving average of  $\%D$ .

A 3-line Stochastics will give you an anticipatory signal in  $\%K$ , a signal in the turnaround of  $\%D$  at or before a bottom, and a confirmation of the turnaround in  $\%D$ -Slow.<sup>[3]</sup> Typical values for  $N$  are 5, 9, or 14 periods. Smoothing the indicator over 3 periods is standard.



Dr. George Lane, a financial analyst, is one of the first to publish on the use of stochastic oscillators to forecast prices. According to Lane, the Stochastics indicator is to be used with cycles, Elliot Wave Theory and Fibonacci retracement for timing. In low margin, calendar futures spreads, you might use Wilders parabolic as a trailing stop after a stochastics entry. A centerpiece of his teaching is the divergence and convergence of trendlines drawn on stochastics, as diverging/converging to trendlines drawn on price cycles. Stochastics predicts tops and bottoms.

## Interpretation

The signal to act is when you have a divergence-convergence, in an extreme area, with a crossover on the right hand side, of a cycle bottom.<sup>[4]</sup> As plain crossovers can occur frequently, one typically waits for crossovers occurring together with an extreme pullback, after a peak or trough in the %D line. If price volatility is high, an exponential moving average of the %D indicator may be taken, which tends to smooth out rapid fluctuations in price.

Stochastics attempts to predict turning points by comparing the closing price of a security to its price range. Prices tend to close near the extremes of the recent range just before turning points. In the case of an uptrend, prices tend to make higher highs, and the settlement price usually tends to be in the upper end of that time period's trading range. When the momentum starts to slow, the settlement prices will start to retreat from the upper boundaries of the range, causing the stochastic indicator to turn down at or before the final price high.<sup>[5]</sup>

An alert or set-up is present when the %D line is in an extreme area and diverging from the price action. The actual signal takes place when the faster % K line crosses the % D line.<sup>[6]</sup>

Divergence-convergence is an indication that the momentum in the market is waning and a reversal may be in the making. The chart below illustrates an example of where a divergence in stochastics relative to price forecasts a reversal in the price's direction.



## Stochastics pop

This is when prices pop through and keep on going - that is, break out.

Rules to follow:

Increase long position — When price crosses the upper band from below.

Increase short position — When price crosses the lower band from above.

Liquidate position — When Stochastic %D crosses %K in direction reversed to open trade.<sup>[7]</sup>

## References

- [1] Murphy, John J. (1999). " John Murphy's Ten Laws of Technical Trading ([http://stockcharts.com/school/doku.php?id=chart\\_school:trading\\_strategies:john\\_murphy\\_s\\_ten\\_laws](http://stockcharts.com/school/doku.php?id=chart_school:trading_strategies:john_murphy_s_ten_laws))".
- [2] Lane, George M.D. (May/June 1984) "Lane's Stochastics," second issue of Technical Analysis of Stocks and Commodities magazine. pp 87-90.
- [3] Lane, George C. & Caire (1998) "Getting Started With Stochastics" pg 3
- [4] Lane, George M.D. (May/June 1984) "Lane's Stochastics," second issue of Technical Analysis of Stocks and Commodities magazine. pp 87-90.
- [5] Person, John L (2004). *A Complete Guide to Technical Trading Tactics: How to Profit Using Pivot Points, Candlesticks & Other Indicators*. Hoboken, NJ: Wiley. pp. 144–145. ISBN 0-471-58455-X.
- [6] Murphy, John J (1999). *Technical Analysis of the Financial Markets: A Comprehensive Guide to Trading Methods and Applications*. New York: New York Institute of Finance. p. 247. ISBN 0-7352-0066-1.
- [7] Bernstein, Jake (1995). *The Complete Day Trader*. New York: McGraw Hill. ISBN 0-07-009251-6.

## External links

- Stochastic Oscillator at Investopedia (<http://www.investopedia.com/terms/s/stochasticoscillator.asp>)
- Stochastic Oscillator page ([http://stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators:stochastic\\_oscillator](http://stockcharts.com/school/doku.php?id=chart_school:technical_indicators:stochastic_oscillator)) at StockCharts.com

# Williams %R

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**Williams %R**, or just **%R**, is a technical analysis oscillator showing the current closing price in relation to the high and low of the past N days (for a given N). It was developed by a publisher and promoter of trading materials, Larry Williams. Its purpose is to tell whether a stock or commodity market is trading near the high or the low, or somewhere in between, of its recent trading range.

$$\%R = \frac{\text{close}_{\text{today}} - \text{high}_{N\text{days}}}{\text{high}_{N\text{days}} - \text{low}_{N\text{days}}} \times 100$$

The oscillator is on a negative scale, from -100 (lowest) up to 0 (highest), considered unusual since it is the obverse of the more common 0 to 100 scale found in many Technical Analysis oscillators. Although sometimes altered (by simply adding 100), this scale needn't cause any confusion. A value of -100 is the close today at the lowest low of the past N days, and 0 is a close today at the highest high of the past N days.

## Buy-/Sell-Signalling

Williams used a 10 trading day period and considered values below -80 as oversold and above -20 as overbought. But they were not to be traded directly, instead his rule to buy an oversold was

- %R reaches -100%.
- Five trading days pass since -100% was last reached
- %R rises above -95% or -85%.

or conversely to sell an overbought condition

- %R reaches 0%.
- Five trading days pass since 0% was last reached
- %R falls below -5% or -15%.

The timeframe can be changed for either more sensitive or smoother results. The more sensitive you make it, though, the more false signals you will get.

## Notes

Due to the equivalence

$$(\text{close}_{\text{today}} - \text{low}_{N\text{days}}) - (\text{close}_{\text{today}} - \text{high}_{N\text{days}}) = \text{high}_{N\text{days}} - \text{low}_{N\text{days}}$$

the %R indicator is arithmetically exactly equivalent to the %K stochastic oscillator, mirrored at the 0%-line, when using the same time interval.

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# INDICATORS: Volume

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## Volume (finance)

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**Volume**, or **trading volume**, is a term in capital markets, referring to the number of shares or contracts traded in a security or in an entire market during a given period of time.

In the context of stock trading on a stock exchange, the volume is commonly reported as the number of shares that changed hands during the day. Average volume is reported as the average volume over a longer period of time, normally one to three months. When the significant positive or negative news is made public about a company, the volume of the company's stock will usually deviate from its average volume, meaning that more people are trading this stock.

Higher volume for a stock is an indicator of higher liquidity. For institutional investors who wish to sell a large number of shares of a certain stock, lower volume will force them to sell the stock slowly over a longer period of time.

### Legal implications

The calculation of the volume of a security has some legal implications. For example, in the United States, a person who sells a certain number of shares of a security in proportion to its weekly volume may be deemed an underwriter of that security under Rule 144 of the Securities Act of 1933. The calculation of the trading volume is therefore regulated by the SEC<sup>[1]</sup>.

### References

[1] SEC Interpretation: Calculation of Average Weekly Trading Volume under Rule 144 and Termination of a Rule 10b5-1 Trading Plan (<http://www.sec.gov/rules/interp/33-8005a.htm>)

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# Accumulation/distribution index

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**Accumulation/distribution index** is a technical analysis indicator intended to relate price and volume in the stock market.

## Formula

$$CLV = \frac{(close - low) - (high - close)}{high - low}$$

This ranges from -1 when the close is the low of the day, to +1 when it's the high. For instance if the close is 3/4 the way up the range then CLV is +0.5. The accumulation/distribution index adds up volume multiplied by the CLV factor, ie.

$$accdist = accdist_{prev} + volume \times CLV$$

The starting point for the acc/dist total, ie. the zero point, is arbitrary, only the shape of the resulting indicator is used, not the actual level of the total.

The name accumulation/distribution comes from the idea that during accumulation buyers are in control and the price will be bid up through the day, or will make a recovery if sold down, in either case more often finishing near the day's high than the low. The opposite applies during distribution.

The accumulation/distribution index is similar to on balance volume, but acc/dist is based on the close within the day's range, instead of the close-to-close up or down that the latter uses.

## Chaikin oscillator

A Chaikin oscillator is formed by subtracting a 10-day exponential moving average from a 3-day exponential moving average of the accumulation/distribution index. Being an indicator of an indicator, it can give various sell or buy signals, depending on the context and other indicators.

## Similar indicators

Other Price × Volume indicators:

- Money Flow
- On-balance Volume
- Price and Volume Trend

## See also

- Dimensional analysis - explains why volume and price are multiplied (not divided) in such indicators

# Money Flow Index

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**Money Flow Index** (MFI) is an oscillator calculated over an N-day period, ranging from 0 to 100, showing *money flow* on up days as a percentage of the total of up and down days. Money flow in technical analysis is typical price multiplied by volume, a kind of approximation to the dollar value of a day's trading.

The calculations are as follows. The *typical price* for each day is the average of high, low and close,

$$\text{typical price} = \frac{\text{high} + \text{low} + \text{close}}{3}$$

*Money flow* is the product of typical price and the volume on that day.

$$\text{money flow} = \text{typical price} \times \text{volume}$$

Totals of the money flow amounts over the given N days are then formed. *Positive money flow* is the total for those days where the typical price is higher than the previous day's typical price, and *negative money flow* where below. (If typical price is unchanged then that day is discarded.) A *money ratio* is then formed

$$\text{money ratio} = \frac{\text{positive money flow}}{\text{negative money flow}}$$

From which a *money flow index* ranging from 0 to 100 is formed,

$$\text{MFI} = 100 - \frac{100}{1 + \text{money ratio}}$$

This can be expressed equivalently as follows. This form makes it clearer how the MFI is a percentage,

$$\text{MFI} = 100 \times \frac{\text{positive money flow}}{\text{positive money flow} + \text{negative money flow}}$$

MFI is used as an oscillator. A value of 80 is generally considered overbought, or a value of 20 oversold. Divergences between MFI and price action are also considered significant, for instance if price makes a new rally high but the MFI high is less than its previous high then that may indicate a weak advance, likely to reverse.

It will be noted the MFI is constructed in a similar fashion to the relative strength index. Both look at up days against total up plus down days, but the scale, i.e. what is accumulated on those days, is volume (or dollar volume approximation rather) for the MFI, as opposed to price change amounts for the RSI.

It's important to be clear about what "money flow" means. It refers to dollar volume, i.e. the total value of shares traded. Sometimes finance commentators speak of money "flowing into" a stock, but that expression only refers to the enthusiasm of buyers (obviously there's never any net money in or out, because for every buyer there's a seller of the same amount).

For the purposes of the MFI, "money flow", i.e. dollar volume, on an up day is taken to represent the enthusiasm of buyers, and on a down day to represent the enthusiasm of sellers. An excessive proportion in one direction or the other is interpreted as an extreme, likely to result in a price reversal.

## Similar indicators

Other Price × Volume indicators:

- On-balance Volume
  - Price and Volume Trend
  - Accumulation/distribution index
-

# On-balance volume

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**On-balance volume (OBV)** is a technical analysis indicator intended to relate price and volume in the stock market. OBV is based on a cumulative total volume.<sup>[1]</sup>

## The formula

$$OBV = OBV_{prev} + \begin{cases} volume & \text{if } close > close_{prev} \\ 0 & \text{if } close = close_{prev} \\ -volume & \text{if } close < close_{prev} \end{cases}$$

## Application

Total volume for each day is assigned a positive or negative value depending on prices being higher or lower that day. A higher close results in the volume for that day to get a positive value, while a lower close results in negative value.<sup>[2]</sup> So, when prices are going up, OBV should be going up too, and when prices make a new rally high, then OBV should too. If OBV fails to go past its previous rally high, then this is a negative divergence, suggesting a weak move.<sup>[3]</sup>

The technique, originally called "cumulative volume" by Woods and Vignolia, was later named in 1946, "on-balance volume" by Joseph Granville who popularized the technique in his 1963 book *Granville's New Key to Stock Market Profits*<sup>[1]</sup>. The index can be applied to stocks individually based upon their daily up or down close, or to the market as a whole, using breadth of market data, i.e. the advance/decline ratio.<sup>[1]</sup>

OBV is generally used to confirm price moves.<sup>[4]</sup> The idea is that volume is higher on days where the price move is in the dominant direction, for example in a strong uptrend more volume on up days than down days.<sup>[5]</sup>

## Similar indicators

Other Price × Volume indicators:

- Money Flow
- Price and Volume Trend
- Accumulation/distribution index

## See also

- Dimensional analysis — explains why volume and price are multiplied (not divided) in such indicators

## References

- [1] Joseph E. Granville, *Granville's New Strategy of Daily Stock Market Timing for Maximum Profit*, Prentice-Hall, Inc., 1976. ISBN 0-13-363432-9
- [2] *On Balance Volume ( OBV )* (<http://www.oxfordfutures.com/futures-education/tech/on-balance-volume.htm>). 22 September 2007.
- [3] OBV Behavioral Limitations and Formulas (<http://financial-edu.com/on-balance-volume-obv.php>) at Financial-edu.com.
- [4] What Does On-Balance Volume Mean (<http://www.investopedia.com/terms/o/onbalancevolume.asp>)
- [5] StockCharts.com article on On Balance Volume (<http://stockcharts.com/education/IndicatorAnalysis/indic-OBV.htm>)

# Volume Price Trend

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**Volume Price Trend** (VPT) (sometimes Price Volume Trend) is a technical analysis indicator intended to relate price and volume in the stock market. VPT is based on a running cumulative volume that adds or subtracts a multiple of the percentage change in share price trend and current volume, depending upon their upward or downward movements.<sup>[1]</sup>

## Formula

$$VPT = VPT_{prev} + volume \times \frac{close_{today} - close_{prev}}{close_{prev}}$$

The starting point for the VPT total, i.e. the zero point, is arbitrary. Only the shape of the resulting indicator is used, not the actual level of the total.

VPT is similar to On-balance Volume (OBV),<sup>[2]</sup> but where OBV takes volume just according to whether the close was higher or lower, VPT includes how much higher or lower it was.

VPT is interpreted in similar ways to OBV. Generally, the idea is that volume is higher on days with a price move in the dominant direction, for example in a strong uptrend more volume on up days than down days. So, when prices are going up, VPT should be going up too, and when prices make a new rally high, VPT should too. If VPT fails to go past its previous rally high then this is a negative divergence, suggesting a weak move.

## Similar indicators

Other Price × Volume indicators:

- Money Flow Index
- On-balance Volume
- Accumulation/distribution index

## References

[1] Volume Price Trend Indicator - VPT (<http://www.investopedia.com/terms/v/vptindicator.asp>)

[2] Price/Volume Trend ([http://www.gannalyst.com/Gannalyst\\_Professional/Gannalyst\\_Indicators\\_Price\\_Volume\\_Trend.shtml](http://www.gannalyst.com/Gannalyst_Professional/Gannalyst_Indicators_Price_Volume_Trend.shtml))

## External links

- STEP3\_Tutorial ([https://www.psg-online.co.za/Documentation/Webdocs/Education/STEP3\\_Tutorial.ppt](https://www.psg-online.co.za/Documentation/Webdocs/Education/STEP3_Tutorial.ppt))
- OUTPERFORMANCE WITH TECHNICAL ANALYSIS? — AN INTRADAY STUDY ON THE SWISS STOCK MARKET ([http://www.sbf.unisg.ch/org/sbf/web.nsf/SysWebResources/AmmannRekatevonWyss04/\\$FILE/TechAnalysis.pdf](http://www.sbf.unisg.ch/org/sbf/web.nsf/SysWebResources/AmmannRekatevonWyss04/$FILE/TechAnalysis.pdf))

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## Force Index

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The **Force Index (FI)** is an indicator used in technical analysis to illustrate how strong the actual buying or selling pressure is. High positive values mean there is a strong rising trend, and low values signify a strong downward trend.

The FI is calculated by multiplying the difference between the last and previous closing prices by the volume of the commodity, yielding a momentum scaled by the volume. The strength of the force is determined by a larger price change or by a larger volume.

The FI was created by Alexander Elder.

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## Negative volume index

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Nearly 75 years have passed since Paul L. Dysart, Jr. invented the Negative Volume Index and Positive Volume Index indicators. The indicators remain useful to identify primary market trends and reversals.

In 1936, Paul L. Dysart, Jr. began accumulating two series of advances and declines distinguished by whether volume was greater or lesser than the prior day's volume. He called the cumulative series for the days when volume had been greater than the prior day's volume the Positive Volume Index (PVI), and the series for the days when volume had been lesser the Negative Volume Index (NVI).

A native of Iowa, Dysart worked in Chicago's LaSalle Street during the 1920s. After giving up his Chicago Board of Trade membership, he published an advisory letter geared to short-term trading using advance-decline data. In 1933, he launched the *Trendway* weekly stock market letter and published it until 1969 when he died. Dysart also developed the 25-day Plurality Index, the 25-day total of the absolute difference between the number of advancing issues and the number of declining issues, and was a pioneer in using several types of volume of trading studies.

### Dysart's NVI and PVI

The daily volume of the New York Stock Exchange and the NYSE Composite Index's advances and declines drove Dysart's indicators. Dysart believed that "volume is the driving force in the market." He began studying market breath numbers in 1931, and was familiar with the work of Col. Leonard P. Ayres and James F. Hughes, who pioneered the tabulation of advances and declines to interpret stock market movements.

Dysart calculated NVI as follows: 1) if today's volume is less than yesterday's volume, subtract declines from advances, 2) add the difference to the cumulative NVI beginning at zero, and 3) retain the current NVI reading for the days when volume is greater than the prior day's volume. He calculated PVI in the same manner but for the days when volume was greater than the prior day's volume. NVI and PVI can be calculated daily or weekly.

Initially, Dysart believed that PVI would be the more useful series, but in 1967, he wrote that NVI had "proved to be the most valuable of all the breath indexes." He relied most on NVI, naming it AMOMET, the acronym of "**A Measure Of Major Economic Trend.**"

Dysart's theory, expressed in his 1967 Barron's article, was that "if volume advances and prices move up or down in accordance [with volume], the move is assumed to be a good movement - if it is sustained when the volume subsides." In other words, after prices have moved up on positive volume days, "if prices stay up when the volume subsides for a number of days, we can say that such a move is 'good'." If the market "holds its own on negative volume days after advancing on positive volume, the market is in a strong position."

He called PVI the "majority" curve. Dysart distinguished between the actions of the "majority" and those of the "minority." The majority tends to emulate the minority, but its timing is not as sharp as that of the minority. When the majority showed an appetite for stocks, the PVI was usually "into new high ground" as happened in 1961.

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It is said that the two indicators assume that "smart" money is traded on quiet days (low volume) and that the crowd trades on very active days. Therefore, the negative volume index picks out days when the volume is lower than on the previous day, and the positive index picks out days with a higher volume.

## Dysart's Interpretation of NVI and PVI

Besides an article he wrote for Barron's in 1967, not many of Dysart's writings are available. What can be interpreted about Dysart's NVI is that whenever it rises above a prior high, and the DJIA is trending up, a "Bull Market Signal" is given. When the NVI falls below a prior low, and the DJIA is trending down, a "Bear Market Signal" is given. The PVI is interpreted in reverse. However, not all movements above or below a prior NVI or PVI level generate signals, as Dysart also designated "bullish" and "bearish penetrations." These penetrations could occur before or after a Bull or Bear Market Signal, and at times were called "reaffirmations" of a signal. In 1969, he articulated one rule: "signals are most authentic when the NVI has moved sideways for a number of months in a relatively narrow range." Dysart cautioned that "there is no mathematical system devoid of judgment which will continuously work without error in the stock market."

According to Dysart, between 1946 and 1967, the NVI "rendered 17 significant signals," of which 14 proved to be right (an average of 4.32% from the final high or low) and 3 wrong (average loss of 6.33%). However, NVI "seriously erred" in 1963-1964 and in 1968, which concerned him. In 1969, Dysart reduced the weight he had previously given to the NVI in his analyses because NVI was no longer a "decisive" indicator of the primary trend, although it retained an "excellent ability to give us 'leading' indications of short-term trend reversals."

A probable reason for the NVI losing its efficacy during the mid-1960s may have been the steadily higher NYSE daily volume due to the dramatic increase in the number of issues traded so that prices rose on declining volume. Dysart's NVI topped out in 1955 and trended down until at least 1968, although the DJIA moved higher during that period. Norman G. Fosback has attributed the "long term increase in the number of issues traded" as a reason for a downward bias in a cumulative advance-decline line. Fosback was the next influential technician in the story of NVI and PVI.

## Fosback's Variations

Fosback studied NVI and PVI and in 1976 reported his findings in his classic *Stock Market Logic*. He did not elucidate on the indicators' background or mentioned Dysart except for saying that "in the past Negative Volume Indexes have always [his emphasis] been constructed using advance-decline data...." He posited, "There is no good reason for this fixation on the A/D Line. In truth, a Negative Volume Index can be calculated with any market index - the Dow Jones Industrial Average, the S&P 500, or even 'unweighted' market measures.... Somehow this point has escaped the attention of technicians to date."

The point had not been lost on Dysart, who wrote in Barron's, "we prefer to use the issues-traded data [advances and declines] rather than the price data of any average because it is more all-encompassing, and more truly represents what's happening in the entire market." Dysart was a staunch proponent of using advances and declines.

Fosback made three variations to NVI and PVI:

1. He cumulated the daily percent change in the market index rather than the difference between advances and declines. On negative volume days, he calculated the price change in the index from the prior day and added it to the most recent NVI. His calculations are as follows:

If  $C_t$  and  $C_y$  denote the closing prices of today and yesterday, respectively, the NVI for today is calculated by

- adding  $NVI_{\text{yesterday}} \cdot (C_t - C_y) / C_y$  to yesterday's NVI if today's volume is lower than yesterday's, adding zero otherwise,

and the PVI is calculated by:

- adding  $PVI_{\text{yesterday}} (C_t - C_y) / C_y$  to yesterday's PVI if today's volume is higher than yesterday's, adding zero otherwise.
2. He suggested starting the cumulative count at a base index level such as 100.
  3. He derived buy or sell signals by whether the NVI or PVI was above or below its one-year moving average.

Fosback's versions of NVI and PVI are what are popularly described in books and posted on Internet financial sites. Often reported are his findings that whenever NVI is above its one-year moving average there is a 96% (PVI - 79%) probability that a bull market is in progress, and when it is below its one-year moving average, there is a 53% (PVI - 67%) probability that a bear market is in place. These results were derived using a 1941-1975 test period. Modern tests might reveal different probabilities.

Today, NVI and PVI are commonly associated with Fosback's versions, and Dysart, their inventor, is forgotten. It cannot be said that one version is better than the other. While Fosback provided a more objective interpretation of these indicators, Dysart's versions offer value to identify primary trends and short-term trend reversals.

Although some traders use Fosback's NVI and PVI to analyze individual stocks, the indicators were created to track, and have been tested, on major market indexes. NVI was Dysart's most invaluable breath index, and Fosback found that his version of "the Negative Volume Index is an excellent indicator of the primary market trend." Traders can benefit from both innovations.

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- Schade, Jr., George A., *Traders Adjust the Volume Indicators*, *Stocks Futures and Options Magazine* (Nov. 2005)

# Ease of movement

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**Ease of movement** is an indicator used in technical analysis to relate an asset's price change to its volume. Ease of Movement was developed by Richard W. Arms, Jr and highlights the relationship between volume and price changes and is particularly useful for assessing the strength of a trend<sup>[1]</sup>. High positive values indicate the price is increasing on low volume: strong negative values indicate the price is dropping on low volume. The moving average of the indicator can be added to act as a trigger line, which is similar to other indicators like the MACD<sup>[2]</sup>.

## References

- [1] *Arms Ease of Movement* (<http://www.oxfordfutures.com/futures-education/tech/ease-of-movement.htm>), , retrieved 17 February 2008
- [2] Financial dictionary.reference ([http://dictionary.reference.com/browse/ease of movement](http://dictionary.reference.com/browse/ease%20of%20movement))

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# INDICATORS: Volatility

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## Volatility (finance)

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In finance, **volatility** most frequently refers to the standard deviation of the continuously compounded returns of a financial instrument within a specific time horizon. It is common for discussions to talk about the volatility of a security's price, even while it is the returns' volatility that is being measured. It is used to quantify the risk of the financial instrument over the specified time period. Volatility is normally expressed in annualized terms, and it may either be an absolute number (\$5) or a fraction of the mean (5%).

### Volatility terminology

Volatility as described here refers to the **actual current** volatility of a financial instrument for a specified period (for example 30 days or 90 days). It is the volatility of a financial instrument based on historical prices over the specified period with the last observation the most recent price. This phrase is used particularly when it is wished to distinguish between the actual current volatility of an instrument and

- **actual historical** volatility which refers to the volatility of a financial instrument over a specified period but with the last observation on a date in the past
- **actual future** volatility which refers to the volatility of a financial instrument over a specified period starting at the current time and ending at a future date (normally the expiry date of an option)
- **historical implied volatility** which refers to the implied volatility observed from historical prices of the financial instrument (normally options)
- **current implied volatility** which refers to the implied volatility observed from current prices of the financial instrument
- **future implied volatility** which refers to the implied volatility observed from future prices of the financial instrument

For a financial instrument whose price follows a Gaussian random walk, or Wiener process, the width of the distribution increases as time increases. This is because there is an increasing probability that the instrument's price will be farther away from the initial price as time increases. However, rather than increase linearly, the volatility increases with the square-root of time as time increases, because some fluctuations are expected to cancel each other out, so the most likely deviation after twice the time will not be twice the distance from zero.

Since observed price changes do not follow Gaussian distributions, others such as the Lévy distribution are often used.<sup>[1]</sup> These can capture attributes such as "fat tails".

### Volatility for investors

Investors care about volatility for five reasons. 1) The wider the swings in an investment's price the harder emotionally it is to not worry. 2) When certain cash flows from selling a security are needed at a specific future date, higher volatility means a greater chance of a shortfall. 3) Higher volatility of returns while saving for retirement results in a wider distribution of possible final portfolio values. 4) Higher volatility of return when retired gives withdrawals a larger permanent impact on the portfolio's value. 5) Price volatility presents opportunities to buy assets cheaply and sell when overpriced.<sup>[2]</sup>

In today's markets, it is also possible to trade volatility directly, through the use of derivative securities such as options and variance swaps. See Volatility arbitrage.

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## Volatility versus direction

Volatility does not measure the direction of price changes, merely their dispersion. This is because when calculating standard deviation (or variance), all differences are squared, so that negative and positive differences are combined into one quantity. Two instruments with different volatilities may have the same expected return, but the instrument with higher volatility will have larger swings in values over a given period of time.

For example, a lower volatility stock may have an expected (average) return of 7%, with annual volatility of 5%. This would indicate returns from approximately -3% to 17% most of the time (19 times out of 20, or 95%). A higher volatility stock, with the same expected return of 7% but with annual volatility of 20%, would indicate returns from approximately -33% to 47% most of the time (19 times out of 20, or 95%). These estimates assume a normal distribution; in reality stocks are found to be leptokurtotic.

Volatility is a poor measure of risk, as explained by Peter Carr, "it is only a good measure of risk if you feel that being rich then being poor is the same as being poor then rich".

## Volatility over time

Although the Black Scholes equation assumes predictable constant volatility, none of these are observed in real markets, and amongst the models are Bruno Dupire's Local Volatility, Poisson Process where volatility jumps to new levels with a predictable frequency, and the increasingly popular Heston model of Stochastic Volatility.<sup>[3]</sup>

It's common knowledge that types of assets experience periods of high and low volatility. That is, during some periods prices go up and down quickly, while during other times they might not seem to move at all.

Periods when prices fall quickly (a crash) are often followed by prices going down even more, or going up by an unusual amount. Also, a time when prices rise quickly (a bubble) may often be followed by prices going up even more, or going down by an unusual amount.

The converse behavior, 'doldrums' can last for a long time as well.

Most typically, extreme movements do not appear 'out of nowhere'; they're presaged by larger movements than usual. This is termed autoregressive conditional heteroskedasticity. Of course, whether such large movements have the same direction, or the opposite, is more difficult to say. And an increase in volatility does not always presage a further increase—the volatility may simply go back down again.

## Mathematical definition

The annualized volatility  $\sigma$  is the standard deviation of the instrument's yearly logarithmic returns.

The generalized volatility  $\sigma_T$  for time horizon  $T$  in years is expressed as:

$$\sigma_T = \sigma\sqrt{T}.$$

Therefore, if the daily logarithmic returns of a stock have a standard deviation of  $\sigma_{SD}$  and the time period of returns is  $P$ , the annualized volatility is

$$\sigma = \frac{\sigma_{SD}}{\sqrt{P}}.$$

A common assumption is that  $P = 1/252$  (there are 252 trading days in any given year). Then, if  $\sigma_{SD} = 0.01$  the annualized volatility is

$$\sigma = \frac{0.01}{\sqrt{\frac{1}{252}}} = 0.1587.$$

The monthly volatility (i.e.,  $T = 1/12$  of a year) would be

$$\sigma_{\text{month}} = 0.1587\sqrt{\frac{1}{12}} = 0.0458.$$

The formula used above to convert returns or volatility measures from one time period to another assume a particular underlying model or process. These formulas are accurate extrapolations of a random walk, or Wiener process, whose steps have finite variance. However, more generally, for natural stochastic processes, the precise relationship between volatility measures for different time periods is more complicated. Some use the Lévy stability exponent  $\alpha$  to extrapolate natural processes:

$$\sigma_T = T^{1/\alpha} \sigma.$$

If  $\alpha = 2$  you get the Wiener process scaling relation, but some people believe  $\alpha < 2$  for financial activities such as stocks, indexes and so on. This was discovered by Benoît Mandelbrot, who looked at cotton prices and found that they followed a Lévy alpha-stable distribution with  $\alpha = 1.7$ . (See New Scientist, 19 April 1997.)

## Crude volatility estimation

Using a simplification of the formulas above it is possible to estimate annualized volatility based solely on approximate observations. Suppose you notice that a market price index, which has a current value near 10,000, has moved about 100 points a day, on average, for many days. This would constitute a 1% daily movement, up or down.

To annualize this, you can use the "rule of 16", that is, multiply by 16 to get 16% as the annual volatility. The rationale for this is that 16 is the square root of 256, which is approximately the number of trading days in a year (252). This also uses the fact that the standard deviation of the sum of  $n$  independent variables (with equal standard deviations) is  $\sqrt{n}$  times the standard deviation of the individual variables.

Of course, the average magnitude of the observations is merely an approximation of the standard deviation of the market index. Assuming that the market index daily changes are normally distributed with mean zero and standard deviation  $\sigma$ , the expected value of the magnitude of the observations is  $\sqrt{(2/\pi)}\sigma = 0.798\sigma$ . The net effect is that this crude approach overestimates the true volatility by about 25%.

## Estimate of compound annual growth rate (CAGR)

Consider the Taylor series:

$$\log(1 + y) = y - \frac{1}{2}y^2 + \frac{1}{3}y^3 - \frac{1}{4}y^4 + \dots$$

Taking only the first two terms one has:

$$CAGR \approx AR - \frac{1}{2}\sigma^2$$

Realistically, most financial assets have negative skewness and leptokurtosis, so this formula tends to be over-optimistic. Some people use the formula:

$$CAGR \approx AR - \frac{1}{2}k\sigma^2$$

for a rough estimate, where  $k$  is an empirical factor (typically five to ten).

## See also

- Beta (finance)
- Derivative (finance)
- Financial economics
- Implied volatility
- IVX
- Risk
- Standard deviation
- Stochastic volatility
- Volatility arbitrage

- Volatility smile

## References

- [1] [http://www.wilmottwiki.com/wiki/index.php/Levy\\_distribution](http://www.wilmottwiki.com/wiki/index.php/Levy_distribution)
- [2] Investment Risks - Price Volatility (<http://www.retailinvestor.org/risk.html#volatility>)
- [3] <http://www.wilmottwiki.com/wiki/index.php/Volatility#Definitions>
- Lin Chen (1996). *Stochastic Mean and Stochastic Volatility – A Three-Factor Model of the Term Structure of Interest Rates and Its Application to the Pricing of Interest Rate Derivatives*. Blackwell Publishers.

## External links

- Complex Options ([http://www.optionistics.com/f/strategy\\_calculator](http://www.optionistics.com/f/strategy_calculator)) Multi-Leg Option Strategy Calculator
- An introduction to volatility and how it can be calculated in excel, by Dr A. A. Kotzé ([http://quantonline.co.za/Articles/article\\_volatility.htm](http://quantonline.co.za/Articles/article_volatility.htm))
- Interactive Java Applet " What is Historic Volatility? ([http://www.frog-numerics.com/ifs/ifs\\_LevelA/HistVolaBasic.html](http://www.frog-numerics.com/ifs/ifs_LevelA/HistVolaBasic.html))"
- Diebold, Francis X.; Hickman, Andrew; Inoue, Atsushi & Schuermann, Til (1996) "Converting 1-Day Volatility to h-Day Volatility: Scaling by sqrt(h) is Worse than You Think" (<http://citeseer.ist.psu.edu/244698.html>)
- A short introduction to alternative mathematical concepts of volatility (<http://staff.science.uva.nl/~marvisse/volatility.html>)

# Average True Range

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**Average True Range (ATR)** is a technical analysis volatility indicator originally developed by J. Welles Wilder, Jr. for commodities<sup>[1]</sup>. The indicator does not provide an indication of price trend, simply the degree of price volatility.<sup>[2]</sup> The average true range is an N-day exponential moving average of the **true range** values. Wilder recommended a 14-period smoothing.<sup>[3]</sup>

## Calculation

The range of a day's trading is simply **high** – **low**. The **true range** extends it to yesterday's closing price if it was outside of today's range.

$$\text{true range} = \max(\text{high}, \text{close}_{\text{prev}}) - \min(\text{low}, \text{close}_{\text{prev}})$$

The **true range** is the largest of the:

- Most recent period's high less the most recent period's low
- Absolute value of the most recent period's high less the previous close
- Absolute value of the most recent period's low less the previous close

The idea of ranges is that they show the commitment or enthusiasm of traders. Large or increasing ranges suggest traders prepared to continue to bid up or sell down a stock through the course of the day. Decreasing range suggests waning interest.

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## References

- [1] J. Welles Wilder, Jr. (June 1978). *New Concepts in Technical Trading Systems*. Greensboro, NC: Trend Research. ISBN 978-0894590276.
- [2] ATR Definition - investopedia.com (<http://www.investopedia.com/terms/a/atr.asp>)
- [3] This is by his reckoning of EMA periods, meaning an  $\alpha=2/(1+14)=0.1333$ .

## External links

- *Measure Volatility With Average True Range* (<http://www.investopedia.com/articles/trading/08/average-true-range.asp>) at investopedia.com
- *Enter Profitable Territory With Average True Range* (<http://www.investopedia.com/articles/trading/08/ATR.asp>) at investopedia.com
- Average True Range (ATR) ([http://stockcharts.com/help/doku.php?id=chart\\_school:technical\\_indicators:average\\_true\\_range\\_a](http://stockcharts.com/help/doku.php?id=chart_school:technical_indicators:average_true_range_a)) at stockcharts.com

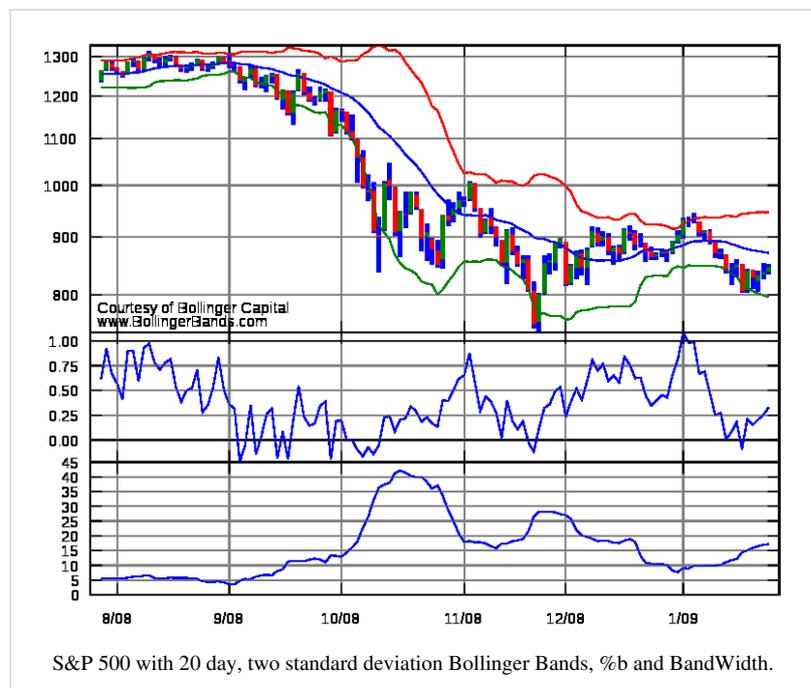
# Bollinger Bands

**Bollinger Bands** is a technical analysis tool invented by John Bollinger in the 1980s. Having evolved from the concept of trading bands, Bollinger Bands can be used to measure the highness or lowness of the price relative to previous trades.

Bollinger Bands consist of:

- a middle band being an  $N$ -period simple moving average (MA)
- an upper band at  $K$  times an  $N$ -period standard deviation above the middle band ( $MA + K\sigma$ )
- a lower band at  $K$  times an  $N$ -period standard deviation below the middle band ( $MA - K\sigma$ )

Typical values for  $N$  and  $K$  are 20 and 2, respectively. The default choice for the average is a simple moving average, but other types of averages can be employed as needed. Exponential moving averages are a common second choice. <sup>[1]</sup> Usually the same period is used for both the middle band and the calculation of standard deviation. <sup>[2]</sup>



## Purpose

The purpose of Bollinger Bands is to provide a relative definition of high and low. By definition, prices are high at the upper band and low at the lower band. This definition can aid in rigorous pattern recognition and is useful in comparing price action to the action of indicators to arrive at systematic trading decisions.<sup>[3]</sup>

## Indicators derived from Bollinger Bands

There are two indicators derived from Bollinger Bands, *%b* and *BandWidth*.

*%b*, pronounced 'percent b', is derived from the formula for Stochastics and tells you where you are in relation to the bands. *%b* equals 1 at the upper band and 0 at the lower band. Writing *upperBB* for the upper Bollinger Band, *lowerBB* for the lower Bollinger Band, and *last* for the last (price) value:

$$\%b = (\text{last} - \text{lowerBB}) / (\text{upperBB} - \text{lowerBB})$$

*BandWidth* tells you how wide the Bollinger Bands are on a normalized basis. Writing the same symbols as before, and *middleBB* for the moving average, or middle Bollinger Band:

$$\text{BandWidth} = (\text{upperBB} - \text{lowerBB}) / \text{middleBB}$$

Using the default parameters of a 20-period look back and plus/minus two standard deviations, *BandWidth* is equal to four times the 20-period coefficient of variation.

Uses for *%b* include system building and pattern recognition. Uses for *BandWidth* include identification of opportunities arising from relative extremes in volatility and trend identification.

In a series of lectures at The World Money Show in Hong Kong, Asian Traders Investment Conference in Singapore, the Italian Trading Forum in Rimini, Italy, The European Technical Analysis Conference in London, England and the Market Technicians Symposium in New York, USA, all in Spring of 2010, John Bollinger introduced three new indicators based on Bollinger Bands. They are BB Impulse, which measures price change as a function of the bands, BandWidth Percent, which normalizes the width of the bands over time, and BandWidth Delta, which quantifies the changing width of the bands.

## Interpretation

The use of Bollinger Bands varies widely among traders. Some traders buy when price touches the lower Bollinger Band and exit when price touches the moving average in the center of the bands. Other traders buy when price breaks above the upper Bollinger Band or sell when price falls below the lower Bollinger Band.<sup>[4]</sup> Moreover, the use of Bollinger Bands is not confined to stock traders; options traders, most notably implied volatility traders, often sell options when Bollinger Bands are historically far apart or buy options when the Bollinger Bands are historically close together, in both instances, expecting volatility to revert back towards the average historical volatility level for the stock.

When the bands lie close together a period of low volatility in stock price is indicated. When they are far apart a period of high volatility in price is indicated. When the bands have only a slight slope and lie approximately parallel for an extended time the price of a stock will be found to oscillate up and down between the bands as though in a channel.

Traders are often inclined to use Bollinger Bands with other indicators to see if there is confirmation. In particular, the use of an oscillator like Bollinger Bands will often be coupled with a non-oscillator indicator like chart patterns or a trendline; if these indicators confirm the recommendation of the Bollinger Bands, the trader will have greater evidence that what the bands forecast is correct.

## Effectiveness

A recent study concluded that Bollinger Band trading strategies may be effective in the Chinese marketplace, stating: "Finally, we find significant positive returns on buy trades generated by the contrarian version of the moving average crossover rule, the channel breakout rule, and the Bollinger Band trading rule, after accounting for transaction costs of 0.50 percent." Nauzer J. Balsara, Gary Chen and Lin Zheng *The Chinese Stock Market: An Examination of the Random Walk Model and Technical Trading Rules*.<sup>[5]</sup> (By "the contrarian version", they mean buying when the conventional rule mandates selling, and vice versa.)

A paper by Rostan, Pierre, Théoret, Raymond and El moussadek, Abdeljalil from 2008 at SSRN uses Bollinger Bands in forecasting the yield curve.<sup>[6]</sup>

In his 2006 master's thesis, Oliver Douglas Williams at the University of Western Ontario studied Bollinger Bands and suggested that fundamental analysis was key to setting Bollinger Band parameters, a process John Bollinger dubbed rational analysis. Williams concluded: "Alone, Bollinger Bands do not seem to yield the extraordinary results. Fundamental analysis is required to determine the best moving average window to match the business cycle of the asset. When combined with other techniques such as fundamental analysis, Bollinger Bands can give systematic traders a method of choosing their buy and sell points."<sup>[7]</sup>

Companies like Forbes suggest that the use of Bollinger Bands is a simple and often an effective strategy but stop-loss orders should be used to mitigate losses from market pressure.<sup>[8]</sup>

## Statistical properties

Security prices have no known statistical distribution, normal or otherwise; they are known to have fat tails, compared to the Normal.<sup>[9]</sup> The sample size typically used, 20, is too small for conclusions derived from statistical techniques like the Central Limit Theorem to be reliable. Such techniques usually require the sample to be independent and identically distributed which is not the case for a time series like security prices.

For these three primary reasons, it is incorrect to assume that the percentage of the data outside the Bollinger Bands will always be limited to a certain amount. So, instead of finding about 95% of the data inside the bands, as would be the expectation with the default parameters if the data were normally distributed, one will typically find less; how much less is a function of the security's volatility.

## Bollinger Bands outside of finance

In a paper published in 2006 by the Society of Photo-Optical Engineers, "Novel method for patterned fabric inspection using Bollinger Bands", Henry Y. T. Ngan and Grantham K. H. Pang present a method of using Bollinger Bands to detect defects in patterned fabrics. From the abstract: "In this paper, the upper band and lower band of Bollinger Bands, which are sensitive to any subtle change in the input data, have been developed for use to indicate the defective areas in patterned fabric."<sup>[10]</sup>

The International Civil Aviation Organization is using Bollinger Bands to measure the accident rate as a safety indicator to measure efficiency of global safety initiatives.<sup>[11]</sup> %b and BandWidth are also used in this analysis.

## Notes

- [1] When the average used in the calculation of Bollinger Bands is changed from a simple moving average to an exponential or weighted moving average, it must be changed for both the calculation of the middle band and the calculation of standard deviation. Bollinger On Bollinger Bands – The Seminar, DVD I ISBN 978-0-9726111-0-7
- [2] Bollinger Bands use the population method of calculating standard deviation, thus the proper divisor for the sigma calculation is  $n$ , not  $n - 1$ .
- [3] (<http://www.bollingerbands.com>) second paragraph, center column
- [4] Technical Analysis: The Complete Resource for Financial Market Technicians by Charles D. Kirkpatrick and Julie R. Dahlquist Chapter 14
- [5] ([http://findarticles.com/p/articles/mi\\_qa5466/is\\_200704/ai\\_n21292807/pg\\_1?tag=artBody;col1](http://findarticles.com/p/articles/mi_qa5466/is_200704/ai_n21292807/pg_1?tag=artBody;col1)) The Quarterly Journal of Business and Economics, Spring 2007
- [6] ([http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=671581](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=671581)) Forecasting the Interest-Rate Term Structure at SSRN
- [7] (<http://ir.lib.sfu.ca/retrieve/3836/etd2519.pdf>) Empirical Optimization of Bollinger Bands for Profitability
- [8] Bollinger Band Trading John Devcic 05.11.07 ([http://www.forbes.com/2007/05/11/bollinger-intel-yahoo-pf-education-in\\_jd\\_0511chartroom\\_inl.html](http://www.forbes.com/2007/05/11/bollinger-intel-yahoo-pf-education-in_jd_0511chartroom_inl.html))
- [9] Rachev; Svetlozar T., Menn, Christian; Fabozzi, Frank J. (2005), Fat Tailed and Skewed Asset Return Distributions, Implications for Risk Management, Portfolio Selection, and Option Pricing, John Wiley, New York
- [10] (<http://spiedl.aip.org/getabs/servlet/GetabsServlet?prog=normal&id=OPEGAR000045000008087202000001&idtype=cvips&gifs=yes>) Optical Engineering, Volume 45, Issue 8
- [11] ([http://www.skybrary.aero/index.php/ICAO\\_Methodology\\_for\\_Accident\\_Rate\\_Calculation\\_and\\_Trending](http://www.skybrary.aero/index.php/ICAO_Methodology_for_Accident_Rate_Calculation_and_Trending)) ICAO Methodology for Accident Rate Calculation and Trending on SKYbary

## References

### Further reading

- Achelis, Steve. *Technical Analysis from A to Z* (pp. 71–73). Irwin, 1995. ISBN 978-0-07-136348-8
- Bollinger, John. *Bollinger on Bollinger Bands*. McGraw Hill, 2002. ISBN 978-0-07-137368-5
- Cahen, Philippe. *Dynamic Technical Analysis*. Wiley, 2001. ISBN 978-0-471-89947-1
- Kirkpatrick, Charles D. II; Dahlquist, Julie R. *Technical Analysis: The Complete Resource for Financial Market Technicians*, FT Press, 2006. ISBN 0-13-153113-1
- Murphy, John J. *Technical Analysis of the Financial Markets* (pp. 209–211). New York Institute of Finance, 1999. ISBN 0-7352-0066-1

### External links

- John Bollinger's website (<http://www.bollingerbands.com>)
- John Bollinger's website on Bollinger Band analysis (<http://www.bollingeronbollingerbands.com>)
- December 2008 Los Angeles Times profile of John Bollinger (<http://www.latimes.com/business/la-fi-himi7-2008dec07,0,1338099.story>)

# Donchian channel

The **Donchian channel** is an indicator used in market trading developed by Richard Donchian. It is formed by taking the highest high of the daily maxima and the lowest low of the daily minima of the last  $n$  days, then marking the area between those values on a chart.

The Donchian channel is a useful indicator for seeing the volatility of a market price. If a price is stable the Donchian channel will be relatively narrow. If the price fluctuates a lot the Donchian channel will be wider. Its primary use, however, is for providing signals for long and short positions. If a security trades above its highest  $n$  day high, then a long is established. If it trades below its lowest  $n$  day low, then a short is established.

## See also

- Bollinger bands
- Financial modeling

## External links

- Using the Donchian Channel in Trading <sup>[1]</sup>
- Capture Profits using Bands and Channels <sup>[2]</sup>

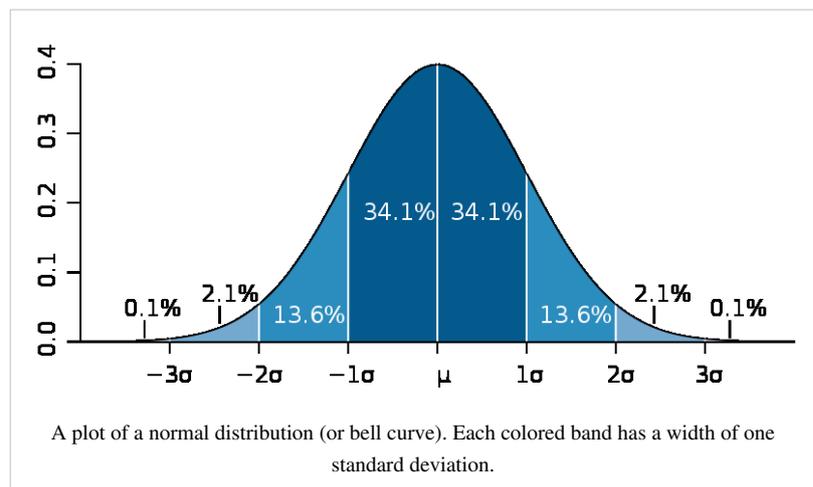
## References

[1] <http://www.indicatorforex.com/content/using-donchian-bands>

[2] <http://www.investopedia.com/articles/forex/06/BandsChannels.asp>

# Standard deviation

**Standard deviation** is a widely used measurement of variability or diversity used in statistics and probability theory. It shows how much variation or "dispersion" there is from the "average" (mean, or expected/budgeted value). A low standard deviation indicates that the data points tend to be very close to the mean, whereas high standard deviation indicates that the data are spread out over a large range of values.



Technically, the standard deviation of a statistical population, data set, or probability distribution is the square root of its variance. It is algebraically simpler though practically less robust than the average absolute deviation.<sup>[1]</sup>

[2] A useful property of standard deviation is that, unlike variance, it is expressed in the same units as the data. Note, however, that for measurements with percentage as unit, the standard deviation will have percentage points as unit.

In addition to expressing the variability of a population, standard deviation is commonly used to measure confidence in statistical conclusions. For example, the margin of error in polling data is determined by calculating the expected standard deviation in the results if the same poll were to be conducted multiple times. The reported margin of error is typically about twice the standard deviation – the radius of a 95 percent confidence interval. In science, researchers commonly report the standard deviation of experimental data, and only effects that fall far outside the range of standard deviation are considered statistically significant – normal random error or variation in the measurements is in this way distinguished from causal variation. Standard deviation is also important in finance, where the standard deviation on the rate of return on an investment is a measure of the volatility of the investment.

When only a sample of data from a population is available, the population standard deviation can be estimated by a modified quantity called the sample standard deviation, explained below.

### Basic examples

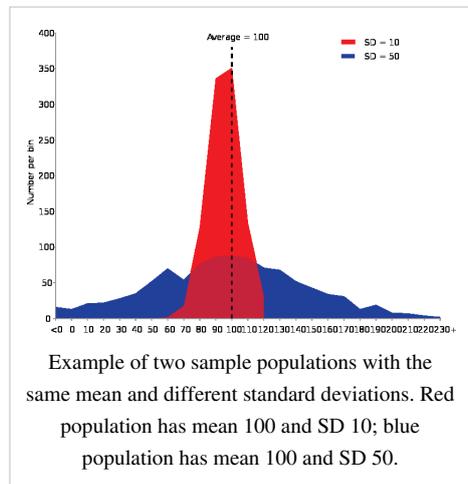
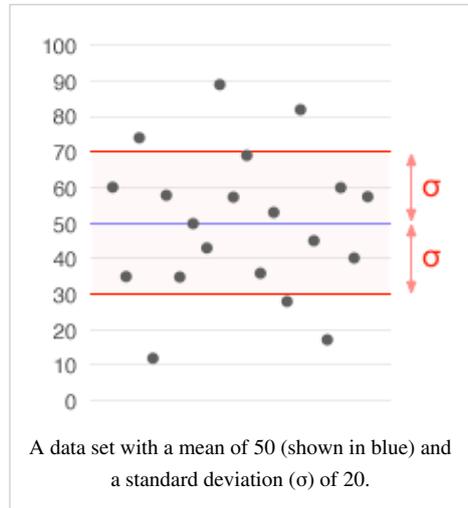
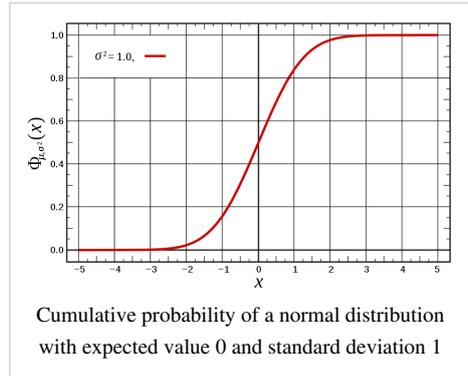
Consider a population consisting of the following eight values:

2, 4, 4, 4, 5, 5, 7, 9

These eight data points have the mean (average) of 5:

$$\frac{2 + 4 + 4 + 4 + 5 + 5 + 7 + 9}{8} = 5$$

To calculate the population standard deviation, first compute the difference of each data point from the mean, and square the result of each:



$$\begin{aligned} (2 - 5)^2 &= (-3)^2 = 9 & (5 - 5)^2 &= 0^2 = 0 \\ (4 - 5)^2 &= (-1)^2 = 1 & (5 - 5)^2 &= 0^2 = 0 \\ (4 - 5)^2 &= (-1)^2 = 1 & (7 - 5)^2 &= 2^2 = 4 \\ (4 - 5)^2 &= (-1)^2 = 1 & (9 - 5)^2 &= 4^2 = 16 \end{aligned}$$

Next compute the average of these values, and take the square root:

$$\sqrt{\frac{9 + 1 + 1 + 1 + 0 + 0 + 4 + 16}{8}} = 2$$

This quantity is the **population standard deviation**; it is equal to the square root of the variance. The formula is valid *only* if the eight values we began with form the *complete* population. If they instead were a random sample, drawn from some larger, “parent” population, then we should have used  $7 (n - 1)$  instead of  $8 (n)$  in the denominator of the last formula, and then the quantity thus obtained would have been called the **sample standard deviation**. See the section Estimation below for more details.

A slightly more complicated real life example, the average height for adult men in the United States is about 70", with a standard deviation of around 3". This means that most men (about 68%, assuming a normal distribution) have a height within 3" of the mean (67"–73") — one standard deviation — and almost all men (about 95%) have a height within 6" of the mean (64"–76") — two standard deviations. If the standard deviation were zero, then all men would be exactly 70" high. If the standard deviation were 20", then men would have much more variable heights, with a typical range of about 50"–90". Three standard deviations account for 99.7% of the sample population being studied, assuming the distribution is normal (bell-shaped).

## Definition of population values

Let  $X$  be a random variable with mean value  $\mu$ :

$$E[X] = \mu.$$

Here the operator  $E$  denotes the average or expected value of  $X$ . Then the **standard deviation** of  $X$  is the quantity

$$\sigma = \sqrt{E[(X - \mu)^2]}.$$

That is, the standard deviation  $\sigma$  (sigma) is the square root of the average value of  $(X - \mu)^2$ .

The standard deviation of a (univariate) probability distribution is the same as that of a random variable having that distribution. Not all random variables have a standard deviation, since these expected values need not exist. For example, the standard deviation of a random variable that follows a Cauchy distribution is undefined because its expected value  $\mu$  is undefined.

## Discrete random variable

In the case where  $X$  takes random values from a finite data set  $x_1, x_2, \dots, x_N$  with each value having the same probability, the standard deviation is

$$\sigma = \sqrt{\frac{1}{N} [(x_1 - \mu)^2 + (x_2 - \mu)^2 + \dots + (x_N - \mu)^2]}, \quad \text{where } \mu = \frac{1}{N}(x_1 + \dots + x_N),$$

or, using summation notation,

$$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - \mu)^2}, \quad \text{where } \mu = \frac{1}{N} \sum_{i=1}^N x_i.$$

If, instead of having equal probabilities, the values have different probabilities, let  $x_1$  have probability  $p_1$ ,  $x_2$  have probability  $p_2$ , ...,  $x_N$  have probability  $p_N$ . In this case, the standard deviation will be

$$\sigma = \sqrt{\sum_{i=1}^N p_i (x_i - \mu)^2}, \quad \text{where } \mu = \sum_{i=1}^N p_i x_i.$$

### Continuous random variable

The standard deviation of a continuous real-valued random variable  $X$  with probability density function  $p(x)$  is

$$\sigma = \sqrt{\int_{\mathbf{X}} (x - \mu)^2 p(x) dx},$$

where

$$\mu = \int_{\mathbf{X}} x p(x) dx,$$

and where the integrals are definite integrals taken for  $x$  ranging over the set of possible values of the random variable  $X$ .

In the case of a parametric family of distributions, the standard deviation can be expressed in terms of the parameters. For example, in the case of the log-normal distribution with parameters  $\mu$  and  $\sigma^2$ , the standard deviation is  $[(\exp(\sigma^2) - 1)\exp(2\mu + \sigma^2)]^{1/2}$ .

### Estimation

One can find the standard deviation of an entire population in cases (such as standardized testing) where every member of a population is sampled. In cases where that cannot be done, the standard deviation  $\sigma$  is estimated by examining a random sample taken from the population. Some estimators are given below:

#### With standard deviation of the sample

An estimator for  $\sigma$  sometimes used is the **standard deviation of the sample**, denoted by  $s_N$  and defined as follows:

$$s_N = \sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - \bar{x})^2}.$$

This estimator has a uniformly smaller mean squared error than the *sample standard deviation* (see below), and is the maximum-likelihood estimate when the population is normally distributed. But this estimator, when applied to a small or moderately sized sample, tends to be too low: it is a biased estimator.

The standard deviation of the sample is the same as the population standard deviation of a discrete random variable that can assume precisely the values from the data set, where the probability for each value is proportional to its multiplicity in the data set.

#### With sample standard deviation

The most common estimator for  $\sigma$  used is an adjusted version, the **sample standard deviation**, denoted by  $s$  and defined as follows:

$$s = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (x_i - \bar{x})^2},$$

where  $\{x_1, x_2, \dots, x_N\}$  are the observed values of the sample items and  $\bar{x}$  is the mean value of these observations.

This correction (the use of  $N-1$  instead of  $N$ ) is known as Bessel's correction. The reason for this correction is that  $s^2$  is an unbiased estimator for the variance  $\sigma^2$  of the underlying population, if that variance exists and the sample values are drawn independently with replacement. However,  $s$  is *not* an unbiased estimator for the standard deviation  $\sigma$ ; it tends to underestimate the population standard deviation.

The term *standard deviation of the sample* is used for the uncorrected estimator (using  $N$ ) while the term *sample standard deviation* is used for the corrected estimator (using  $N - 1$ ). The denominator  $N - 1$  is the number of degrees of freedom in the vector of residuals,  $(x_1 - \bar{x}, \dots, x_N - \bar{x})$ .

### Other estimators

Although an unbiased estimator for  $\sigma$  is known when the random variable is normally distributed, the formula is complicated and amounts to a minor correction. Moreover, unbiasedness (in this sense of the word) is not always desirable.

### Identities and mathematical properties

The standard deviation is invariant under changes in location, and scales directly with the scale of the random variable. Thus, for a constant  $c$  and random variables  $X$  and  $Y$ :

$$\begin{aligned}\text{stdev}(X + c) &= \text{stdev}(X), \\ \text{stdev}(cX) &= |c| \text{stdev}(X).\end{aligned}$$

The standard deviation of the sum of two random variables can be related to their individual standard deviations and the covariance between them:

$$\text{stdev}(X + Y) = \sqrt{\text{var}(X) + \text{var}(Y) + 2 \text{cov}(X, Y)}.$$

where  $\text{var} = \text{stdev}^2$  and  $\text{cov}$  stand for variance and covariance, respectively.

The calculation of the sum of squared deviations can be related to moments calculated directly from the data. The standard deviation of the sample can be computed as:

$$\text{stdev}(X) = \sqrt{E[X - E(X)]^2} = \sqrt{E[X^2] - (E[X])^2}.$$

The sample standard deviation can be computed as:

$$\text{stdev}(X) = \sqrt{\frac{N}{N-1}} \sqrt{E[X - E(X)]^2}.$$

For a finite population with equal probabilities at all points, we have

$$\sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - \bar{x})^2} = \sqrt{\frac{1}{N} \left( \sum_{i=1}^N x_i^2 \right) - \bar{x}^2}.$$

Thus, the standard deviation is equal to the square root of (the average of the squares less the square of the average). See computational formula for the variance for a proof of this fact, and for an analogous result for the sample standard deviation.

### Interpretation and application

A large standard deviation indicates that the data points are far from the mean and a small standard deviation indicates that they are clustered closely around the mean.

For example, each of the three populations  $\{0, 0, 14, 14\}$ ,  $\{0, 6, 8, 14\}$  and  $\{6, 6, 8, 8\}$  has a mean of 7. Their standard deviations are 7, 5, and 1, respectively. The third population has a much smaller standard deviation than the other two because its values are all close to 7. In a loose sense, the standard deviation tells us how far from the mean the data points tend to be. It will have the same units as the data points themselves. If, for instance, the data set  $\{0, 6, 8, 14\}$  represents the ages of a population of four siblings in years, the standard deviation is 5 years.

As another example, the population  $\{1000, 1006, 1008, 1014\}$  may represent the distances traveled by four athletes, measured in meters. It has a mean of 1007 meters, and a standard deviation of 5 meters.

Standard deviation may serve as a measure of uncertainty. In physical science, for example, the reported standard deviation of a group of repeated measurements should give the precision of those measurements. When deciding whether measurements agree with a theoretical prediction, the standard deviation of those measurements is of crucial importance: if the mean of the measurements is too far away from the prediction (with the distance measured in standard deviations), then the theory being tested probably needs to be revised. This makes sense since they fall outside the range of values that could reasonably be expected to occur if the prediction were correct and the standard deviation appropriately quantified. See prediction interval.

### **Application examples**

The practical value of understanding the standard deviation of a set of values is in appreciating how much variation there is from the "average" (mean).

#### **Climate**

As a simple example, consider the average daily maximum temperatures for two cities, one inland and one on the coast. It is helpful to understand that the range of daily maximum temperatures for cities near the coast is smaller than for cities inland. Thus, while these two cities may each have the same average maximum temperature, the standard deviation of the daily maximum temperature for the coastal city will be less than that of the inland city as, on any particular day, the actual maximum temperature is more likely to be farther from the average maximum temperature for the inland city than for the coastal one.

#### **Sports**

Another way of seeing it is to consider sports teams. In any set of categories, there will be teams that rate highly at some things and poorly at others. Chances are, the teams that lead in the standings will not show such disparity but will perform well in most categories. The lower the standard deviation of their ratings in each category, the more balanced and consistent they will tend to be. Whereas, teams with a higher standard deviation will be more unpredictable. For example, a team that is consistently bad in most categories will have a low standard deviation. A team that is consistently good in most categories will also have a low standard deviation. However, a team with a high standard deviation might be the type of team that scores a lot (strong offense) but also concedes a lot (weak defense), or, vice versa, that might have a poor offense but compensates by being difficult to score on.

Trying to predict which teams, on any given day, will win, may include looking at the standard deviations of the various team "stats" ratings, in which anomalies can match strengths vs. weaknesses to attempt to understand what factors may prevail as stronger indicators of eventual scoring outcomes.

In racing, a driver is timed on successive laps. A driver with a low standard deviation of lap times is more consistent than a driver with a higher standard deviation. This information can be used to help understand where opportunities might be found to reduce lap times.

#### **Finance**

In finance, standard deviation is a representation of the risk associated with a given security (stocks, bonds, property, etc.), or the risk of a portfolio of securities (actively managed mutual funds, index mutual funds, or ETFs). Risk is an important factor in determining how to efficiently manage a portfolio of investments because it determines the variation in returns on the asset and/or portfolio and gives investors a mathematical basis for investment decisions (known as mean-variance optimization). The overall concept of risk is that as it increases, the expected return on the asset will increase as a result of the risk premium earned – in other words, investors should expect a higher return on an investment when said investment carries a higher level of risk, or uncertainty of that return. When evaluating investments, investors should estimate both the expected return and the uncertainty of future returns. Standard deviation provides a quantified estimate of the uncertainty of future returns.

For example, let's assume an investor had to choose between two stocks. Stock A over the past 20 years had an average return of 10 percent, with a standard deviation of 20 percentage points (pp) and Stock B, over the same period, had average returns of 12 percent but a higher standard deviation of 30 pp. On the basis of risk and return, an investor may decide that Stock A is the safer choice, because Stock B's additional two percentage points of return is not worth the additional 10 pp standard deviation (greater risk or uncertainty of the expected return). Stock B is likely to fall short of the initial investment (but also to exceed the initial investment) more often than Stock A under the same circumstances, and is estimated to return only two percent more on average. In this example, Stock A is expected to earn about 10 percent, plus or minus 20 pp (a range of 30 percent to -10 percent), about two-thirds of the future year returns. When considering more extreme possible returns or outcomes in future, an investor should expect results of as much as 10 percent plus or minus 60 pp, or a range from 70 percent to -50 percent, which includes outcomes for three standard deviations from the average return (about 99.7 percent of probable returns).

Calculating the average return (or arithmetic mean) of the return of a security over a given period will generate the expected return of the asset. For each period, subtracting the expected return from the actual return results in the difference from the mean. Squaring the difference in each period and taking the average gives the overall variance of the return of the asset. The larger the variance, the greater risk the security carries. Finding the square root of this variance will give the standard deviation of the investment tool in question.

Population standard deviation is used to set the width of Bollinger Bands, a widely adopted technical analysis tool. For example, the upper Bollinger Band is given as  $x + n\sigma_x$ . The most commonly used value for  $n$  is 2; there is about a five percent chance of going outside, assuming a normal distribution of returns.

### Geometric interpretation

To gain some geometric insights, we will start with a population of three values,  $x_1, x_2, x_3$ . This defines a point  $P = (x_1, x_2, x_3)$  in  $\mathbf{R}^3$ . Consider the line  $L = \{(r, r, r) : r \in \mathbf{R}\}$ . This is the "main diagonal" going through the origin. If our three given values were all equal, then the standard deviation would be zero and  $P$  would lie on  $L$ . So it is not unreasonable to assume that the standard deviation is related to the *distance* of  $P$  to  $L$ . And that is indeed the case. To move orthogonally from  $L$  to the point  $P$ , one begins at the point:

$$M = (\bar{x}, \bar{x}, \bar{x})$$

whose coordinates are the mean of the values we started out with. A little algebra shows that the distance between  $P$  and  $M$  (which is the same as the orthogonal distance between  $P$  and the line  $L$ ) is equal to the standard deviation of the vector  $x_1, x_2, x_3$ , multiplied by the square root of the number of dimensions of the vector (3 in this case.)

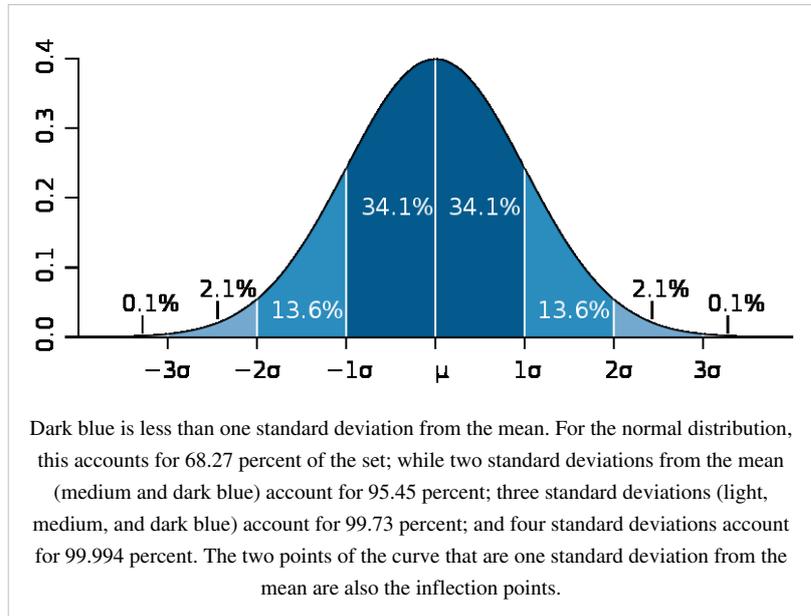
### Chebyshev's inequality

An observation is rarely more than a few standard deviations away from the mean. Chebyshev's inequality ensures that, for all distributions for which the standard deviation is defined, the amount of data within a number of standard deviations of the mean is at least as much as given in the following table.

Minimum population	Distance from mean
50%	$\sqrt{2}$
75%	2
89%	3
94%	4
96%	5
97%	6
$1 - \frac{1}{k^2}$ [3]	$k$

### Rules for normally distributed data

The central limit theorem says that the distribution of an average of many independent, identically distributed random variables tends toward the famous bell-shaped normal distribution with a probability density function of:



$$\frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{[x - \mu]^2}{2\sigma^2}\right)$$

where  $\mu$  is the expected value of the random variable,  $\sigma$  equals its standard deviation divided by  $n^{1/2}$ , and  $n$  is the number of random variables. The standard deviation therefore is simply a scaling variable that adjusts how broad the curve will be, though it also appears in the normalizing constant.

If a data distribution is approximately normal then the proportion of data values within  $z$  standard deviations of the mean is defined by:

$$\text{Proportion} = \text{erf}\left(\frac{z}{\sqrt{2}}\right)$$

where  $\text{erf}$  is the error function. If a data distribution is approximately normal then about 68 percent of the data values are within one standard deviation of the mean (mathematically,  $\mu \pm \sigma$ , where  $\mu$  is the arithmetic mean), about 95 percent are within two standard deviations ( $\mu \pm 2\sigma$ ), and about 99.7 percent lie within three standard deviations ( $\mu \pm 3\sigma$ ). This is known as the 68-95-99.7 rule, or the empirical rule.

For various values of  $z$ , the percentage of values expected to lie in and outside the symmetric interval,  $CI = (-z\sigma, z\sigma)$ , are as follows:

$z\sigma$	Percentage within CI	Percentage outside CI	Fraction outside CI
$0.674\sigma$	50%	50%	1 / 2
$1\sigma$	68.2689492%	31.7310508%	1 / 3.1514872
$1.645\sigma$	90%	10%	1 / 10
$1.960\sigma$	95%	5%	1 / 20
$2\sigma$	95.4499736%	4.5500264%	1 / 21.977895
$2.576\sigma$	99%	1%	1 / 100
$3\sigma$	99.7300204%	0.2699796%	1 / 370.398
$3.2906\sigma$	99.9%	0.1%	1 / 1000
$4\sigma$	99.993666%	0.006334%	1 / 15,787
$5\sigma$	99.9999426697%	0.0000573303%	1 / 1744278
$6\sigma$	99.999998027%	0.000001973%	1 / 506,800,000
$7\sigma$	99.99999997440%	0.00000002560%	1 / 39070000000

### Relationship between standard deviation and mean

The mean and the standard deviation of a set of data are usually reported together. In a certain sense, the standard deviation is a "natural" measure of statistical dispersion if the center of the data is measured about the mean. This is because the standard deviation from the mean is smaller than from any other point. The precise statement is the following: suppose  $x_1, \dots, x_n$  are real numbers and define the function:

$$\sigma(r) = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (x_i - r)^2}.$$

Using calculus or by completing the square, it is possible to show that  $\sigma(r)$  has a unique minimum at the mean:

$$r = \bar{x}.$$

Variability can also be measured by the coefficient of variation, which is the ratio of the standard deviation to the mean. It is a dimensionless number.

Often we want some information about the precision of the mean we obtained. We can obtain this by determining the standard deviation of the sampled mean. The standard deviation of the mean is related to the standard deviation of the distribution by:

$$\sigma_{\text{mean}} = \frac{1}{\sqrt{N}}\sigma$$

where  $N$  is the number of observation in the sample used to estimate the mean. This can easily be proven with:

$$\begin{aligned} \text{var}(X) &\equiv \sigma_X^2 \\ \text{var}(X_1 + X_2) &\equiv \text{var}(X_1) + \text{var}(X_2) \\ \text{var}(cX_1) &\equiv c^2 \text{var}(X_1) \end{aligned}$$

hence

$$\begin{aligned} \text{var}(\text{mean}) &= \text{var}\left(\frac{1}{N} \sum_{i=1}^N X_i\right) = \frac{1}{N^2} \text{var}\left(\sum_{i=1}^N X_i\right) \\ &= \frac{1}{N^2} \sum_{i=1}^N \text{var}(X_i) = \frac{N}{N^2} \text{var}(X) = \frac{1}{N} \text{var}(X). \end{aligned}$$

Resulting in:

$$\sigma_{\text{mean}} = \frac{\sigma}{\sqrt{N}}.$$

## Rapid calculation methods

The following two formulas can represent a running (continuous) standard deviation. A set of three power sums  $s_0$ ,  $s_1$ ,  $s_2$  are each computed over a set of  $N$  values of  $x$ , denoted as  $x_1, \dots, x_N$ :

$$s_j = \sum_{k=1}^N x_k^j.$$

Note that  $s_0$  raises  $x$  to the zero power, and since  $x^0$  is always 1,  $s_0$  evaluates to  $N$ .

Given the results of these three running summations, the values  $s_0$ ,  $s_1$ ,  $s_2$  can be used at any time to compute the *current* value of the running standard deviation:

$$\sigma = \frac{1}{s_0} \sqrt{s_0 s_2 - s_1^2}$$

Similarly for sample standard deviation,

$$s = \sqrt{\frac{s_0 s_2 - s_1^2}{s_0(s_0 - 1)}}.$$

In a computer implementation, as the three  $s_j$  sums become large, we need to consider round-off error, arithmetic overflow, and arithmetic underflow. The method below calculates the running sums method with reduced rounding errors:

$$A_0 = 0$$

$$A_i = A_{i-1} + \frac{1}{i}(x_i - A_{i-1})$$

where  $A$  is the mean value.

$$Q_0 = 0$$

$$Q_i = Q_{i-1} + \frac{i-1}{i}(x_i - A_{i-1})^2$$

$$Q_i = Q_{i-1} + (x_i - A_{i-1})(x_i - A_i)$$

Sample variance:

$$s_n^2 = \frac{1}{n-1} Q_n$$

Standard variance:

$$\sigma_n^2 = \frac{1}{n} Q_n$$

## Weighted calculation

When the values  $x_i$  are weighted with unequal weights  $w_i$ , the power sums  $s_0$ ,  $s_1$ ,  $s_2$  are each computed as:

$$s_j = \sum_{k=1}^N w_k x_k^j.$$

And the standard deviation equations remain unchanged. Note that  $s_0$  is now the sum of the weights and not the number of samples  $N$ .

The incremental method with reduced rounding errors can also be applied, with some additional complexity.

A running sum of weights must be computed:

$$W_0 = 0$$

$$W_i = W_{i-1} + w_i$$

and places where  $1/i$  is used above must be replaced by  $w_i/W_i$ :

$$A_0 = 0$$

$$A_i = A_{i-1} + \frac{w_i}{W_i}(x_i - A_{i-1})$$

$$Q_0 = 0$$

$$Q_i = Q_{i-1} + \frac{w_i W_{i-1}}{W_i}(x_i - A_{i-1})^2 = Q_{i-1} + w_i(x_i - A_{i-1})(x_i - A_i)$$

In the final division,

$$\sigma_n^2 = \frac{Q_n}{W_n}$$

and

$$s_n^2 = \frac{n'}{n' - 1} \sigma_n^2$$

where  $n$  is the total number of elements, and  $n'$  is the number of elements with non-zero weights. The above formulas become equal to the simpler formulas given above if weights are taken as equal to one.

## Combining standard deviations

### Population-based statistics

The populations of sets, which may overlap, can be calculated simply as follows:

$$N_{X \cup Y} = N_X + N_Y - N_{X \cap Y}$$

$$X \cap Y = \emptyset \Rightarrow N_{X \cap Y} = 0$$

$$\Rightarrow N_{X \cup Y} = N_X + N_Y$$

Standard deviations of non-overlapping ( $X \cap Y = \emptyset$ ) sub-populations can be aggregated as follows if the size (actual or relative to one another) and means of each are known:

$$\mu_{X \cup Y} = \frac{N_X \mu_X + N_Y \mu_Y}{N_X + N_Y}$$

$$\sigma_{X \cup Y} = \sqrt{\frac{N_X \sigma_X^2 + N_Y \sigma_Y^2}{N_X + N_Y} + \frac{N_X N_Y}{(N_X + N_Y)^2} (\mu_X - \mu_Y)^2}$$

For example, suppose it is known that the average American man has a mean height of 70 inches with a standard deviation of three inches and that the average American woman has a mean height of 65 inches with a standard deviation of two inches. Also assume that the number of men,  $N$ , is equal to the number of woman. Then the mean and standard deviation of heights of American adults could be calculated as:

$$\mu = \frac{N \cdot 70 + N \cdot 65}{N + N} = \frac{70 + 65}{2} = 67.5$$

$$\sigma = \sqrt{\frac{3^2 + 2^2}{2} + \frac{(70 - 65)^2}{2^2}} = \sqrt{12.75} \approx 3.57$$

For the more general case of  $M$  non-overlapping populations,  $X_1$  through  $X_M$ , and the aggregate population  $X = \bigcup_i X_i$ :

$$\mu_X = \frac{\sum_i N_{X_i} \mu_{X_i}}{\sum_i N_{X_i}}$$

$$\sigma_X = \sqrt{\frac{\sum_i N_{X_i} (\sigma_{X_i}^2 + \mu_{X_i}^2)}{\sum_i N_{X_i}} - \mu_X^2} = \sqrt{\frac{\sum_i N_{X_i} \sigma_{X_i}^2}{\sum_i N_{X_i}} + \frac{\sum_{i < j} N_{X_i} N_{X_j} (\mu_{X_i} - \mu_{X_j})^2}{(\sum_i N_{X_i})^2}}$$

where

$$X_i \cap X_j = \emptyset, \quad \forall i < j.$$

If the size (actual or relative to one another), mean, and standard deviation of two overlapping populations are known for the populations as well as their intersection, then the standard deviation of the overall population can still be calculated as follows:

$$\mu_{X \cup Y} = \frac{1}{N_{X \cup Y}} (N_X \mu_X + N_Y \mu_Y - N_{X \cap Y} \mu_{X \cap Y})$$

$$\sigma_{X \cup Y} = \sqrt{\frac{1}{N_{X \cup Y}} (N_X [\sigma_X^2 + \mu_X^2] + N_Y [\sigma_Y^2 + \mu_Y^2] - N_{X \cap Y} [\sigma_{X \cap Y}^2 + \mu_{X \cap Y}^2]) - \mu_{X \cup Y}^2}$$

If two or more sets of data are being added together datapoint by datapoint, the standard deviation of the result can be calculated if the standard deviation of each data set and the covariance between each pair of data sets is known:

$$\sigma_X = \sqrt{\sum_i \sigma_{X_i}^2 + \sum_{i,j} \text{cov}(X_i, X_j)}$$

For the special case where no correlation exists between any pair of data sets, then the relation reduces to the root-mean-square:

$$\text{cov}(X_i, X_j) = 0, \quad \forall i < j$$

$$\Rightarrow \sigma_X = \sqrt{\sum_i \sigma_{X_i}^2}.$$

### Sample-based statistics

Standard deviations of non-overlapping ( $X \cap Y = \emptyset$ ) sub-samples can be aggregated as follows if the actual size and means of each are known:

$$\mu_{X \cup Y} = \frac{1}{N_{X \cup Y}} (N_X \mu_X + N_Y \mu_Y)$$

$$\sigma_{X \cup Y} = \sqrt{\frac{1}{N_{X \cup Y} - 1} ([N_X - 1] \sigma_X^2 + N_X \mu_X^2 + [N_Y - 1] \sigma_Y^2 + N_Y \mu_Y^2 - [N_X + N_Y] \mu_{X \cup Y}^2)}$$

For the more general case of  $M$  non-overlapping data sets,  $X_1$  through  $X_M$ , and the aggregate data set  $X = \bigcup_i X_i$ :

$$\mu_X = \frac{1}{\sum_i N_{X_i}} \left( \sum_i N_{X_i} \mu_{X_i} \right)$$

$$\sigma_X = \sqrt{\frac{1}{\sum_i N_{X_i} - 1} \left( \sum_i [(N_{X_i} - 1) \sigma_{X_i}^2 + N_{X_i} \mu_{X_i}^2] - \left[ \sum_i N_{X_i} \right] \mu_X^2 \right)}$$

where:

$$X_i \cap X_j = \emptyset, \quad \forall i < j.$$

If the size, mean, and standard deviation of two overlapping samples are known for the samples as well as their intersection, then the standard deviation of the aggregated sample can still be calculated. In general:

$$\mu_{X \cup Y} = \frac{1}{N_{X \cup Y}} (N_X \mu_X + N_Y \mu_Y - N_{X \cap Y} \mu_{X \cap Y})$$

$$\sigma_{X \cup Y} = \sqrt{\frac{1}{N_{X \cup Y} - 1} ([N_X - 1] \sigma_X^2 + N_X \mu_X^2 + [N_Y - 1] \sigma_Y^2 + N_Y \mu_Y^2 - [N_{X \cap Y} - 1] \sigma_{X \cap Y}^2 - N_{X \cap Y} \mu_{X \cap Y}^2 - [N_X + N_Y - N_{X \cap Y}] \mu_{X \cup Y}^2)}$$

## History

The term *standard deviation* was first used<sup>[4]</sup> in writing by Karl Pearson<sup>[5]</sup> in 1894, following his use of it in lectures. This was as a replacement for earlier alternative names for the same idea: for example, Gauss used *mean error*.<sup>[6]</sup>

## References

- [1] Gauss, Carl Friedrich (1816). "Bestimmung der Genauigkeit der Beobachtungen". *Zeitschrift für Astronomie und verwandte Wissenschaften* **1**: 187–197.
- [2] Walker, Helen (1931). *Studies in the History of the Statistical Method*. Baltimore, MD: Williams & Wilkins Co. pp. 24–25.
- [3] Ghahramani, Saeed (2000). *Fundamentals of Probability* (2nd Edition). Prentice Hall: New Jersey. p. 438.
- [4] Dodge, Yadolah (2003). *The Oxford Dictionary of Statistical Terms*. Oxford University Press. ISBN 0-19-920613-9.
- [5] Pearson, Karl (1894). "On the dissection of asymmetrical frequency curves". *Phil. Trans. Roy. Soc. London, Series A* **185**: 719–810.
- [6] Miller, Jeff. "Earliest Known Uses of Some of the Words of Mathematics" (<http://jeff560.tripod.com/mathword.html>). .

## External links

- Online Standard Deviation Calculator (<http://www.miniwebtool.com/standard-deviation-calculator/>)
- A Guide to Understanding & Calculating Standard Deviation (<http://stats4students.com/measures-of-spread-3.php>)
- C++ Source Code (<http://www.chrisevansdev.com/rapidlive-statistics/>) (license free) C++ implementation of rapid mean, variance and standard deviation calculation
- Interactive Demonstration and Standard Deviation Calculator (<http://www.usablestats.com/tutorials/StandardDeviation>)
- Standard Deviation – an explanation without maths (<http://www.techbookreport.com/tutorials/stddev-30-secs.html>)
- Standard Deviation, an elementary introduction (<http://davidmlane.com/hyperstat/A16252.html>)
- Standard Deviation, a simpler explanation for writers and journalists (<http://www.robertniles.com/stats/stdev.shtml>)
- Standard Deviation Calculator (<http://invsee.asu.edu/srinivas/stdev.html>)
- Texas A&M Standard Deviation and Confidence Interval Calculators (<http://www.stat.tamu.edu/~jhardin/applets/>)
- The concept of Standard Deviation is shown in this 8-foot-tall (2.4 m) Probability Machine (named Sir Francis) comparing stock market returns to the randomness of the beans dropping through the quincunx pattern. (<http://www.youtube.com/watch?v=AUSKTK9ENzg>) from Index Funds Advisors IFA.com (<http://www.ifa.com>)

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# INDICATORS: Other

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## Advance decline line

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The **Advance/Decline line** is a stock market technical indicator used by speculators to measure the number of individual stocks participating in a market rise or fall. As price changes of large stocks can have a disproportionate effect on capitalization weighted stock market indices such as the S&P 500, the NYSE Composite Index, and the NASDAQ Composite index, it can be useful to know how broadly this movement extends into the larger universe of smaller stocks. Since market indexes represent a group of stocks, they do not present the whole picture of the trading day and the performance of the market during this day. Though the market indices give an idea about what has happened during the trading day, advance/decline numbers give an idea about the individual performance of particular stocks.

The Advance/Decline line is a plot of the cumulative sum of the daily difference between the number of issues advancing and the number of issues declining in a particular stock market index. Thus it moves up when the index contains more advancing than declining issues, and moves down when there are more declining than advancing issues. The formula for ADL is<sup>[1]</sup>:

$$\text{A/D Line} = (\# \text{ of Advancing Stocks} - \# \text{ of Declining Stocks}) + \text{Yesterday's A/D Line Value}$$

The Advance/Decline Line (ADL) is the most popular of all internal indicators by far<sup>[1]</sup>.

### Divergence

"Divergence" is when the stock market index moves in one direction while the ADL on that index moves in the opposite direction<sup>[2]</sup>. If the index moves up while the ADL moves down, the index may be misleading about the true direction of the overall market, as happened toward the end of the US Dot-com bubble in 1999-2000<sup>[3]</sup>, when the indices continued to rally while the ADL diverged downward starting at the beginning of 1999. Such negative divergence was also seen toward the end of the roaring twenties bull market, during 1929 at the height of the Nifty Fifty market<sup>[4]</sup>, and starting in March 2008 before the late-2008 market collapse<sup>[5]</sup>.

### Advance/Decline Numbers Application

There may be cases in which an index reports a gain at the end of the trading day. This gain may be caused by an increase in a certain number of stocks. However, a significant lead by declining stocks may be observed relative to the advancing stocks.<sup>[6]</sup>

However, these results should be interpreted as a decline in the market, no matter that the index has experienced an increase. Therefore, you should base your judgments regarding the performance of the market on the advance/decline numbers, not on the performance of a particular index no matter how broad it is.

There have been many cases in which a major increase in an index was not accompanied by an increase in the advance number. In such a case it is reasonable to conclude that by the end of the trading day the index will decline.

The reverse is also true. For instance, if there is a significant movement in the advance/decline numbers, you can expect a movement in the different indexes as well.

Additionally, a market that experiences a trend toward either a decline or an advance is highly unlikely to reverse its movement immediately on the next trading day.

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Advance/decline numbers can be also used in your daily observations of the trades in order to determine whether a particular trend is a false or a spot.

Finally, use advance/decline numbers whenever you need to make a judgment on the performance of the market. These numbers can also give you understanding on the movements of the indexes.

## Example of Market Breadth Chart

- NASDAQ Breadth <sup>[7]</sup>
- DAX Breadth <sup>[8]</sup>
- FTSE Breadth <sup>[9]</sup>
- STI Breadth <sup>[10]</sup>

## References

- [1] "Market Breadth: Advance/Decline Indicators" (<http://www.investopedia.com/university/marketbreadth/marketbreadth3.asp>). Investopedia. 2010. . Retrieved 2010-09-12.
- [2] <http://www.trade10.com/advanceDecline.html>
- [3] <http://blogs.stockcharts.com/chartwatchers/2006/09/the-importance-of-the-ny-a-d-line.html>
- [4] <http://www.lewrockwell.com/orig5/duffy4.html>
- [5] <http://www.marketoracle.co.uk/Article4754.html>
- [6] "Advance/Decline Ratio Basics" (<http://www.stock-market-investors.com/stock-investing-basics/advance-decline-ratio-basics.html>). Stock-Market-Investors.com. 2008. . Retrieved 2010-09-12.
- [7] [http://www.livecharts.co.uk/breadth\\_charts/nasdaq\\_advance\\_decline.php](http://www.livecharts.co.uk/breadth_charts/nasdaq_advance_decline.php)
- [8] [http://www.livecharts.co.uk/breadth\\_charts/dax\\_advance\\_decline.php](http://www.livecharts.co.uk/breadth_charts/dax_advance_decline.php)
- [9] [http://www.livecharts.co.uk/breadth\\_charts/ftse\\_100\\_advance\\_decline.php](http://www.livecharts.co.uk/breadth_charts/ftse_100_advance_decline.php)
- [10] <http://stibreadth.blogspot.com/>

# Commodity Channel Index

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The **Commodity Channel Index (CCI)** is an oscillator originally introduced by Donald Lambert in an article published in the October 1980 issue of *Commodities* magazine (now known as *Futures* magazine).

Since its introduction, the indicator has grown in popularity and is now a very common tool for traders in identifying cyclical trends not only in commodities, but also equities and currencies. The CCI can be adjusted to the timeframe of the market traded on by changing the averaging period.

## Calculation

The CCI is calculated as the difference between the typical price of a commodity and its simple moving average, divided by the mean absolute deviation of the typical price. The index is usually scaled by an inverse factor of 0.015 to provide more readable numbers:

$$CCI = \frac{1}{0.015} \frac{p_t - SMA(p_t)}{\sigma(p_t)},$$

where the  $p_t$  is the Typical Price =  $\frac{H + L + C}{3}$ , SMA is the simple moving average, and  $\sigma$  is the mean absolute deviation.

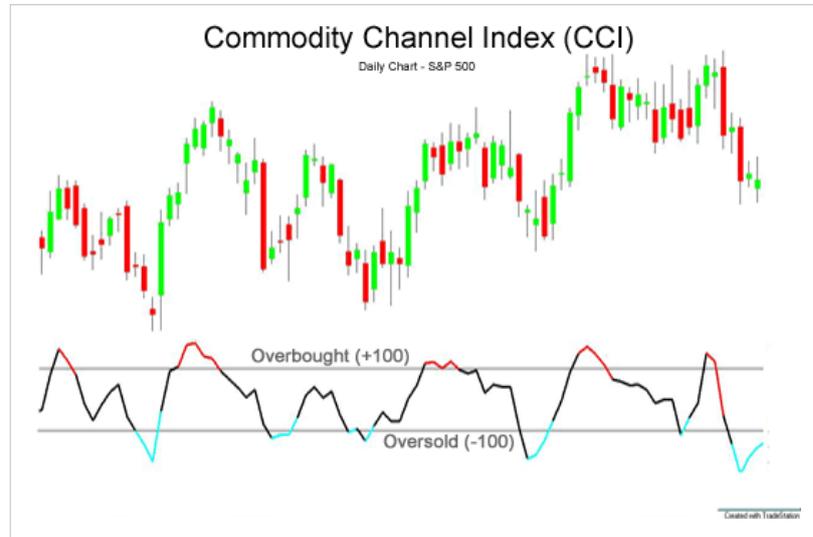
For scaling purposes, Lambert set the constant at 0.015 to ensure that approximately 70 to 80 percent of CCI values would fall between -100 and +100. The CCI fluctuates above and below zero. The percentage of CCI values that fall between +100 and -100 will depend on the number of periods used. A shorter CCI will be more volatile with a smaller percentage of values between +100 and -100. Conversely, the more periods used to calculate the CCI, the

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higher the percentage of values between +100 and -100.

## Interpretation

Traders and investors use the **Commodity Channel Index** to help identify price reversals, price extremes and trend strength. As with most indicators, the CCI should be used in conjunction with other aspects of technical analysis. CCI fits into the momentum category of oscillators. In addition to momentum, volume indicators and the price chart may also influence a technical assessment. It is often used for detecting divergences from price trends as an overbought/oversold indicator, and to



draw patterns on it and trade according to those patterns. In this respect, it is similar to bollinger bands, but is presented as an indicator rather than as overbought/oversold levels.

The CCI typically oscillates above and below a zero line. Normal oscillations will occur within the range of +100 and -100. Readings above +100 imply an overbought condition, while readings below -100 imply an oversold condition. As with other overbought/oversold indicators, this means that there is a large probability that the price will correct to more representative levels.

The CCI has seen substantial growth in popularity amongst technical investors; today's traders often use the indicator to determine cyclical trends in not only commodities, but also equities and currencies.<sup>[1]</sup>

The CCI, when used in conjunction with other oscillators, can be a valuable tool to identify potential peaks and valleys in the asset's price, and thus provide investors with reasonable evidence to estimate changes in the direction of price movement of the asset.<sup>[1]</sup>

Lambert's trading guidelines for the CCI focused on movements above +100 and below -100 to generate buy and sell signals. Because about 70 to 80 percent of the CCI values are between +100 and -100, a buy or sell signal will be in force only 20 to 30 percent of the time. When the CCI moves above +100, a security is considered to be entering into a strong uptrend and a buy signal is given. The position should be closed when the CCI moves back below +100. When the CCI moves below -100, the security is considered to be in a strong downtrend and a sell signal is given. The position should be closed when the CCI moves back above -100.

Since Lambert's original guidelines, traders have also found the CCI valuable for identifying reversals. The CCI is a versatile indicator capable of producing a wide array of buy and sell signals.

- CCI can be used to identify overbought and oversold levels. A security would be deemed oversold when the CCI dips below -100 and overbought when it exceeds +100. From oversold levels, a buy signal might be given when the CCI moves back above -100. From overbought levels, a sell signal might be given when the CCI moved back below +100.
- As with most oscillators, divergences can also be applied to increase the robustness of signals. A positive divergence below -100 would increase the robustness of a signal based on a move back above -100. A negative divergence above +100 would increase the robustness of a signal based on a move back below +100.
- Trend line breaks can be used to generate signals. Trend lines can be drawn connecting the peaks and troughs. From oversold levels, an advance above -100 and trend line breakout could be considered bullish. From

overbought levels, a decline below +100 and a trend line break could be considered bearish.<sup>[2]</sup>

## References

- [1] Commodity Channel Index (CCI) (<http://www.investopedia.com/terms/c/commoditychannelindex.asp>) on Investopedia
- [2] Commodity Channel Index (CCI) ([http://stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators:commodity\\_channel\\_in](http://stockcharts.com/school/doku.php?id=chart_school:technical_indicators:commodity_channel_in)) on StockCharts.com - ChartSchool

## External links

- Commodities & Charts Blog post on CCI (<http://cmd-chart.blogspot.com/2007/04/cci-index.html>)
- Commodities & Charts Blog images on CCI (<http://cmd-chart.blogspot.com/2007/06/cci-commodities-index.html>)

# Coppock curve

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The **Coppock curve** or **Coppock indicator** is a technical analysis indicator for long-term stock market investors created by E.S.C. Coppock, first published in *Barron's Magazine* on October 15, 1962.<sup>[1]</sup>

The indicator is designed for use on a monthly time scale. It's the sum of a 14-month rate of change and 11-month rate of change, smoothed by a 10-period weighted moving average.

$$Coppock = WMA[10] \text{ of } (ROC[14] + ROC[11]).$$

Coppock, the founder of Trendex Research in San Antonio, Texas,<sup>[2]</sup> was an economist. He had been asked by the Episcopal Church to identify buying opportunities for long-term investors. He thought market downturns were like bereavements and required a period of mourning. He asked the church bishops how long that normally took for people, their answer was 11 to 14 months and so he used those periods in his calculation.<sup>[3]</sup>

A buy signal is generated when the indicator is below zero and turns upwards from a trough. No sell signals are generated (that not being its design). The indicator is trend-following, and based on averages, so by its nature it doesn't pick a market bottom, but rather shows when a rally has become established.

Coppock designed the indicator (originally called the "Trendex Model"<sup>[1]</sup>) for the S&P 500 index, and it's been applied to similar stock indexes like the Dow Jones Industrial Average. It's not regarded as well-suited to commodity markets, since bottoms there are more rounded than the spike lows found in stocks.<sup>[4]</sup>

## Variations

Although designed for monthly use, a daily calculation over the same period can be made, converting the periods to 294 day and 231 day rate of changes, and a 210 day weighted moving average.<sup>[5]</sup>

A slightly different version of the indicator is still used by the *Investors Chronicle*, a British investment magazine. The main difference is that the Investors Chronicle version does include the sell signals, although it stresses that they are to be treated with caution. This is because such signals could merely be a dip in a continuing bull market.<sup>[6]</sup>

## References

- [1] Donald J. Durham Jr. (1964). "An Analysis of Stock Market Indicators" (<http://handle.dtic.mil/100.2/AD480859>). *Master's thesis, Naval Postgraduate School*. Monterey, California: Defense Technical Information Center. . "The Trendex model first came to the attention of the author when it was described by E.S.C. Coppock in the 15 October 1962 issue of *Barron's*."
- [2] 2001 Interview with John Bollinger (<http://www.theforexvillage.com/Interviews-withTopTraders/Interview-with-John-Bollinger.html>) from *Active Trader* magazine via theforexvillage.com
- [3] Coppock Indicator (<http://www.finance-glossary.com/terms/Coppock-Indicator.htm?ginPtrCode=00000&id=2262&PopupMode=>) at the Global-Investor Glossary
- [4] Coppock Curve Interpretation page ([http://www.topline-charts.com/Encyclopedia/coppock\\_curve\\_interpretation.htm](http://www.topline-charts.com/Encyclopedia/coppock_curve_interpretation.htm)) at Topline Investment Graphics
- [5] Coppock Indicator page ([http://www.incrediblecharts.com/technical/coppock\\_indicator.htm](http://www.incrediblecharts.com/technical/coppock_indicator.htm)) at Incredible Charts
- [6] IC/Coppock: Sell, sell, sell (<http://www.investorchronicle.co.uk/InvestmentGuides/Shares/article/20070906/ce752b0c-727f-11dc-baee-00144f2af8e8/ICCoppock-Sell-sell-sell.jsp>) from Investors Chronicle

## External links

- MQL5 implementation of Coppock curve (<http://www.earnforex.com/mt5-forex-indicators/Coppock.mq5>)
- VT Trader implementation of Coppock curve ([http://www.vtstrader.com/resources/helps/0000/HTML\\_VTtrader\\_Help\\_Manual\\_1-9/index.html?ti\\_coppockcurve.html](http://www.vtstrader.com/resources/helps/0000/HTML_VTtrader_Help_Manual_1-9/index.html?ti_coppockcurve.html))

## Keltner channel

**Keltner channel** is a technical analysis indicator showing a central moving average line plus channel lines at a distance above and below. The indicator is named after Chester W. Keltner (1909-1998) who described it in his 1960 book *How To Make Money in Commodities*. But this name was applied only by those who heard about it from him, Keltner called it the **Ten-Day Moving Average Trading Rule** and indeed made no claim to any originality for the idea.

In Keltner's description the centre line is an 10-day simple moving average of *typical price*, where typical price each day is the average of high, low and close,

$$\text{typical price} = \frac{\text{high} + \text{low} + \text{close}}{3}$$

The lines above and below are drawn a distance from that centre line, a distance which is the simple moving average of the past 10 days' trading ranges (ie. range high to low on each day).

The trading strategy is to regard a close above the upper line as a strong bullish signal, or a close below the lower line as strong bearish sentiment, and buy or sell with the trend accordingly, but perhaps with other indicators to confirm.

The origin of this idea is uncertain. Keltner was a Chicago grain trader and perhaps it was common knowledge among traders of the day. Or in the 1930s as a young man Keltner worked for Ralph Ainsworth (1884-1965) backtested trading systems submitted when Ainsworth offered a substantial prize for a winning strategy, so it could have been among those. But ideas of channels with fixed-widths go back to the earliest days of charting, so perhaps applying some averaging is not an enormous leap in any case.

Later authors, such as Linda Bradford Raschke, have published modifications for the Keltner channel, such as different averaging periods; or an exponential moving average; or using a multiple of Wilder's average true range (ATR) for the bands. These variations have merit, but are often still just called Keltner channel, creating some



Keltner channel example

confusion as to what exactly one gets from an indicator called that.

## References

- Titans Of Technical Analysis <sup>[1]</sup>, letter by Don Jones to Technical Analysis of Stocks and Commodities magazine, February 2003
- Trader.Online.pl - MetaStock Zone - Keltner Channels <sup>[2]</sup>, describing 10-day SMA
- Discovering Keltner Channels and the Chaikin Oscillator <sup>[3]</sup>, article from Investopedia

## References

- [1] [http://web.archive.org/web/20030303192912/http://www.traders.com/Documentation/FEEDbk\\_docs/Archive/022003/Letters/Letters.html](http://web.archive.org/web/20030303192912/http://www.traders.com/Documentation/FEEDbk_docs/Archive/022003/Letters/Letters.html)
- [2] [http://trader.online.pl/MSZ/e-w-Keltner\\_Channels.html](http://trader.online.pl/MSZ/e-w-Keltner_Channels.html)
- [3] <http://www.investopedia.com/articles/technical/03/021903.asp>

# McClellan Oscillator

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The **McClellan Oscillator** is a market breadth indicator used by financial analysts of the New York Stock Exchange to evaluate the rate of money entering or leaving the market and interpretively indicate overbought or oversold conditions of the market.<sup>[1]</sup>

## History

Developed by Sherman and Marian McClellan in 1969, the Oscillator is computed using the exponential moving average (EMA) of the daily ordinal difference of advancing issues (stocks which gained in value) from declining issues (stocks which fell in value) over 39 trading day and 19 trading day periods.

## How it works

The simplified formula for determining the Oscillator is:

$$\text{Oscillator} = (19 \text{ day EMA of Advances minus Declines}) - (39 \text{ day EMA of Advances minus Declines})$$

The McClellan Summation Index (MSI) is calculated by adding each day's McClellan Oscillator to the previous day's Summation Index.

By using the Summation Index of the McClellan Oscillator, you can judge the markets overall bullishness or bearishness.

MSI properties

- above zero it is considered to be bullish (positive growth)
- below zero it is considered to be bearish (negative growth)

The Summation Index is oversold at -1000 to -1250 or overbought at 1000 to 1250.<sup>[1]</sup>

The number of stocks in a stock market determine the dynamic range of the MSI. For the NZSX (one of the smallest exchanges in the English speaking world) the MSI would probably range between (-50 ... +50), the 19 and 39 constants (used for the US exchanges) would have to be revised. For the NZSX a MSI moving average mechanism might be needed to smooth out the perturbations of such a small number of traded stocks.

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## References

[1] Illustrative description by McClellan Publications of the McClellan Oscillator (<http://www.mcoscillator.com/Oscillator.html>)

## External links

- Investopedia description of the McClellan Oscillator (<http://www.investopedia.com/terms/m/mcclellanoscillator.asp>)
- Current NYSE McClellan Oscillator and Summation Index at StockCharts.com (<http://stockcharts.com/charts/indices/McSumNYSE.html>)

## Ulcer Index

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The **Ulcer Index** is a stock market risk measure or technical analysis indicator devised by Peter Martin in 1987,<sup>[1]</sup> and published by him and Byron McCann in their 1989 book *The Investors Guide to Fidelity Funds*. It's designed as a measure of volatility, but only volatility in the downward direction, i.e. the amount of drawdown or retracement occurring over a period.

Other volatility measures like standard deviation treat up and down movement equally, but a trader doesn't mind upward movement, it's the downside that causes stress and stomach ulcers that the index's name suggests. (The name pre-dates the discovery, described in the ulcer article, that most gastric ulcers are actually caused by a bacterium.)

The term Ulcer Index has also been used (later) by Steve Shellans, editor and publisher of MoniResearch Newsletter for a different calculation, also based on the ulcer causing potential of drawdowns.<sup>[2]</sup> Shellans index is not described in this article.

## Calculation

The index is based on a given past period of N days. Working from oldest to newest a highest price (highest closing price) seen so-far is maintained, and any close below that is a retracement, expressed as a percentage

$$R_i = 100 \times \frac{\text{price}_i - \text{maxprice}}{\text{maxprice}}$$

For example if the high so far is \$5.00 then a price of \$4.50 is a retracement of -10%. The first R is always 0, there being no drawdown from a single price. The quadratic mean (or root mean square) of these values is taken, similar to a standard deviation calculation.

$$\text{Ulcer} = \sqrt{\frac{R_1^2 + R_2^2 + \dots + R_N^2}{N}}$$

The squares mean it doesn't matter if the R values are expressed as positives or negatives, both come out as a positive Ulcer Index.

The calculation is relatively immune to the sampling rate used. It gives similar results when calculated on weekly prices as it does on daily prices. Martin advises against sampling less often than weekly though, since for instance with quarterly prices a fall and recovery could take place entirely within such a period and thereby not appear in the index.

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## Usage

Martin recommends his index as a measure of risk in various contexts where usually the standard deviation (SD) is used for that purpose. For example the Sharpe ratio, which rates an investment's excess return (return above a safe cash rate) against risk, is

$$\text{Sharpe ratio} = \frac{\text{Return} - \text{RiskFreeReturn}}{\text{standard deviation}}$$

The ulcer index can replace the SD to make an Ulcer Performance Index (UPI) or Martin ratio,

$$\text{UPI} = \frac{\text{Return} - \text{RiskFreeReturn}}{\text{ulcer index}}$$

In both cases annualized rates of return would be used (net of costs, inclusive of dividend reinvestment, etc.).

The index can also be charted over time and used as a kind of technical analysis indicator, to show stocks going into ulcer-forming territory (for one's chosen time-frame), or to compare volatility in different stocks.<sup>[3]</sup> As with the Sharpe Ratio, a higher value is better than a lower value (investors prefer more return for less risk).

## References

- [1] Peter Martin's Ulcer Index page (<http://www.tangotools.com/ui/ui.htm>)
- [2] Pankin Managed Funds, client newsletter 3rd Quarter 1996, Questions and Answers (<http://www.pankin.com/qa963.htm>)
- [3] Discovering the Absolute-Breadth Index and the Ulcer Index (<http://www.investopedia.com/articles/technical/03/030403.asp>) at Investopedia.com

## Further reading

- *The Investors Guide to Fidelity Funds*, Peter Martin and Byron McCann, John Wiley & Sons, 1989. Now out of print, but offered for sale in electronic form by Martin at his web site (<http://www.tangotools.com/ui/igff.htm>).

## External links

- Peter Martin's web site (<http://www.tangotools.com/misc/index.html>)

# Ultimate Oscillator

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The **Ultimate Oscillator** is a technical analysis oscillator developed by Larry Williams based on a notion of buying or selling "pressure" represented by where a day's closing price falls within the day's true range.

The calculation starts with "buying pressure", which is the amount by which the close is above the "true low" on a given day. The true low is the lesser of the given day's trading low and the previous close.

$$bp = close - \min(low, prev\ close)$$

The true range (the same as used in average true range) is the difference between the "true high" and the true low above. The true high is the greater of the given day's trading high and the previous close.

$$tr = \max(high, prev\ close) - \min(low, prev\ close)$$

The total buying pressure over the past 7 days is expressed as a fraction of the total true range over the same period. If  $bp_1$  is today,  $bp_2$  is yesterday, etc, then

$$avg_7 = \frac{bp_1 + bp_2 + \dots + bp_7}{tr_1 + tr_2 + \dots + tr_7}$$

The same is done for the past 14 days and past 28 days and the resulting three ratios combined in proportions 4:2:1, and scaled to make a percentage 0 to 100. The idea of the 7, 14 and 28 day periods is to combine short, intermediate and longer time frames.

$$UltOsc = 100 \times \frac{4 \times avg_7 + 2 \times avg_{14} + avg_{28}}{4 + 2 + 1}$$

Williams had specific criteria for a buy or sell signal. A buy signal occurs when,

- Bullish divergence between price and the oscillator is observed, meaning prices make new lows but the oscillator doesn't
- During the divergence the oscillator has fallen below 30.
- The oscillator then rises above its high during the divergence, ie. the high in between the two lows. The buy trigger is the rise through that high.

The position is closed when the oscillator rises above 70 (considered overbought), or a rise above 50 but then a fallback through 45.

A sell signal is generated conversely on a bearish divergence above level 70, to be subsequently closed out below 30 (as oversold).

## References

- Ultimate Oscillator <sup>[1]</sup> at StockCharts.com
- Ultimate Oscillator <sup>[2]</sup> at ChartFilter.com
- The Ultimate Buy Signal <sup>[3]</sup>, Motley Fool

## Further reading

- *The Ultimate Oscillator*, by Larry Williams, Technical Analysis of Stocks and Commodities magazine V.3:4 (140-141) (introduction <sup>[4]</sup>)
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## References

- [1] [http://www.stockcharts.com/education/IndicatorAnalysis/indic\\_ultimate.html](http://www.stockcharts.com/education/IndicatorAnalysis/indic_ultimate.html)
  - [2] <http://www.chartfilter.com/reports/c52.htm>
  - [3] <http://www.fool.com/investing/small-cap/2007/04/05/the-ultimate-buy-signal.aspx>
  - [4] <http://store.traders.com/-v03-c04-ulti-pdf.html>
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