Technical Analysis

Concepts and Indicators for Technical Analysis of Financial Markets

Contents

0.1 Technical analysis

In finance, **technical analysis** is a security analysis methodology for forecasting the direction of prices through the study of past market data, primarily price and volume.*[1] Behavioral economics and quantitative analysis use many of the same tools of technical analysis,*[2]*[3]*[4]*[5] which, being an aspect of active management, stands in contradiction to much of modern portfolio theory. The efficacy of both technical and fundamental analysis is disputed by the efficient-market hypothesis which states that stock market prices are essentially unpredictable.*[6]

0.1.1 History

The principles of technical analysis are derived from hundreds of years of financial market data.*[7] Some aspects of technical analysis began to appear in Joseph de la Vega's accounts of the Dutch markets in the 17th century. In Asia, technical analysis is said to be a method developed by Homma Munehisa during early 18th century which evolved into the use of candlestick techniques, and is today a technical analysis charting tool.*[8]*[9] In the 1920s and 1930s Richard W. Schabacker published several books which continued the work of Charles Dow and William Peter Hamilton in their books *Stock Market Theory and Practice* and *Technical Market Analysis*. In 1948 Robert D. 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. Early technical analysis was almost exclusively the analysis of charts, because the processing power of computers was not available for the modern degree of statistical analysis. Charles Dow reportedly originated a form of point and figure chart 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 at 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. More technical tools and theories have been developed and enhanced in recent decades, with an increasing emphasis on computer-assisted techniques using specially designed computer software.

0.1.2 General description

Fundamental analysts examine earnings, dividends, new products, research and the like. Technicians employ many methods, tools and techniques as well, 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.*[10]

Technicians using charts search for archetypal price chart patterns, such as the well-known head and shoulders *[11] 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.*[12]

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 assess whether an asset is trending, and if it is, the probability of its direction and of continuation. Technicians also look for relationships between price/volume indices and market indicators. Examples include the moving average, 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, 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.

Contrasting with technical analysis is *fundamental analysis*, the study of economic factors that influence the way investors price financial markets. Technical analysis holds that prices already reflect all the underlying fundamental factors. Uncovering the trends is what technical indicators are designed to do, although neither technical nor fundamental indicators are perfect. Some traders use technical or fundamental analysis exclusively, while others use both types to make trading decisions.*[13]

0.1.3 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, business cycles, stock market 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 analyzes price, volume and other market information, whereas fundamental analysis looks at the facts of the company, market, currency or commodity. Most large brokerage, trading group, or financial institutions 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*[14] reported that 56 of 95 modern studies found that 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.*[15] 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.*[16]*[17] Users hold that even if technical analysis cannot predict the future, it helps to identify trading opportunities.*[18]

In the foreign exchange markets, its use may be more widespread than fundamental analysis.*[19]*[20] This does not mean technical analysis is more applicable to foreign markets, but that technical analysis is more recognized 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,*[21]*[22]*[23]*[24] most academic work has focused on the nature of the anomalous position of the foreign exchange market.*[25] It is speculated that this anomaly is due to central bank intervention, which obviously technical analysis is not designed to predict.*[26] 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.*[27]

0.1.4 Principles

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.

A fundamental principle of technical analysis is 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. Therefore, price action tends to repeat itself due to investors collectively tending toward patterned behavior – hence technical analysis focuses on identifiable trends and conditions.*[28]*[29]

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.

Prices move in trends

See also: Market trend

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.*[10]

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.*[30] 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 does not 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. 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.*[10] Recognition of these patterns can allow the technician to select trades that have a higher probability of success.*[31]

Technical analysis is not limited to charting, but it always considers price trends.*[1] 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.*[32] 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.*[33]

Recently, Kim Man Lui, Lun Hu, and Keith C.C. Chan have suggested that there is statistical evidence of association relationships between some of the index composite stocks whereas there is no evidence for such a relationship between some index composite others. They show that the price behavior of these Hang Seng index composite stocks is easier to understand than that of the index.*[34]

0.1.5 Industry

The industry is globally represented by the International Federation of Technical Analysts (IFTA), which is a federation of regional and national organizations. 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.*[35] In Australia, the industry is represented by the Australian Technical Analysts Association (ATAA),*[36] (which is affiliated to IFTA) and the Australian Professional Technical Analysts (APTA) Inc.*[37]

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.*[38] The Market Technicians Association (MTA) has published a body of knowledge, which is the structure for the MTA's Chartered Market Technician (CMT) exam.*[39]

0.1.6 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,*[40]*[41] 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-hold strategies as well as traditional linear technical analysis methods when combined with rule-based expert systems.*[42]*[43]*[44]

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.

Backtesting

Systematic trading is most often employed after testing an investment strategy on historic data. This is known as backtesting. Backtesting is most often performed for technical indicators, but can be applied to most investment strategies (e.g. fundamental analysis). While traditional backtesting was done by hand, this was usually only performed on human-selected stocks, and was thus prone to prior knowledge in stock selection. With the advent of computers, backtesting can be performed on entire exchanges over decades of historic data in very short amounts of time.

The use of computers does have its drawbacks, being limited to algorithms that a computer can perform. Several trading strategies rely on human interpretation,*[45] and are unsuitable for computer processing.*[46] Only technical indicators which are entirely algorithmic can be programmed for computerised automated backtesting.

0.1.7 Combination with other market forecast methods

John Murphy states that the principal sources of information available to technicians are price, volume and open interest.*[10] 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.*[47] Another such approach, fusion analysis, 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.*[48] 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.*[49] 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.*[50]

0.1.8 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.*[51] Of 95 modern studies, 56 concluded that technical analysis had positive results, although data-snooping bias and other problems make the analysis difficult.*[14] Nonlinear prediction using neural networks occasionally produces statistically significant prediction results.*[52] A Federal Reserve working paper*[22] 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." *[53]

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;*[54] 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." *[17] 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.*[55]

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.*[56]

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." *[57] 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.*[58]

Thomas DeMark's indicators enjoy a remarkable endorsement in the financial industry. A recent work *[59] has investigated the predictive power of three DeMark indicators (Sequential, Combo and Setup Trend), over 21 commodity futures markets and 10 years of data. Market entry signals have been tested by comparing conditional returns (i.e. conditioned on the entry signals) to unconditional returns. For the period from Jan. 2004 to Jan. 2014, the tests suggest statistically significant predictive power on a wide range of commodity futures.

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." *[60]

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.*[61] 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.*[62] 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.*[61]

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).*[63] Likewise, complete information is reflected in the price because all market participants bring their own individual, but incomplete, knowledge together in the market.*[63]

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." *[64] Malkiel has stated that while momentum may explain some stock price movements, there is not enough momentum to make excess profits. Malkiel has compared technical analysis to "astrology".*[65]

In the late 1980s, professors Andrew Lo and Craig McKinlay published a paper which cast doubt on the random walk hypothesis. In a 1999 response to Malkiel, Lo and McKinlay collected empirical papers that questioned the hypothesis' applicability*[66] 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, which is an entirely separate concept from RWH. In a 2000 paper, Andrew Lo back-analyzed data from U.S. from 1962 to 1996 and found that "several technical indicators do provide incremental information and may have some practical value" .*[57] Burton Malkiel dismissed the irregularities mentioned by Lo and McKinlay as being too small to profit from.*[65]

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.*[30]*[67] Some signal processing researchers negate the random walk hypothesis that stock market prices resemble Wiener processes, because the statistical moments of such processes and real stock data vary significantly with respect window size and similarity measure.*[68] They argue that feature transformations used for the description of audio and biosignals can also be used to predict stock market prices successfully which would contradict the random walk hypothesis.

The random walk index (RWI) is a technical indicator that attempts to determine if a stock's price movement is random in nature or a result of a statistically significant trend. The random walk index attempts to determine when the market is in a strong uptrend or downtrend by measuring price ranges over N and how it differs from what would be expected by a random walk (randomly going up or down). The greater the range suggests a stronger trend.*[69]

0.1.9 Scientific technical analysis

Caginalp and Balenovich in 1994*[70] used their asset-flow differential equations model to show that the major patterns of technical analysis could be generated with some basic assumptions. Some of the patterns such as a triangle continuation or reversal pattern can be generated with the assumption of two distinct groups of investors with different assessments of valuation.The major assumptions of the models are that the finiteness of assets and the use of trend as well as valuation in decision making. Many of the patterns follow as mathematically logical consequences of these assumptions.

One of the problems with conventional technical analysis has been the difficulty of specifying the patterns in a manner that permits objective testing.

Japanese candlestick patterns involve patterns of a few days that are within an uptrend or downtrend. Caginalp and Laurent*[71] were the first to perform a successful large scale test of patterns. A mathematically precise set of criteria were tested by first using a definition of a short term trend by smoothing the data and allowing for one deviation in the smoothed trend. They then considered eight major three day candlestick reversal patterns in a non-parametric manner and defined the patterns as a set of inequalities. The results were positive with an overwhelming statistical confidence for each of the patterns using the data set of all S&P 500 stocks daily for the five-year period 1992-1996.

Among the most basic ideas of conventional technical analysis is that a trend, once established, tends to continue. However, testing for this trend has often led researchers to conclude that stocks are a random walk. One study, performed by Poterba and Summers,*[72] found a small trend effect that was too small to be of trading value. As Fisher Black noted,*[73] "noise" in trading price data makes it difficult to test hypotheses.

One method for avoiding this noise was discovered in 1995 by Caginalp and Constantine*[74] who used a ratio of two essentially identical closed-end funds to eliminate any changes in valuation. A closed-end fund (unlike an open-end fund) trades independently of its net asset value and its shares cannot be redeemed, but only traded among investors as any other stock on the exchanges. In this study, the authors found that the best estimate of tomorrow's price is not yesterday's price (as the efficient market hypothesis would indicate), nor is it the pure momentum price (namely, the same relative price change from yesterday to today continues from today to tomorrow). But rather it is almost exactly halfway between the two.

Starting from the characterization of the past time evolution of market prices in terms of price velocity and price acceleration, an attempt towards a general framework for technical analysis has been developed, with the goal of establishing a principled classification of the possible patterns characterizing the deviation or defects from the random walk market state and its time translational invariant properties.*[75] The classification relies on two dimensionless parameters, the Froude number characterizing the relative strength of the acceleration with respect to the velocity and the time horizon forecast dimensionalized to the training period. Trend-following and contrarian patterns are found to coexist and depend on the dimensionless time horizon. Using a renormalisation group approach, the probabilistic based scenario approach exhibits statistically significant predictive power in essentially all tested market phases.

A survey of modern studies by Park and Irwin*[76] showed that most found a positive result from technical analysis.

In 2011, Caginalp and DeSantis*[77] have used large data sets of closed-end funds, where comparison with valuation is possible, in order to determine quantitatively whether key aspects of technical analysis such as trend and resistance have scientific validity. Using data sets of over 100,000 points they demonstrate that trend has an effect that is at least half as important as valuation. The effects of volume and volatility, which are smaller, are also evident and statistically significant. An important aspect of their work involves the nonlinear effect of trend. Positive trends that occur within approximately 3.7 standard deviations have a positive effect. For stronger uptrends, there is a negative effect on returns, suggesting that profit taking occurs as the magnitude of the uptrend increases. For downtrends the situation is similar except that the "buying on dips" does not take place until the downtrend is a 4.6 standard deviation event. These methods can be used to examine investor behavior and compare the underlying strategies among different asset classes.

In 2013, Kim Man Lui and T Chong pointed out that the past findings on technical analysis mostly reported the profitability of specific trading rules for a given set of historical data. These past studies had not taken the human trader into consideration as no real-world trader would mechanically adopt signals from any technical analysis method. Therefore, to unveil the truth of technical analysis, we should get back to understand the performance between experienced and novice traders. If the market really walks randomly, there will be no difference between these two kinds of traders. However, it is found by experiment that traders who are more knowledgeable on technical analysis significantly outperform those who are less knowledgeable.*[78]

0.1.10 Ticker-tape reading

Main article: Ticker tape

Until the mid-1960s, **"tape reading"** was a popular form of technical analysis. It consisted of reading market information such as price, volume, order size, and so on from a paper strip which ran through a machine called a stock ticker. Market data was sent to brokerage houses and to the homes and offices of the most active speculators. This system fell into disuse with the advent of electronic information panels in the late 60's, and later computers, which allow for the easy preparation of charts.

0.1.11 Quotation board

Another form of technical analysis used so far was via interpretation of stock market data contained in quotation boards, that in the times before electronic screens, were huge chalkboards located in the stock exchanges, with data of the main financial assets listed on exchanges for analysis of their movements.*[79] It was manually updated with chalk, with the updates regarding some of these data being transmitted to environments outside of exchanges (such as brokerage houses, bucket shops, etc.) via the aforementioned tape, telegraph, telephone and later telex.*[80]

This analysis tool was used both, on the spot, mainly by market professionals for day trading and scalping, as well as by general public through the printed versions in newspapers showing the data of the negotiations of the previous day, for swing and position trades.*[81]

Despite to continue appearing in print in newspapers, as well as computerized versions in some websites, analysis via quotation board is another form of technical analysis that has fallen into disuse by the majority.

0.1.12 Charting terms and indicators

Concepts

- Average true range – averaged daily trading range, adjusted for price gaps.
- Breakout – the concept whereby prices forcefully penetrate an area of prior support or resistance, usually, but not always, accompanied by an increase in volume.
- Chart pattern – distinctive pattern created by the movement of security prices on a chart
- Cycles – time targets for potential change in price action (price only moves up, down, or sideways)
- 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
- 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
- Trending – the phenomenon by which price movement tends to persist in one direction for an extended period of time

Types of charts

- 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.
- 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.
- 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.

- Bollinger bands – a range of price volatility
- Channel – a pair of parallel trend lines
- Ichimoku kinko hyo – a moving average-based system that factors in time and the average point between a candle's high and low
- Moving average – an average over a window of time before and after a given time point that is repeated at each time point in the given chart. A moving average can be thought of as a kind of dynamic trend-line.
- 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
- 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
- Zig Zag – This chart overlay that shows filtered price movements that are greater than a given percentage.

Breadth indicators

These indicators are based on statistics derived from the broad market.

- Advance–decline line – a popular indicator of market breadth.
- McClellan Oscillator - a popular closed-form indicator of breadth.
- McClellan Summation Index - a popular open-form indicator of breadth.

Price-based indicators

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

- %C – denotes current markets environment as range expansion or a range contraction, it also forecast when extremes in trend or choppiness are being reached, so the trader can expect change.
- Average directional index – a widely used indicator of trend strength.
- Commodity Channel Index – identifies cyclical trends.
- MACD – moving average convergence/divergence.
- Momentum – the rate of price change.
- Relative strength index (RSI) – oscillator showing price strength.
- Relative Vigor Index (RVI) – oscillator measures the conviction of a recent price action and the likelihood that it will continue.
- Stochastic oscillator – close position within recent trading range.
- Trix – an oscillator showing the slope of a triple-smoothed exponential moving average.

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.

0.1.13 See also

- Algorithmic trading
- Market analysis
- Market timing
- Price action trading
- Chartered Market Technician
- Behavioral finance
- Mathematical finance
- Multimedia Information Retrieval

0.1.14 Notes

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0.1.17 External links

International and national organizations

- International Federation of Technical Analysts
- New Zealand: Society of Technical Analysts of New Zealand
- Singapore: Technical Analysts Society (Singapore)

Chapter 1

Concepts

1.1 Breakout (technical analysis)

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. Oftentimes, a stock or commodity will bounce between the areas of support and resistance and when it breaks through either one of these barriers you can consider the direction that it's heading in a trend. This can be a "Buy" or "Sell" signal depending on which barrier it broke through.

1.2 Dead cat bounce

For the Irish comedy rock band, see Dead Cat Bounce (comedy band).

In finance, a **dead cat bounce** is a small, brief recovery in the price of a declining stock.*[1] Derived from the idea that "even a dead cat will bounce if it falls from a great height",*[2] the phrase, which originated on Wall Street, is also popularly applied to any case where a subject experiences a brief resurgence during or following a severe decline.

1.2.1 History

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. Journalists Horace Brag and Wong Sulong of the *Financial Times* were reported as saying the market rise was a "dead cat bounce".*[3]

1.2.2 Variations and usage

The standard usage of the term is: A short rise in price of a stock which already suffered a fall. 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, the decline is "correct" in that the underlying business is weak (e.g. declining sales or shaky financials). Along with this, it is doubtful that the security will recover with better conditions (overall market or economy).

Some variations on the definition of the term include:

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

Technical analysis

A "dead cat bounce" price pattern may be used as a part of the technical analysis method of stock trading. 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 surpasses the prior low.*[7]

1.2.3 See also

- Don't fight the tape
- Market trend

1.2.4 References

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1.3 Dow theory

The **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.

1.3.1 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 (or absorption) 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 demanding (absorbing) stock that the market at large is supplying (releasing). 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 Average in chart form. The index contains major railroads, shipping companies, and air freight carriers in the US.

5. Trends are confirmed by volume

   Dow believed that volume confirmed price trends. When prices move on low volume, there could be many different explanations. 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.

1.3.2 Analysis

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 W.P. Hamilton's application of the Dow theory from 1902 to 1929 produced excess risk-adjusted returns .*[2] 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.

On the 160th anniversary of Charles Dow's Birthday, Jack Schannep of TheDowTheory.com, delivered a speech to the Market Technicians Association, describing recent contributions to the Evolution of the Dow Theory and showed that traditional Dow Theory gives a total annualized return, from 1953 until 2011, about 1.5% per year greater than Buy and Hold. *[3]

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.

1.3.3 References

[1]

[2] The Dow Theory: William Peter Hamilton's Record Reconsidered

[3]

1.3.4 Further reading

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

1.3.5 External links

- Review of the Dow Theory
- Goetzmann's Dow Page Includes a link to Dow's editorials and links to numerous articles describing support of Dow Theory.
- Richard Russell's Dow Theory letters weekly newsletter and charts.
- Record of Dow Theory Signals
- Dow Theory blog and definition
- Dow Theory blog with evaluation of the Rhea’ s and Schannep’ s Dow Theory outperformance versus buy and hold since 1896

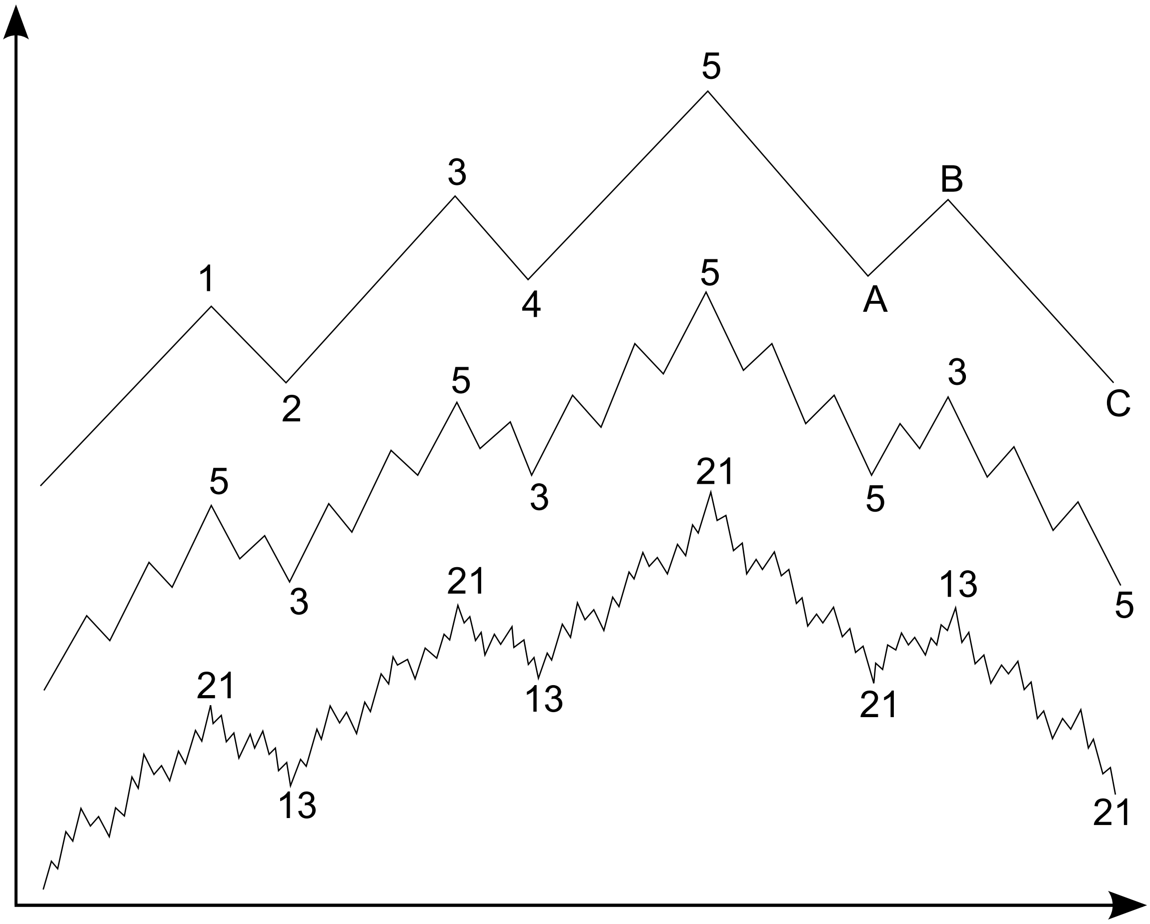
1.3.6 Books by dow theorists

- Dow Theory for the 21st Century, by Jack Schannep
- Dow Theory Today, by Richard Russell
- The Dow Theory, by Robert Rhea
- The Stock Market Barometer, by William Hamilton
- The ABC of Stock Speculation, by S.A. Nelson

1.4 Elliott wave principle

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.” *[1] The empirical validity of the Elliott Wave Principle remains the subject of debate.

1.4.1 Foundation



From R.N. Elliott's essay, "The Basis of the Wave Principle," October 1940.

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.

1.4.2 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 lowermost 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.*[2]

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.*[2]

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

1.4.3 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.*[2]*[3] 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.)

1.4.4 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.” *[4]

Critics say it is a form of pareidolia.

1.4.5 Elliott wave rules and guidelines

A correct Elliott wave count must observe three rules:

- Wave 2 never retraces more than 100% of wave 1.
- Wave 3 cannot be the shortest of the three impulse waves, namely waves 1, 3 and 5.
- Wave 4 does not overlap with the price territory of wave 1, except in the rare case of a diagonal triangle formation.

A common guideline observes that in a five-wave pattern, waves 2 and 4 often take alternate forms; a sharp move in wave 2, for example, suggests 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.*[3] Similarly, a triangular corrective pattern is formed usually in wave 4, but very rarely in wave 2, and is the indication of the end of a correction.

1.4.6 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".*[1] Numbers from the Fibonacci sequence surface repeatedly in Elliott wave structures, including motive waves (1, 3, 5), a single full cycle (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".*[1]

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.*[5] See Fibonacci retracement.

Finance professor Roy Batchelor and researcher Richard Ramyar, a former Director of the United Kingdom Society of Technical Analysts and formerly Global Head of Research at Lipper and Thomson Reuters Wealth Management, 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".*[6]

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".*[7] 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".*[8]

Extracted from the same relationship between Elliott Waves and Fibonacci ratio, a 78.6% retracement level is identified as a best place for buying or selling (in continuation to the larger trend) as it increases the risk to reward ratio up to 1:3.

It has been suggested that Fibonacci relationships are not the only irrational number based relationships evident in waves.*[9]

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 or even touches the wave-1 low.

1.4.7 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, also known as BCA Research Inc., provided wave analysis to a wide readership in the 1950s and 1960s through a number of annual supplements of market commentary. He also authored the book "The Elliott Wave Principle of Stock Market Behavior".

Bolton introduced the Elliott Wave Principle to A.J. Frost (1908-1999), who provided weekly financial commentary on the Financial News Network in the 1980s. Over the course of his lifetime Frost's contributions to the field were of great significance and today the Canadian Society of Technical Analysts awards the A.J. Frost Memorial Award to someone each year who has also made a significant contribution to the field of technical analysis.

The first A.J. Frost Memorial Award was awarded to Robert Prechter in 1999, with whom Frost co-authored *Elliott Wave Principle* in 1978.

1.4.8 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.*[10]

Among market technicians, wave analysis is widely accepted as a component of their trade. The Elliott 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." *[11]

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." *[12]

One such academic is the physicist Didier Sornette, professor at ETH Zurich. 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.*[13]

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.*[14]

Glenn Neely, financial market analyst and author of the book *Mastering Elliott Wave**[15]*, studied the Elliott Wave Principle for years and used it to develop his own forecasting method by expanding on the concepts Elliott created in the 1930s.*[16]

1.4.9 Criticism

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.*[17]

Robert Prechter had previously stated that ideas in an article by Mandelbrot*[18] "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*." *[19]

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:*[20]

> 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.

The Elliott Wave Principle is also thought by some to be too dated to be applicable in today's markets, as explained by market analyst Glenn Neely:

"Elliott wave was an incredible discovery for its time. But, as technologies, governments, economies, and social systems have changed, the behavior of people has also. These changes have affected the wave patterns R.N. Elliott discovered. Consequently, strict application of orthodox Elliott wave concepts to current day markets skews forecasting accuracy. Markets have evolved, but Elliott has not." *[21]

1.4.10 See also

- Behavioral economics
- Business cycle
- The Wisdom of Crowds
- Demarcation problem

1.4.11 Notes

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[19] Details here.

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- *Mastering Elliott Wave: Presenting the Neely Method: The First Scientific, Objective Approach to Market Forecasting with Elliott Wave Theory* by Glenn Neely with Eric Hall. Published by Windsor Books. ISBN 0-930233-44-1
- *Applying Elliott Wave Theory Profitably* by Steven W. Poser. Published by John Wiley & Sons, Ltd. ISBN 0-471-42007-7
- *R.N. Elliott's Masterworks* by R.N. Elliott, edited by Robert R. Prechter, Jr. Published by New Classics Library. ISBN 978-0-932750-76-1
- *Elliott Wave Principle Applied to the Foreign Exchange Markets* by Robert Balan. Published by BBS Publications, Ltd.
- *Elliott Wave Explained* by Robert C. Beckman. Published by Orient Paperbacks. ISBN 978-81-7094-532-1
- *Harmonic Elliott Wave: The Case for Modification of R.N. Elliott's Impulsive Wave Structure* by Ian Copsey, Published by John Wiley & Sons. ISBN 978-0-470-82870-0

1.4.13 External links

- Elliott Wave International - What Is the Wave Principle?
- Elliott Wave theory at Investopedia

1.5 Market trend

A **market trend** is a tendency of financial markets to move in a particular direction over time.*[1] These trends are classified as *secular* for long time frames, *primary* for medium time frames, and *secondary* for short time frames.*[2] Traders identify market trends using technical analysis, a framework which characterizes market trends as predictable price tendencies within the market when price reaches support and resistance levels, varying over time.

Strictly, a trend can only be determined in hindsight, since at any time prices in the future are not known, although derivatives such as futures and options can give a clue about expectations.

The terms bull market and bear market describe upward and downward market trends, respectively,*[3] and can be used to describe either the market as a whole or specific sectors and securities.*[2] The names perhaps correspond to the fact that a bull attacks from the ground lifting its horns upward, while a bear strikes from above moving its claws in a downward motion.

Charging Bull *by Arturo Di Modica that stands in Bowling Green Park in the Financial District in Manhattan, New York City.*

1.5.1 Etymology

The fighting styles of both animals may have a major impact on the names.*[4]

One hypothetical etymology points to London bearskin "jobbers" (market makers),*[5] 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.*[5] 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.

Some analogies that have been used as mnemonic devices:

- Bull is short for "bully", in its now somewhat dated meaning of "excellent".
- 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.*[6]
- They were originally used in reference to two old merchant banking families, the Barings and the Bulstrodes.
- The word "bull" plays off the market's returns being "full", whereas "bear" alludes to the market's returns being "bare".
- "Bull" symbolizes charging ahead with excessive confidence, whereas "bear" symbolizes preparing for winter and hibernation in doubt.

1.5.2 Secular trends

A secular market trend is a long-term trend that lasts 5 to 25 years and consists of a series of 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 market collapse of 2000-2002 triggered by the dot-com bubble.

In a secular bear market, the prevailing trend is "bearish" or downward-moving. An example of a secular bear market occurred in gold 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),*[7] and became part of the Great Commodities Depression.

1.5.3 Primary trends

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

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 a period of generally rising prices. The start of a bull market is marked by widespread pessimism. This point is when the "crowd" is the most "bearish".*[8] The feeling of despondency changes to hope, "optimism", and eventually euphoria, as the bull runs its course.*[9] This often leads the economic cycle, for example in a full recession, or earlier.

Examples

> India's Bombay Stock Exchange Index, BSE 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. Notable bull

A 1901 cartoon depicting financier J. P. Morgan as a bull with eager investors

markets marked the 1925-1929, 1953–1957 and the 1993-1997 periods when the U.S. and many other stock markets rose; while the first period ended abruptly with the start of the Great Depression, the end of the later time periods were mostly periods of soft landing, which became large bear markets. (see: Recession of 1960–61 and the dot-com bubble in 2000-2001)

Bear market

A bear market is a general decline in the stock market over a period of time.*[10] 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." *[11]

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. Recent examples occurred between October 2007 and March 2009, as a result of the financial crisis of 2007–08. See also 2015 Chinese stock market crash.

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. 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 1,565 and the Nasdaq at 2861.50.

Market bottom

A market bottom is a trend reversal, the end of a market downturn, and 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.*[12]

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*[13]).
> - 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*[14]). The "tech-heavy" Nasdaq fell a more precipitous 79% from its 5132 peak (10 March 2000) to its 1108 bottom (10 October 2002).
> - A bottom of 6,440.08 (DJIA) on 9 March 2009 was reached after a decline associated with the subprime mortgage crisis starting at 14164.41 on 9 October 2007 (chart*[15]).

1.5.4 Secondary trends

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.*[16] An example occurred from April to June 2010, when the S&P 500 went from above 1200 to near 1000; this was hailed as the end of the bull market and start of a bear market, but it was not, and the market turned back up. 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** (sometimes called "sucker's rally" or "dead cat bounce") which consist of a market price increase of only 10% or 20% and then the prevailing, bear market trend resumes.*[17] 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.

The Australian market in the beginning of 2015 has been described as a "meerkat market", being timid with low consumer and business sentiment.*[18]

1.5.5 Causes

The price of assets such as stocks is set by supply and demand. 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. For a surge in demand, the buyers will increase the price they are willing to pay, while the sellers will increase the price they wish to receive. For a surge in supply, the opposite happens.

Supply and demand are created when investors shift allocation of investment between asset types. For example, at one time, investors may move money from government bonds to “tech” stocks; at another time, they may move money from “tech” stocks to government bonds. In each case, this will affect the price of both types of assets.

Generally, investors try to follow a buy-low, sell-high strategy but often mistakenly end up buying high and selling low.*[19] Contrarian investors and traders attempt to “fade” the investors' actions (buy when they are selling, sell when they are buying). A time when most investors are selling stocks is known as distribution, while a time when most investors are buying stocks is known as accumulation.

According to standard theory, a decrease in price will result in less supply and more demand, while an increase in price will do the opposite. This works well for most assets but it often works in reverse for stocks due to the mistake many investors make of buying high in a state of euphoria and selling low in a state of fear or panic as a result of the herding instinct. In case an increase in price causes an increase in demand, or a decrease in price causes an increase in supply, this destroys the expected negative feedback loop and prices will be unstable.*[20] This can be seen in a bubble or crash.

1.5.6 Investor sentiment

Investor sentiment is a contrarian stock market indicator.

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.*[21] Indicators that measure investor sentiment may include:

David Hirshleifer sees in the trend phenomenon a path starting with underreaction and ending in overreaction by investors / traders.

- 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.

1.5.7 See also

- Mr. Market
- Black Monday
- Bull-bear line
- Business cycle
- Don't fight the tape
- Trend following
- Recession

- Economic expansion
- Market sentiment
- Animal spirits
- Herd mentality
- Real estate trends

1.5.8 References

[1] [Start Market Course, George Fontanills, Tommy Gentile, John Wiley and Sons Inc. 2001, p91http://books.google.com/books?id=gtrLvlojNzIC&pg=PA91&dq=stock+market+trends#v=onepage&q=stock%20market%20trends&f=false] Archived July 5, 2014 at the Wayback Machine

[2] Edwards, R.; McGee, J.; Bessetti, W. H. C. (2007). *Technical Analysis of Stock Trends*. CRC Press. ISBN 978-0-8493-3772-7.

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[5] Bulls and bears

[6] "The Speed Of Grizzly Bears" William E. Kearns, Assistant Park Naturalist

[7] Chart of gold 1968–99

[8] Winning on Wall Street Martin Zweig

[9] The 6 Stages Of Bull Markets -- And Where We Are Right Now | Markets | Minyanville's Wall Street Minyanville

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[13] stockcharts.com chart

[14] stockcharts.com chart

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[21] Trying to Plumb a Bottom, By MARK HULBERT, http://online.barrons.com/article/SB122652105098621685.html

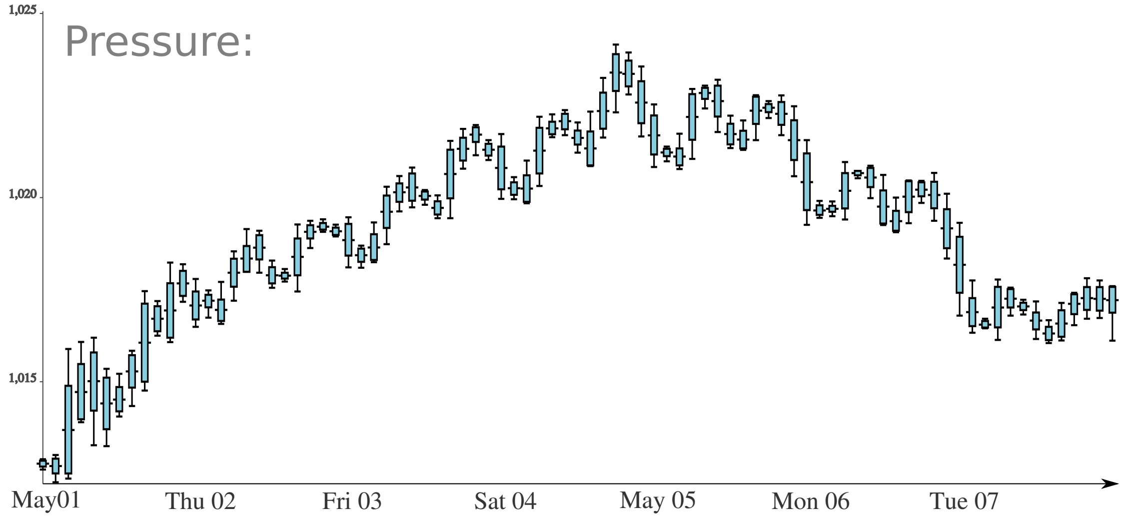
1.5.9 External links

- Market trend definition, explanations, and examples provided in simple terms
- Description and Charts of Trend Indicators

Chapter 2

Charts

2.1 Candlestick chart



Meteorological chart with a series of candlesticks to display hourly pressures and variations.

A **candlestick chart** is a style of financial chart used to describe price movements of a security, derivative, or currency. Each "candlestick" typically shows one day; so for example a one-month chart may show the 20 trading days as 20 "candlesticks".

It is like a combination of line-chart and a bar-chart: each bar represents all four important pieces of information for that day: the open, the close, the high and the low.

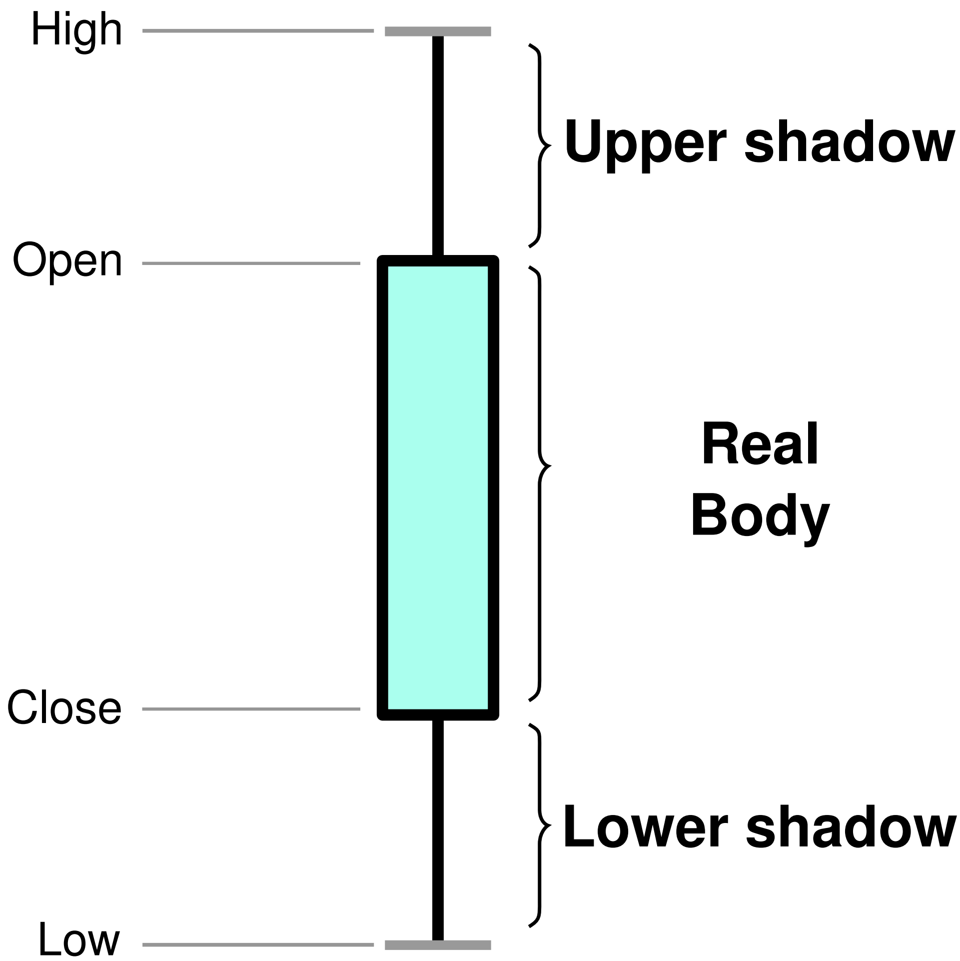
Candlestick charts are most often used in technical analysis of equity and currency price patterns. They appear superficially similar to box plots, but are unrelated.

2.1.1 History

Candlestick charts are thought to have been developed in the 18th century by Munehisa Homma, Japanese rice trader of financial instruments.*[1] They were introduced to the Western world by Steve Nison in his book, *Japanese Candlestick Charting Techniques*.*[2]

In *Beyond Candlesticks*,*[3] Nison says, "However, based on my research, it is unlikely that Homma used candle charts. As will be seen later, when I discuss the evolution of the candle charts, it was more likely that candle charts were developed in the early part of the Meiji period in Japan (in the late 1800s)."

2.1.2 Description



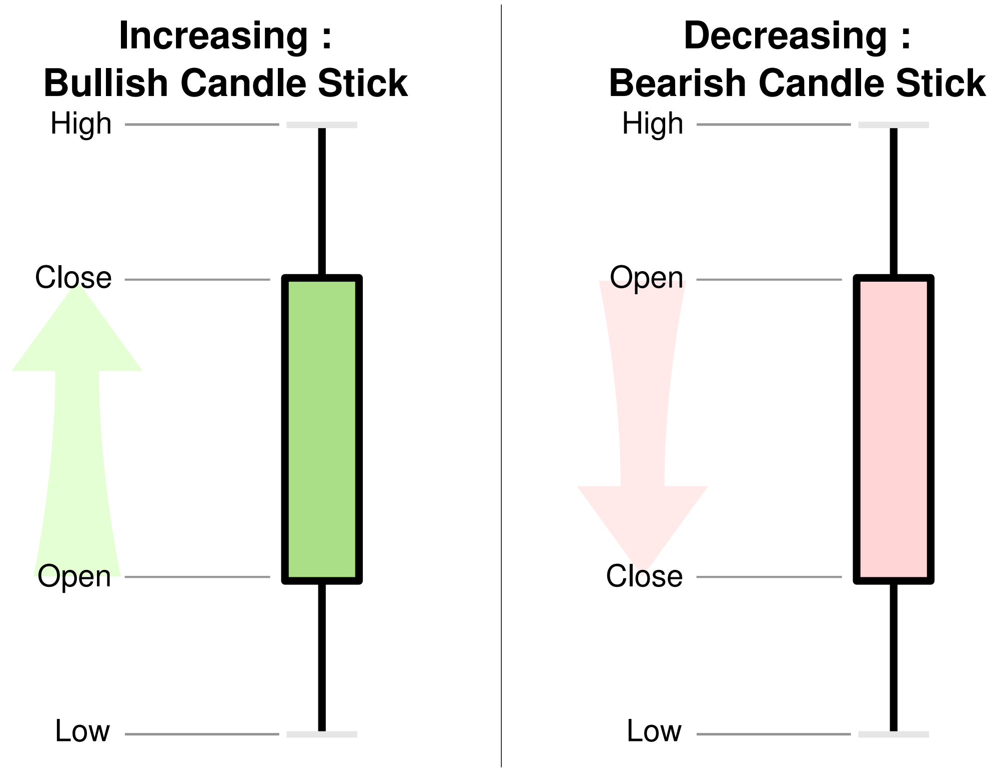
Scheme of a single candlestick chart. The Low and High caps are usually not present but may be added to ease reading.

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.

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). In some East Asian countries such as Taiwan, China, Japan, and South Korea, the colouring scheme is reversed (red for higher closing, and green/blue for a lower closing).

Candlestick patterns

Further information: Candlestick pattern



In trading, the trend of the candlestick chart is critical and often shown with colors.

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.

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).

2.1.3 Usage

Candlestick charts are a visual aid for decision making in stock, foreign exchange, commodity, and option 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. Candlestick charts serve as a cornerstone of technical analysis.

2.1.4 Heikin Ashi candlesticks

Heikin-Ashi (平均足, Japanese for 'average bar') candlesticks are a weighted version of candlesticks calculated with the following formula:*[4]*[5]

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

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.

2.1.5 See also

- Chart pattern
- Hikkake Pattern
- Kagi chart
- Open-high-low-close chart
- Pivot point calculations
- Spinning top (candlestick pattern)

2.1.6 References

[1] *Candlestick Charting Explained: Timeless Techniques for Trading Stocks and Futures*, Gregory L. Morris, McGraw-Hill, 2006, ISBN 0-07-146154-X / 9780071461542

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[3] Nison, Steve, *Beyond Candlesticks: New Japanese Charting Techniques Revealed*, ISBN 978-0-471-00720-3

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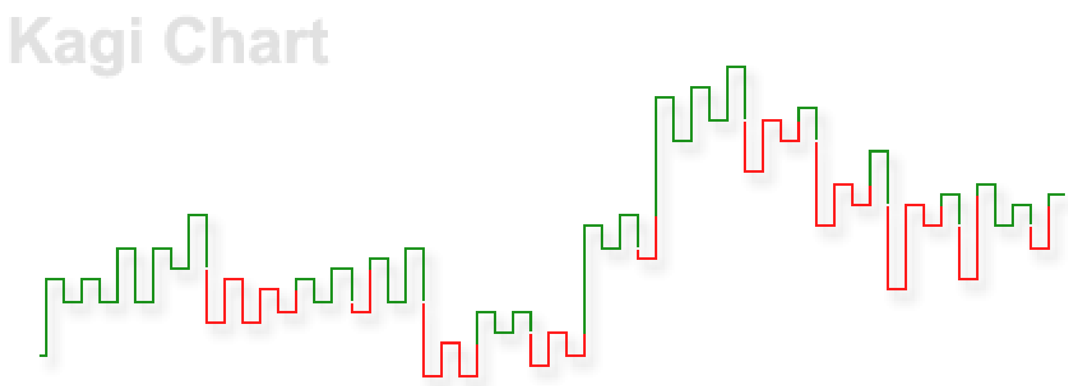
[5] Cromley, Kelly. “Heiken-Ashi Candles” . Binary Trading. Retrieved 28 June 2015.

2.2 Kagi chart



An example Kagi chart

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.*[1] 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.

2.2.1 Construction

Kagi charts look similar to swing charts and do not have a time axis.*[2] 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/color of the line changes when the price reaches the high or low of the previous horizontal 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.

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.

The basic algorithm used is:

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.

2.2.2 References

[1] Kagi Chart, Investopedia. Retrieved 16 Oct 2008.

[2] A Look At Kagi Charts, Investopedia. Retrieved 16 Oct 2008.

2.2.3 Further reading

- Nison, Steve, *Beyond Candlesticks: New Japanese Charting Techniques Revealed*, ISBN 978-0471007203

2.2.4 External links

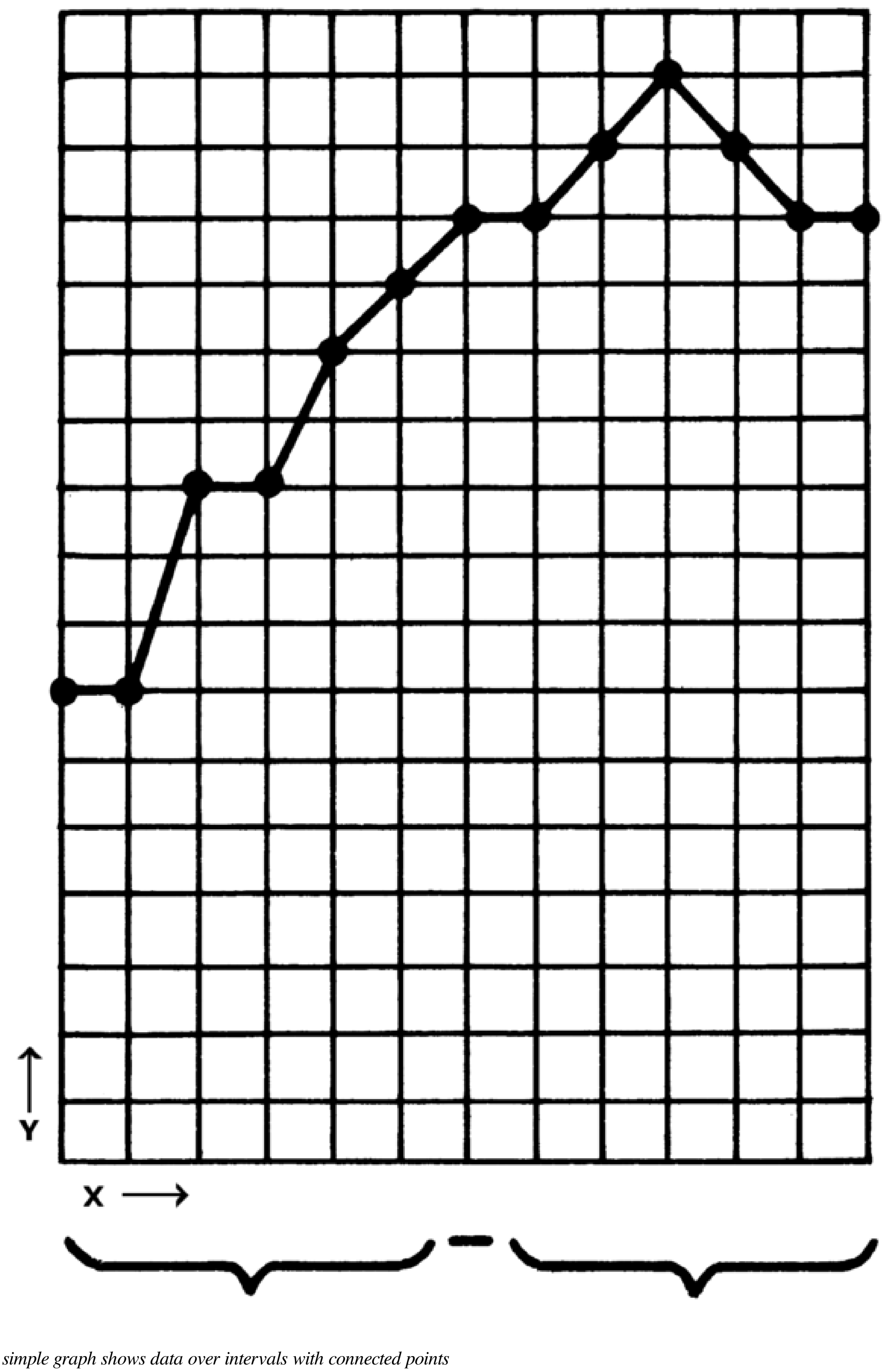
- Kagi Chart, Investopedia
- A Look At Kagi Charts, Investopedia

2.3 Line chart

A **line chart** or **line graph** is a type of chart which displays information as a series of data points called 'markers' connected by straight line segments.*[1] It is a basic type of chart common in many fields. It is similar to a scatter plot except that the measurement points are ordered (typically by their x-axis value) and joined with straight 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. In these cases they are known as run charts.*[2]

2.3.1 History

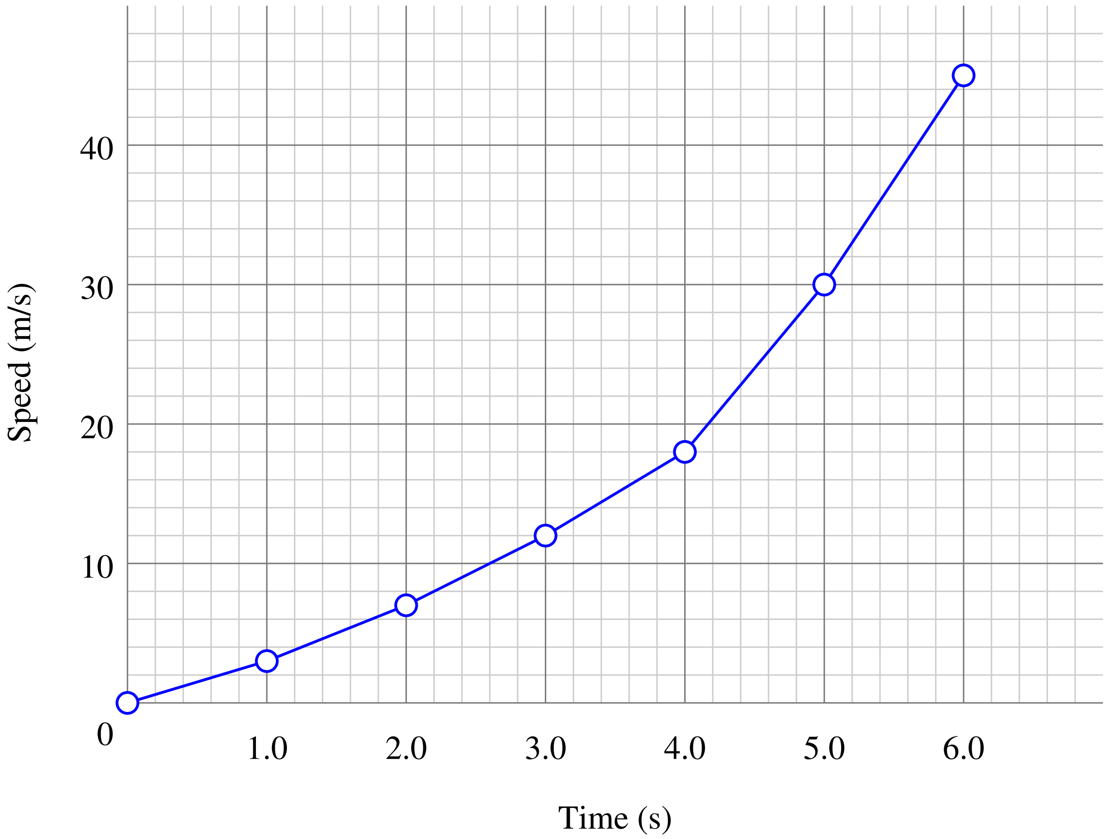
Some of the earliest known line charts are generally credited to Francis Hauksbee, Nicolaus Samuel Cruquius, Johann Heinrich Lambert and William Playfair.*[3]



This simple graph shows data over intervals with connected points

2.3.2 Example

In the experimental sciences, data collected from experiments are often visualized by a 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:



Graph of Speed Vs Time

The table “visualization” is a great way of displaying exact values, but can be a poor way to understand 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*. Such a visualisation appears in the figure to the right.

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 .

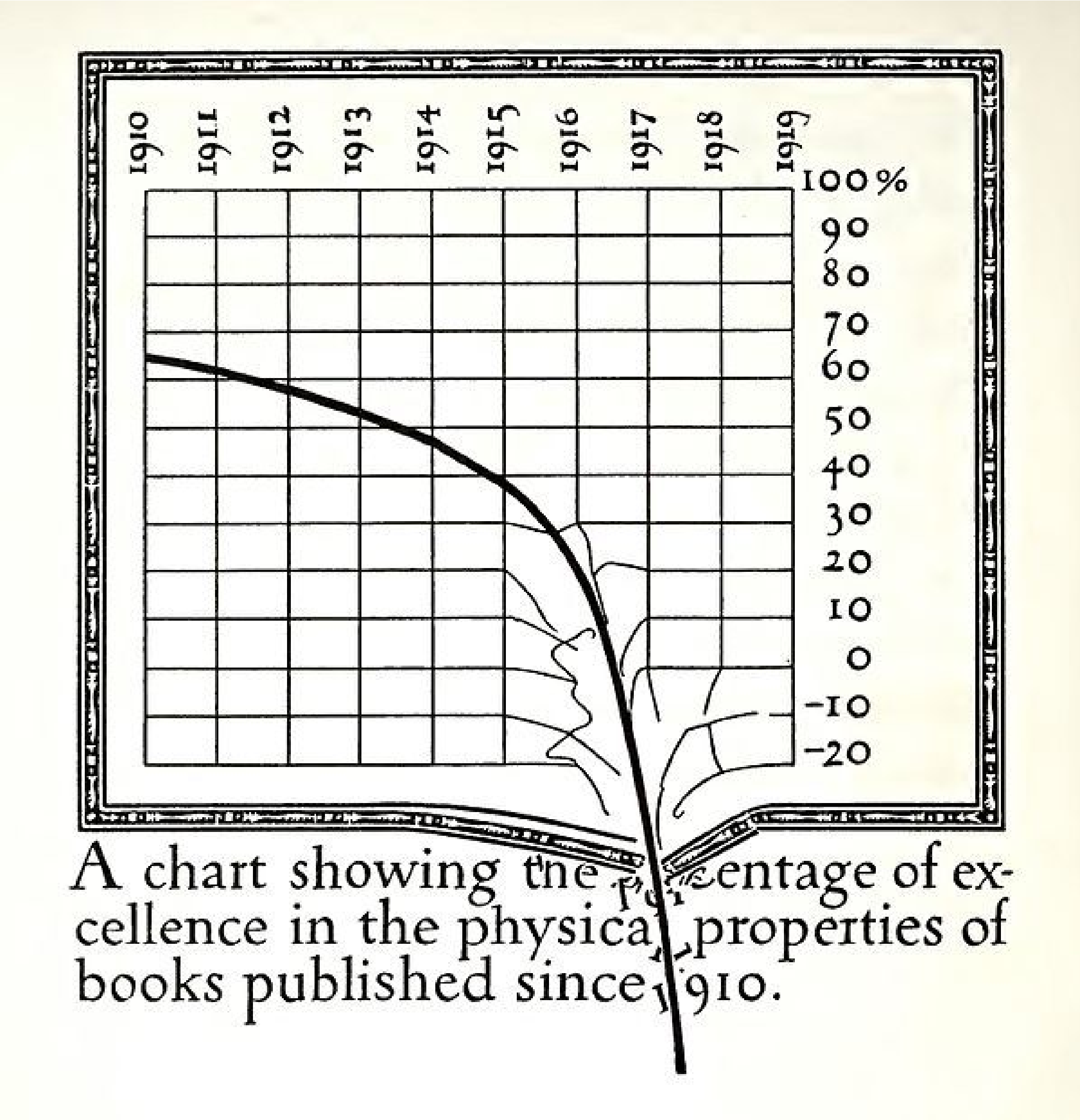
2.3.3 Best-fit

Charts often include 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.

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 parody line graph published in 1919.

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.

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. Such curve fitting functionality is often found in graphing software or spreadsheets. Best-fit curves may vary from simple linear equations to more complex quadratic, polynomial, exponential, and periodic curves.*[4]

2.3.4 See also

- Fan chart (time series)
- List of information graphics software
- Curve fitting

2.3.5 References

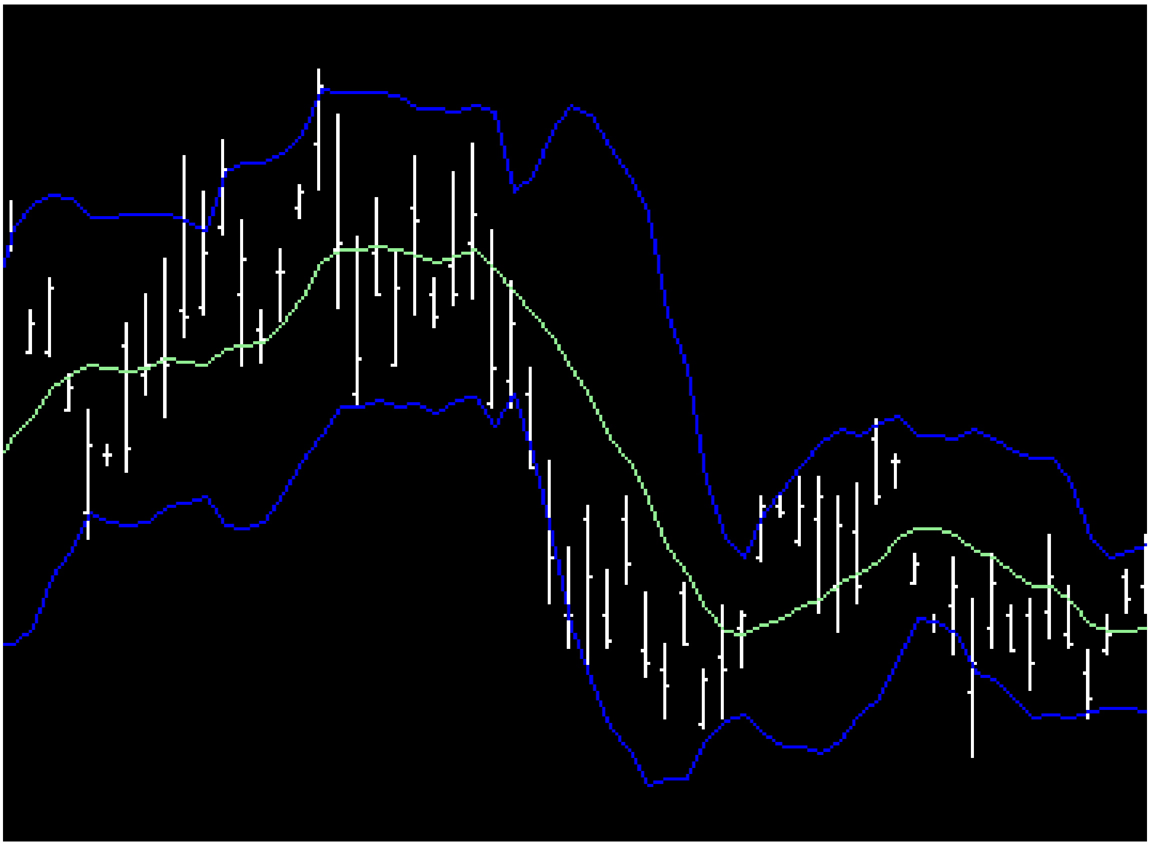
[1] Burton G. Andreas (1965). *Experimental psychology*. p.186

[2] Neil J. Salkind (2006). *Statistics for People who (think They) Hate Statistics: The Excel Edition*. page 106.

[3] Michael Friendly (2008). "Milestones in the history of thematic cartography, statistical graphics, and data visualization". pp 13–14. Retrieved 7 July 2008.

[4] "Curve fitting". *The Physics Hypertextbook*.

2.4 Open-high-low-close chart



An OHLC chart, with a moving average and Bollinger bands superimposed.

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. Day traders, who by default have to watch the price movements on a chart, prefer to use the Japanese candlesticks, because they show the "live action" price movements by expanding and contracting the candlestick's body, which is easier to grasp (and trade upon) than the standard OHLC bar. Therefore, for dynamic real-time chart analysis, Japanese candlesticks offer advantages over standard OHLC bars. However, for technical analysis of static charts, such as after-market analysis of historical data, the OHLC bars have very clear advantages over the Japanese candlesticks: the OHLC bars do not require color or fill pattern to show the Open and Close levels, and they do not create confusion in cases when, for example, the Open price is lower than the Close price (a bullish sign), but the Close price for the studied bar is lower than the Close price for the previous bar, i.e. the bar to the left on the same chart (a bearish sign).*[1]

A simple variant on the OHLC chart is the HLC **high-low-close chart** that identifies the range of the time unit's price action (high - low) and the end result of the time unit's price action (the close).

In technical analysis OHLC charts are often combined with charts of other types such as line charts (showing moving average), column charts (trading volume), and range areas (Bollinger Bands).*[2]

2.4.1 References

[1] Rockefeller, Barbara (Feb. 6 2014). Technical Analysis for Dummies, 3rd Edition. Wiley Publishing, Inc.

[2] Open High Low Close (OHLC) Chart, AnyChart JavaScript Chart Documentation

2.4.2 External links

- Video describing the parts of the OHLC chart, determining uptrends/downtrends and reversals. Sources cited

2.4.3 Other Languages

Visit the main overall explanation for Technical analysis that is translated into many languages.

2.5 Point and figure chart

Point and figure (P&F) is a charting technique used in technical analysis. Point and figure charting is unique in that it does not plot price against time in the same manner as most other charting techniques. It plots price against subsequent changes in direction by plotting a column of Xs as the price rises and a column of Os as the price falls.*[1]*[2]

2.5.1 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.*[3] 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 Thomas Dorsey who would go on to write authoritative texts on the subject.

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.

2.5.2 Advantages of point and figure

Point and Figure charts are based on price action, not time. If there are no significant price moves, nothing changes. Proponents argue that this difference makes finding patterns and trends in P&F charts easier than other charts because it filters out unnecessary data.

2.5.3 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.

2.5.4 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.

2.5.5 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.

2.5.6 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*.

P&F charts are now widely presented in many trading applications either as a native component or as a third-party plug-in, script, or external technical indicator.

2.5.7 See also

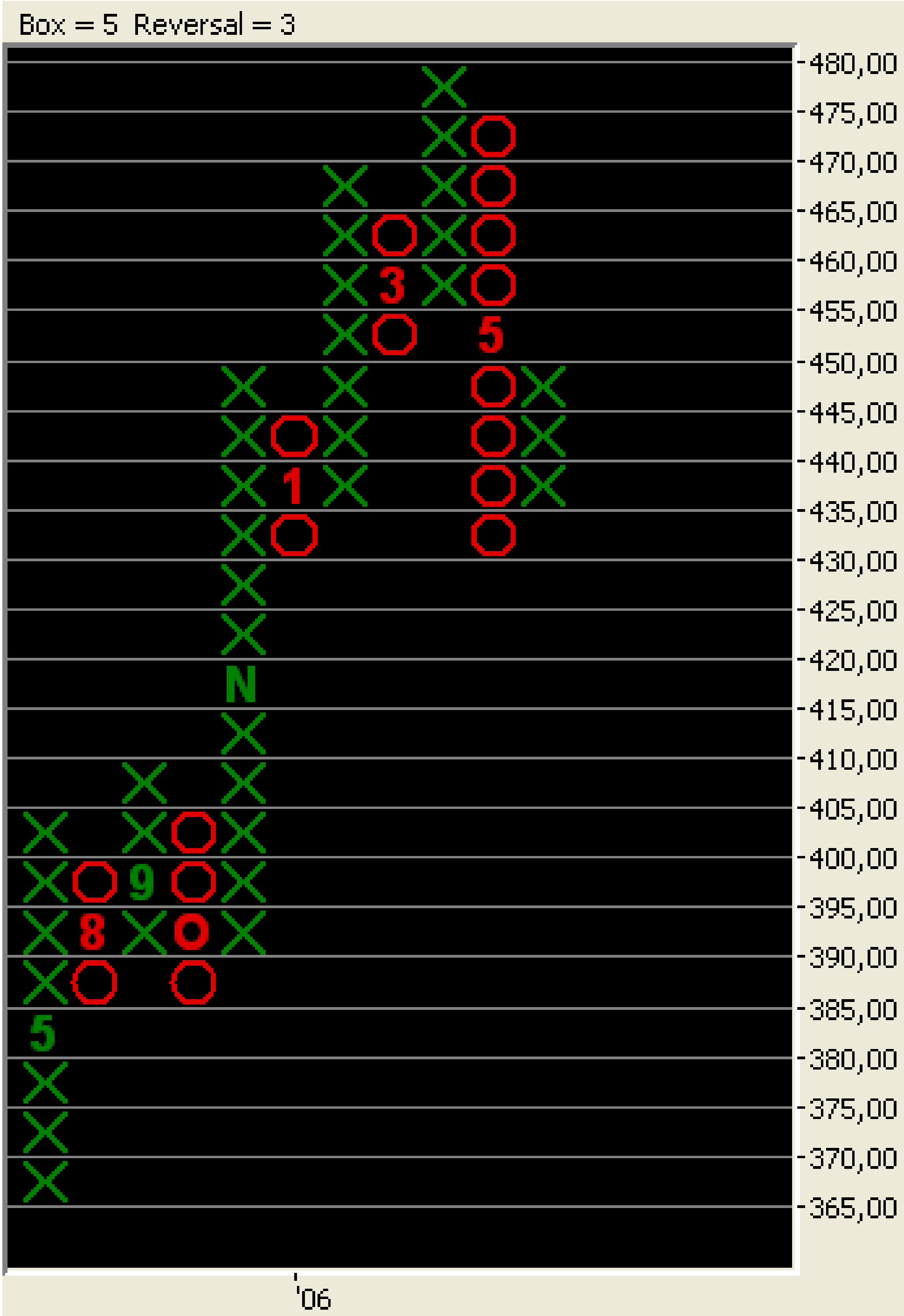
- Advisors Sentiment

2.5.8 External links

- Sample P&F stock chart for Dow Jones Industrial Average

2.5.9 Further reading

- Aby, Carroll D.Jr. *Point & Figure Charting: The Complete Guide*, ISBN 0-934380-30-9



Sample point and figure chart with box size set to $5 and reversal threshold set to 3 box sizes.

- 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
- De Villiers, Victor Taylor. *Devilliers & Taylor On Point And Figure Charting*, ISBN 0-273-64975-2
- 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
- Du Plessis, Jeremy *The Definitive Guide to Point and Figure,A Comprehensive Guide to the Theory and Practical Use of the Point and Figure Charting Method*, ISBN 1-897597-63-0
- Hauschild, K. and Winkelmann, M. (1985), *Kapitalmarketeffizienz und Point and Figure Analyse, Kredit Und Kapital*, 18.
- Kaufman, Perry J.. (2005), *New Trading Systems and Methods*, Chapters 5 and 21, ISBN 978-0-471-26847-5
- LeBeau, Charles and Lucas, David (1991), *Technical Traders Guide to Computer Analysis of the Futures Markets*, ISBN 978-1-55623-468-2
- Rivalland, Marc *Marc Rivalland on Swing Trading*, 214 pages, paperback, ISBN 1-897597-19-3
- Stottner, R. (1990), - P&F-Filteranalyse, Averaging-Strategie und Buy&Hold-Anlageregel, Jahrb. f. Nationalok. u. Stat., 207.
- Weber Heinrich and Kermit Zieg. *The Complete Guide to Point and Figure Charting: The New Science of an Old Art*, ISBN 1-897597-28-2
- Wheelan, Alexander H. *Study Helps in Point and Figure Technique*, first edition 1947 - Out Of Print
- Zieg, Kermit Zieg. *Point and Figure Commodity and Stock Trading Techniques Also Options Bonds International Currency Indices*, ISBN 0-934380-38-4

2.5.10 References

[1] Plessis, Jeremy du (2012-10-04). *The Definitive Guide to Point and Figure: A Comprehensive Guide to the Theory and Practical Use of the Point and Figure Charting Method*. Harriman House Limited. ISBN 9780857192615.

[2] Staff, Investopedia. “Point And Figure Charting Basics | Investopedia”. *Investopedia*. Retrieved 2016-01-28.

[3] http://books.google.com/books?id=EPMpAAAAYAAJ&redir_esc=y

Chapter 3

Chart Patterns

3.1 Chart pattern

A **chart pattern** or **price pattern** is a pattern 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. Chart patterns are used as either reversal or continuation signals.

3.1.1 See also

- Market trends
- Trend following
- Elliot wave
- Candlestick chart
- Price action trading

3.2 Broadening top

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

3.2.1 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.

3.2.2 Role of big players

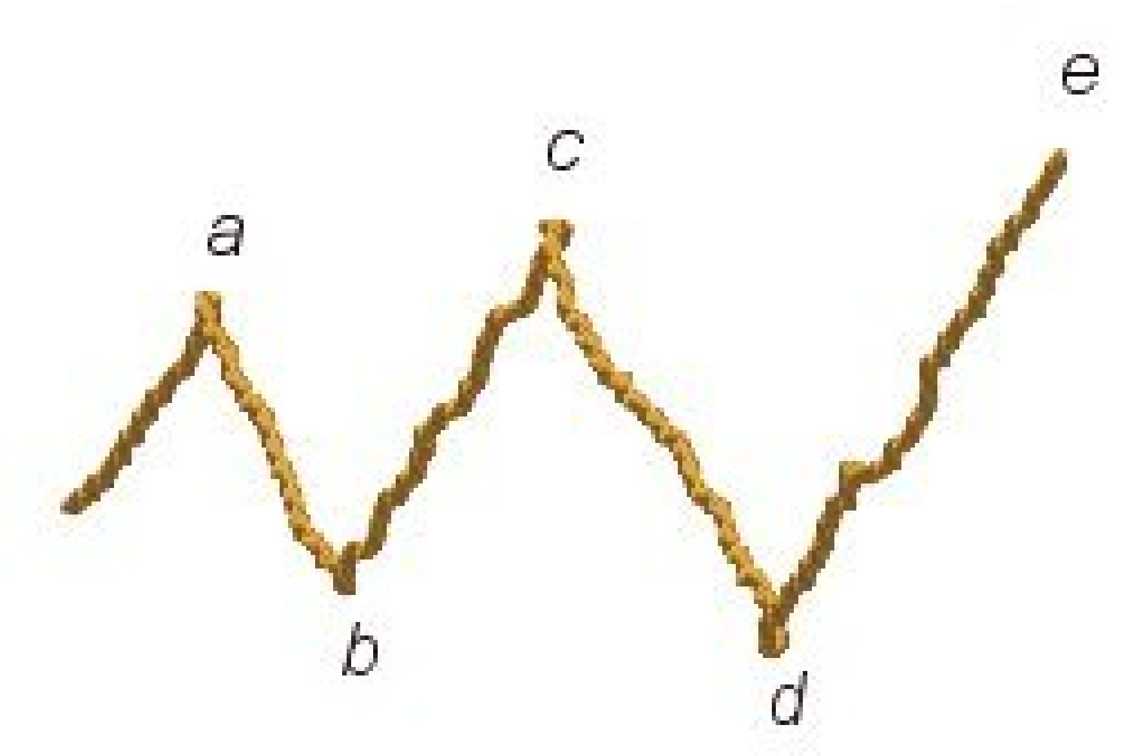
It is a common saying that *smart money* is out of market in such formation and market is out of control. In its formation, most of the selling is completed in the early stage by big players and the participation is from general public in the later stage.

3.2.3 Price and 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.

3.2.4 How broadening top is formed

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



Five minor reversals a-b-c-d-e

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*.

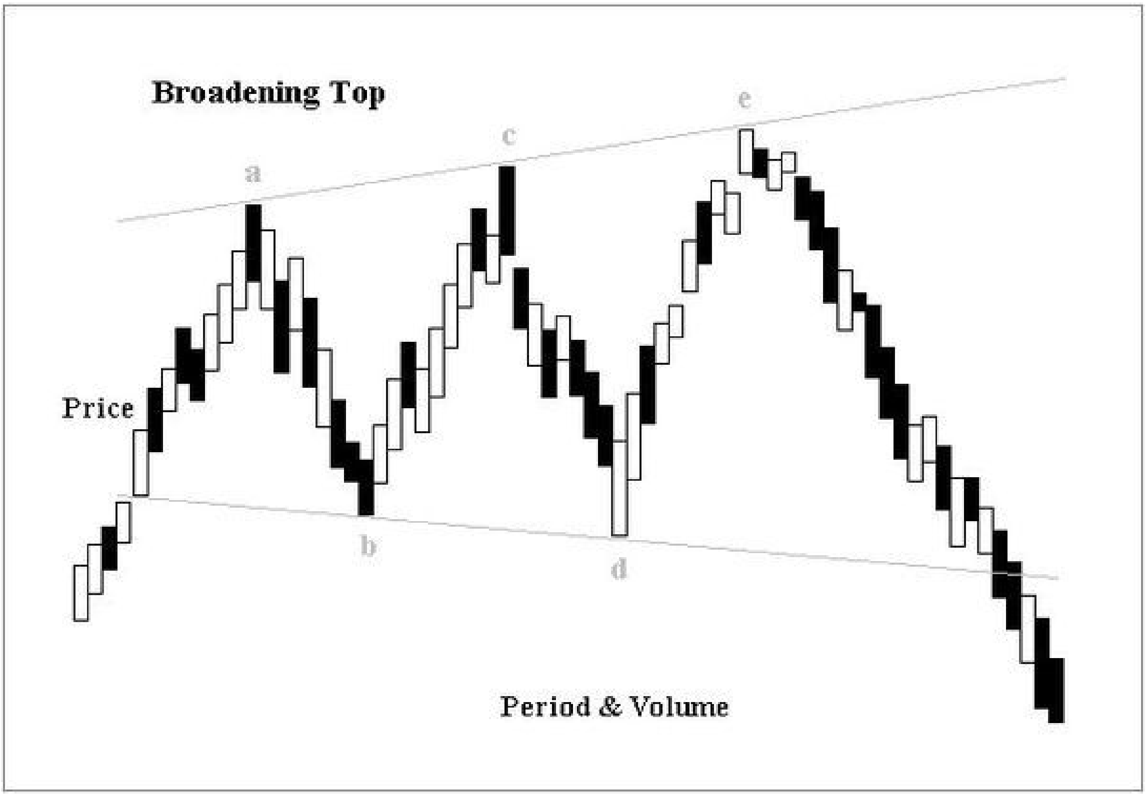
One can't be sure of the trend unless price breaks down the lower of the two points *(b & d)* and keeps on falling. In the figure below, *Broading Top is confirmed*.

3.2.5 See also

- Acquisitions, mergers, and takeovers terminology

3.2.6 Other chart patterns

- Candlestick pattern
- Double top and double bottom
- Gap (chart pattern)
- Head and shoulders top and bottom
- Island reversal
- Triple top and triple bottom
- Wedge pattern



Broadening Top confirmation

3.3 Cup and handle

In the domain of technical analysis of market prices, a **cup and handle** or **cup with handle** formation is a chart pattern consisting of a drop in the price and a rise back up to the original value, followed a smaller drop and a rise past the previous peak.*[1] It is interpreted as an indication of bullish sentiment in the market and possible further price increases.*[2]

The cup part of the pattern should be fairly shallow, with a rounded or flat "bottom" (not a V-shaped one), and ideally reach to the same price at the upper end of both sides. The drop of the handle part should retrace about 30% to 50% of the rise at the end of the cup. For stock prices, the pattern may span from a few weeks to a few years; but commonly the cup lasts from 1 to 6 months, while the handle should only last for 1 to 4 weeks.*[3]

The "cup and handle" formation was defined by William O'Neil"*[2]*[4]

3.3.1 Context and interpretation

A cup and handle formation is considered significant when it follows an increasing price 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. The trade volume 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.*[3]

3.3.2 References

[1] "Cup and Handle". *Investopedia*. Retrieved 28 June 2015.

[2] William O'Neill (2009), "How to Make Money in Stocks: A Winning System in Good Times and Bad". 4th Edition, paperback, 464 pages. McGraw-Hill. ISBN 978-0071614139

[3] Cup and handle at stockcharts.com

[4] http://stockcharts.com/school/doku.php?id=chart_school:chart_analysis:chart_patterns:cup_with_handle_cont

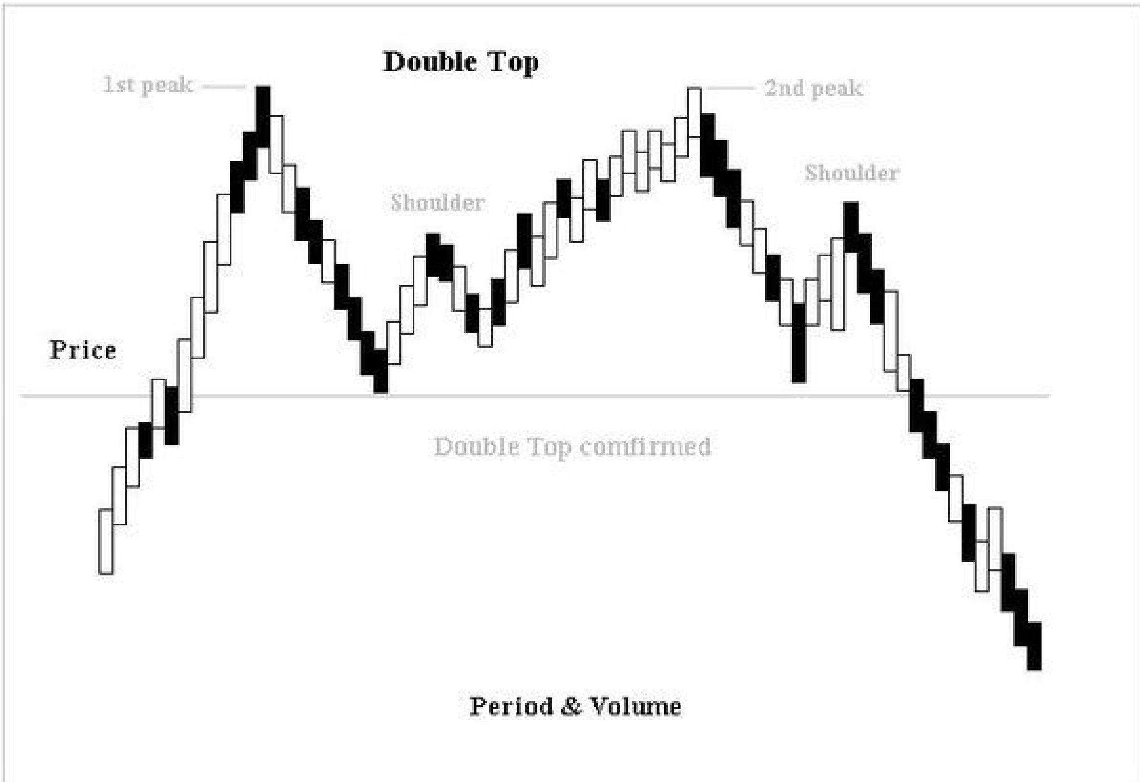
3.3.3 External links

- Video Analyzing the Cup and Handle Pattern and the Inverted Cup and Handle Pattern
- *Analyzing Chart Patterns: Cup And Handle* at investopedia.com

3.4 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.*[1]

3.4.1 Double top



Double top confirmation

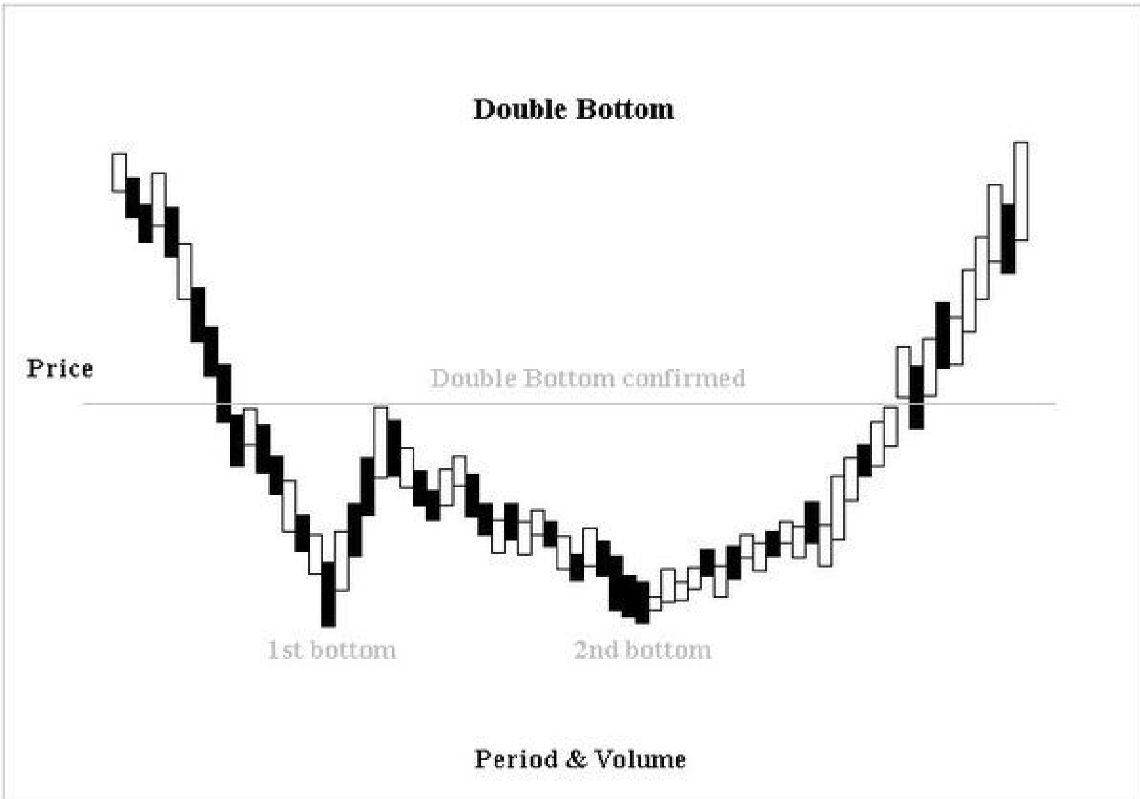
The double top is a frequent price formation at the end of a bull market. It appears as two consecutive peaks of approximately the same price on a price-versus-time chart of a market. The two peaks are separated by a minimum in price, a *valley*. The price level of this minimum is called the neck line 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.

3.4.2 Double bottom



Double bottom confirmation

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. The formation is completed and confirmed when the price rises above the neck line, indicating that further price rise is imminent or highly likely.

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.

3.4.3 References

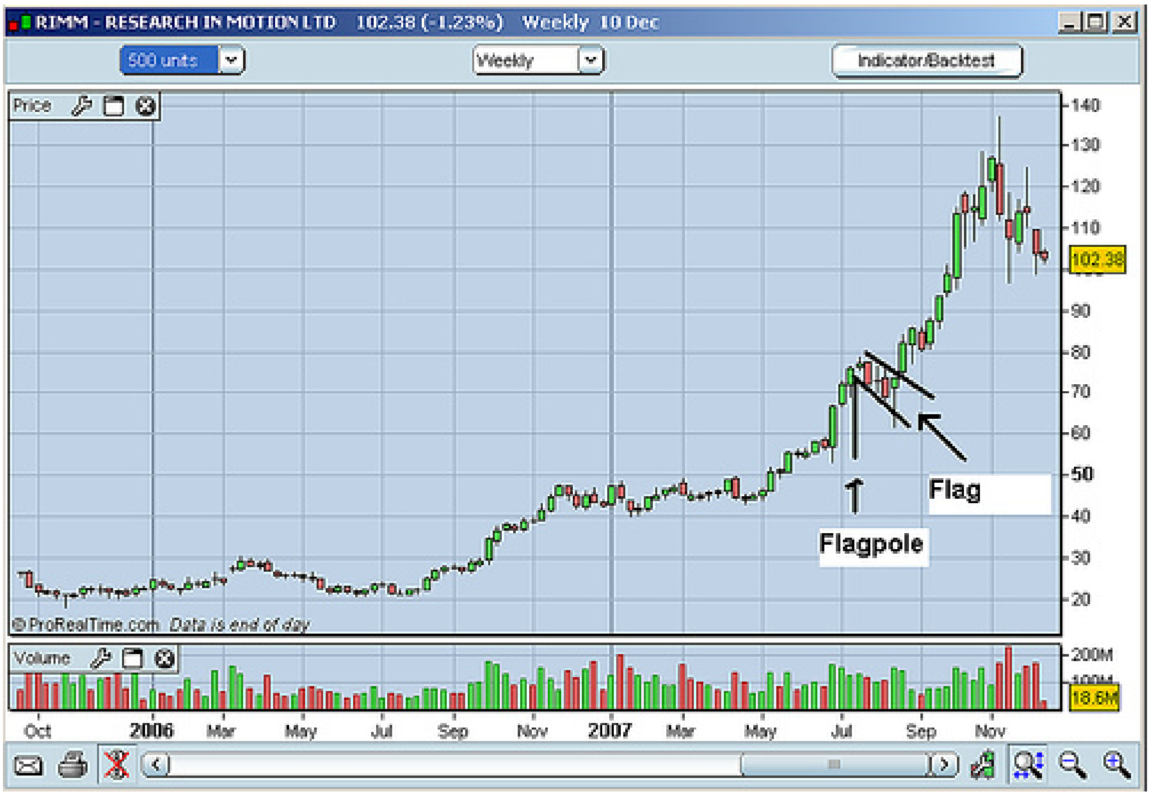
[1] "Double Bottom". investopedia.com. Retrieved 2015-01-30.

3.5 Flag and pennant patterns

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.

3.5.1 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.



3.5.2 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.

3.5.3 External links

- Video of Flag Pattern and High & Tight Flag; referenced sources
- Video of Pennant Pattern with cited sources
- *Analyzing Chart Patterns: Flags And Pennants* at investopedia.com

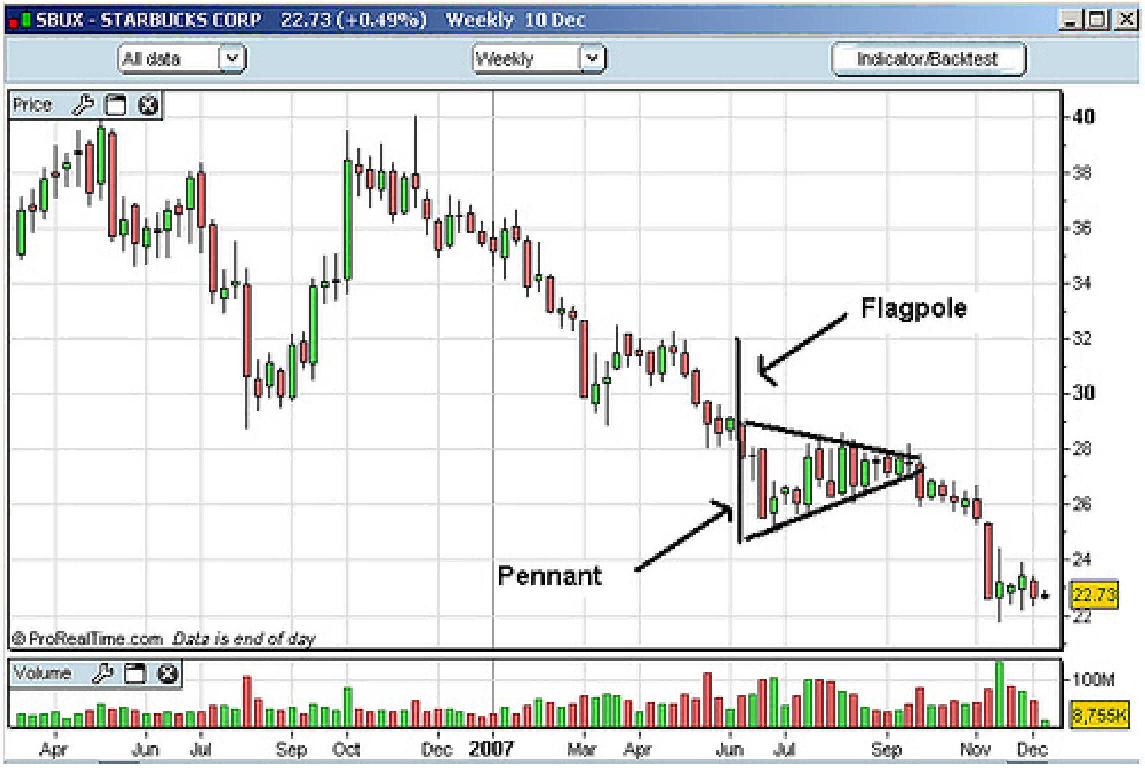
3.6 Gap (chart pattern)

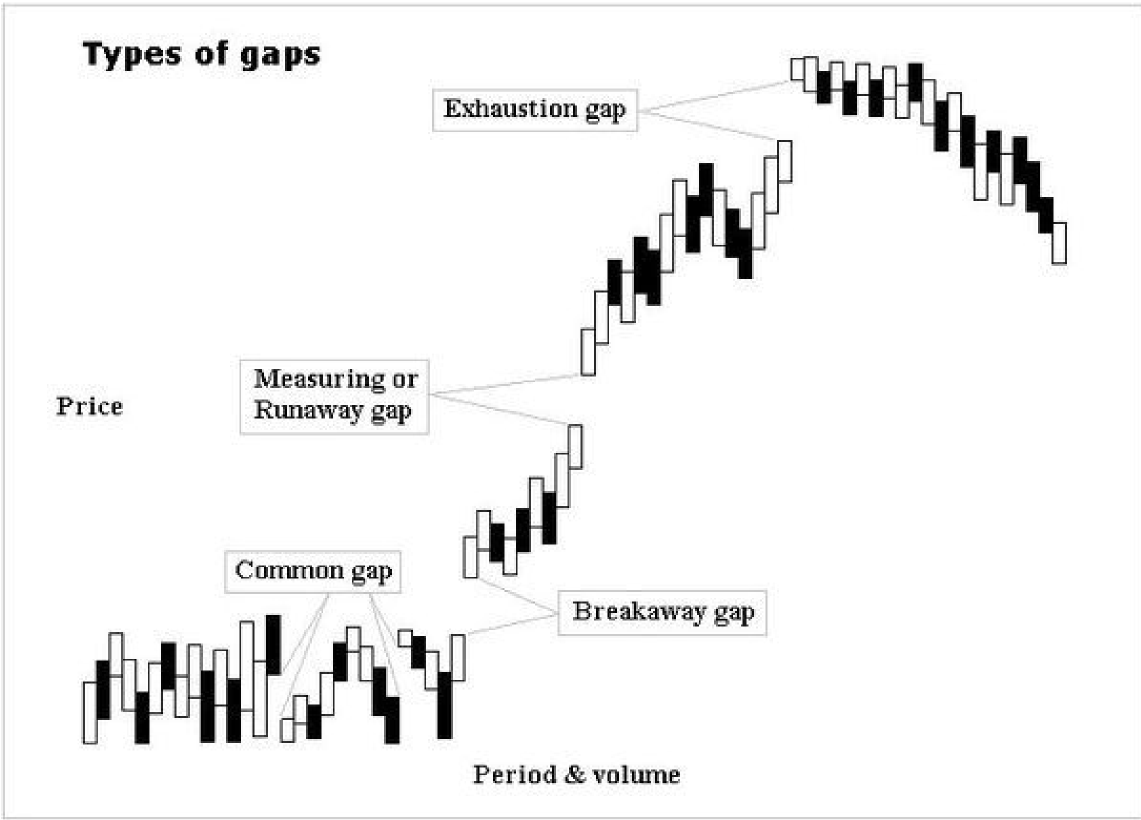
A **gap** is defined as an unfilled space or interval. On a technical analysis chart, a gap represents an area where no trading takes place. On the Japanese candlestick chart, a window is interpreted as a gap.

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 $31.20 on Thursday, falls down to $31.00 in the early hour, moves straight up again to $31.45, and no trading occurs in between $30.00 and $31.00 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.





Sequence of Gaps

3.6.1 Types of gaps

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

- **Breakaway gap –** 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 –** also known as an *area gap*, *pattern gap*, or *temporary gap*, tend to occur when trading is bound between support and resistance level on a short span of time and market price is moving sideways ("where the price trend...has been experiencing neither an uptrend nor a downtrend. Instead, the price activity has been oscillating between a relatively narrow range without forming any distinct trends").*[1] 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, they offer little forecasting significance.

- **Exhaustion gap –** signals the end of a move. These gaps are associated with a rapid, straight-line advance or decline. A reversal day can easily help to differentiate between the Measuring gap and the Exhaustion gap. When it is formed at the top with heavy volume, there is significant chance that the market is exhausted and prevailing trend is at halt which is ordinarily followed by some other area pattern development. An Exhaustion gap should not be read as a major reversal.

- **Measuring Gap –** also known as a *runaway gap*, 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 roughly how much further ahead a move will go. Runaway gaps are not normally filled for a considerable period of time.

3.6.2 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*.

3.6.3 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 the market. 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.

3.6.4 Examples

3.6.5 References

[1] "Sideways Market / Sideways Drift" . *Investopedia*. Retrieved February 9, 2015.

[2] Exhaustion gap - investopedia.com

[3] Common gap - investopedia.com

[4] Breakaway gap - investopedia.com

3.6.6 External links

- Gap Video; all referenced sources
- *Analyzing Chart Patterns: Gaps* at investopedia.com
- *Playing The Gap* at investopedia.com
- Windows (Gaps) at onlinetradingconcepts.com

3.7 Head and shoulders (chart pattern)

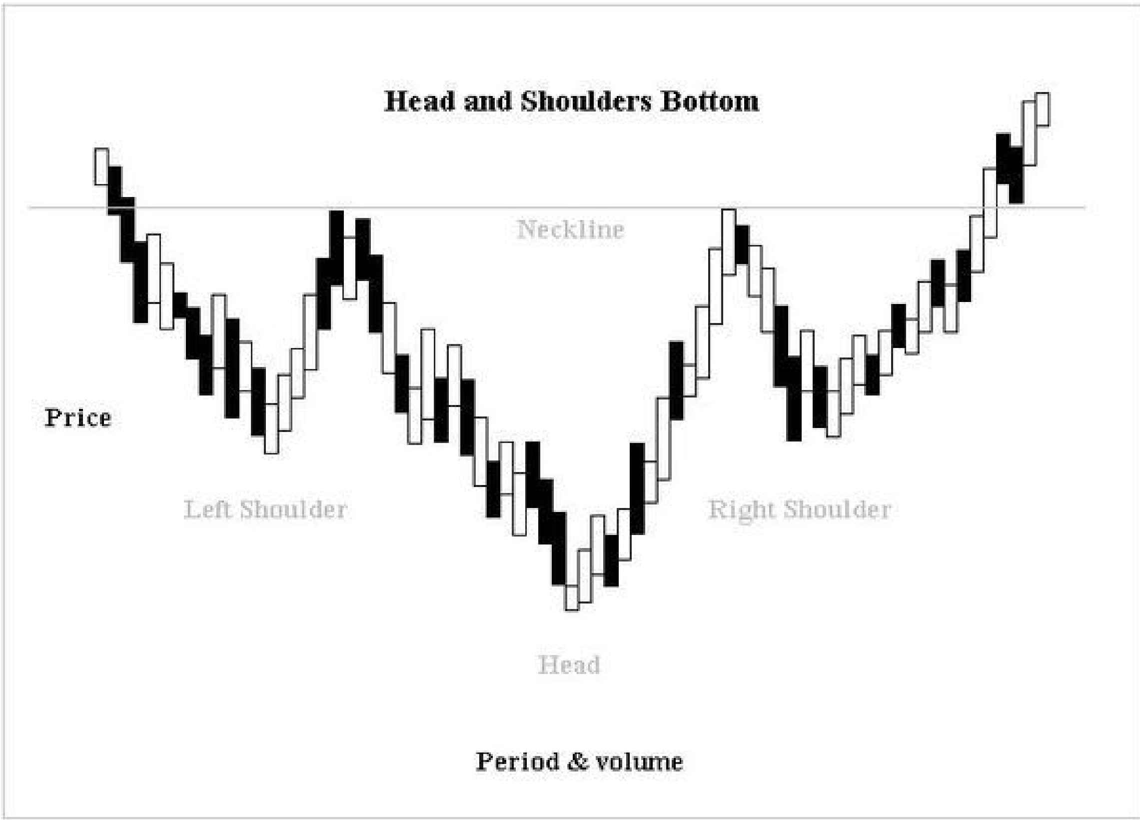
On the technical analysis chart, the **Head and shoulders** formation occurs when a market trend is in the process of reversal either from a bullish or bearish trend; a characteristic pattern takes shape and is recognized as reversal formation.

3.7.1 Head and shoulders top

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 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.

3.7.2 Head and shoulders bottom



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 from 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 though 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.

3.7.3 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.

3.7.4 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.

3.7.5 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 vertical distance from the peak of the head to the neckline. Then measure this same distance down from the neckline beginning at 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.

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.

3.7.6 Complex head and shoulders

Further information: Double top and double bottom and Triple top and triple bottom

This type of Head and Shoulders pattern has more than one left and/or right shoulders and/or head. It is also known as *Multiple Head and Shoulders* pattern.

3.7.7 External links

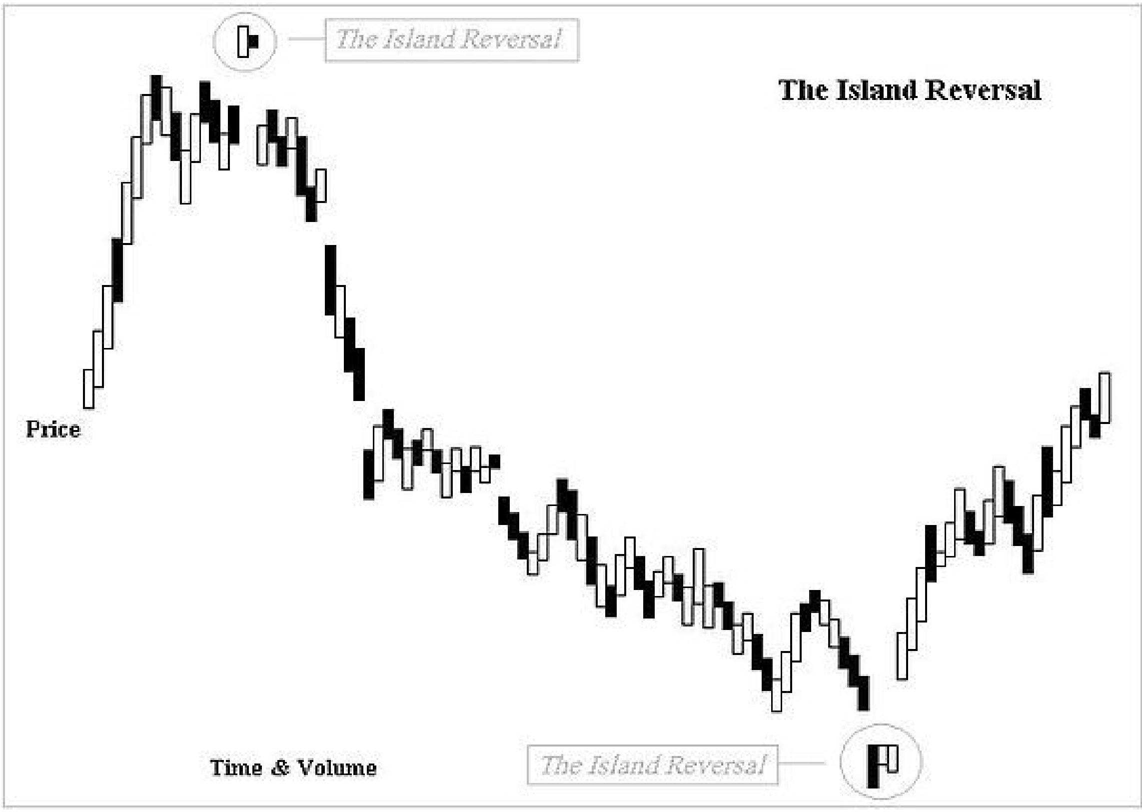
- *Analyzing Chart Patterns: Head And Shoulders* at investopedia.com

3.8 Island reversal

In stock trading and technical analysis, an **island reversal** is a candlestick pattern with compact trading activity within a range of prices, separated from the move preceding it. This separation is said to be caused by an exhaustion gap and the subsequent move in the opposite direction occurs as a result of a breakaway gap.

3.8.1 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 also, inversely, at the peak or the reverse of head and shoulders formations.



The Island Reversals

For example, assume that the price in a rising trend closes at its high of $84.00 and opens at $86.00 the following day and then does not fall below its opening. Near the end of the day, it moves up further and touches $88.00 but closes at $87.60 however. Observation thus shows a gap of $2.00 which is not filled. On the following day market price open at $87.40, touches high of $88.90 and closes at $87.00. A few days later or the very next day, market price opens at $84.00 and closes at $82.90, keeping itself below the area of $86.00 and $84.00. All the trading above $86.00 will appear on the technical analysis chart to be isolated and is known as, an island reversal.

An example of a bearish island reversal pattern was identified by Kenneth Gruneisen and published via CANSLIM.net when ITT Educational Services (ESI) topped in January 2009. ESI fell from $120 to $12 in the 4 years that followed. http://premium.canslim.net/CSNNews/templates/OPENARCHIVES.aspx?a=16266

3.8.2 Characteristics

- The occurrence of an 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”.

3.9 Price channels

Trend channel

A **price channel** is a pair of parallel trend lines that form a chart pattern for a stock or commodity.*[1] 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".*[2]

3.9.1 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

3.9.2 See also

- Bollinger bands
- Control chart
- Donchian channel
- Richard Donchian

3.10 Triangle (chart pattern)

Triangles are 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).

3.10.1 See also

- Technical analysis
- Chart pattern
- Support (technical analysis)

3.11 Triple top and triple bottom

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

3.11.1 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.

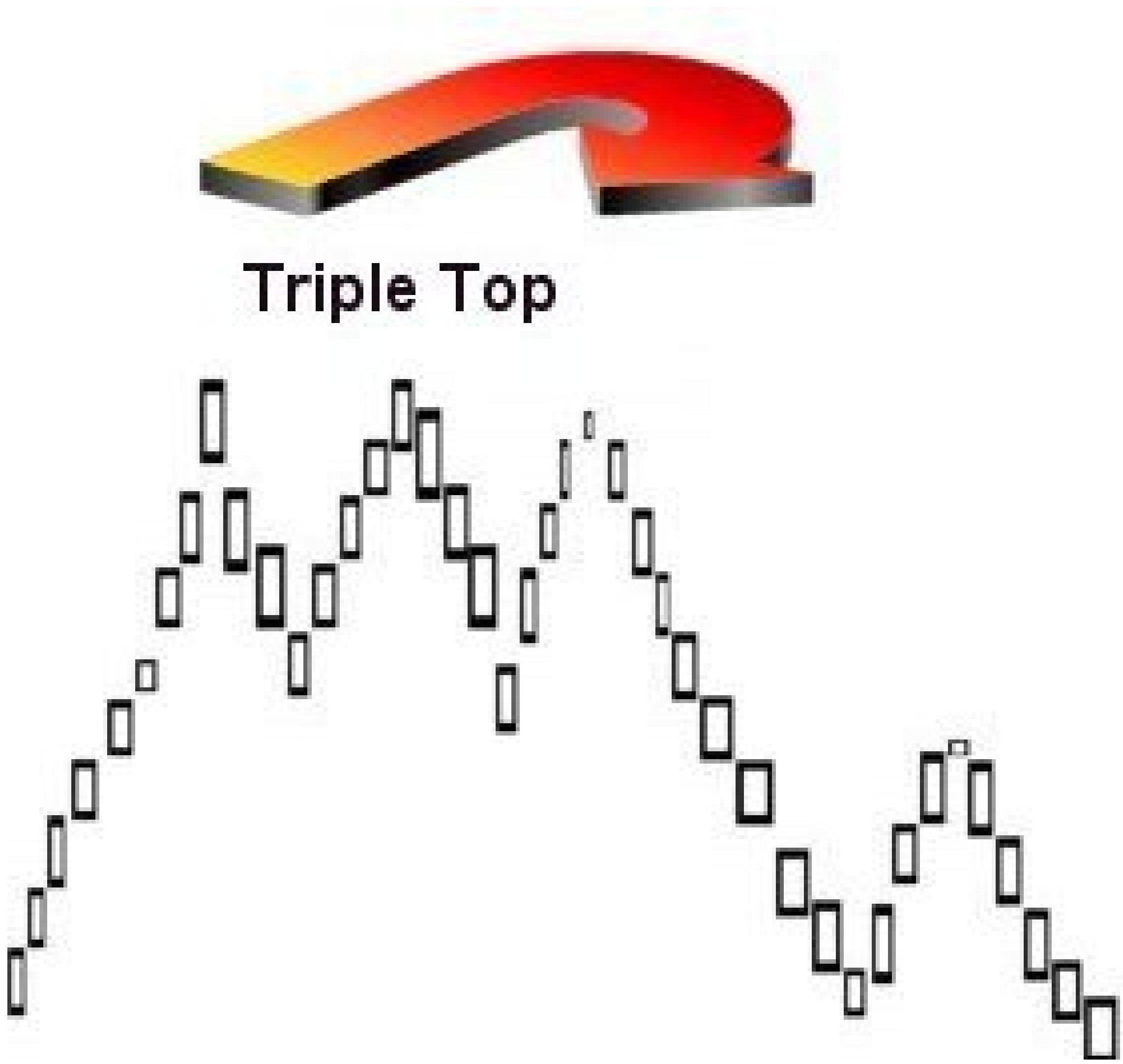
3.11.2 Triple bottom

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.

3.11.3 External links

- Triple Bottom Video with Statistics and Price Targets
- *Analyzing Chart Patterns: Triple Tops And Bottoms* at investopedia.com
- *How to Trade the Double Bottom Pattern* at StockChartPatterns.org



Triple top confirmation

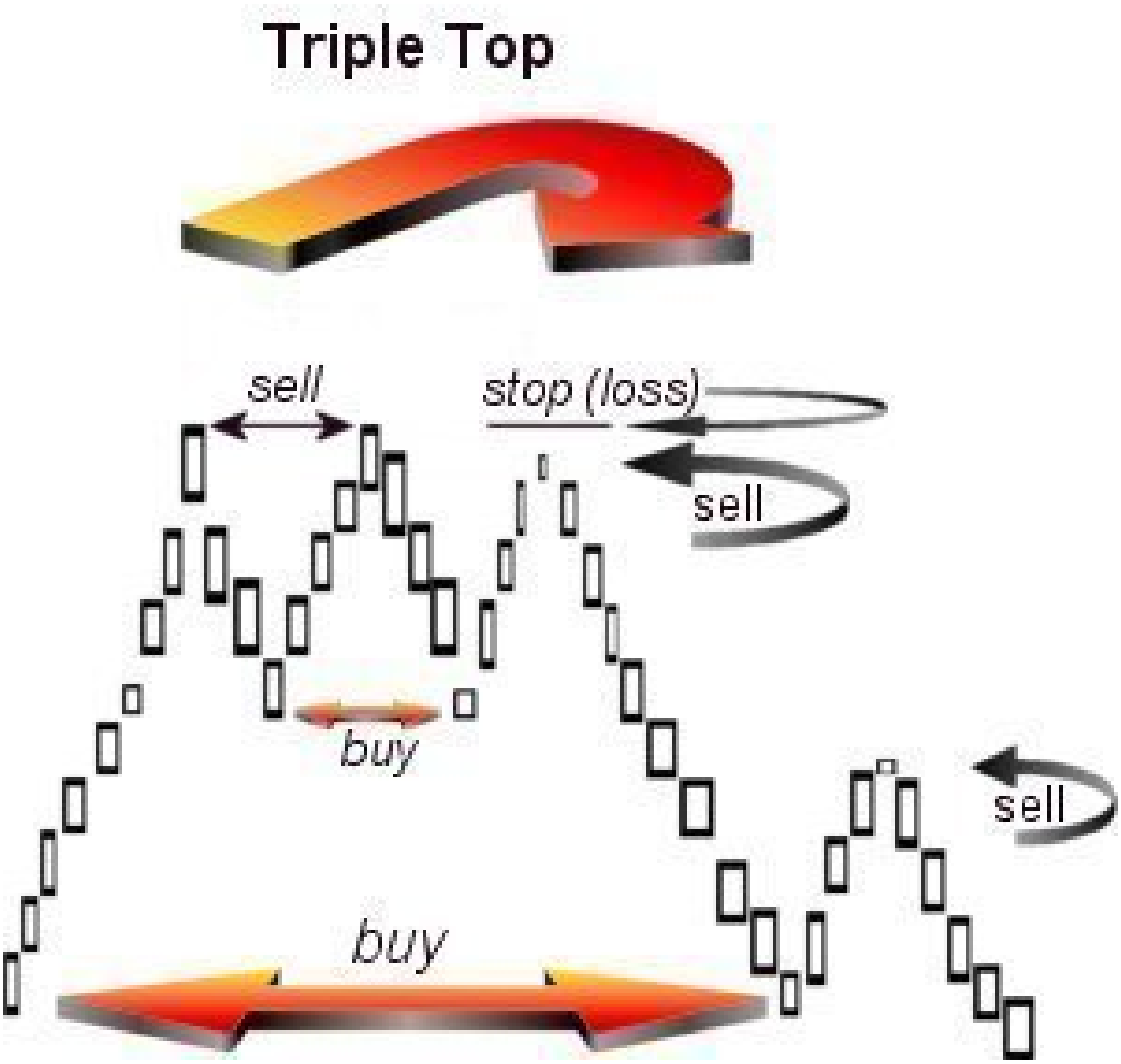
3.12 Wedge pattern

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 pattern which is forming at the top or bottom of the 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.

3.12.1 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.



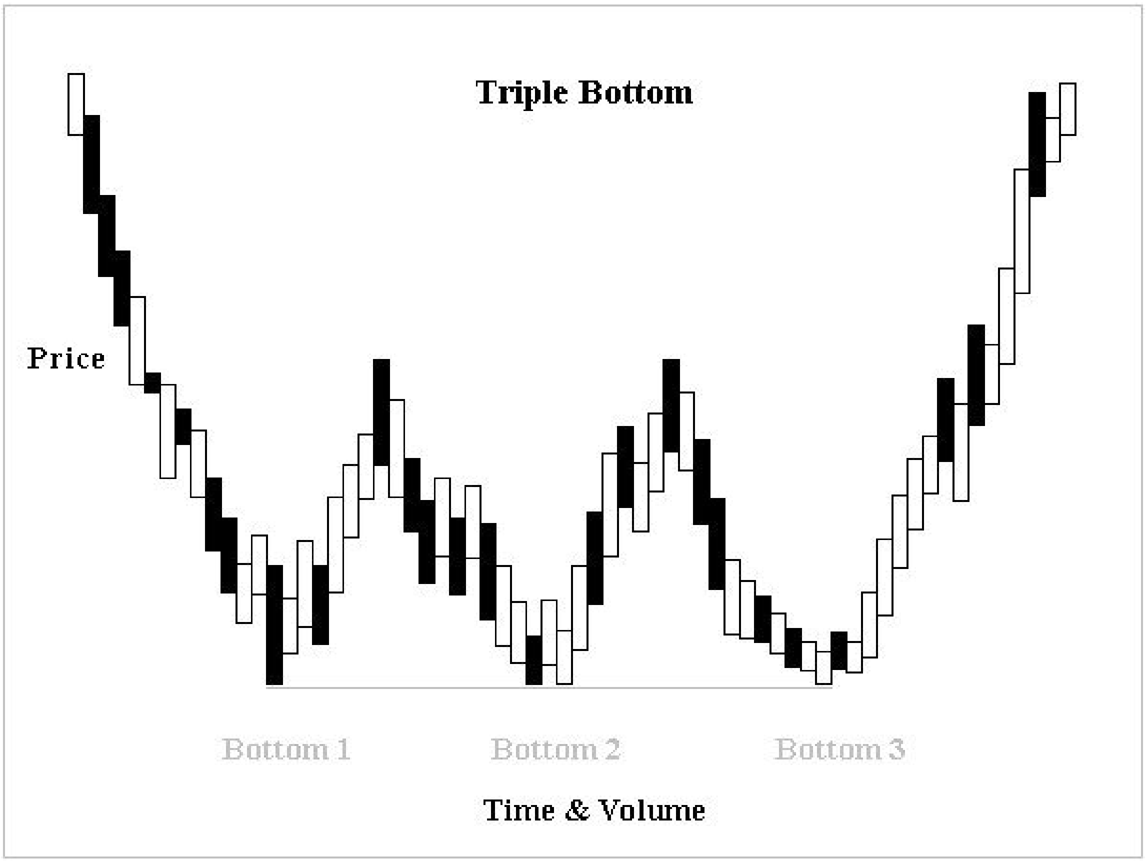
Opportunity

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.

3.12.2 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 then 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

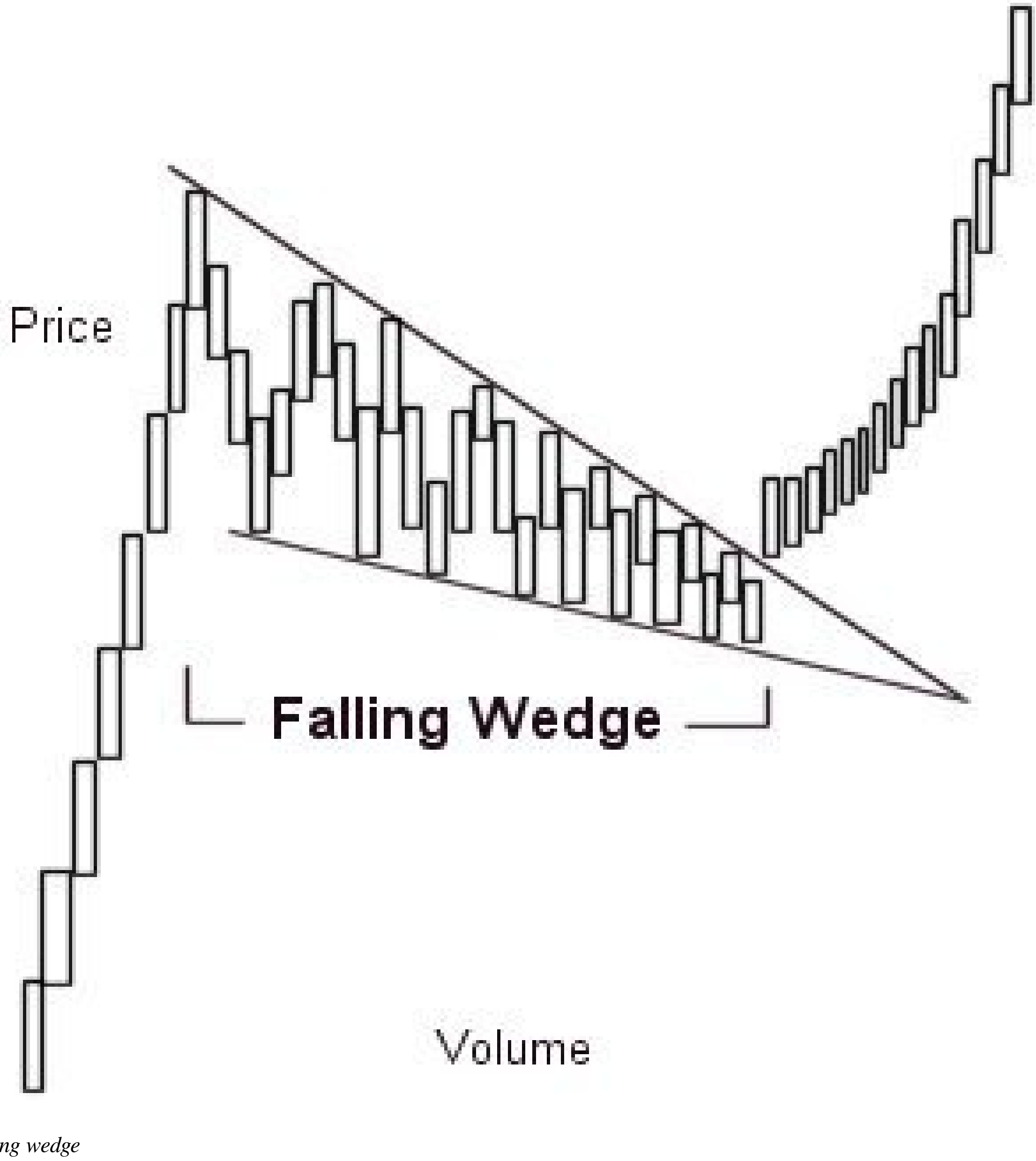


Triple bottom

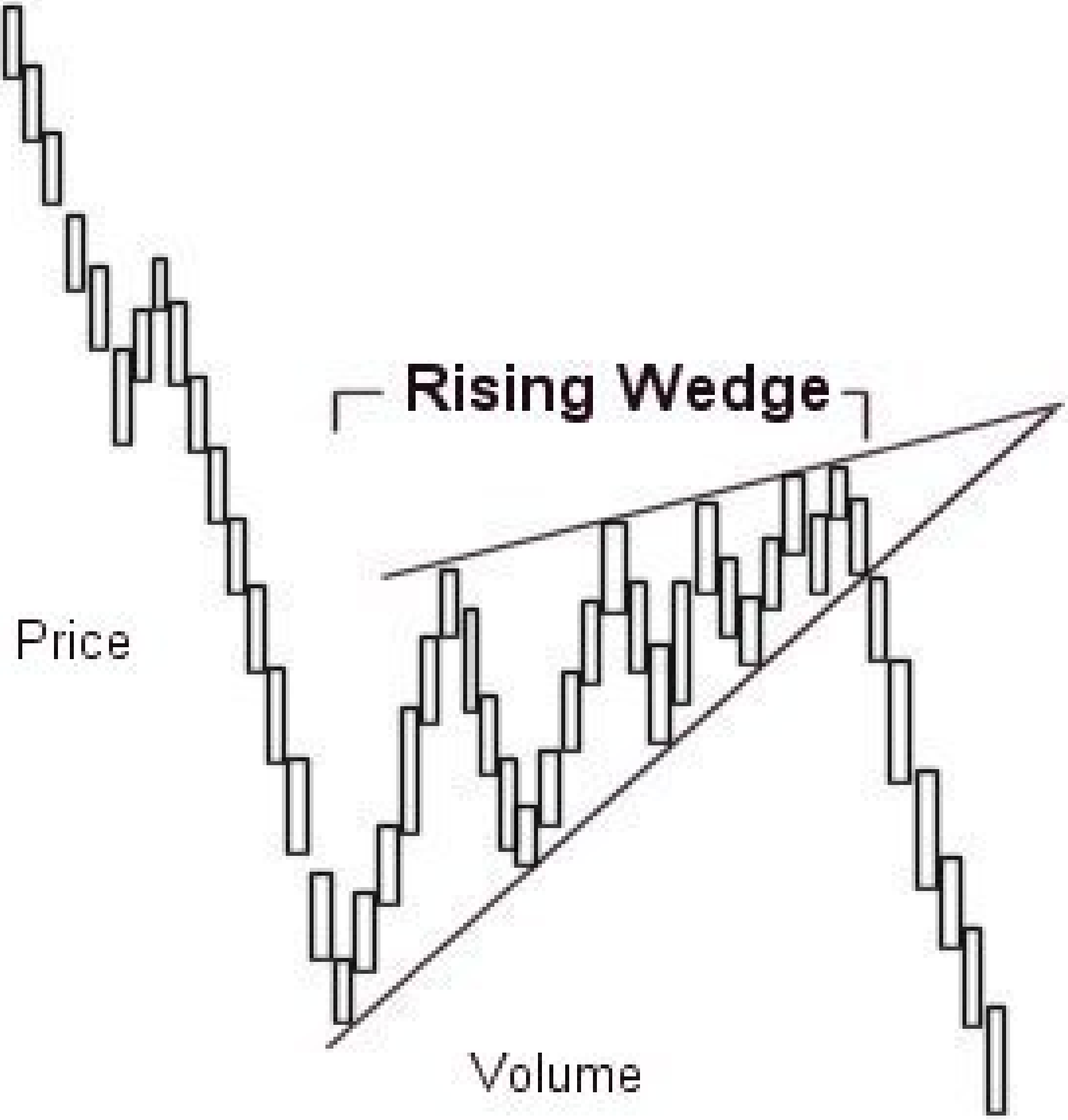
of a wedge) requiring about 4 weeks to complete.

3.12.3 External links

- *How To Trade Wedges* at investopedia.com
- *Analyzing Chart Patterns: The Wedge* at investopedia.com



Falling wedge



Rising wedge

Chapter 4

Candlestick patterns

4.1 Candlestick pattern

In technical analysis, a **candlestick pattern** is a movement in prices shown graphically on a candlestick chart that some believe can predict a particular market movement. The recognition of the pattern is subjective and programs that are used for charting have to rely on predefined rules to match the pattern. There are 42 recognised patterns that can be split into simple and complex patterns.

4.1.1 History

Some of the earliest technical trading analysis was used to track prices of rice in the 17th century. Much of the credit for candlestick charting goes to Munehisa Homma (1724–1803), a rice merchant from Sakata, Japan who traded in the Ojima Rice market in Osaka during the Tokugawa Shogunate. According to Steve Nison, however, candlestick charting came later, probably beginning after 1850.

4.1.2 Formation of candlestick

Further information: Candlestick chart
Candlesticks are graphical representations of price movements for a given period of time. They are commonly formed by the opening, high, low, and closing prices of a financial instrument.

If the opening price is above the closing price then a filled (normally red or black) candlestick is drawn.

If the closing price is above the opening price, then normally a green or a hollow candlestick (white with black outline) is shown.

The filled or hollow portion of the candle is known as the body or *real body*, and can be long, normal, or short depending on its proportion to the lines above or below it.

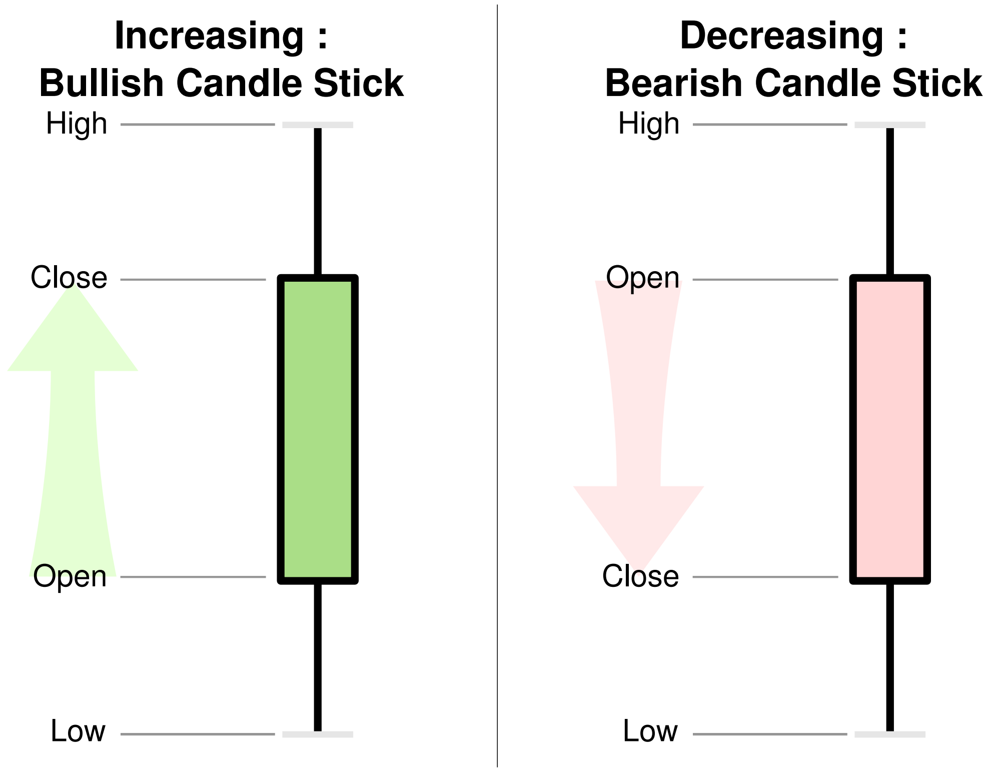
The lines above and below, known as *shadows*, *tails*, or *wicks* represent the high and low price ranges within a specified time period. However, not all candlesticks have shadows.

4.1.3 Simple patterns

4.1.4 Complex patterns

4.1.5 See also

- Acquisitions, mergers, and takeovers terminology
- The Island Reversal



The aspects of a candlestick pattern

4.1.6 Further reading

- Lebeau, Charles (1991). *Technical Traders Guide to Computer Analysis of the Futures Markets*.

4.1.7 External links

- *Bulkowski's Stock Market Patterns.* On line, includes research, statistical validation, and follow-on results.
- *HotCandlestick.com Glossary of Patterns.* Daily and Weekly results of common candlestick patterns, flashcard game.

Chapter 5

Simple Candlestick Patterns

5.1 Doji

Main article: Candlestick pattern

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

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.

5.1.1 Types of Doji

A doji is a key trend reversal indicator. This is particularly true when there is a high trading volume following an extended move in either direction.*[6] When a market has been in an uptrend and trades to a higher high than the previous three trading days, fails to hold that high, and closes in the lower 10% of that day's trading range, there is a high probability of a downtrend in the ensuing days. Likewise, when the market has been in a downtrend and trades to a new low that's lower than the three previous trading days, fails to hold that low, and closes in the upper 10% of that day's trading range, there is a high probability of an uptrend in the ensuing days.

4-Price Doji is a horizontal line indicating that high, low, open and close were equal.*[7]*[8]

5.1.2 See also

- Candlestick chart
- Harami cross
- Doji star

5.1.3 References

[1] Doji - stockcharts.com

[2] Neutral Doji - investopedia.com

[3] Long-Legged Doji - investopedia.com

[4] Gravestone Doji - investopedia.com

[5] Dragonfly Doji - investopedia.com

[6] Baiynd, Anne-Marie (2011). *The Trading Book: A Complete Solution to Mastering Technical Systems and Trading Psychology*. McGraw-Hill. p. 272. ISBN 9780071766494. Retrieved 2013-04-30.

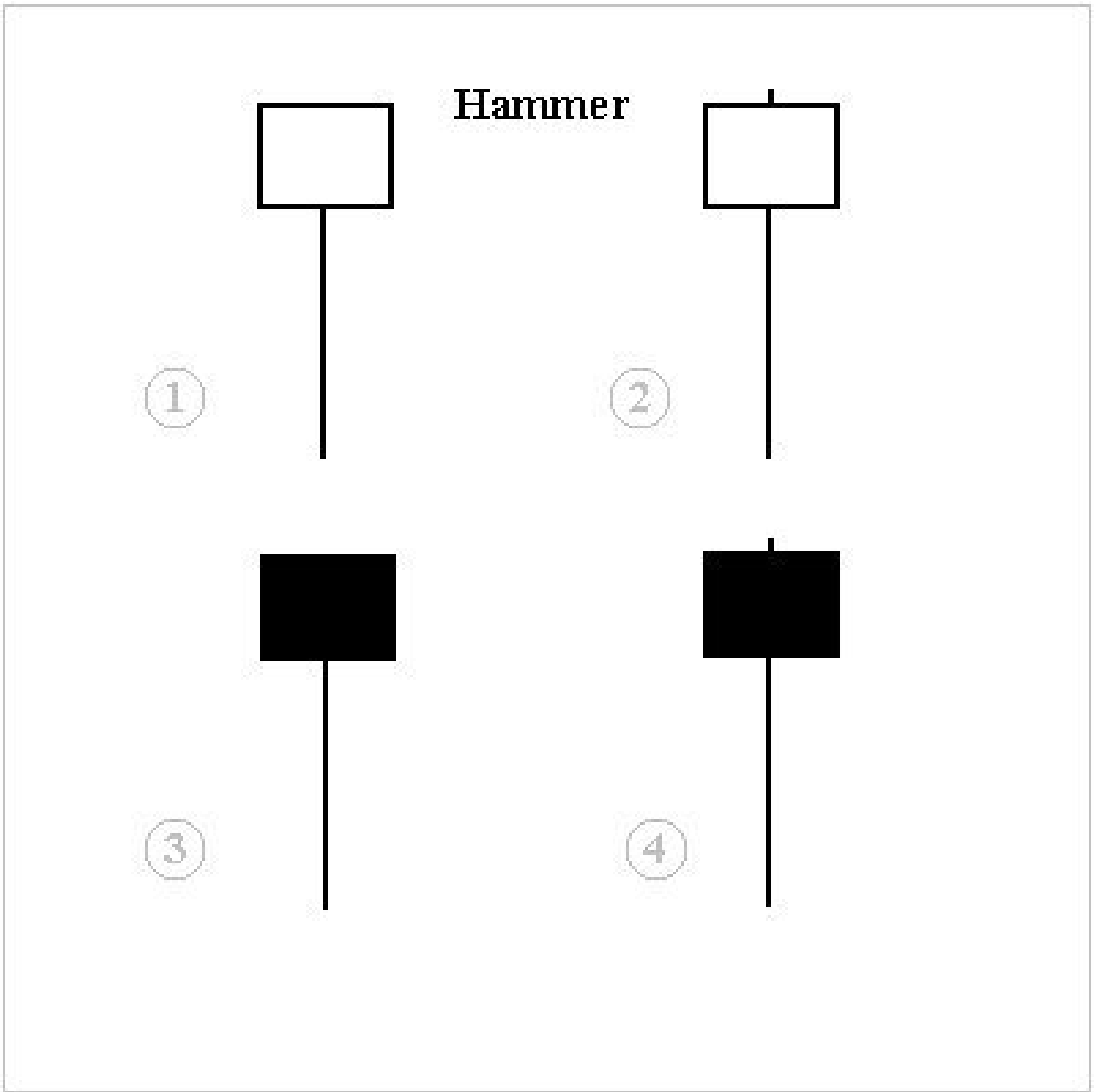
[7] http://docslide.us/documents/candlestick-charts-explanation.html

[8] http://www.dailyfx.com/forex/education/trading_tips/post_of_the_day/2012/03/21/Did_You_Know_That_There_are_Five_Different_Types_of_Doji_Candlesticks.html

5.1.4 External links

- Video and Chart Examples of Doji, fully sourced references
- Doji at chartscorner.com

5.2 Hammer (candlestick pattern)



Hammers are found in downtrends

Main article: Candlestick pattern

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.

5.2.1 See also

- Hanging man —Hammer found in an uptrend

5.2.2 External links

- Video and Chart Examples of Hammer Candlestick Pattern
- Hammer pattern at onlinetradingconcepts.com
- Bullish Hammer at candlesticker.com
- Hammer definition at investopedia.com
- Hammer Information at candlecharts.com
- Hammer at chartscorner.com

5.3 Hanging man (candlestick pattern)

Main article: Candlestick pattern

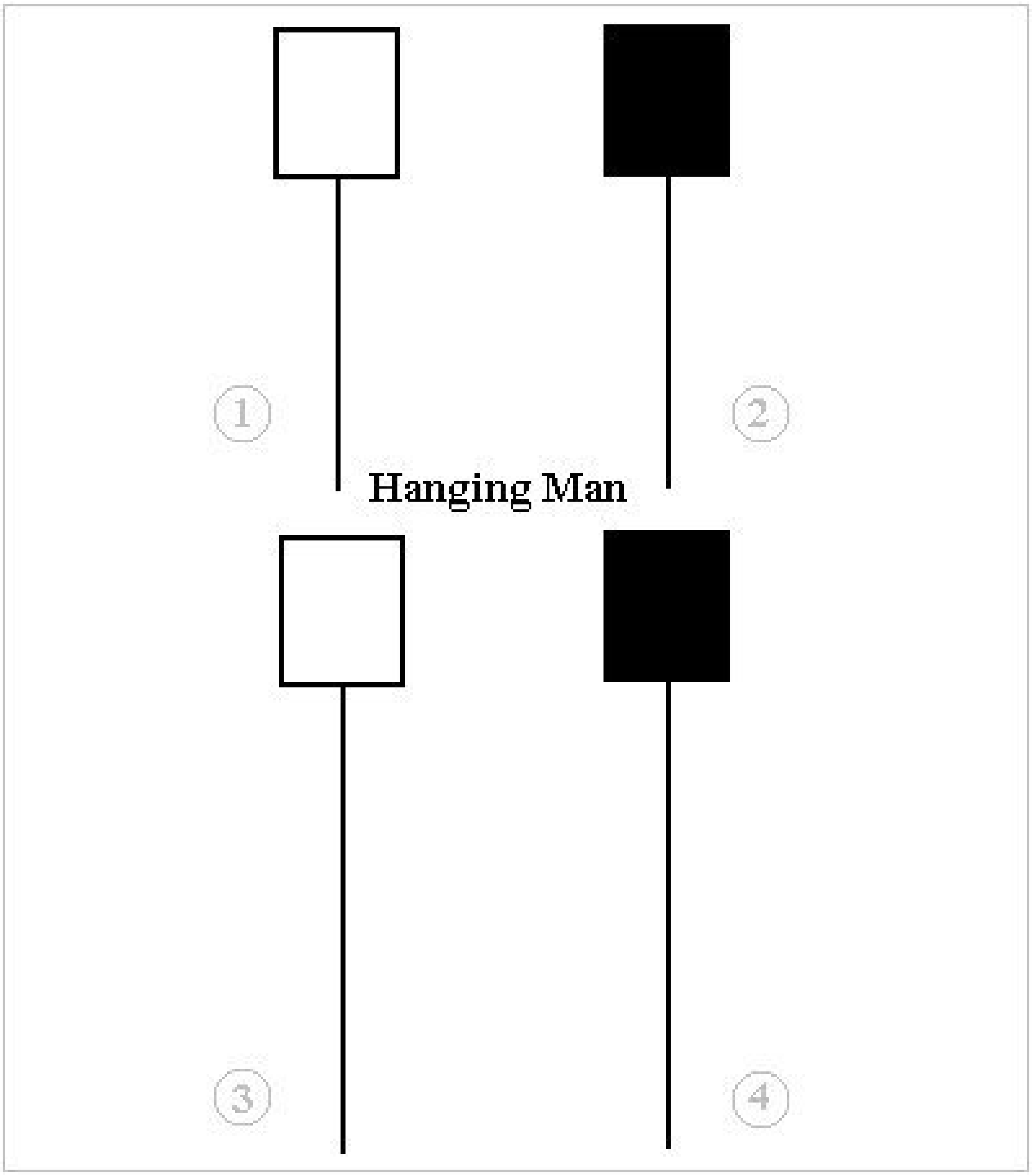
A **hanging man** is a type of **bearish reversal** pattern, made up of just one candle, found in an uptrend of price charts of financial assets. It has a long lower wick and a short body at the top of the candlestick with little or no upper wick. In order for a candle to be a valid hanging man most 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.

5.3.1 See also

- Hammer —Hanging man pattern found in a downtrend

5.3.2 External links

- Video and chart examples of hanging man pattern
- Hanging man pattern at onlinetradingconcepts.com
- Bearish Hanging man at candlesticker.com
- Hanging man definition at investopedia.com
- Hanging Man Information at candlecharts.com
- Hanging Man Explained at chartscorner.com



Hanging man patterns are found in uptrends

5.4 Inverted hammer

The **inverted hammer** is a type of candlestick pattern found after a downtrend and is usually taken to be a trend-reversal signal. The inverted hammer looks like an upside down version of the hammer candlestick pattern, and when it appears in an uptrend is called a shooting star.

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 to close near to where they opened. When encountering an inverted hammer, traders often check for a higher open and close on the next period to validate it as a bullish signal.

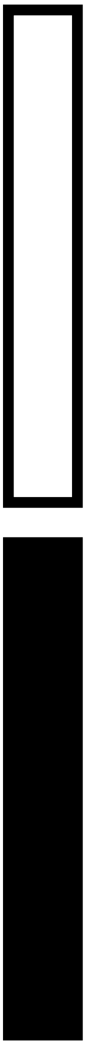
5.4.1 See also

- Shooting star —Inverted hammer pattern found in an uptrend

5.4.2 External links

- Inverted hammer at onlinetradingconcepts.com
- Inverted Hammer Information at candlecharts.com

5.5 Marubozu



White v. black marubozu

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.*[1]

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.

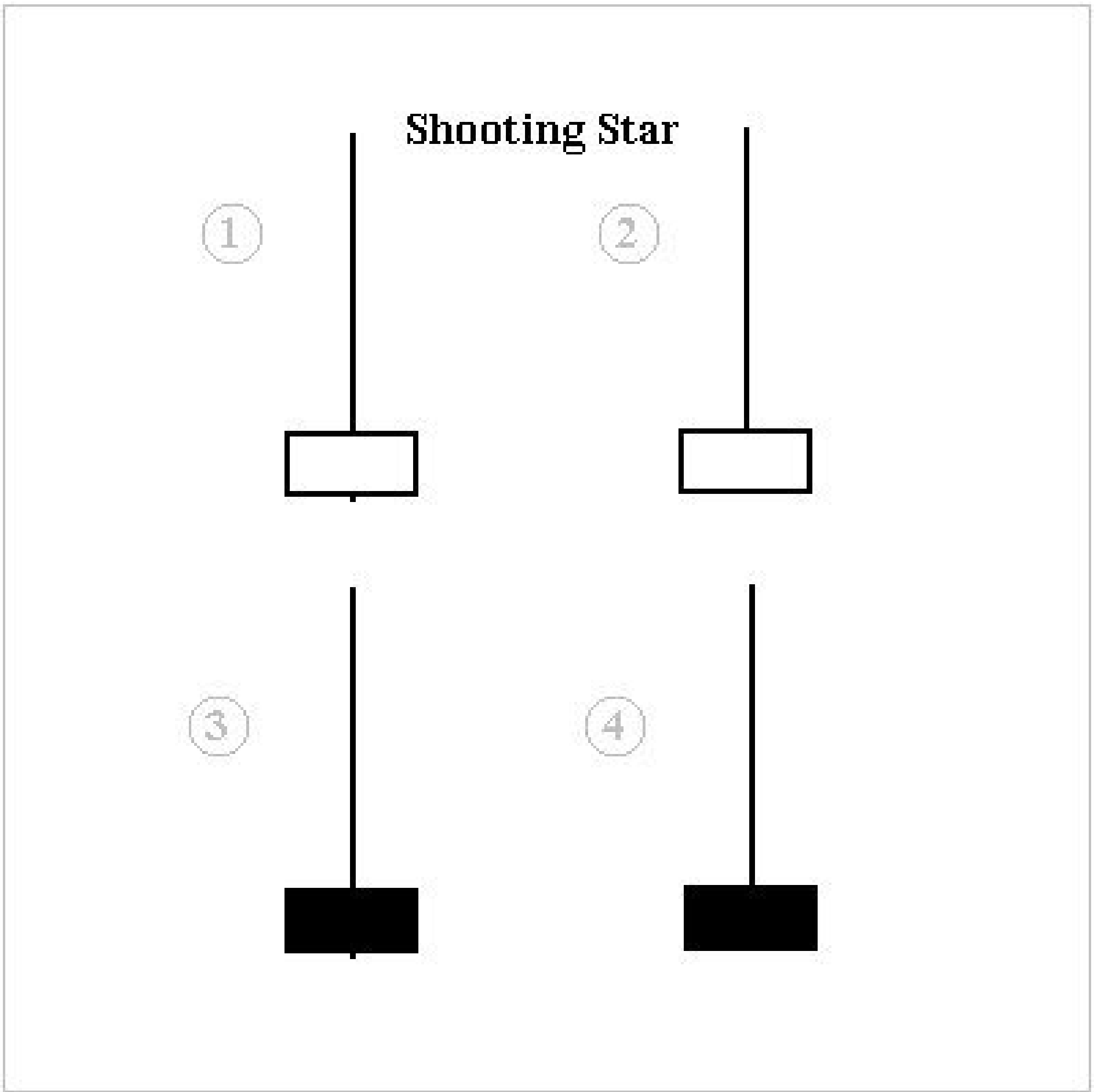
5.5.1 References

[1] "Candlestick Charting - the Marubozu indicator (FT Press)". *www.ftpress.com*. Retrieved 2015-12-11.

5.6 Shooting star (candlestick pattern)

Main article: Candlestick pattern

A **shooting star**, in finance, is a type of reversal pattern presaging a falling price. The Shooting Star looks exactly



Shooting star patterns are found in uptrends

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. After encountering this pattern traders often check for a lower open on the next period before considering the sell-signal valid.

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.

5.6.1 See also

- Inverted hammer —Shooting star pattern found in a downtrend
- Shooting Star Information at candlecharts.com

5.6.2 External links

- Shooting star pattern at onlinetradingconcepts.com
- Bearish Shooting star at candlesticker.com
- Shooting star definition at investopedia.com

5.7 Spinning top (candlestick pattern)

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.

5.7.1 Examples

5.7.2 See also

- Candlestick chart
- Candlestick pattern

5.7.3 External links

- Spinning Tops Video and Chart Examples

Chapter 6

Complex Candlestick Patterns

6.1 Hikkake pattern

The **Hikkake pattern** (or **Hikkake**), 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, point and figure charts, or Japanese candlestick charts. The pattern does not belong to the collection of traditional candlestick chart patterns.

Though some have referred to the hikkake pattern as an "inside day false breakout" or a "fakey pattern", *[1] these are deviations from the original name given to the pattern by Daniel L. Chesler, CMT and are not popularly used to describe the pattern. For example, the name "hikkake pattern" has been chosen over "inside day false breakout" or "fakey pattern" by the majority of book authors who have covered the subject, including: "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, and "Diary of a Professional Commodity Trader" by Peter L. Brandt.

6.1.1 Conceptual basis

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.

6.1.2 Description

The pattern is recognized 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.

6.1.3 Origin

The hikkake pattern was first conceived and introduced to the financial community through a series of published articles written by technical analyst Daniel L. Chesler, CMT.*[2] The phrase "Hikkake" is a Japanese verb which means to "trick" or "ensnare." Chesler chose the name "hikkake" after consulting with Yohey Arakawa, Associate Professor of Japanese, Tokyo University of Foreign Studies.

6.1.4 Institutional uses and peer recognition

The hikkake pattern has been adopted for use by IntStream Oy, a global data distributor of the Nordic electricity energy market Nord Pool, in their E2 energy market analysis platform designed for use by institutional traders.*[3] The hikkake pattern has also been chosen for inclusion among other foundational, technical analysis chart patterns comprising the Market Technicians Association Educational Foundation (MTAEF), College Level Introduction to Technical Analysis.*[4] The hikkake pattern has attracted international attention among the financial community.*[5]

6.1.5 References

[1] "The 'Fakey' Entry by Nial Fuller" . Retrieved 2012-03-09.

[2] Daniel L. Chesler, CMT

[3] "New IntStream E2 Energy Market Analysis Platform - Product Overview" (PDF). IntStream. 2011-01-07. Retrieved 2012-03-08.

[4] "College Level Introduction to Technical Analysis, Lecture No. 4, Pattern recognition" (PDF). Market Technicians Association Educational Foundation. Retrieved 2013-08-05.

[5] "L' Hikkake di Dan Chesler by Gianluca Defendi" . Milano Finanza Interattivo Class CNBC. Retrieved 2013-10-27.

6.1.6 External links

- Trading False Moves with the Hikkake Pattern
- Quantifying Market Deception with The Hikkake Pattern
- Noted technical analysis authority Thomas Bulkowski considers in detail the historical performance record of the Hikkake pattern
- The Hikkake Pattern - eSignal Trading Education Article Archives
- Historical performance (1980-2013) of the hikkake pattern across 42 futures markets

6.2 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.

6.2.1 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. To have a valid Morning Star formation, most traders look for the top of the third candle to be at least halfway up the body of the first candle in the pattern. Black candles indicate falling prices, and white candles indicate rising prices.

6.2.2 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 of the first black candle. Then, a period of lower trading with a reduced range, which indicates indecision in the market, forms the second candle. This is followed by a large white candle, which represents buyers taking control of the market. As the Morning Star is a three-candle pattern, traders often don't wait for confirmation from a fourth candle before they buy the stock. High volumes on the third trading day confirm the pattern. Traders 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.

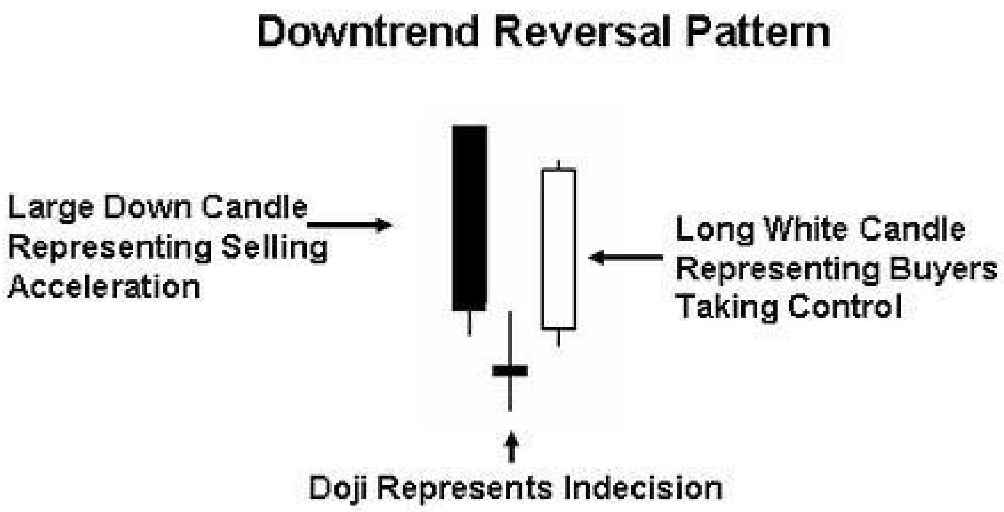


Illustration of the morningstar pattern

The Morning Star pattern is circled. Note the high trading volumes on the third day.

The chart below illustrates.

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

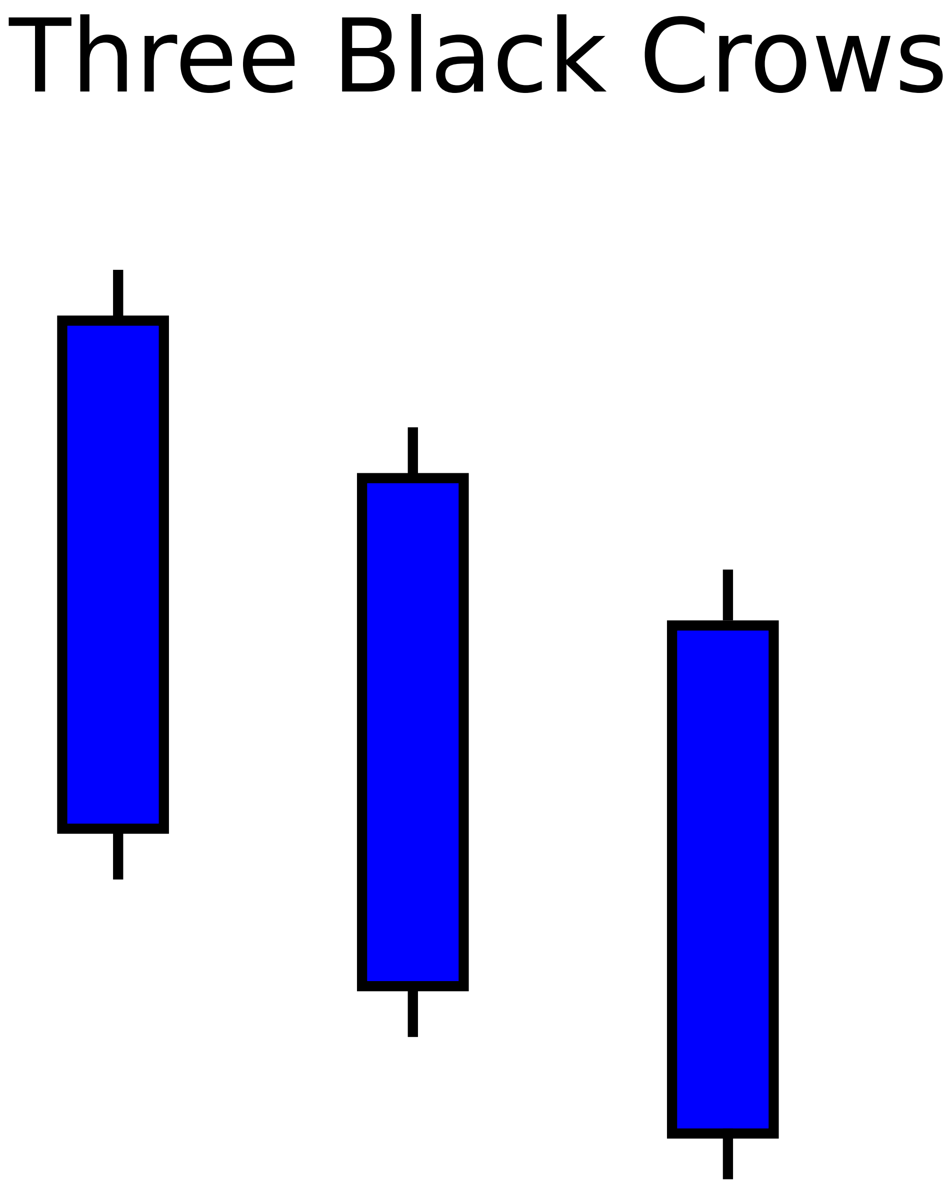
6.2.3 See also

- Technical analysis
- Chart pattern
- Spinning top (chart pattern)

6.2.4 External links

- Morning Star at chartscorner.com

6.3 Three Black Crows



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.*[1]

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." *[2]

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

6.3.1 See also

- Candlestick chart
- Technical analysis
- Market timing

6.3.2 References

[1] "Stock market investing 101 - Simplified utilizing candlestick signals" . 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

6.3.3 External links

- Stock Charts - Glossary
- Investopedia - Dictionary
- Prosticks - Chart Patterns

6.4 Three white soldiers

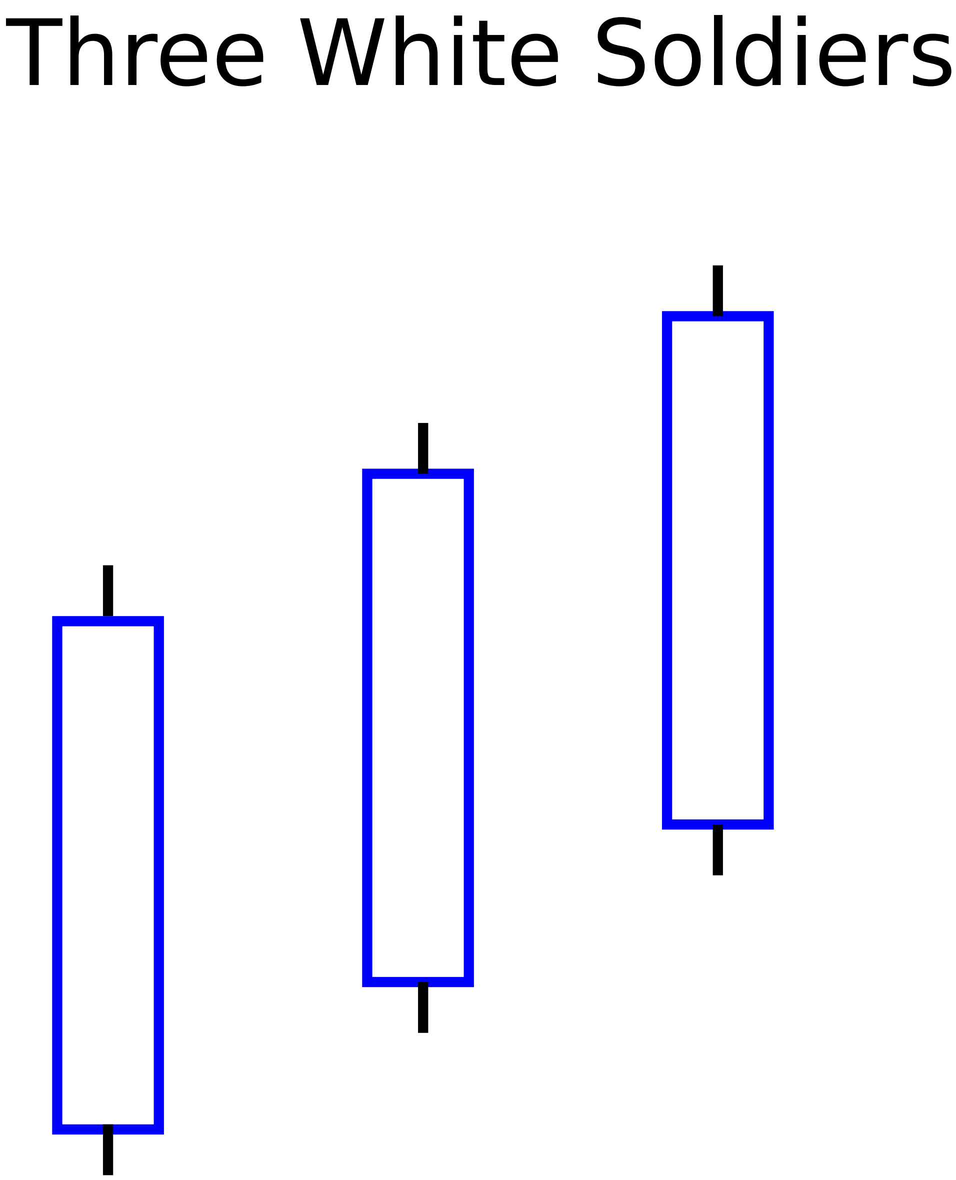
Three white soldiers is a candlestick chart pattern in the financial markets. It unfolds across three trading sessions and suggests a strong price reversal from a bear market to a bull market. The pattern consists of three long candlesticks that trend upward like a staircase; each should open above the 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.*[1]

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." *[2]

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

6.4.1 See also

- Candlestick chart
- Technical analysis
- Market timing



6.4.2 Notes

[1] "Japanese Candlesticks". 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.

6.4.3 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

6.4.4 External links

- Stock Charts - Glossary
- Investopedia - Dictionary
- Prosticks - Chart Patterns

Chapter 7

Support and Resistance Indicators

7.1 Support and resistance

“Support levels” redirects here. For technical support levels, see Technical support.

In technical analysis, **support and resistance** is a concept that the movement of the price of a security will tend to stop and reverse at certain predetermined price levels.*[1] These levels are denoted by multiple touches of price without a breakthrough of the level.

7.1.1 Support versus resistance

A **support level** is a level where the price tends to find support as it falls. This means the price is more likely to “bounce” off this level rather than break through it. However, once the price has breached this level, by an amount exceeding some noise, it is likely to continue falling until meeting another support level.*[2]

A **resistance level** is the opposite of a support level. It is where the price tends to find resistance as it rises. This means the price is more likely to “bounce” off this level rather than break through it. However, once the price has breached this level, by an amount exceeding some noise, it is likely to continue rising until meeting another resistance level.

7.1.2 Reactive vs Proactive support and resistance

Proactive support and resistance methods are 'predictive' in that they often outline areas where price has not actually been.*[3] They are based upon current price action that through analysis has been shown to be predictive of future price action. Proactive support and resistance methods include Measured Moves, Swing Ratio Projection/Confluence (Static (Square of Nine), Dynamic (Fibonacci)), Calculated Pivots, Volatility Based, Trendlines and Moving averages, VWAP, Market Profile (VAH, VAL and POC).*[3]

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, certain Candle Patterns (e.g. Engulfing, Tweezers) and OHLC.*[3]

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.*[3]

7.1.3 Identifying support and resistance levels

Support and resistance levels can be identified by trend lines (technical analysis).*[4] Some traders believe in using pivot point calculations.*[5]

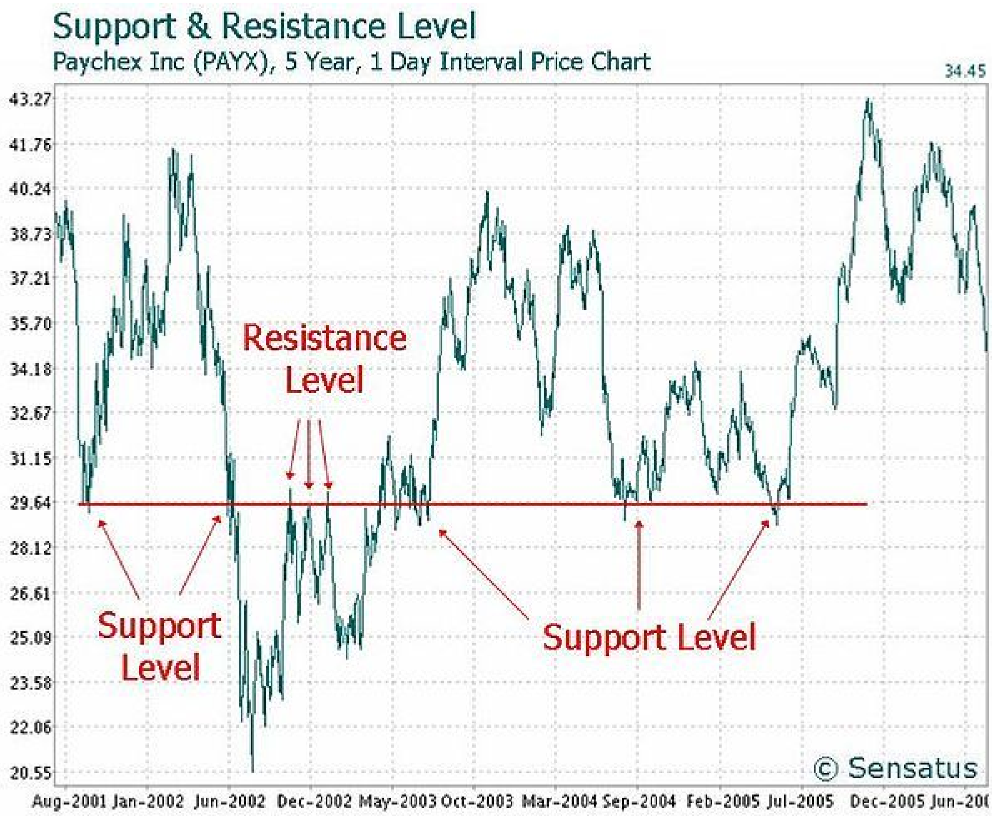
The more often a support/resistance level is “tested” (touched and bounced off by price), the more significance given to that specific level.

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.*[6]

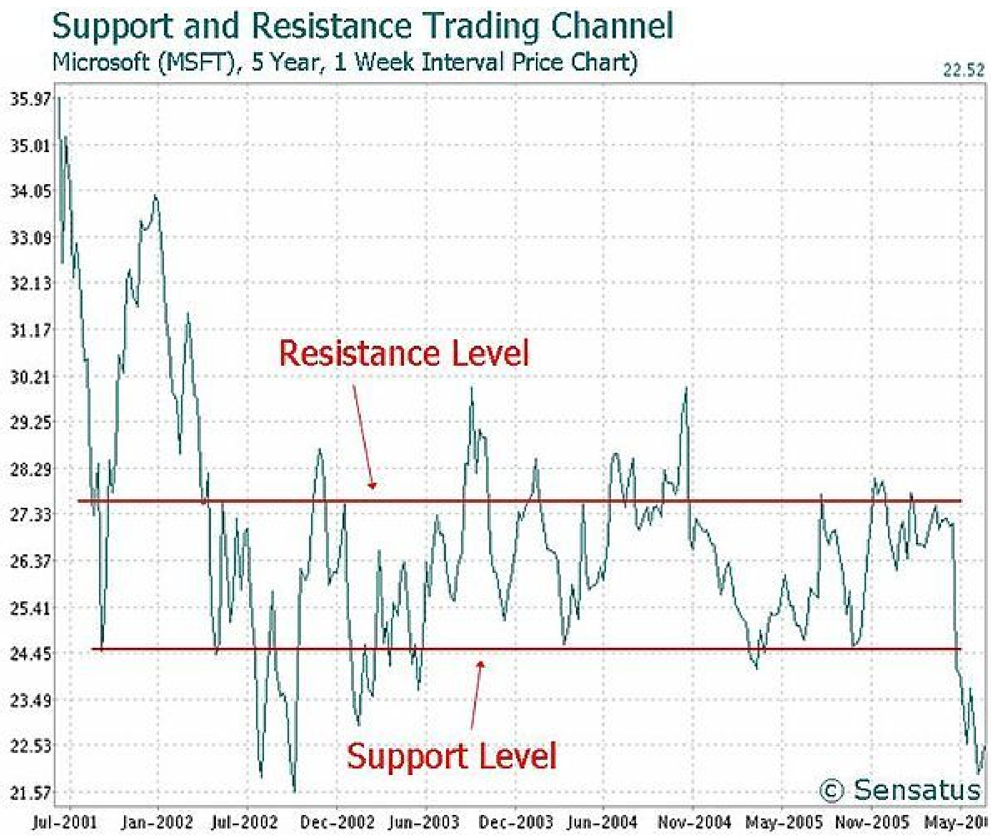
Psychological Support and Resistance levels form an important part of a trader's technical analysis.*[7] As price reaches a value ending in 50 (ex. 1.2050) or 00 (ex. 1.3000), humans often see these levels as a strong potential for interruption in the current movement. The price may hit the line and reverse, it could hover around the level as Bulls and Bears fought for supremacy, or it may punch straight through. A trader should always exercise caution when approaching 00 levels in general and 50 levels if it has previously acted as Support or Resistance.

7.1.4 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*[8] as per the following example:



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.

7.1.5 See also

- Top (technical analysis)
- Trend line (technical analysis)
- Bottom (technical analysis)
- Price discovery
- Representativeness heuristic
- Fibonacci retracement

7.1.6 References

[1] Amiri, M.; Zandieh, M.; Vahdani, B.; Soltani, R.; Roshanaei, V. (January 2010). "An integrated eigenvector–DEA–TOPSIS methodology for portfolio risk evaluation in the FOREX spot market". *Expert Systems with Applications* **37** (1): 509–516. doi:10.1016/j.eswa.2009.05.041. Retrieved 13 August 2015.

[2] McLeod, Gregory (21 January 2014). "Forex Support and Resistance Explained". Daily FX. Retrieved 13 August 2015.

[3] Schlossberg, Boris (2006). *Technical Analysis of the Currency Market: Classic Techniques for Profiting from Market Swings and Trader Sentiment*. John Wiley & Sons. ISBN 9780471973065.

[4] "A Guide To Correctly Drawing Support and Resistance Levels Accurately". *The Forex Guy*. Retrieved 13 August 2015.

[5] "Identify support and resistance on a chart". *FX Street*. Retrieved 13 August 2015.

[6] Thomsett, Michael C. "Support and resistance simplified" (PDF). *Google Scholar*. Retrieved 13 August 2015.

[7] Stanley, James. "The Hidden Patterns of Support and Resistance in the Forex Market". *Yahoo! Finance*. Retrieved 13 August 2015.

[8] Chapman-Blench, Neil F (2012). *Traderevolution: Training for Traders*. AuthorHouse. ISBN 9781477215555.

7.1.7 External links

- John Murphy, Technical Analysis of the Financial Markets, ISBN 978-0-7352-0066-1

7.2 Bottom (technical analysis)

In the technical analysis of security prices, a **bottom** is a chart pattern where prices reach a low, then a lower low, and then a higher low.

According to some technical analysis theories, the first low signifies the pressure from selling was greater than the pressure from buying. The second lower low suggests that selling still had more pressure than the buying. The third higher low suggests that buying pressure will not let prices fall as low as the previous low. This turning point from selling pressure to buying pressure is called a bottom.

7.3 Fibonacci retracement

Fibonacci retracement levels shown on the USD/CAD currency pair. In this case, price retraced approximately 38.2% of a move down before continuing.

In finance, **Fibonacci retracement** is 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.

The appearance of retracement can be ascribed to ordinary price volatility as described by Burton Malkiel, a Princeton economist in his book *A Random Walk Down Wall Street*, who found no reliable predictions in technical analysis methods taken as a whole. Malkiel argues that asset prices typically exhibit signs of random walk and that one cannot consistently outperform market averages. 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.

7.3.1 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%, 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 (second number in the sequence) by the number 2 (third number in the sequence).

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

7.3.2 Academic studies

Bhattacharya, Sukanto and Kumar, Kuldeep (2006) A computational exploration of the efficacy of Fibonacci sequences in technical analysis and trading. Annals of Economics and Finance, Volume 7, Issue 1, May 2006, pp. 219-230. http://epublications.bond.edu.au/business_pubs/32/

Chatterjee, Amitava, O. Felix Ayadi, and Balasundram Maniam. "The Applications Of The Fibonacci Sequence And Elliott Wave Theory In Predicting The Security Price Movements: A Survey." Journal of Commercial Banking and Finance 1 (2002): 65-76.

Tai-Liang Chena, Ching-Hsue Chenga, Hia Jong Teoha. Fuzzy time-series based on Fibonacci sequence for stock price forecasting. Physica A: Statistical Mechanics and its Applications, Volume 380, 1 July 2007, Pages 377–390.

7.3.3 References

- Stevens, Leigh (2002). *Essential technical analysis: tools and techniques to spot market trends*. New York: Wiley. ISBN 0-471-15279-X. OCLC 48532501.
- Brown, Constance M. (2008). *Fibonacci analysis*. New York: Bloomberg Press. ISBN 1-57660-261-3.
- Posamentier, Alfred S.; Lehmann, Ingmar (2007). *The fabulous Fibonacci numbers*. Amherst, NY: Prometheus Books. ISBN 1-59102-475-7.
- Malkiel, Burton (2011). *A random walk down Wall Street: the time-tested strategy for successful investing*. OCLC 50919959.
- MFTA Pershikov, Viktor (2014). *The Complete Guide To Comprehensive Fibonacci Analysis on FOREX*. ISBN 978-1607967606.

7.3.4 External links

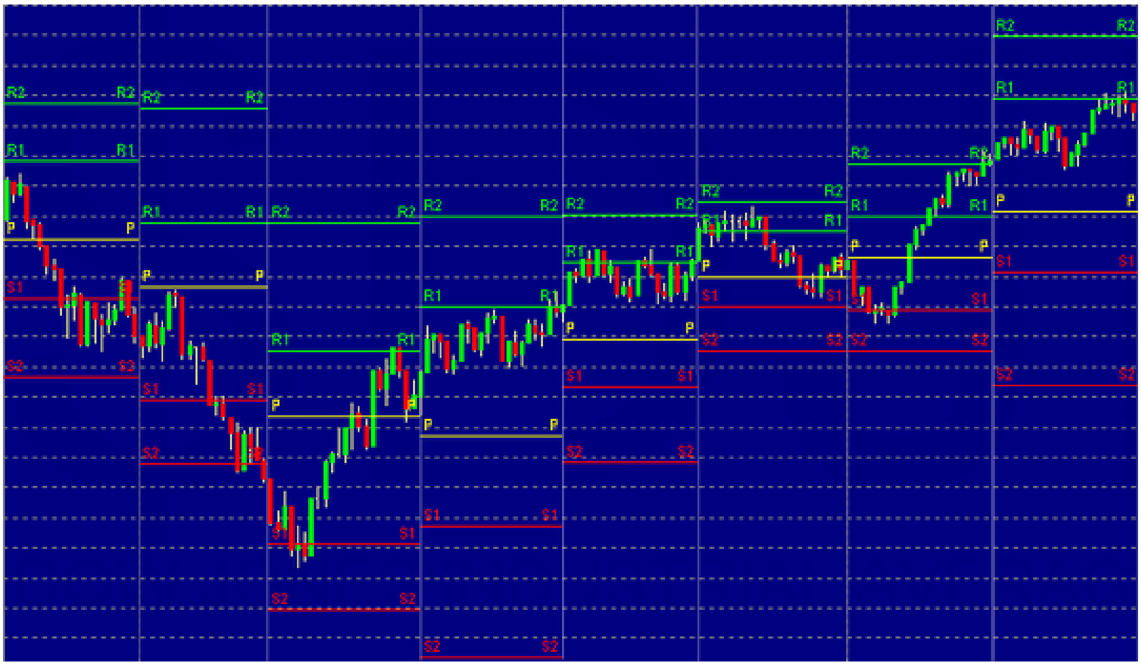
- *What is Fibonacci retracement, and where do the ratios that are used come from?* at investopedia.com
- Fibonacci Retracements at stockcharts.com
- *Number Sequence Fibonacci Retracement* at tradersdaytrading.com

7.4 Pivot point (technical analysis)

In financial markets, a **pivot point** is a price level that is used by traders as a possible 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 Industrial 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.

7.4.1 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.

7.4.2 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.*[1]

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:*[2]

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:

- $R_3 = H + 2\times(P - L) = R_1 + (H - L)$
- $S_3 = L - 2\times(H - P) = S_1 - (H - L)$

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.

7.4.3 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 may 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.*[2]

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.

Many traders recognize the half-way levels between any of these levels as additional, but weaker resistance or support areas. 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.

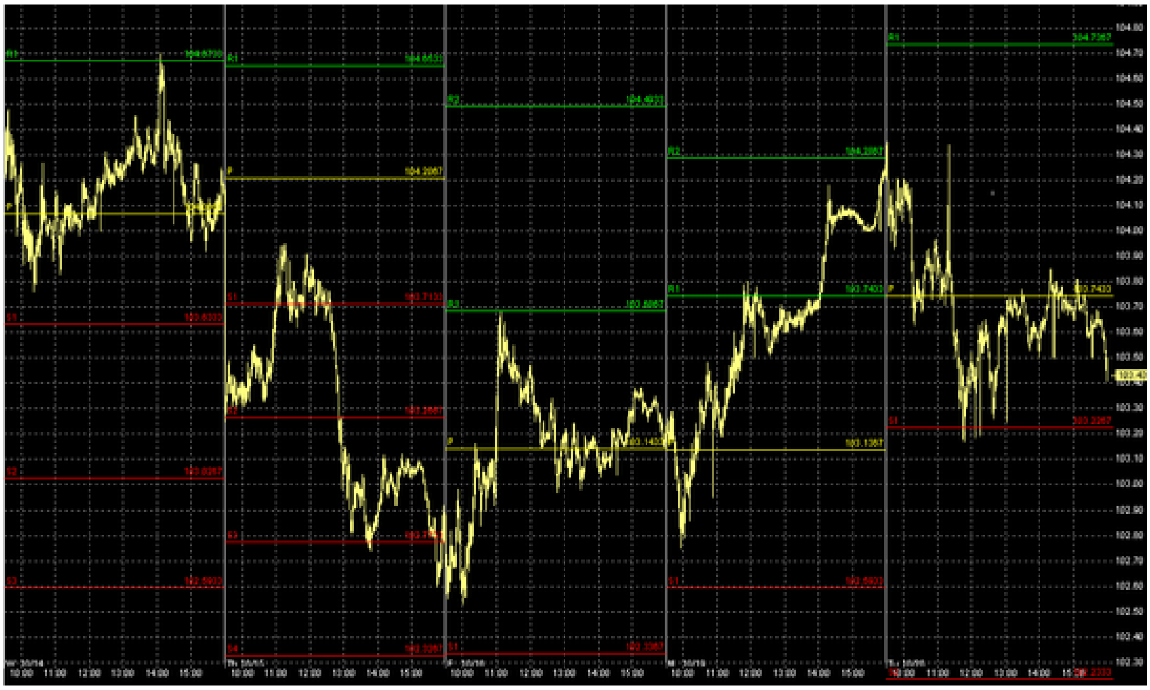
7.4.4 See also

- Fundamental analysis
- Market analysis
- Market timing
- Technical indicator
- Technical analysis software

7.4.5 References

[1] Gil Morales & Chris Kacher, *Trade Like an O'Neil Disciple: How We Made 18,000% in the Stock Market*, John Wiley & Sons (2010), ISBN 978-0470616536

[2] John L. Person, *Candlestick and Pivot Point Trading Triggers*, John Wiley & Sons (2007), ISBN 978-0-471-98022-3



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

7.5 Top (technical analysis)

In technical analysis, a **top** is an event in which a security's market price reaches a high, then a higher high, and then a lower high.

The first high signifies the pressure from buying was greater than the pressure from selling. The second higher high suggests that buying still had more pressure than the selling. The third lower high suggests that selling pressure will not let prices rise as high as the previous high. This turning point from buying pressure to selling pressure is called a top.

7.5.1 See also

- Bottom (technical analysis)
- Support and resistance

Chapter 8

Trend Indicators

8.1 Average directional movement index

The **average directional movement index** (**A.D.X.**) was developed in 1978 by J. Welles Wilder as an indicator of trend strength in a series of prices of a financial instrument.*[1] A.D.X. has become a widely used indicator for technical analysts, and is provided as a standard in collections of indicators offered by various trading platforms.

8.1.1 Calculations

The A.D.X. is a combination of two other indicators developed by Wilder, the positive directional indicator (abbreviated +DI) and negative directional indicator (-DI).*[2] The A.D.X. combines them and smooths the result with a smoothed 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):

UpMove = today's high − yesterday's high

DownMove = yesterday's low − today's low

if UpMove > DownMove and UpMove > 0, then +DM = UpMove, else +DM = 0

if DownMove > UpMove and DownMove > 0, then −DM = DownMove, else −DM = 0

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

+DI = 100 times the smoothed moving average of (+DM) divided by average true range

−DI = 100 times the smoothed moving average of (−DM) divided by average true range

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

A.D.X. = 100 times the smoothed moving average of the absolute value of (+DI − −DI) divided by (+DI + −DI)

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

8.1.2 Interpretation

The A.D.X. does not indicate trend direction or momentum, only trend strength.*[3] It is a lagging indicator; that is, a trend must have established itself before the A.D.X. will generate a signal that a trend is under way. A.D.X.

will range between 0 and 100. Generally, A.D.X. readings below 20 indicate trend weakness, and readings above 40 indicate trend strength. An extremely strong trend is indicated by readings above 50. Alternative interpretations have also been proposed and accepted among technical analysts. For example it has been shown how A.D.X. is a reliable coincident indicator of classical chart pattern development, whereby A.D.X. readings below 20 occur just prior to pattern breakouts.*[4]

8.1.3 Timing

Various market timing methods have been devised using A.D.X.. One of these methods is discussed by Alexander Elder in his book Trading for a Living. According to Elder, there is a buy signal when the A.D.X. peaks and starts to decline when the +DI is above the -DI. With this strategy you would sell when the A.D.X. stops falling and goes flat.*[5]

8.1.4 References

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

[2] Michael D. Sheimo (1998). *Cashing in on the Dow: using Dow theory to trade and determine trends in today's markets*. CRC Press. p. 87. ISBN 9780910944069.

[3] Newsome, Jerremy (2013-07-25). “One of my favorite technical indicators…". Trade Smart University. Retrieved 2013-07-31.

[4] Chesler, Daniel (Winter 2000). “Volatility and Structure: Building Blocks of Classical Chart Pattern Analysis” . Market Technicians Association.

[5] Alexander Elder (Winter 1993). *Trading for a Living*. John Wiley & Sons. p. 141. ISBN 0471592242.

8.2 Commodity channel index

The **commodity channel index** (**CCI**) is an oscillator originally introduced by Donald Lambert in 1980.

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.

8.2.1 Calculation

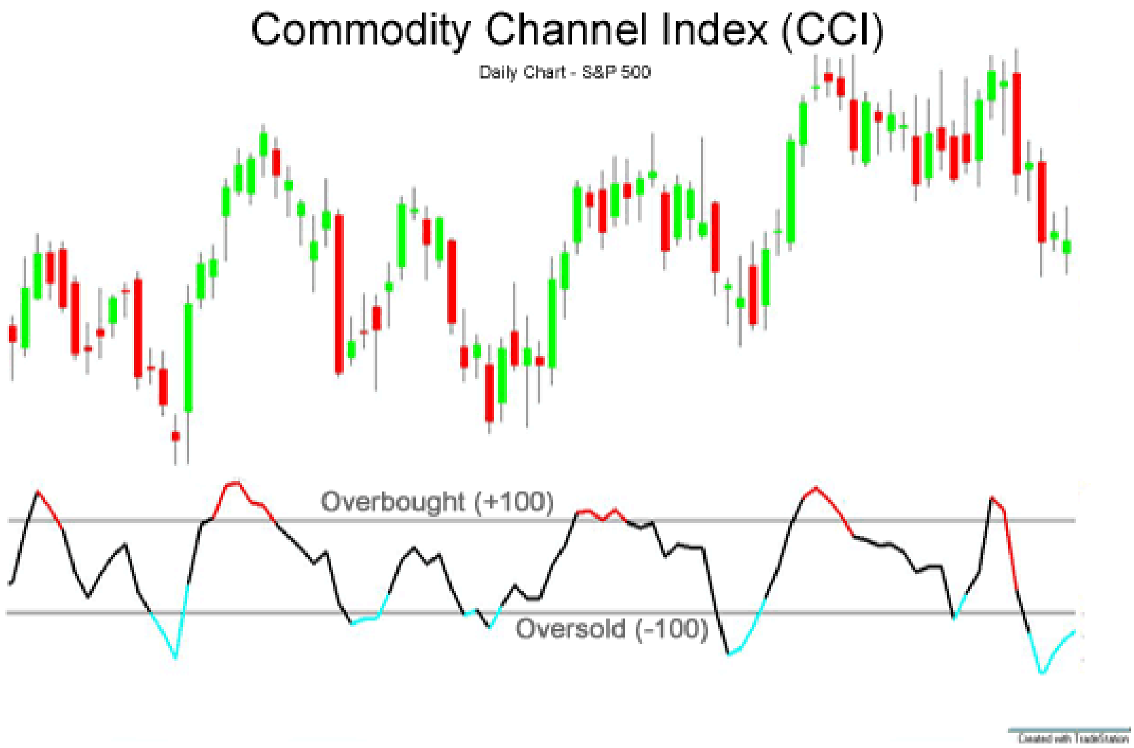
CCI measures a security’ s variation from the statistical mean.*[1]

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 Price Typical $= \frac{H+L+C}{3}$, SMA is the simple moving average, and σ 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 higher the percentage of values between +100 and −100.



Relative strength index 14-period

8.2.2 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.*[2]

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.*[2]

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.*[3]

8.2.3 References

[1] AsiaPacFinance.com Trading Indicator Glossary

[2] Commodity channel index on Investopedia

[3] Commodity Channel Index (CCI) on StockCharts.com – ChartSchool

8.2.4 External links

- Commodities & Charts Blog post on CCI
- Commodities & Charts Blog images on CCI

8.3 Detrended price oscillator

The **detrended price oscillator** (**DPO**) is an indicator in technical analysis that attempts to eliminate the long-term trends in prices by using a displaced moving average so it does not react to the most current price action. This allows the indicator to show intermediate overbought and oversold levels effectively.

The detrended price oscillator is a form of price oscillator, like the "percentage price oscillator" (PPO) and the "absolute price oscillator" (APO) both of which are forms of Gerald Appel's MACD indicator. The APO is an equivalent to the moving average convergence/divergence (MACD) indicator while the PPO is an improved alternative to the APO or the MACD for use when a stock's price change has been large, or when comparing the oscillator behavior for different stocks which have significantly different prices.

Although these are not so commonly used with the DPO, for the other price oscillators, as for the MACD, a signal line is frequently generated for the price oscillators by taking an exponential moving average (EMA) of the price oscillator values and plotting the two lines together. A histogram can also be generated for the price oscillators, if desired, just as is done for the MACD indicator.

The DPO is calculated by subtracting the simple moving average over an "n" day period and shifted n/2+1 days back from the price.

To calculate the detrended price oscillator:

Decide on the time frame that you wish to analyze. Set "n" as half of that cycle period.

Calculate a simple moving average for n periods.

Calculate (n / 2 + 1)

Subtract the moving average, from (n / 2 + 1) days ago, from the closing price:

DPO = Close - Simple moving average [from (n / 2 + 1) days ago

8.3.1 References

8.4 KST oscillator

In technical analysis, the **know sure thing (KST) oscillator** is a complex, smoothed price velocity indicator developed by Martin J. Pring.*[1]*[2]

A 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 be more greatly influenced by the longer and more dominant time spans, in order to better reflect the primary swings of stock market cycle.*[3] 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.

8.4.1 Formula

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

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

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

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

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

http://search.cpan.org/~{ }kmx/Finance-TA-v0.4.1/TA.pod#TA_ROC_(Rate_of_change_:_((price/prevPrice)−1)*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 trends, Martin J Pring suggests 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 in, various technical analysis software packages such as MetaStock*[5] or OmniTrader.

8.4.2 Implications

Entry rules KST Indicator

When KST crosses below its 9-day exponential average, short at the next day opening price.

Exit rules KST indicator

When KST crosses above its 9-day exponential average, close short position at the next day opening price.*[4]

8.4.3 Variations

It can be calculated on **daily***[6] or **long term***[7] basis.

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

8.4.4 KST interpretation

KST can be interpreted in the ways mentioned below.*[6]

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.

8.4.5 See also

- AdvisorShares

8.4.6 References

[1] Martin J. Pring (1991). *Technical Analysis Explained* (3rd ed.). McGraw/Hill.

[2] Robert W. Colby (2003). *The encyclopedia of technical market indicators*. McGraw-Hill Professional. p. 346. Retrieved 2010-11-10.

[3] "Technical Analysis – Online Know Sure Thing (KST) Indicator Lessons" . Retrieved 2010-11-10.

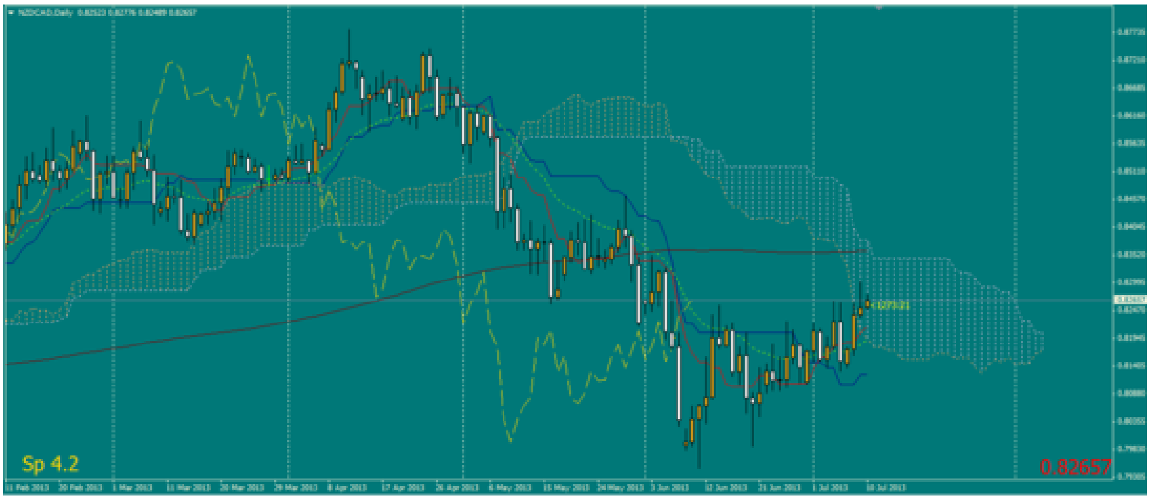
[4] "KST(Know sure thing) indicator in stock market" . http://abc-stock-market.blogspot.com. Retrieved 2010-11-10. External link in |publisher= (help)

[5] "KST Oscillator: Martin Prings formula" . eSignal. Retrieved 2010-11-10.

[6] Martin J. Pring. "Introducing the Daily KST" . pring.com. Retrieved 2010-11-10.

[7] Martin J. Pring. "Long-term KST" . pring.com. Retrieved 2010-11-10.

8.5 Ichimoku Kinkō Hyō



Ichimoku trading system example in forex market for NZDCAD pair

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 forecast price moves.*[1] 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 30 years perfecting the technique before releasing his findings to the general public in the late 1960s.*[2]

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.*[3]*[4]

Ichimoku is a moving average-based trend identification system and because it contains more data points than standard candlestick charts, it provides a clearer picture of potential price action.*[5] 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.

In the Western World is solely known for its "Graphic Environment" due to the authors that have translated the original manual into English, German nor Spanish. However Ichimoku is also integrated by three other theories that improves and enhances the indicator:

Time Theory *[6]

Wave Movement Theory *[7]

Target Price Theory *[8]

8.5.1 The key elements of Ichimoku's Graphic Environment

Tenkan-sen

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

It is primarily used as a signal line and a minor support/resistance line.Tenkan Sen (red line): **This is also known as the** turning line **and is derived by averaging the highest** high and the lowest low for the past nine periods**.** *The Tenkan Sen is an indicator of the market trend. If the red line is moving up or down, it indicates that the market is trending. If it moves horizontally, it signals that the market is ranging.*

Kijun-sen

Kijun-sen (基準 線) calculation: (highest high + 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. **The Kijun Sen acts as an indicator of future price movement. If the price is higher than the** blue line, it could continue to climb higher. If the price is below the blue line, it could keep dropping.

Senkou span A

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

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

If the price is above the Senkou span, the top line serves as the first support level while the bottom line serves as the second support level.

If the price is below the Senkou span, the bottom line forms the first resistance level while the top line is the second resistance level.

Senkou span B

Senkou span B calculation: (highest high + 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.

The Kumo cloud changes in shape and height based on price changes. This height represents volatility as larger price movements form thicker clouds, which creates a stronger support and resistance. As thinner clouds offer only weak support and resistance, prices can and tend to break through such thin clouds.

Generally, markets are bullish when Senkou Span A is above Senkou Span B and vice versa when markets are bearish. Traders often look for Kumo Twists in future clouds, where Senkou Span A and B exchange positions, a signal of potential trend reversals.

In addition to thickness, the strength of the cloud can also be ascertained by its angle; upwards for bullish and downwards for bearish. Any clouds behind price are also known as Kumo Shadows.

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.

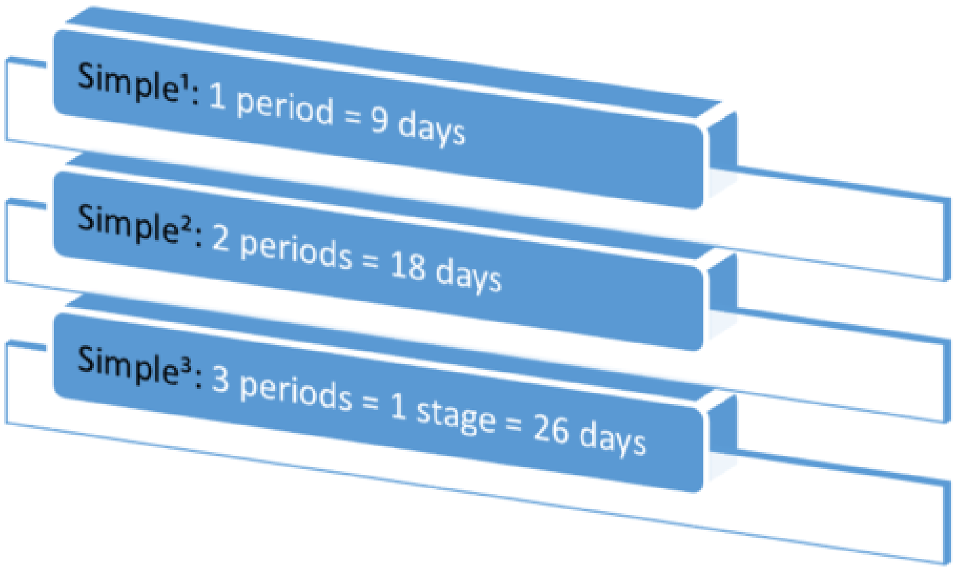
If the Chikou Span or the green line crosses the price in the bottom-up direction, that is a buy signal. If the green line crosses the price from the top-down, that is a sell signal.

8.5.2 The key elements of Ichimoku's Time Theory

Goichi Hosoda also developed the time theory by differentiating 3 time ranges and two different levels: Simple and compound.

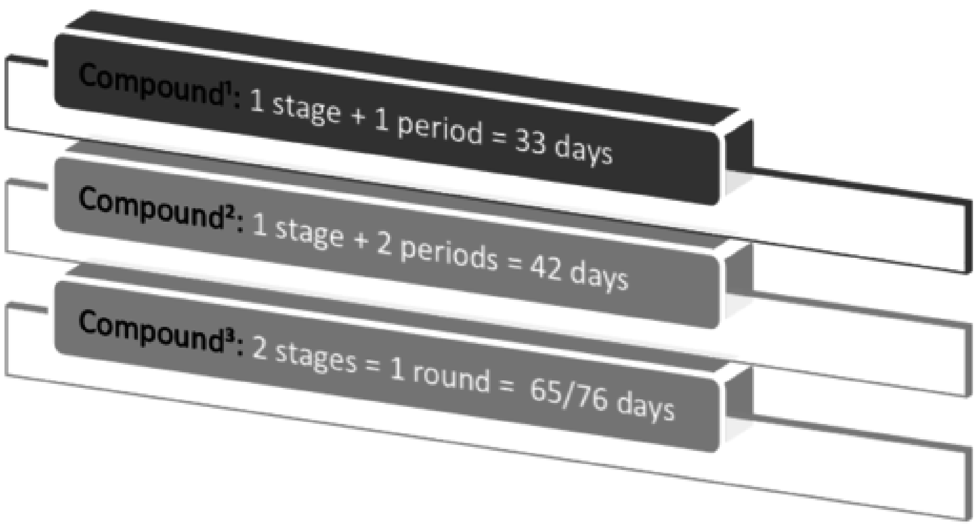
Numerical values

Simple ranges



Simple ranges at ICHIMOKU

Compound ranges



Compound ranges at ICHIMOKU

Equality in the numerical values or Taitou-Suchi

Hen-Gi: Using a numerical value that happened before and applying it from another

Jyu-Gi: Proposing a numerical value that happened before and applying it from a point between the time range

8.5.3 The key elements of Ichimoku's Wave Movement Theory

Hosoda knew about Elliot' s wave principle but his renderings about it were not as complex as Elliot' s. Goichi opted for a simpler version which is focused on pattern detection. Those patterns allowed him to monitor any trend structure but not to define clear target levels or take profits. He classified two main movements:

Primary movements

Primary Waves at ICHIMOKU

Secondary movements

8.5.4 The key elements of Ichimoku's Price Theory

In order to define target levels, Ichimoku uses 4 different ways to calculate them.

Value E: most frequent one

Value V

Value N

Secondary Waves at ICHIMOKU

Value NT: just in case of minor corrections

Those target prices left us a range at **1,2750 –1,2800** which **is invalid** to set as a possible target. This invalid level match with the range between Values V & N.

8.5.5 References

[1] "Ichimoku complementing candlestick chart" section of the page "Ichimoku cloud". ForexAbode.com.

[2] Kumotrader Ichimoku Wiki

[3] "The History of Ichimoku 1968 - Present Day". ichi-mo-ku.com. Archived from the original on 22 June 2012. Retrieved 13 May 2013.

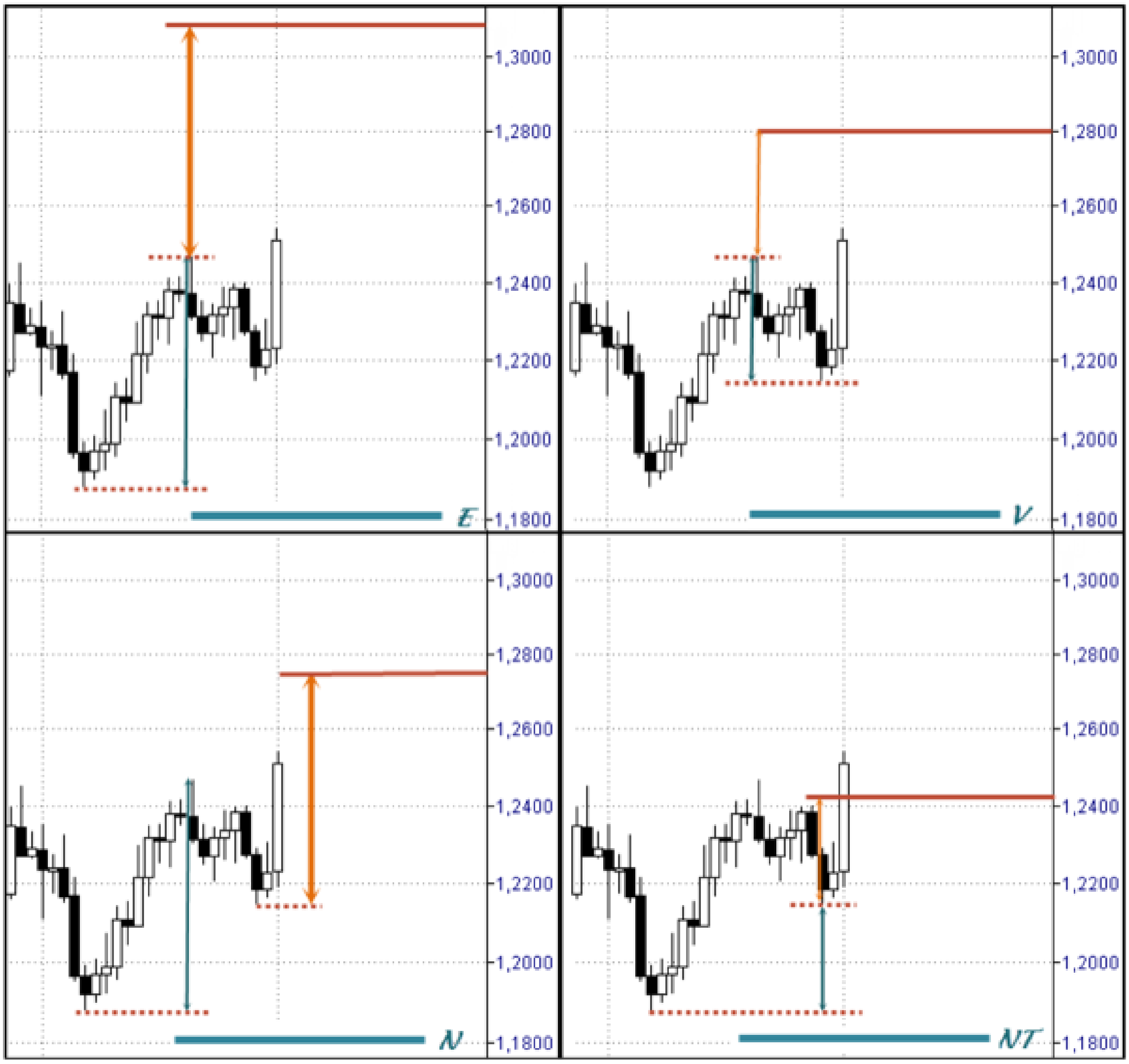
[4] Ichimoku Chinkou Cross

[5] Ichimoku Cloud Filters Information Storm

[6] "Ichimoku Time Theory" section of the page "Ichimoku TimeTheory". Ichimoku.com.

[7] "Ichimoku Wave Movement Theory" section of the page "Ichimoku TimeTheory". Ichimoku.com.

[8] "Ichimoku Price Theory" section of the page "Ichimoku TimeTheory". Ichimoku.com.



Target levels at ICHIMOKU

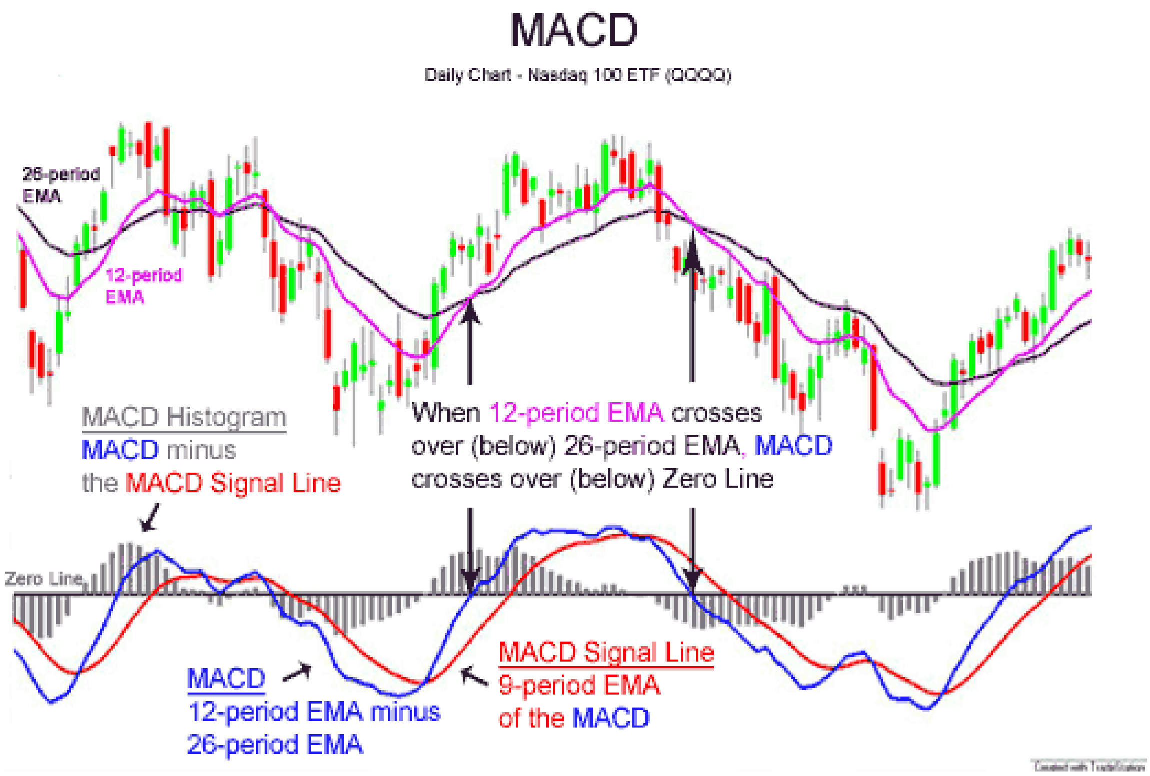
8.5.6 External links

8.6 MACD

MACD, short for **moving average convergence/divergence**, is a trading indicator used in technical analysis of stock prices, created by Gerald Appel in the late 1970s.*[1] It is supposed to reveal changes in the strength, direction, momentum, and duration of a trend in a stock's price.

The MACD indicator (or "oscillator") is a collection of three time series calculated from historical price data, most often the closing price. These three series are: the MACD series proper, the "signal" or "average" series, and the "divergence" series which is the difference between the two. The MACD series is the difference between a "fast" (short period) exponential moving average (EMA), and a "slow" (longer period) EMA of the price series. The average series is an EMA of the MACD series itself.

The MACD indicator thus depends on three time parameters, namely the time constants of the three EMAs. The notation "MACD(a,b,c)" usually denotes the indicator where the MACD series is the difference of EMAs with characteristic times a and b, and the average series is an EMA of the MACD series with characteristic time c. These parameters are usually measured in days. The most commonly used values are 12, 26, and 9 days, that is, MACD(12,26,9). As true with most of the technical indicators, MACD also finds its period settings from the old days when technical analysis used to be mainly based on the daily charts. The reason was the lack of the modern trading platforms which show the changing prices every moment. As the working week used to be 6-days, the period



Example of historical stock price data (top half) with the typical presentation of a MACD(12,26,9) indicator (bottom half). The blue line is the MACD series proper, the difference between the 12-day and 26-day EMAs of the price. The red line is the average or signal series, a 9-day EMA of the MACD series. The bar graph shows the divergence series, the difference of those two lines.

settings of (12, 26, 9) represent 2 weeks, 1 month and one and a half week. *[2] Now when the trading weeks have only 5 days, possibilities of changing the period settings cannot be overruled. However, it is always better to stick to the period settings which are used by the majority of traders as the buying and selling decisions based on the standard settings further push the prices in that direction.

The MACD and average series are customarily displayed as continuous lines in a plot whose horizontal axis is time, whereas the divergence is shown as a bar graph (often called a histogram).

A fast EMA responds more quickly than a slow EMA to recent changes in a stock's price. By comparing EMAs of different periods, the MACD series can indicate changes in the trend of a stock. It is claimed that the divergence series can reveal 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 (trading in a range) or are trading with erratic price action.

8.6.1 History

The MACD series proper was invented by Gerald Appel*[3] in the 1970s. Thomas Aspray added the divergence bar graph to the MACD in 1986, as a means to anticipate MACD crossovers, an indicator of important moves in the underlying security.

Variations of the MACD include the zero lag MACD*[4]

8.6.2 Terminology

Over the years, elements of the MACD have become known by multiple and often over-loaded terms. The common definitions of particularly overloaded terms are:

Divergence: 1. As the D in MACD, "divergence" refers to the two underlying moving averages drifting apart, while "convergence" refers to the two underlying moving averages coming towards each other. 2. Gerald Appel referred to a “divergence” as the situation where the MACD line does not conform to the price movement, e.g. a price low is not accompanied by a low of the MACD.*[5] and 3. Thomas Asprey dubbed the difference between the MACD and its signal line the “divergence” series. In practice, definition number 2 above is often preferred.

Histogram:*[6] 1. Gerald Appel referred to bar graph plots of the basic MACD time series as “histogram”. In Appel's Histogram the height of the bar corresponds to the MACD value for a particular point in time. 2. The difference between the MACD and its Signal line is often plotted as a bar chart and called a “histogram”. In practice, definition number 2 above is often preferred.

8.6.3 Mathematical interpretation

In signal processing terms, the MACD series is a filtered measure of the derivative of the input (price) series with respect to time. (The derivative is called “velocity” in technical stock analysis). MACD estimates the derivative as if it were calculated and then filtered by the two low-pass filters in tandem, multiplied by a “gain” equal to the difference in their time constants. It also can be seen to approximate the derivative as if it were calculated and then filtered by a single low pass exponential filter (EMA) with time constant equal to the sum of time constants of the two filters, multiplied by the same gain.*[7] So, for the standard MACD filter time constants of 12 and 26 days, the MACD derivative estimate is filtered approximately by the equivalent of a low-pass EMA filter of 38 days. The time derivative estimate (per day) is the MACD value divided by 14.

The average series is also a derivative estimate, with an additional low-pass filter in tandem for further smoothing (and additional lag). The difference between the MACD series and the average series (the divergence series) represents a measure of the second derivative of price with respect to time (“acceleration” in technical stock analysis). This estimate has the additional lag of the signal filter and an additional gain factor equal to the signal filter constant.

Classification

The MACD can be classified as 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.

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

8.6.4 Trading interpretation

Exponential moving averages highlight recent changes in a stock's price. By comparing EMAs of different lengths, the MACD series gauges changes in the trend of a stock. The difference between the MACD series and its average is claimed to reveal subtle shifts in the strength and direction of a stock's trend. It may be necessary to correlate the signals with the MACD to indicators like RSI power.

Some traders attribute special significance to the MACD line crossing the signal line, or the MACD line crossing the zero axis. Significance is also attributed to disagreements between the MACD line or the difference line and the stock price (specifically, higher highs or lower lows on the price series that are not matched in the indicator series).

Signal-line crossover

A “signal-line crossover” occurs when the MACD and average lines cross; that is, when the divergence (the bar graph) changes sign. The standard interpretation of such an event is a recommendation to buy if the MACD line crosses up through the average line (a “bullish” crossover), or to sell if it crosses down through the average line (a “bearish” crossover). These events are taken as indications that the trend in the stock is about to accelerate in the direction of the crossover.

Zero crossover

A “zero crossover” event occurs when the MACD series changes sign, that is, the MACD line crosses the horizontal zero axis. This happens when there is no difference between the fast and slow EMAs of the price series. A change from positive to negative MACD is interpreted as “bearish”, and from negative to positive as “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

A “positive divergence” or “bullish divergence” occurs when the price makes a new low but the MACD does not confirm with a new low of its own. A “negative divergence” or “bearish divergence” occurs when the price makes a new high but the MACD does not confirm with a new high of its own. A divergence with respect to price may occur on the MACD line and/or the MACD Histogram.*[8]

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.*[9] 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 forecasting algorithm, 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 may be to apply a filter to signal line crossovers to ensure that they have held up. 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 the probability of false signals but increases the frequency of missed profit.

Analysts use a variety of approaches to filter out false signals and confirm true ones.

A 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.

8.6.5 Further reading

8.6.6 See also

- Relative Strength Index
- Ultimate Oscillator
- Williams %R

8.6.7 References

[1] Appel, Gerald (2005). *Technical Analysis Power Tools for Active Investors*. Financial Times Prentice Hall. p. 166. ISBN 0-13-147902-4.

[2] “Why MACD (12, 26, 9)?" section of the page “Moving Average Convergence-Divergence (MACD) - The Complete Guide”. ForexAbode.com.

[3] Gerald Appel (), INO TV

[4] http://www.forexo.co.uk/macd-moving-average-convergence-divergence

[5] Appel, Gerald (2005). *Technical Analysis Power Tools for Active Investors*. Financial Times Prentice Hall. ISBN 0-13-147902-4.

[6] Patterson, Jackie Ann (2014). *Truth About MACD: What Worked, What Didn't Work, and How to Avoid Mistakes Even Experts Make*. Own Mountain Trading Company. pp. 19–21. ISBN 1492749842.

[7] The MACD Approach to Derivative (Rate of Change) Estimation

[8] Patterson, Jackie Ann (2014). *Truth About MACD: What Worked, What Didn't Work, and How to Avoid Mistakes Even Experts Make*. Own Mountain Trading Company. pp. 45–99. ISBN 1492749842.

[9] Murphy, John (1999). *Technical Analysis of the Financial Markets*. Prentice Hall Press. pp. 252–255. ISBN 0-7352-0066-1.

8.6.8 External links

8.7 Mass index

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*[1] 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).

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

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).*[2] 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.

8.7.1 References

[1] Mass Index construction at IncredibleCharts.com

[2] Mass Index at IncredibleCharts.com

8.8 Moving average

For other uses, see Moving average (disambiguation).

In statistics, a **moving average** (**rolling average** or **running average**) is a calculation to analyze data points by creating series of averages of different subsets of the full data set. It is also called a **moving mean (MM)***[1] or **rolling mean** and is a type of finite impulse response filter. Variations include: simple, and cumulative, or weighted forms (described below).

Given a series of numbers and a fixed subset size, the first element of the moving average is obtained by taking the average of the initial fixed subset of the number series. Then the subset is modified by "shifting forward"; that is, excluding the first number of the series and including the next number following the original subset in the series. This creates 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. A moving average is a set of numbers, each of which is the

average of the corresponding subset of a larger set of datum points. A moving average may also use unequal weights for each datum 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 can be viewed as an example of a low-pass filter used in signal processing. When used with non-time series data, a moving average filters higher frequency components without any specific connection to time, although typically some kind of ordering is implied. Viewed simplistically it can be regarded as smoothing the data.

8.8.1 Simple moving average

In financial applications a **simple moving average** (SMA) is the unweighted mean of the previous *n* data. However, in science and engineering the mean is normally taken from an equal number of data on either side of a central value. This ensures that variations in the mean are aligned with the variations in the data rather than being shifted in time. An example of a simple equally weighted running mean for a n-day sample of closing price is the mean of the previous *n* days' closing prices. If those prices are $p_M, p_{M-1}, \ldots, p_{M-(n-1)}$ then the formula is

$$\begin{aligned} SMA &= \frac{p_M + p_{M-1} + \ldots + p_{M-(n-1)}}{n} \\ &= \frac{1}{n}\sum_{i=0}^{n-1} p_{M-i} \end{aligned}$$

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 for this simple case,

$$\textit{SMA}_{\text{today}} = \textit{SMA}_{\text{yesterday}} + \frac{p_M}{n} - \frac{p_{M-n}}{n}$$

The period selected depends on the type of movement of interest, such as short, intermediate, or long-term. In financial terms moving-average levels can be interpreted as support in a falling market, or resistance in a rising market.

If the data used are not centered around the mean, a simple moving average lags behind the latest datum point by half the sample width. An SMA can also be disproportionately influenced by old datum points dropping out or new data coming in. 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.*[2]

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 data equally spaced on either side of the point in the series where the mean is calculated.*[3] This requires using an odd number of datum points in the sample window.

A major drawback of the SMA is that it lets through a significant amount of the signal shorter than the window length. Worse, it *actually inverts it*. This can lead to unexpected artifacts, such as peaks in the smoothed result appearing where there were troughs in the data. It also leads to the result being less smooth than expected since some of the higher frequencies are not properly removed.

8.8.2 Cumulative moving average

In a **cumulative moving average**, the data arrive in an ordered datum stream, and the user would like to get the average of all of the data up until the current datum 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, typically an equally weighted average of the sequence of n values $x_1.\ldots,x_n$ up to the current time:

$$\mathit{CMA}_n = \frac{x_1 + \cdots + x_n}{n}\,.$$

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 datum points every time a new datum point arrived. However, it is possible to simply update cumulative average as a new value, x_{n+1} becomes available, using the formula:

$$\textit{CMA}_{n+1} = \frac{x_{n+1} + n \cdot \textit{CMA}_n}{n+1}$$

Thus the current cumulative average for a new datum point is equal to the previous cumulative average, times *n*, plus the latest datum point, all divided by the number of points received so far, *n*+1. When all of the datum points arrive ($n = N$), then the cumulative average will equal the final average.

The derivation of the cumulative average formula is straightforward. Using

$$x_1 + \cdots + x_n = n \cdot \textit{CMA}_n$$

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

$$x_{n+1} = (x_1 + \cdots + x_{n+1}) - (x_1 + \cdots + x_n) = (n+1) \cdot \textit{CMA}_{n+1} - n \cdot \textit{CMA}_n$$

Solving this equation for $\textit{CMA}_{n+1}$ results in:

$$\textit{CMA}_{n+1} = \frac{x_{n+1} + n \cdot \textit{CMA}_n}{n+1} = \textit{CMA}_n + \frac{x_{n+1} - \textit{CMA}_n}{n+1}$$

8.8.3 Weighted moving average

A weighted average is any average that has multiplying factors to give different weights to data at different positions in the sample window. Mathematically, the moving average is the convolution of the datum points with a fixed weighting function. One application is removing pixelisation from a digital graphical image.

In technical analysis of financial data, a **weighted moving average** (WMA) has the specific meaning of weights that decrease in arithmetical progression.*[4] In an *n*-day WMA the latest day has weight *n*, the second latest $n - 1$, etc., down to one.

$$\text{WMA}_M = \frac{np_M + (n-1)p_{M-1} + \cdots + 2p_{(M-n+2)} + p_{(M-n+1)}}{n + (n-1) + \cdots + 2 + 1}$$

The denominator is a triangle number equal to $\frac{n(n+1)}{2}$. In the more general case the denominator will always be the sum of the individual weights.

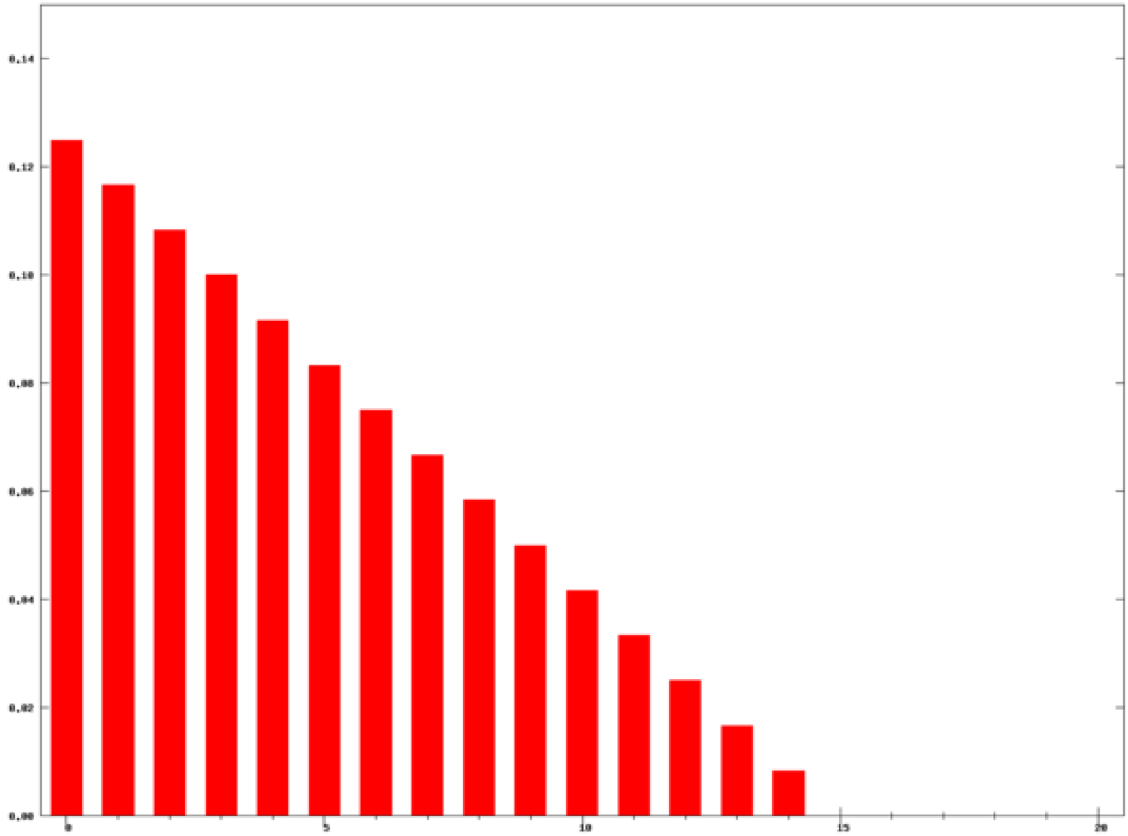
When calculating the WMA across successive values, the difference between the numerators of WMA_{M+1} and WMA_{M} is $np_{M+1} - p_{\text{M}} - \cdots - p_{M-\text{n}+1}$. If we denote the sum $p_{\text{M}} + \cdots + p_{M-n+1}$ by Total_{M}, then

$$\text{Total}_{M+1} = Total_M + p_{M+1} - p_{M-n+1}$$

$$\text{Numerator}_{M+1} = \text{Numerator}_M + np_{M+1} - Total_M$$

$$\text{WMA}_{M+1} = \frac{\text{Numerator}_{M+1}}{n + (n-1) + \cdots + 2 + 1}$$

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



WMA weights n = *15*

8.8.4 Exponential moving average

Further information: EWMA chart and Exponential smoothing

An **exponential moving average** (EMA), also known as an **exponentially weighted moving average** (EWMA),*[5] is a type of infinite impulse response filter that applies weighting factors which decrease exponentially. The weighting for each older datum decreases exponentially, never reaching zero. The graph at right shows an example of the weight decrease.

The EMA for a series Y may be calculated recursively:

$$S_1 = Y_1$$

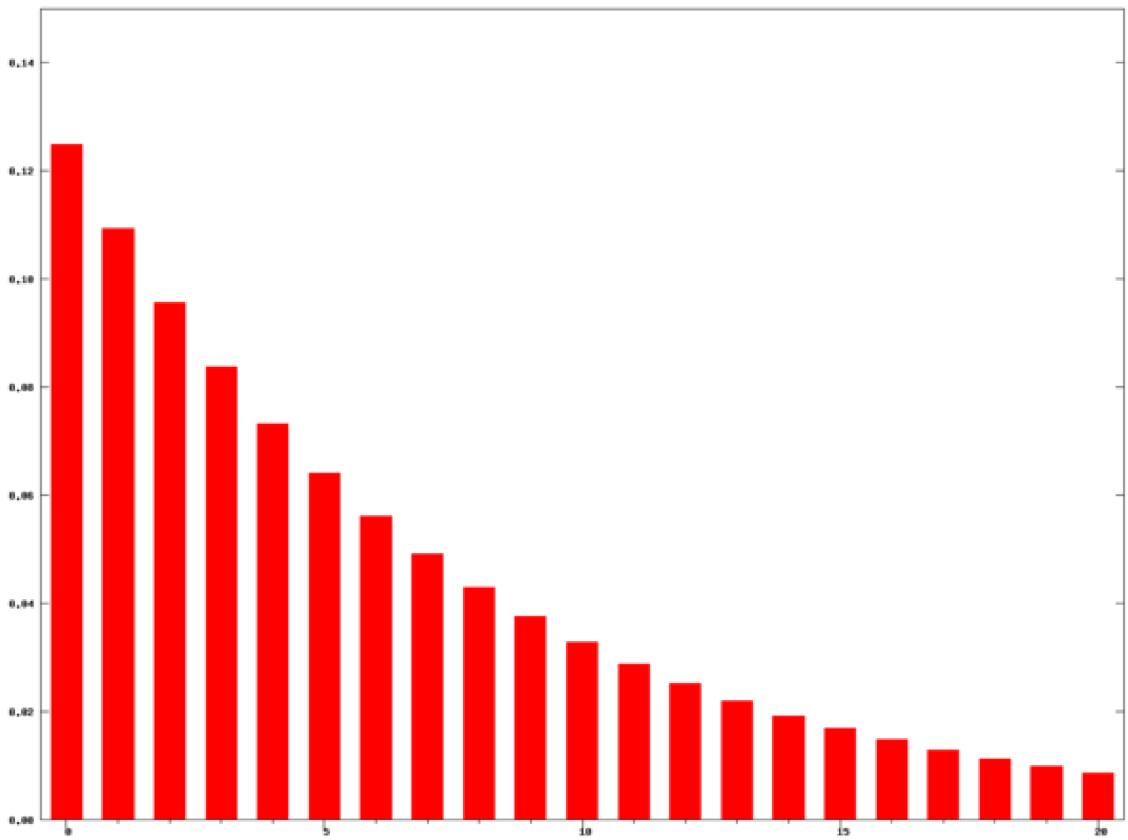
for $t > 1, \quad S_t = \alpha \cdot Y_t + (1 - \alpha) \cdot S_{t-1}$

Where:

- The coefficient α represents the degree of weighting decrease, a constant smoothing factor between 0 and 1. A higher α discounts older observations faster.
- Y_t is the value at a time period t.
- S_t is the value of the EMA at any time period t.

S_1 is undefined. S_1 may be initialized in a number of different ways, most commonly by setting S_1 to Y_1, though other techniques exist, such as setting S_1 to an average of the first 4 or 5 observations. The importance of the S_1 initialisations effect on the resultant moving average depends on α; smaller α values make the choice of S_1 relatively more important than larger α values, since a higher α discounts older observations faster.

Whatever is done for S_1 it assumes something about values prior to the available data and is necessarily in error. In view of this the early results should be regarded as unreliable until the iterations have had time to converge. This is



EMA weights N=*200*

sometimes called a 'spin-up' interval. One way to assess when it can be regarded as reliable is to consider the required accuracy of the result. For example, if 3% accuracy is required, initialising with Y_1 and taking data after five time constants (defined above) will ensure that the calculation has converged to within 3% (only <3% of Y_1 will remain in the result). Sometimes with very small alpha, this can mean little of the result is useful. This is analogous to the problem of using a convolution filter (such as a weighted average) with a very long window.

This formulation is according to Hunter (1986).*[6] By repeated application of this formula for different times, we can eventually write S_t as a weighted sum of the datum points Y_t, as:

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

for any suitable k = 0, 1, 2, ... The weight of the general datum 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}:*[7]

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

This formula can also be expressed in technical analysis terms as follows, showing how the EMA steps towards the latest datum point, but only by a proportion of the difference (each time):

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

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

$$\text{EMA}_{\text{today}} = \alpha \times (p_1 + (1-\alpha)p_2 + (1-\alpha)^2 p_3 + (1-\alpha)^3 p_4 + \cdots)$$

where

- p_1 is price$_{\text{today}}$
- p_2 is price$_{\text{yesterday}}$
- and so on

$\text{EMA}_{\text{today}} = \frac{p_1+(1-\alpha)p_2+(1-\alpha)^2p_3+(1-\alpha)^3p_4+\cdots}{1+(1-\alpha)+(1-\alpha)^2+(1-\alpha)^3+\cdots}$,

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

This is an infinite sum with decreasing terms.

The *N* periods in an *N*-day EMA only specify the α 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* datum points in an EMA represent about 86% of the total weight in the calculation when $\alpha = 2/(N+1)$:*[8]

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

i.e. $\lim_{N\to\infty}\left[1-\left(1-\frac{2}{N+1}\right)^{N+1}\right]$ simplified,*[9] tends to $1-\mathrm{e}^{-2} \approx 0.8647$.

The above discussion requires a bit of clarification. The sum of the weights of all the terms (i.e., infinite number of terms) in an exponential moving average is 1. The sum of the weights of N terms is $1-(1-\alpha)^{N+1}$. Both of these sums can be derived by using the formula for the sum of a geometric series. The weight omitted after N terms is given by subtracting this from 1, and you get $1-(1-(1-\alpha)^{N+1}) = (1-\alpha)^{N+1}$ (this is essentially the formula given below for the weight omitted). Note that there is no "accepted" value that should be chosen for α although there are some recommended values based on the application. In the above discussion, we have substituted a commonly used value for $\alpha = 2/(N+1)$ in the formula for the weight of N terms. This value for α comes from setting the average age of the data from a SMA equal to the average age of the data from an EMA and solving for α . Again, it is just a recommendation—not a requirement. If you make this substitution, and you make use of*[10] $\lim_{n\to\infty}\left(1+\frac{a}{1+n}\right)^n = e^a$, then you get the 0.864 approximation. Intuitively, what this is telling us is that the weight after N terms of an "N -period" exponential moving average converges to 0.864.

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. Large price values in old data will affect on the total even if their weighting is very small. If prices have small variations then just the weighting can be considered. The weight omitted by stopping after *k* terms is

$$\alpha \times \left((1-\alpha)^k + (1-\alpha)^{k+1} + (1-\alpha)^{k+2} + \cdots\right),$$

which is

$$\alpha \times (1-\alpha)^k \times \left(1+(1-\alpha)+(1-\alpha)^2+\cdots\right),$$

i.e. a fraction

$$\frac{\text{terms k after stopping by omitted weight}}{\text{weight total}} = \frac{\alpha \times \left[(1-\alpha)^k + (1-\alpha)^{k+1} + (1-\alpha)^{k+2} + \cdots\right]}{\alpha \times \left[1+(1-\alpha)+(1-\alpha)^2+\cdots\right]}$$

$$= \frac{\alpha(1-\alpha)^k \times \frac{1}{1-(1-\alpha)}}{\frac{\alpha}{1-(1-\alpha)}}$$

$$= (1-\alpha)^k$$

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,*[11] this simplifies to approximately*[12]

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

for this example (99.9% weight).

Modified moving average

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

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

In short, this is an 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 α 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

$$\alpha(t_n - t_{n-1}) = 1 - \exp\left(-\frac{t_n - t_{n-1}}{W \times 60}\right)$$

where *exp()* is the exponential function, 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 α , the moving average can be expressed as

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

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

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

8.8.5 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*[13] (a central moving average). The symmetric weight coefficients are −3, −6, −5, 3, 21, 46, 67, 74, 67, 46, 21, 3, −5, −6, −3.

Outside the world of finance, weighted running means have many forms and applications. Each weighting function or "kernel" has its own characteristics. In engineering and science the frequency and phase response of the filter is often of primary importance in understanding the desired and undesired distortions that a particular filter will apply to the data.

A mean does not just "smooth" the data. A mean is a form of low-pass filter. The effects of the particular filter used should be understood in order to make an appropriate choice. On this point, the French version of this article discusses the spectral effects of 3 kinds of means (cumulative, exponential, Gaussian).

8.8.6 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:

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

where the median is found by, for example, sorting the values inside the brackets and finding the value in the middle. For larger values of n, the median can be efficiently computed by updating an indexable skiplist.*[14]

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.*[15] 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.

8.8.7 Moving average regression model

In a moving average regression model, a variable of interest is assumed to be a weighted moving average of an unobserved error term; the weights in the moving average are parameters to be estimated.

8.8.8 See also

- Exponential smoothing
- Moving average convergence/divergence indicator
- Window function
- Moving average crossover
- Rising moving average
- Running total
- Local regression
- Kernel smoothing

8.8.9 Notes and references

[1] Hydrologic Variability of the Cosumnes River Floodplain (Booth et al., San Francisco Estuary and Watershed Science, Volume 4, Issue 2, 2006)

[2] *Statistical Analysis*, Ya-lun Chou, Holt International, 1975, ISBN 0-03-089422-0, section 17.9.

[3] The derivation and properties of the simple central moving average are given in full at Savitzky–Golay filter

[4] "Weighted Moving Averages: The Basics". Investopedia.

[5] http://lorien.ncl.ac.uk/ming/filter/filewma.htm

[6] NIST/SEMATECH e-Handbook of Statistical Methods: Single Exponential Smoothing at the National Institute of Standards and Technology

[7] NIST/SEMATECH e-Handbook of Statistical Methods: EWMA Control Charts at the National Institute of Standards and Technology

[8] The denominator on the left-hand side should be unity, and the numerator will become the right-hand side (geometric series), $\alpha\left(\frac{1-(1-\alpha)^{N+1}}{1-(1-\alpha)}\right)$.

[9] Because (1+*x*/*n*)*n tends to the limit e*x for large n.

[10] See the following link for a proof.

[11] It means α -> 0, and the Taylor series of $\log(1-\alpha) = -\alpha - \alpha^2/2 - \cdots$ is equivalent to $-\alpha$.

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

[13] Spencer's 15-Point Moving Average —from Wolfram MathWorld

[14] http://code.activestate.com/recipes/576930/

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

8.9 Parabolic SAR

In stock and securities market technical analysis, **parabolic SAR** (parabolic stop and reverse) is a method devised by J. Welles Wilder, Jr., to find potential reversals in the market price direction of traded goods such as securities or currency exchanges such as forex.*[1] It is a trend-following (lagging) indicator and may be used to set a trailing stop loss or determine entry or exit points based on prices tending to stay within a parabolic curve during a strong trend.

Similar to option theory's concept of time decay, the concept draws on the idea that "time is the enemy". Thus, unless a security can continue to generate more profits over time, it should be liquidated. The indicator generally works only in trending markets, and creates "whipsaws" during ranging or, sideways phases. Therefore, Wilder recommends first establishing the direction or change in direction of the trend through the use of parabolic SAR, and then using a different indicator such as the Average Directional Index to determine the strength of the trend.

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

8.9.1 Construction

The parabolic SAR is calculated almost independently for each trend in the price. When the price is in an uptrend, the SAR emerges below the price and converges upwards towards it. Similarly, on a downtrend, the SAR emerges above the price and converges downwards. At each step within a trend, the SAR is calculated one period in advance. 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 the current period and the next period's SAR values, respectively.

EP (the extreme point) 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. During each period, if a new maximum (or minimum) is observed, the EP is updated with that value.

The α value represents the acceleration factor. Usually, this is set initially to a value of 0.02, but can be chosen by the trader. This factor is increased by 0.02 each time a new EP is recorded, which means that every time a new EP is observed, it will make the acceleration factor go up. The rate will then quicken to a point where the SAR converges towards the price. To prevent it from getting too large, a maximum value for the acceleration factor is normally set to 0.20. The traders can set these numbers depending on their trading style and the instruments being traded. Generally, it is preferable in stocks trading to set the acceleration factor to 0.01, so that is not too sensitive to local decreases. For commodity or currency trading, the preferred value is 0.02.

The SAR is calculated in this manner for each new period. However, two special cases will modify the SAR value:

- If the next period' s SAR value is inside (or beyond) the current period or the previous period' s price range, the SAR must be set to the closest price bound. For example, if in an upward trend, the new SAR value is calculated and if it results to be more than today' s or yesterday' s lowest price, it must be set equal to that lower boundary.
- If the next period' s SAR value is inside (or beyond) the next period' s price range, a new trend direction is then signaled. The SAR must then switch sides.

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

8.9.2 References

[1] J. Welles Wilder, Jr. (June 1978). *New Concepts in Technical Trading Systems*. Greensboro, NC: Trend Research. ISBN 978-0-89459-027-6.

8.10 Smart money index

Smart money index (SMI) or **smart money flow index** is a technical analysis indicator demonstrating investors' sentiment. The index was invented and popularized by money manager Don Hays.*[1] The indicator is based on intra-day price patterns.*[2]

The main idea is that the majority of traders (emotional, news-driven) overreact at the beginning of the trading day because of the overnight news and economic data. There is also a lot of buying on market orders and short covering at the opening. Smart, experienced investors start trading closer to the end of the day having the opportunity to evaluate market performance. Therefore, the basic strategy is to bet against the morning price trend and bet with the evening price trend. The SMI may be calculated for many markets and market indices (S&P 500, DJIA, etc.)

8.10.1 Basic formula

The basic formula for SMI is:

Today's SMI reading = yesterday's SMI – opening gain or loss + last hour change

For example, the SMI closed yesterday at 10000. During the first 30 minutes of today's trading, the DJIA has gained a total of 100 points. During the final hour, the DJIA has lost 80 points. So, today's SMI is 10000 – 100 + -80 = 9820.

8.10.2 Interpretation

The SMI sends no clear signal whether the market is bullish or bearish. There are also no fixed absolute or relative readings signaling about the trend. Traders need to look at the SMI dynamics relative to that of the market. If, for example, SMI rises sharply when the market falls, this fact would mean that smart money is buying, and the market is to revert to an uptrend soon. The opposite situation is also true. A rapidly falling SMI during a bullish market means that smart money is selling and that market is to revert to a downtrend soon. The SMI is, therefore, a trend-based indicator.

8.10.3 References

[1] "Smart Money Index (SMI)". SentimenTrader. 2006. Retrieved 16 July 2013.

[2] Hertler Market Signal

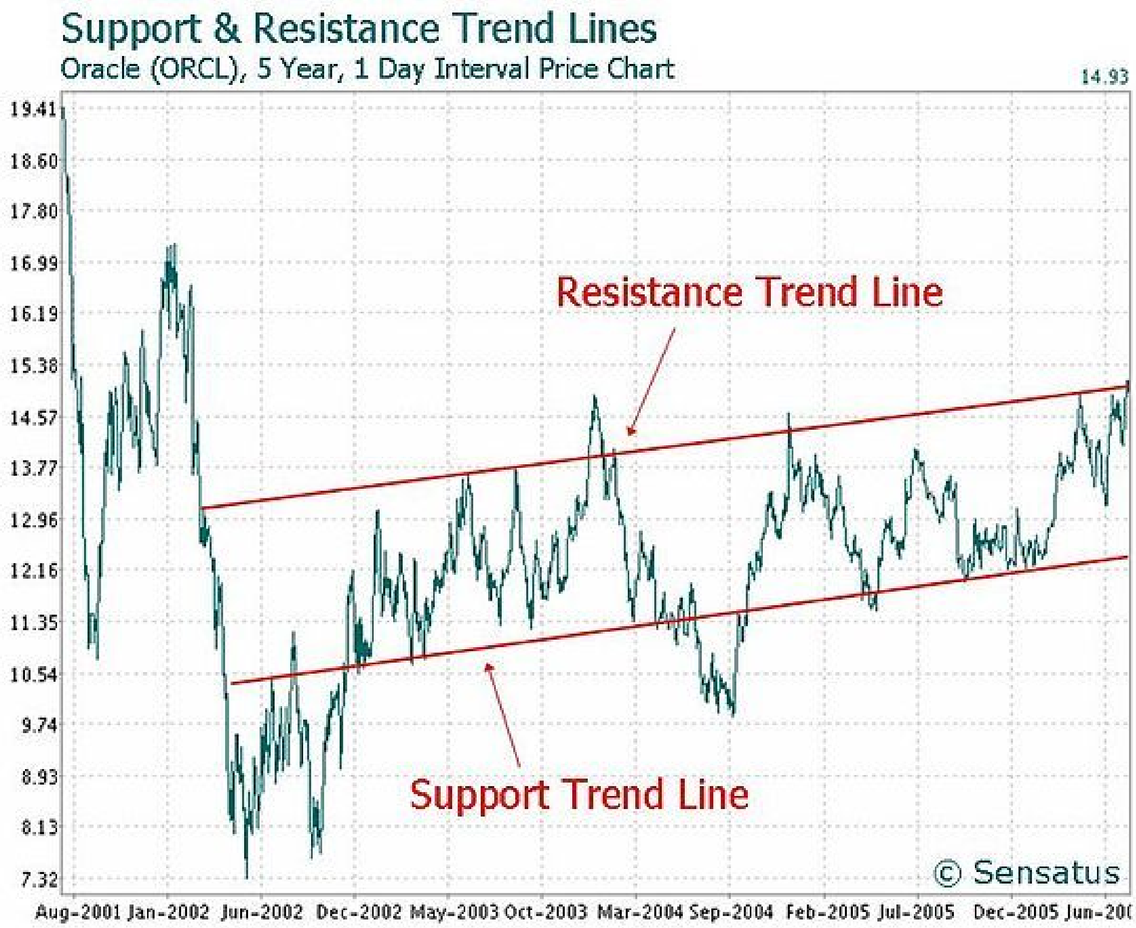
8.10.4 External links

- Smart Money Index: Accumulation During Decline
- SMI charts
- Hertler Market Signal Update
- Detailed description and Charts of the Smart Money Index

8.11 Trend line (technical analysis)

A **trend line** is a bounding line for the price movement of a security. It is formed when a diagonal line can be drawn between two or more price pivot points. Trend lines are commonly used to decide entry and exit timing when trading securities.*[1] They can also be referred to as **Dutch lines**, as the concept was first used in Holland.

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. Stock often begin or end trending because of a stock catalyst such as a product launch or change in management.



Trend lines on a price chart.

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. 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.

Previous chart from 1950 to about 1990, showing how linear scale obscures details by compressing the data.

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 pivots 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.

8.11.1 See also

- Support and resistance

8.11.2 References

[1] Edwards, Robert D.; Magee, John (1948). “14”. *Technical Analysis of Stock Trends.* Springfield, MA, USA: Stock Trend Service. p. 505. ISBN 1-880408-00-7.

8.12 Trix (technical analysis)

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 "**tri**ple e**x**ponential.”

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.

8.12.1 References

- chartalytics.com article on TRIX price trend determination
- StockCharts.com article on TRIX, by Nicholas Fisher

8.13 Vortex indicator

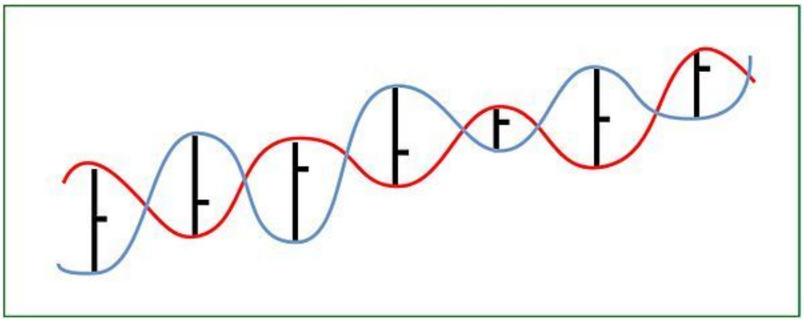
The Vortex Indicator is a technical indicator invented by Etienne Botes and Douglas Siepman to identify the start of a new trend or the continuation of an existing trend within financial markets. It was published in the January 2010 edition of *Technical Analysis of Stocks & Commodities*.*[1]

8.13.1 Inspiration

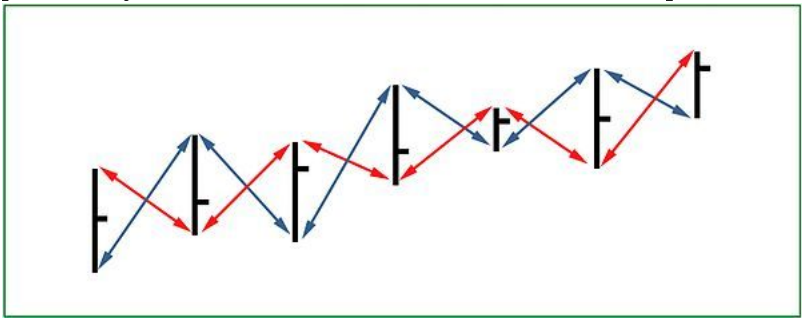
The Vortex Indicator was inspired by the work of an Austrian inventor, Viktor Schauberger, who studied the flow of water in rivers and turbines. Etienne Botes and Douglas Siepman developed the idea that movements and flows within financial markets are similar to the vortex motions found in water. The 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.*[2]

8.13.2 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−).

8.13.3 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.* [3]

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.

8.13.4 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:**
  - SUM VM21+/SUM TR21 = VI21+
  - SUM VM21-/SUM TR21 = VI21−

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

8.13.5 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.

8.13.6 Coding and strategies

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

8.13.7 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.*[7]

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.*[8]

8.13.8 See also

- Technical analysis
- Market trends

8.13.9 References

[1] Botes, Etienne & Siepman, Douglas (January 2010). "The Vortex Indicator". *Technical Analysis of Stocks & Commodities* 28(1), p. 21.

[2] Wilder, J. Welles (1978). *New Concepts In Technical Trading Systems*. Trend Research.

[3] Botes, Etienne & Siepman, Douglas (January 2010). "The Vortex Indicator". *Technical Analysis of Stocks & Commodities* 28(1), p. 25.

[4] "Traders' Tips". Technical Analysis of Stocks & Commodities. January 2010. Retrieved 17 January 2010.

[5] Mills, Mark (January 2010). "TRADESTATION: VORTEX INDICATOR". TradeStation Securities, Inc. Retrieved 17 January 2010.

[6] Rast, Pete (January 2010). "STRATASEARCH: VORTEX INDICATOR". Avarin Systems, Inc. Retrieved 17 January 2010.

[7] Denning, Richard (January 2010). "January 2010 Stocks and Commodities Traders Tips". Traders Edge Systems. Retrieved 17 January 2010.

[8] Denning, Richard (January 2010). "January 2010 Stocks and Commodities Traders Tips". Traders Edge Systems. Retrieved 17 January 2010.

8.13.10 External links

- The Vortex Indicator

Chapter 9

Momentum Indicators

9.1 Momentum (finance)

This article is about the concept related to asset prices. For other uses of *momentum* in finance, see Momentum (disambiguation).

In finance, **momentum** is the empirically observed tendency for rising asset prices to rise further, and falling prices to keep falling. 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.*[1]*[2]

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,*[3]*[4] 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.*[5]

9.1.1 See also

- Carhart four-factor model
- Momentum investing

9.1.2 References

[1] Jegadeesh, N; Titman S (1999). "Profitability of Momentum Strategies: An Evaluation of Alternative Explanations" . *NBER Working paper* (7159).

[2] Jegadeesh, N; Titman S (1993). "Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency" . *Journal of Finance* (48). doi:10.1111/j.1540-6261.1993.tb04702.x.

[3] Daniel, K; Hirschleifer D; Subrahmanyam A (1998). "A Theory of Overconfidence, Self-Attribution, and Security Market Under and Over-reactions" . *Journal of Finance* (53). doi:10.2139/ssrn.2017.

[4] Barberis, N; Shleifer A; Vishny R (1998). "A Model of Investor Sentiment" . *Journal of Financial Economics* (49). doi:10.1016/S0304-405X(98)00027-0.

[5] Crombez, J (2001). "Momentum, Rational Agents and Efficient Markets" . *The Journal of Psychology and Financial Markets* (2). doi:10.1207/S15327760JPFM0204_3.

6. Antonacci, G (2014). "Dual Momentum Investing: An Innovative Approach for Higher Returns with Lower Risk,"McGraw-Hill Education, New York, ISBN 0071849440.

9.2 Money flow index

The **money flow index** (**MFI**) is an oscillator that ranges from 0 to 100. It is used to show the *money flow* (an approximation of the dollar value of a day's trading) over several days.

9.2.1 The steps to calculate the money flow index over N days

Step 1: Calculate the typical price

The typical price for each day is the average of high price, the low price and the closing price.*[1]

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

Step 2: Calculate the positive and negative money flow

The money flow for a certain day is typical price multiplied by volume on that day.

$$money\ flow = typical\ price \times volume$$

The money flow is divided into positive and negative money flow.

- Positive money flow is calculated by adding the money flow of all the days where the typical price is higher than the previous day's typical price.
- Negative money flow is calculated by adding the money flow of all the days where the typical price is lower than the previous day's typical price.
- If typical price is unchanged then that day is discarded.

Step 3: Calculate the money ratio

The money ratio is the ratio of positive money flow to negative money flow.

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

Step 4: Calculate the money flow index

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

The money flow index can be expressed equivalently as follows.

$$MFI = 100 \times \frac{positive\ money\ flow}{positive\ moneyflow + negative\ money\ flow}$$

This form more clearly shows what the MFI is a percentage of positive money flow to total money flow.

9.2.2 Uses

MFI is used to measure the "enthusiasm" of the market. In other words, the money flow index shows how much a stock was traded.

A value of 80 or more is generally considered overbought, a value of 20 or less 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 that is likely to reverse.

It should be noted that MFI is constructed in a similar fashion to the relative strength index (RSI). Both look at up days against total up and 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.

9.2.3 Similar indicators

Other price × volume indicators:

- On-balance volume
- Price and volume trend
- Accumulation/distribution index

9.2.4 References

[1] Calculation of Typical Price while Calculating Commodities Channel Index (CCI)

9.2.5 External links

- *Money Flow Index Lookup* Free display of Money Flow Index for public companies

9.3 Relative strength index

The **relative strength index** (**RSI**) is a technical indicator used in the 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.*[1] It has become one of the most popular oscillator indices.*[2]

9.3.1 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 close (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 smoothed or modified moving average (SMMA or MMA) which is a exponentially smoothed Moving Average with α = 1/period. Some commercial packages, like AIQ, use a standard exponential moving average (EMA) as the average instead of Wilder's SMMA.

Wilder originally formulated the calculation of the moving average as: newval = (prevval * (period - 1) + newdata) / period. This if fully equivalent to the aforementioned exponential smoothing. New data is simply divided by period which is equal to the alpha calculated value of 1/period. Previous average values are modified by (period -1)/period which in effect is period/period - 1/period and finally 1 - 1/period which is 1 - alpha.

The ratio of these averages is the *relative strength* or *relative strength factor*:

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

If the average of *D* values is zero, then according to the equation, the RS value will approach infinity, so that the resulting RSI, as computed below, will approach 100.

The relative strength factor is then converted to a relative strength index between 0 and 100:*[1]

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

The smoothed moving averages should be appropriately initialized with a simple moving average using the first *n* values in the price series.

9.3.2 Interpretation

Basic configuration

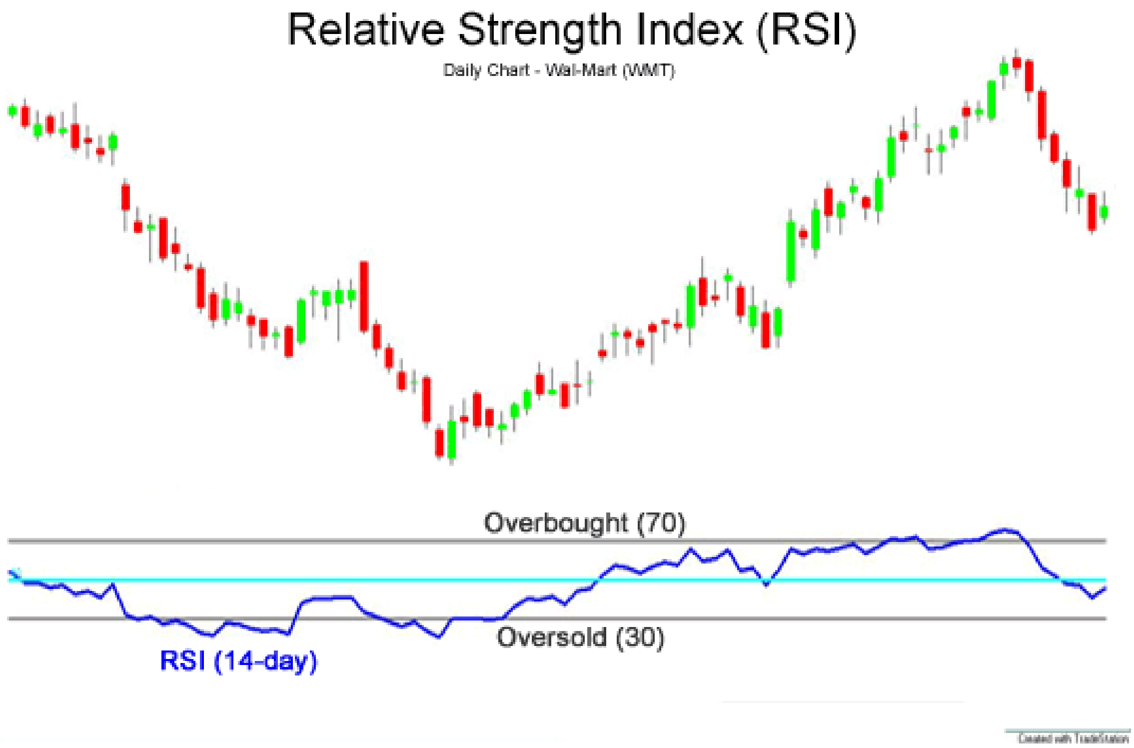
The RSI is presented on a graph above or below the price chart. The indicator has an upper line, typically at 70, a lower line at 30, and a dashed mid-line at 50. Wilder recommended a smoothing period of 14 (see exponential smoothing, i.e. α = 1/14 or *N* = 27).

Principles

Wilder posited*[1] 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.



Relative strength index 14-period

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.*[1]*:68

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.

Example of RSI Indicator Divergence

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.

9.3.3 Cutler's RSI

A variation called Cutler's RSI is based on a simple moving average of U and D,*[3] instead of the exponential average above. Cutler had found that since Wilder used an smoothed 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.

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

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

9.3.4 See also

- MACD moving average convergence/divergence
- True strength index, a similar momentum-based indicator

9.3.5 References

[1] J. Welles Wilder, *New Concepts in Technical Trading Systems*, ISBN 0-89459-027-8

[2] John J. Murphy (2009). *The Visual Investor: How to Spot Market Trends* (2nd ed.). John Wiley and Sons. p. 100. ISBN 9780470382059.

[3] Cutler's RSI page at Aspen Graphics Technical Analysis Software

9.3.6 External links

9.4 Stochastic oscillator

In technical analysis of securities trading, the **stochastic oscillator** is a momentum indicator that uses support and resistance levels. Dr. George Lane developed this indicator in the late 1950s.*[1] The term *stochastic* refers to the point of a current price in relation to its price range over a period of time.*[2] 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:

$$\%K = 100 * ((Price - L5)/(H5 - L5))$$

$$\%D = 100 * ((K1 + K2 + K3)/3)$$

%D is the 3-day moving average of %K (the last 3 values of %K). Usually this is a simple moving average, but can be an exponential moving average for a less standardized weighting for more recent values. There is only one valid signal in working with %D alone —a divergence between %D and the analyzed security.*[3]

9.4.1 Definition

The calculation above finds the range between an asset' s high and low price during a given period of time. The current security's 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
$\%D$ is a 3-period simple moving average of %K, $SMA_3(\%K)$.
$\%D - Slow$ is a 3-period simple moving average of %D, $SMA_3(\%D)$.

A 3-line Stochastics will give 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.*[4] 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, one 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.

9.4.2 Interpretation

The signal to act is when there is a divergence-convergence, in an extreme area, with a crossover on the right hand side, of a cycle bottom.*[3] 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.*[5]

Stochastic divergence.

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.*[6]

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.

An event known as "stochastic pop" occurs when prices break out and keep going. This is interpreted as a signal to increase the current position, or liquidate if the direction is against the current position.*[7]

9.4.3 See also

- Williams %R – Equivalent of %K, mirrored around the 0%-axis
- Detrended price oscillator

9.4.4 References

[1] "Stochastic Indicator [ChartSchool]". Retrieved 6 October 2014.

[2] Murphy, John J. (1999). "John Murphy's Ten Laws of Technical Trading".

[3] Lane, George M.D. (May/June 1984) "Lane's Stochastics," second issue of Technical Analysis of Stocks and Commodities magazine. pp 87-90.

[4] Lane, George C. & Caire (1998) "Getting Started With Stochastics" pg 3

[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.

9.4.5 External links

- Example of a Trading System using Stochastic Oscillator
- Stochastic Oscillator at Investopedia
- Stochastic Oscillator at StockCharts.com
- Fast Stochastic vs Slow Stochastic at Diffen

9.5 True strength index

The **true strength index** (**TSI**) is a technical indicator used in the analysis of financial markets that attempts to show both trend direction and overbought/oversold conditions. It was first published William Blau in 1991.*[1]*[2] The indicator uses moving averages of the underlying momentum of a financial instrument.*[3]*[4] Momentum is considered a leading indicator of price movements, and a moving average characteristically lags behind price. The TSI combines these characteristics to create an indication of price and direction more in sync with market turns than either momentum or moving average.*[5] The TSI is provided as part of the standard collection of indicators offered by various trading platforms.

9.5.1 Calculations

The TSI is a "double smoothed" indicator; meaning that a moving average applied to the data (daily momentum in this case) is smoothed again by a second moving average. The calculation for TSI uses exponential moving averages. The formula for the TSI is:

$$TSI(c_0, r, s) = 100\frac{EMA(EMA(m, r), s)}{EMA(EMA(|m|, r), s)}$$

where

c_0 = today's closing price

$m = c_0 - c_1$ = momentum (difference between today's and yesterday's close)

EMA(m,n) = exponential moving average of m over n periods, that is,

$$EMA(m_0, n) = \frac{2}{n+1}\left[m_0 - EMA(m_1, n)\right] + EMA(m_1, n)$$

r = EMA smoothing period for momentum, typically 25

s = EMA smoothing period for smoothed momentum, typically 13

9.5.2 Interpretation

While the TSI output is bound between +100 and −100, most values fall between +25 and −25. Blau suggests interpreting these values as overbought and oversold levels, respectively, at which point a trader may anticipate a market turn. Trend direction is indicated by the slope of the TSI; a rising TSI suggests an up-trend in the market, and a falling TSI suggests a down-trend.*[5]*[6]

9.5.3 See also

- Relative Strength Index

9.5.4 References

[1] William Blau (Nov 1991). "True Strength Index". *(Technical Analysis of) Stocks & Commodities* (traders.com) **11** (1): 438–446.

[2] William Blau (Jan 1993). "Stochastic Momentum". *(Technical Analysis of) Stocks & Commodities* (traders.com) **9** (11): 11–18. The true strength index (TSI) I introduce here is based on momentum as it occurs in nature, with no need to segregate up and down components of the momentum. ... The double-smoothed true strength index gives a choice to the trader; selection of the smaller smoothing time can be made to satisfy individual trading personalities. ... Calculating the true strength index requires an introduction to exponentially smoothed moving averages (EMA)

[3] Blau, William (1995-03-06). *Momentum, Direction, and Divergence: Applying the Latest Momentum Indicators for Technical Analysis*. Wiley. ISBN 978-0-471-02729-4.

[4] Mark Etzkorn (1997). *Trading with oscillators: pinpointing market extremes—theory and practice*. John Wiley and Sons. pp. 91–93. ISBN 978-0-471-15538-6.

[5] Hartle, Tom (January 2002). "The True Strength Index" (PDF). *Active Trader*.

[6] Michael C. Thomsett (2009). *The options trading body of knowledge: the definitive source for information*. FT Press. p. 268. ISBN 978-0-13-714293-4.

9.6 Ultimate oscillator

The **ultimate oscillator** is a theoretical concept in finance.

Larry Williams developed the **ultimate oscillator** as a way to account for the problems experienced in most oscillators when used over different lengths of time.*[1]

The 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

$$avg_7 = \frac{bp_1 + bp_2 + \cdots + bp_7}{tr_1 + tr_2 + \cdots + tr_7}$$

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, i.e. 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).

9.6.1 References

[1] AsiaPacFinance.com Trading Indicator Glossary

- Ultimate Oscillator at StockCharts.com
- Ultimate Oscillator at Tradersdaytrading.com
- The Ultimate Buy Signal, Motley Fool

9.6.2 Further reading

- *The Ultimate Oscillator*, by Larry Williams, Technical Analysis of Stocks and Commodities magazine V.3:4 (140–141) (introduction)

9.7 Williams %R

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.

$$\%R = \frac{high_{N days} - close_{today}}{high_{N days} - low_{N days}} \times -100$$ *[1]

The oscillator is on a negative scale, from −100 (lowest) up to 0 (highest), obverse of the more common 0 to 100 scale found in many Technical Analysis oscillators. A value of −100 means the close today was the lowest low of the past N days, and 0 means today's close was the highest high of the past N days. (Although sometimes the %R is adjusted by adding 100.)

9.7.1 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 fall below -95% or -85%.

or conversely to sell an overbought condition

- %R reaches 0%.
- Five trading days pass since 0% was last reached

- %R rise above -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.

9.7.2 Notes

Due to the equivalence

$$(close_{today} - low_{Ndays}) - (close_{today} - high_{Ndays}) = high_{Ndays} - low_{Ndays}$$

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

9.7.3 References

[1] http://stockcharts.com/school/doku.php?id=chart_school:technical_indicators:williams_r

Chapter 10

Volume Indicators

10.1 Volume (finance)

In capital markets, **volume**, or **trading volume**, is the amount of a security (or a given set of securities, or an entire market) that were traded during a given period of time. In the context of a single stock trading on a stock exchange, the volume is commonly reported as the number of shares that changed hands during a given day.

The **average volume** of a security over a longer period of time is the total amount traded in that period, divided by the length of the period. Therefore, the unit of measurement for average volume is shares per unit of time, typically per day.

10.1.1 Significance

Trading volume is usually higher when the price of a security is changing. News about a company's financial status, products, or plans, whether positive or negative, will usually result in a temporary increase in the trade volume of its stock.

Higher volume for a stock is an indicator of higher liquidity in the market.*[1] For institutional investors who wish to sell a large number of shares of a certain stock, lower liquidity will force them to sell the stock slowly over a longer period of time, to avoid losses due to slippage.

10.1.2 Legal implications

In the United States, the Rule 144 of the Securities Act of 1933 restricts the buying or selling of an amount of a security that exceed a certain fraction of its average trading volume. Therefore, the calculation of the trading volume is regulated by the SEC.*[2]

10.1.3 References

[1] Baiynd, Anne-Marie (2011). *The Trading Book: A Complete Solution to Mastering Technical Systems and Trading Psychology*. McGraw-Hill. p. 272. ISBN 9780071766494. Retrieved 2013-04-30.

[2] Rule 144: Selling Restricted and Control Securities

10.2 Accumulation/distribution index

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

10.2.1 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, i.e.

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

The starting point for the acc/dist total, i.e. 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.

10.2.2 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.

10.2.3 Similar indicators

Other Price × Volume indicators:

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

10.2.4 See also

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

10.3 Ease of movement

Ease of movement (**EMV**) 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.*[1] 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.

10.3.1 References

[1] *Arms Ease of Movement*, retrieved 17 February 2008

10.4 Force index

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.*[1]

The FI was created by Alexander Elder.*[2]

10.4.1 References

[1] Logue, Ann C. (2011). *Day Trading For Dummies*. Wiley. p. 196. ISBN 9781118051818.

[2] Elder, Alexander (1993). *Trading for a Living: Psychology, Trading Tactics, Money Management*. Wiley. ISBN 0-4715-9224-2.

10.5 Negative volume index

Nearly 78 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. Richard Russell, editor of Dow Theory Letters, in his January 7, 1976 letter called Dysart "one of the most brilliant of the pioneer market technicians."

10.5.1 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 breadth numbers in 1931, and was familiar with the work of 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 breadth indexes." He relied most on NVI, naming it AMOMET, the acronym of "**A** **M**easure **O**f **M**ajor **E**conomic **T**rend."

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.

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.

10.5.2 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.

10.5.3 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 $NVI_{yesterday}$ $(C_t - C_y) / C_y$ to yesterday's NVI if today's volume is lower than yesterday's, adding zero otherwise,

and the PVI is calculated by:

- adding $PVI_{yesterday}$ $(C_t - C_y) / C_y$ 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 breadth 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.

10.5.4 References

- Appel, Gerald, Winning Market Systems, pp. 42–44, Windsor Books, Bridgewaters, New York (1989)
- Dysart, Jr., Paul L., *Bear Market Signal?: A Sensitive Breadth Index Has Just Flashed One*, Barron's (newspaper) (Sept. 4, 1967)
- Fosback, Norman G., Stock Market Logic: A Sophisticated Approach to Profits on Wall Street, pp. 120–124, Deaborn Financial Printing, Chicago, Illinois (1993)
- Market Technicians Association, Paul L. Dysart, Jr. Annual Award (1990, ed. James E. Alphier)
- Russell, Richard, Dow Theory Letters, Jan. 7, 1976 (no. 652); see also Dow Theory Letters nos. 638, 642, and 646
- Schade, Jr., George A., *Traders Adjust the Volume Indicators*, Stocks Futures and Options Magazine (Nov. 2005)

10.6 On-balance volume

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.*[1]

10.6.1 The formula

$$OBV = OBV_{prev} + \begin{cases} volume & \text{if } close > close_{prev} \\ 0 & \text{if } close = close_{prev} \\ -volume & \text{if } close < close_{prev} \end{cases}$$

Because OBV is a cumulative result, the value of OBV depends upon the starting point of the calculation.

10.6.2 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.*[2] 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.*[3]

The technique, originally called "continuous volume" by Woods and Vignola, was later named "on-balance volume" by Joseph Granville who popularized the technique in his 1963 book *Granville's New Key to Stock Market Profits*.*[1]

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.*[1]

OBV is generally used to confirm price moves.*[4] 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.*[5]

10.6.3 Similar indicators

Other price × volume indicators:

- Money flow
- Price and volume trend
- Accumulation/distribution index

10.6.4 See also

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

10.6.5 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)*. 22 September 2007.

[3] OBV Behaviorial Limitations and Formulas at Financial-edu.com.

[4] What Does On-Balance Volume Mean

[5] StockCharts.com article on On Balance Volume

10.7 Put/call ratio

Put/call ratio (or put–call ratio, PCR) is a technical indicator demonstrating investors' sentiment.*[1] The ratio represents a proportion between all the put options and all the call options purchased on any given day. The put/call ratio can be calculated for any individual stock, as well as for any index, or can be aggregated. The ratio may be calculated using the numbers of puts and calls or on a dollar-weighted basis.

10.7.1 Readings

Generally, a lower reading (~0.6) of the ratio reflects a bullish sentiment among investors as they buy more calls, anticipating an uptrend. Conversely, a higher reading (~1.02) of the ratio indicates a bearish sentiment in the market. However, the ratio is considered to be a contrarian indicator, so that an extreme reading above 1.0 is actually a bullish signal, and vice versa.*[2]

Moving averages are used to smooth and normalize the series of ratios.

10.7.2 See also

- VIX index
- IVX

10.7.3 References

[1] Put–Call Ratio

[2] The Put/Call Ratio: A Useful Indicator of Sentiment

10.7.4 External links

- CBOE Volume & Put/Call Ratios
- Options offer traders lots of⋯well, options!
- Put/Call Ratio Soaring
- Historical Put/Call Ratio by Stock
- Data, Charts and Descriptions of Put/Call Ratio

10.8 Volume–price trend

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 the investment's upward or downward movements.*[1]

10.8.1 Formula

$$\mathrm{VPT} = \mathrm{VPT}_{\mathrm{prev}} + \mathrm{volume} \times \frac{\mathrm{close}_{\mathrm{today}} - \mathrm{close}_{\mathrm{prev}}}{\mathrm{close}_{\mathrm{prev}}}$$

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),*[2] 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.

10.8.2 Similar indicators

Other price × volume indicators:

- Money Flow Index
- On-balance volume
- Accumulation/distribution index

10.8.3 References

[1] Volume Price Trend Indicator – VPT

[2] Price/Volume Trend

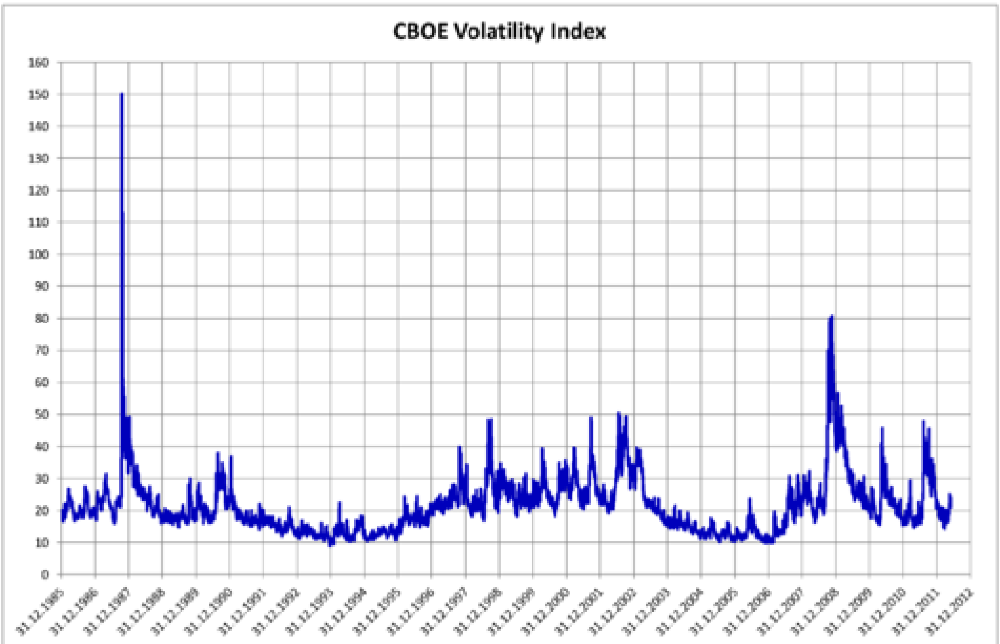
10.8.4 External links

- STEP3_Tutorial
- OUTPERFORMANCE WITH TECHNICAL ANALYSIS? —AN INTRADAY STUDY ON THE SWISS STOCK MARKET

Chapter 11

Volatility Indicators

11.1 Volatility (finance)



The VIX

In finance, **volatility** is the degree of variation of a trading price series over time as measured by the standard deviation of returns.

Historic volatility is derived from time series of past market prices. An implied volatility is derived from the market price of a market traded derivative (in particular an option). The symbol σ is used for volatility, and corresponds to standard deviation, which should not be confused with the similarly named variance, which is instead the square, σ^2.

11.1.1 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.

- **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
  - near synonymous is **realized volatility**, the square root of the realized variance, in turn calculated using the sum of squared returns divided by the number of observations.
- **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.*[1] These can capture attributes such as "fat tails". Volatility is a statistical measure of dispersion around the average of any random variable such as market parameters etc.

11.1.2 Volatility and liquidity

Much research has been devoted to modeling and forecasting the volatility of financial returns, and yet few theoretical models explain how volatility comes to exist in the first place.

Roll (1984) shows that volatility is affected by market microstructure.*[2] Glosten and Milgrom (1985) shows that at least one source of volatility can be explained by the liquidity provision process. When market makers infer the possibility of adverse selection, they adjust their trading ranges, which in turn increases the band of price oscillation.*[3]

11.1.3 Volatility for investors

Investors care about volatility for seven reasons:

1. The wider the swings in an investment's price, the harder emotionally it is to not worry;
2. Price volatility of a trading instrument can define position sizing in a portfolio;
3. When certain cash flows from selling a security are needed at a specific future date, higher volatility means a greater chance of a shortfall;
4. Higher volatility of returns while saving for retirement results in a wider distribution of possible final portfolio values;
5. Higher volatility of return when retired gives withdrawals a larger permanent impact on the portfolio's value;
6. Price volatility presents opportunities to buy assets cheaply and sell when overpriced.
7. Volatility affects pricing of options, being a parameter of the Black–Scholes model

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.

11.1.4 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 negative 3% to positive 17% most of the time (19 times out of 20, or 95% via a two standard deviation rule). A higher volatility stock, with the same expected return of 7% but with annual volatility of 20%, would indicate returns from approximately negative 33% to positive 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.

11.1.5 Volatility over time

Although the Black Scholes equation assumes predictable constant volatility, this is not observed in real markets, and amongst the models are Emanuel Derman and Iraj Kani's*[4] and 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.*[5]

It is 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 barely move at all.*[6]

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 possible 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 are 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.

11.1.6 Mathematical definition

For any fund that evolves randomly with time, the square of volatility is the variance of the sum of infinitely many instantaneous rates of return, each taken over the nonoverlapping, infinitesimal periods that make up a single unit of time.

Thus, “annualized” volatility σ is the standard deviation of an instrument's yearly logarithmic returns.*[7]

The generalized volatility σ_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 σ_{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 σ_{SD} = 0.01 the annualized volatility is

$$\sigma_{\text{annual}} = \frac{0.01}{\sqrt{\frac{1}{252}}} = 0.01\sqrt{252} = 0.1587.$$

The monthly volatility (i.e., T = 1/12 of a year) would be

$\sigma_{\text{monthly}} = 0.1587\sqrt{\frac{1}{12}} = 0.0458.$

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 α 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.)

11.1.7 Implied Volatility parametrisation

There exist several known parametrisation of the implied volatility surface, Schonbucher, SVI and gSVI.*[8]

11.1.8 Crude volatility estimation

Using a simplification of the formulae 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 √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 σ, 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 underestimates the true volatility by about 20%.

11.1.9 Estimate of compound annual growth rate (CAGR)

Consider the Taylor series:

$\log(1+y) = y - \frac{1}{2}y^2 + \frac{1}{3}y^3 - \frac{1}{4}y^4 + \ldots$

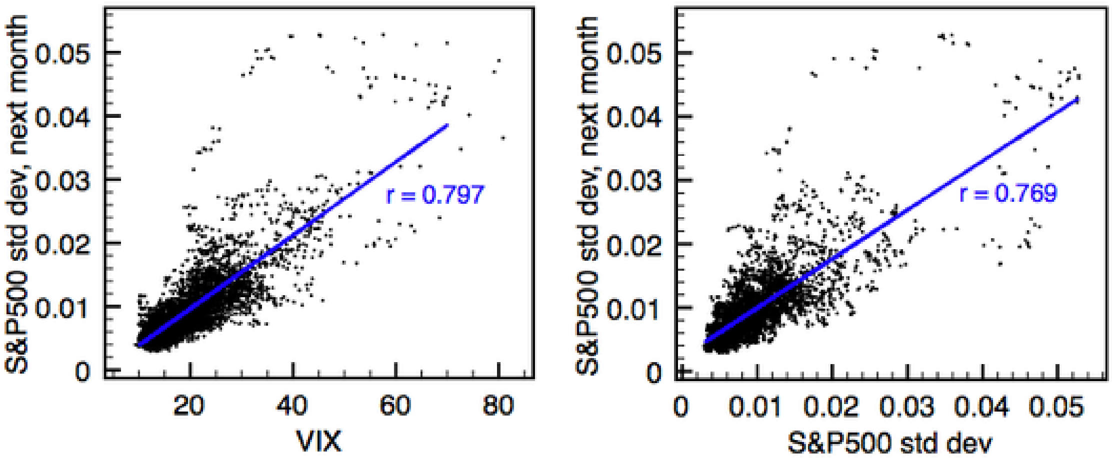
Taking only the first two terms one has:

$\text{CAGR} \approx \text{AR} - \frac{1}{2}\sigma^2$

Realistically, most financial assets have negative skewness and leptokurtosis, so this formula tends to be over-optimistic. Some people use the formula:

$\text{CAGR} \approx \text{AR} - \frac{1}{2}k\sigma^2$

for a rough estimate, where *k* is an empirical factor (typically five to ten).



Performance of VIX (left) compared to past volatility (right) as 30-day volatility predictors, for the period of Jan 1990-Sep 2009. Volatility is measured as the standard deviation of S&P500 one-day returns over a month's period. The blue lines indicate linear regressions, resulting in the correlation coefficients r *shown. Note that VIX has virtually the same predictive power as past volatility, insofar as the shown correlation coefficients are nearly identical.*

11.1.10 Criticisms of volatility forecasting models

Despite the sophisticated composition of most volatility forecasting models, critics claim that their predictive power is similar to that of plain-vanilla measures, such as simple past volatility *[9]*[10] especially out-of-sample, where different data are used to estimate the models and to test them.*[11] Other works have agreed, but claim critics failed to correctly implement the more complicated models.*[12] Some practitioners and portfolio managers seem to completely ignore or dismiss volatility forecasting models. For example, Nassim Taleb famously titled one of his *Journal of Portfolio Management* papers "We Don't Quite Know What We are Talking About When We Talk About Volatility".*[13] In a similar note, Emanuel Derman expressed his disillusion with the enormous supply of empirical models unsupported by theory.*[14] He argues that, while "theories are attempts to uncover the hidden principles underpinning the world around us, as Albert Einstein did with his theory of relativity", we should remember that "models are metaphors -- analogies that describe one thing relative to another".

11.1.11 Volatility Hedge Funds

Well known hedge fund managers with expertise in trading volatility include Paul Britton of Capstone Holdings Group,*[15] Andrew Feldstein of Blue Mountain Capital Management,*[16] and Nelson Saiers from Saiers Capital.*[17]

11.1.12 See also

- Beta (finance)
- Derivative (finance)
- Financial economics
- IVX
- Risk
- Volatility smile

11.1.13 References

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[2] Roll, R. (1984): "A Simple Implicit Measure of the Effective Bid-Ask Spread in an Efficient Market", *Journal of Finance* **39** (4), 1127–1139

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[5] "Volatility". *wilmottwiki.com*.

[6] "Taking Advantage Of Volatility Spikes With Credit Spreads".

[7] "Calculating Historical Volatility: Step-by-Step Example" (PDF). 14 July 2011. Retrieved 15 July 2011.

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[17] Creswell, Julie and Louise Story (17 March 2011). "Funds Find Opportunities in Volatility". *New York Times*. Retrieved 26 April 2013.

11.1.14 External links

- Graphical Comparison of Implied and Historical Volatility, video
- An introduction to volatility and how it can be calculated in excel, by Dr A. A. Kotzé
- Diebold, Francis X.; Hickman, Andrew; Inoue, Atsushi & Schuermannm, Til (1996) "Converting 1-Day Volatility to h-Day Volatility: Scaling by sqrt(h) is Worse than You Think"
- A short introduction to alternative mathematical concepts of volatility
- Volatility estimation from predicted return density Example based on Google daily return distribution using standard density function
- Research paper including excerpt from report entitled Identifying Rich and Cheap Volatility Excerpt from Enhanced Call Overwriting, a report by Ryan Renicker and Devapriya Mallick at Lehman Brothers (2005).

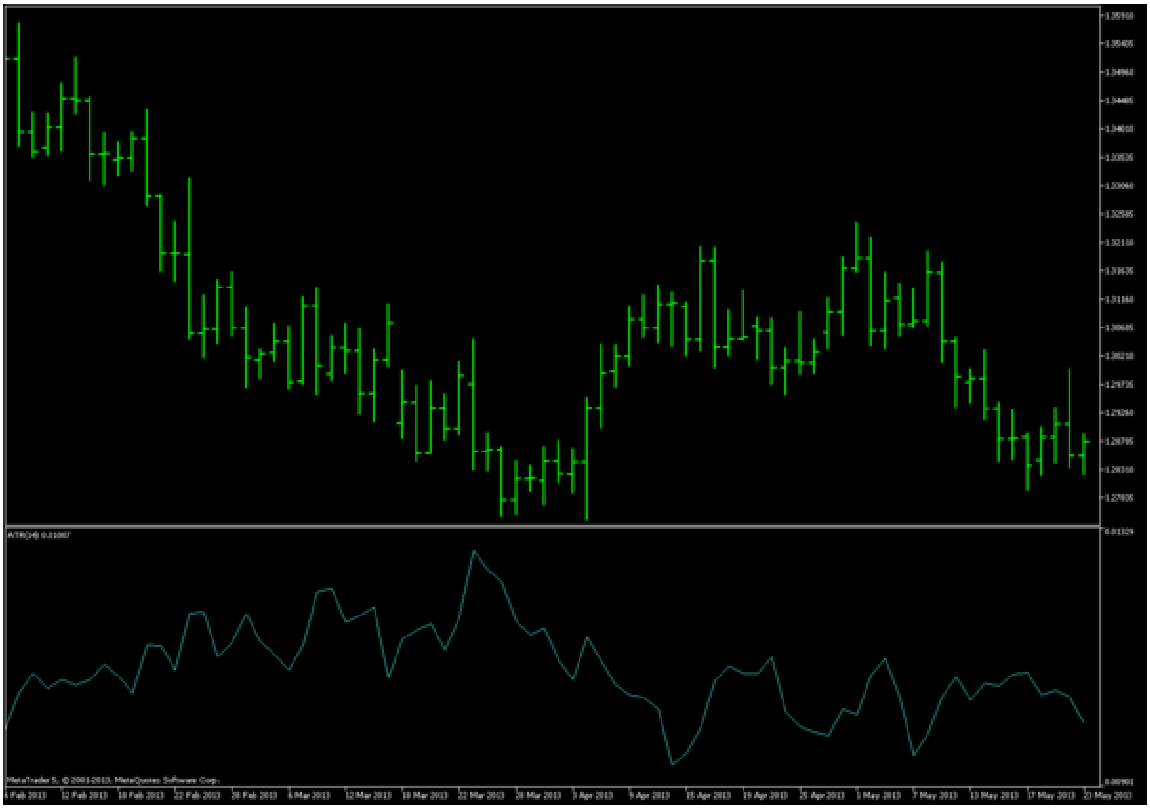
11.1.15 Further reading

1. Bartram, Söhnke M.; Brown, Gregory W.; Stulz, Rene M. (August 2012). "Why Are U.S. Stocks More Volatile?". *Journal of Finance* **67** (4): 1329–1370. doi:10.1111/j.1540-6261.2012.01749.x.

11.2 Average true range

Average true range (**ATR**) is a technical analysis volatility indicator originally developed by J. Welles Wilder, Jr. for commodities.*[1] The indicator does not provide an indication of price trend, simply the degree of price volatility.*[2]*[3] The average true range is an N-day smoothed moving average (SMMA) of the **true range** values. Wilder recommended a 14-period smoothing.*[4]

11.2.1 Calculation



MetaTrader EUR/USD chart showing ATR indicator (cyan line) with period 14.

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.

$$\mathrm{TR} = \max[(\mathrm{high} - \mathrm{low}), \mathrm{abs}(\mathrm{high} - \mathrm{close}_{\mathrm{prev}}), \mathrm{abs}(\mathrm{low} - \mathrm{close}_{\mathrm{prev}})]$$

The **true range** is the largest of the:

- Most recent period's high minus the most recent period's low
- Absolute value of the most recent period's high minus the previous close
- Absolute value of the most recent period's low minus the previous close

The ATR at the moment of time *t* is calculated using the following formula:*[5] (This is one form of an exponential moving average)

$$ATR_t = \frac{ATR_{t-1} \times (n-1) + TR_t}{n}$$

The first ATR value is calculated using the arithmetic mean formula:

$$ATR = \frac{1}{n}\sum_{i=1}^{n} TR_i$$

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.

11.2.2 Applicability to futures contracts vs. stocks

Since true range and ATR are calculated by subtracting prices, the volatility they compute does not change when historical prices are back-adjusted by adding or subtracting a constant to every price. Back-adjustments are often employed when splicing together individual monthly futures contracts to form a continuous futures contract spanning a long period of time. However the standard procedures used to compute volatility of stock prices, such as the standard deviation of logarithmic price ratios, are not invariant (to addition of a constant). Thus futures traders and analysts typically use one method (ATR) to calculate volatility, while stock traders and analysts typically use another (SD of log price ratios).

11.2.3 Use in position size calculation

Apart from being a trend strength gauge, ATR serves as an element of position sizing in financial trading. Current ATR value (or a multiple of it) can be used as the size of the potential adverse movement (stop-loss distance) when calculating the trade volume based on trader's risk tolerance. In this case, ATR provides a self-adjusting risk limit dependent on the market volatility for strategies without a fixed stop-loss placement.*[6] A less volatile market has a larger trading position in comparison to a more volatile market in a portfolio.

11.2.4 References

[1] J. Welles Wilder, Jr. (June 1978). *New Concepts in Technical Trading Systems*. Greensboro, NC: Trend Research. ISBN 978-0-89459-027-6.

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[4] This is by his reckoning of SMMA periods, meaning an α=1/14.

[5] Average True Range calculation

[6] http://www.earnforex.com/blog/position-sizing-rules/#atr-based-position-sizing

11.2.5 External links

- *Measure Volatility With Average True Range* at investopedia.com
- *Enter Profitable Territory With Average True Range* at investopedia.com
- Average True Range (ATR) at stockcharts.com

11.3 Bollinger Bands

Bollinger Bands is a technical analysis tool invented by John Bollinger in the 1980s as well as a term trademarked by him in 2011.*[1] Having evolved from the concept of trading bands, Bollinger Bands and the related indicators

S&P 500 with 20-day, two-standard-deviation Bollinger Bands, %b and bandwidth.

%b and *bandwidth* can be used to measure the "highness" or "lowness" of the price relative to previous trades. Bollinger Bands are a volatility indicator similar to the Keltner channel.

Bollinger Bands consist of:

- an N-period moving average (MA)
- an upper band at K times an N-period standard deviation above the moving average (MA + $K\sigma$)
- a lower band at K times an N-period standard deviation below the moving average (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 is a common second choice.*[note 1] Usually the same period is used for both the middle band and the calculation of standard deviation.*[note 2]

11.3.1 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.*[3]

11.3.2 Indicators derived from Bollinger Bands

In Spring, 2010, John Bollinger introduced three new indicators based on Bollinger Bands. They are BBImpulse, which measures price change as a function of the bands; percent bandwidth (%b), which normalizes the width of the bands over time; and bandwidth delta, which quantifies the changing width of the bands.

%b (pronounced "percent b") is derived from the formula for Stochastics and shows where price is 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 = (last − lowerBB) / (upperBB − lowerBB)

Bandwidth tells 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:

Bandwidth = (upperBB − lowerBB) / 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.

11.3.3 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.*[4] 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 towards the average historical volatility level for the stock.

When the bands lie close together, a period of low volatility is indicated.*[5] Conversely, as the bands expand, an increase in price action/market volatility is indicated.*[5] When the bands have only a slight slope and track approximately parallel for an extended time, the price will generally be found to oscillate between the bands as though in a channel.

Traders are often inclined to use Bollinger Bands with other indicators to confirm price action. In particular, the use of 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 conviction that the bands are predicting correct price action in relation to market volatility.

11.3.4 Effectiveness

Various studies of the effectiveness of the Bollinger Band strategy have been performed with mixed results. In 2007 Lento *et al.* published an analysis using a variety of formats (different moving average timescales, and standard deviation ranges) and markets (e.g., Dow Jones and Forex).*[6] Analysis of the trades, spanning a decade from 1995 onwards, found no evidence of consistent performance over the standard "buy and hold" approach. The authors did, however, find that a simple reversal of the strategy ("contrarian Bollinger Band") produced positive returns in a variety of markets.

Similar results were found in another study, which 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." *[7] (By "the contrarian version", they mean buying when the conventional rule mandates selling, and vice versa.) A recent study examined the application of Bollinger Band trading strategies combined with the ADX for Equity Market indices with similar results.*[8]

A paper from 2008 uses Bollinger Bands in forecasting the yield curve.*[9]

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.*[10]

11.3.5 Statistical properties

Security price returns have no known statistical distribution, normal or otherwise; they are known to have fat tails, compared to a normal distribution.*[11] 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. Just the opposite is true; it is well recognized by practitioners that such price series are very commonly serially correlated—that is, each price will be closely related to its ancestor "most of the time". Adjusting for serial correlation is the purpose of moving standard deviations, which use deviations from the moving average, but the possibility remains of high order price autocorrelation not accounted for by simple differencing from the moving average.

For such reasons, it is incorrect to assume that the long-term percentage of the data that will be observed in the future outside the Bollinger Bands range will always be constrained to a certain amount. 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, studies have found that only about 88% of security prices (85%–90%) remain within the bands.*[12] For an individual security, one can always find factors for which certain percentages of data are contained by the factor defined bands for a certain period of time. Practitioners may also use related measures such as the Keltner channels, or the related Stoller average range channels, which base their band widths on different measures of price volatility, such as the difference between daily high and low prices, rather than on standard deviation.

11.3.6 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 (anomalies) 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." *[13]

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.*[14] %b and bandwidth are also used in this analysis.

11.3.7 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.*[2]

[2] Since Bollinger Bands use the population method of calculating standard deviation, the proper divisor for the sigma calculation is n, not $n - 1$.

11.3.8 References

[1] "Bollinger Bands – Trademark Details". Justia.com. 2011-12-20.

[2] Bollinger On Bollinger Bands – The Seminar, DVD I ISBN 978-0-9726111-0-7

[3] 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] Baiynd, Anne-Marie (2011). *The Trading Book: A Complete Solution to Mastering Technical Systems and Trading Psychology*. McGraw-Hill. p. 272. ISBN 9780071766494. Retrieved 2013-04-30.

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11.3.9 Further reading

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- 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

11.3.10 External links

- John Bollinger's website
- John Bollinger's website on Bollinger Band analysis
- December 2008 Los Angeles Times profile of John Bollinger

11.4 Donchian channel

The **Donchian channel** is an indicator used in market trading developed by Richard Donchian. It is formed by taking the highest high and the lowest low of the last *n* periods. The area between the high and the low is the channel for the period chosen.

It is commonly available on most trading platforms. On a charting program, a line is marked for the high and low values visually demonstrating the channel on the markets price (or other) values.

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* periods high, then a long is established. If it trades below its lowest *n* periods low, then a short is established.

Originally the *n* periods were based upon daily values. With today's trading platforms, the period may be of the value desired by the investor. i.e.: day, hour, minute, ticks, etc.

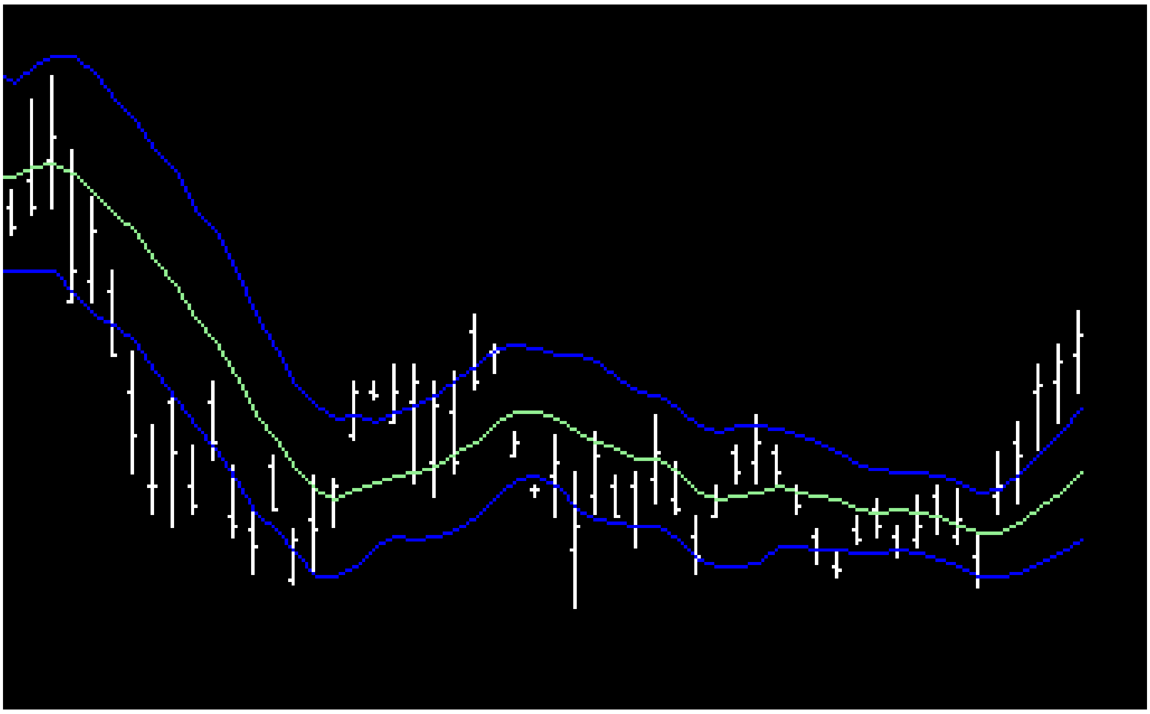
11.4.1 See also

- Bollinger bands
- Financial modeling

11.4.2 External links

- Capture Profits using Bands and Channels

11.5 Keltner channel



Keltner channel example

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*. This name was applied by those who heard about it from him, but 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 a 10-day simple moving average of *typical price*, where typical price each day is the average of high, low and close,

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

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 (i.e. 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) backtesting 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 confusion as to what exactly one gets from an indicator called that.

11.5.1 See also

- Bollinger bands

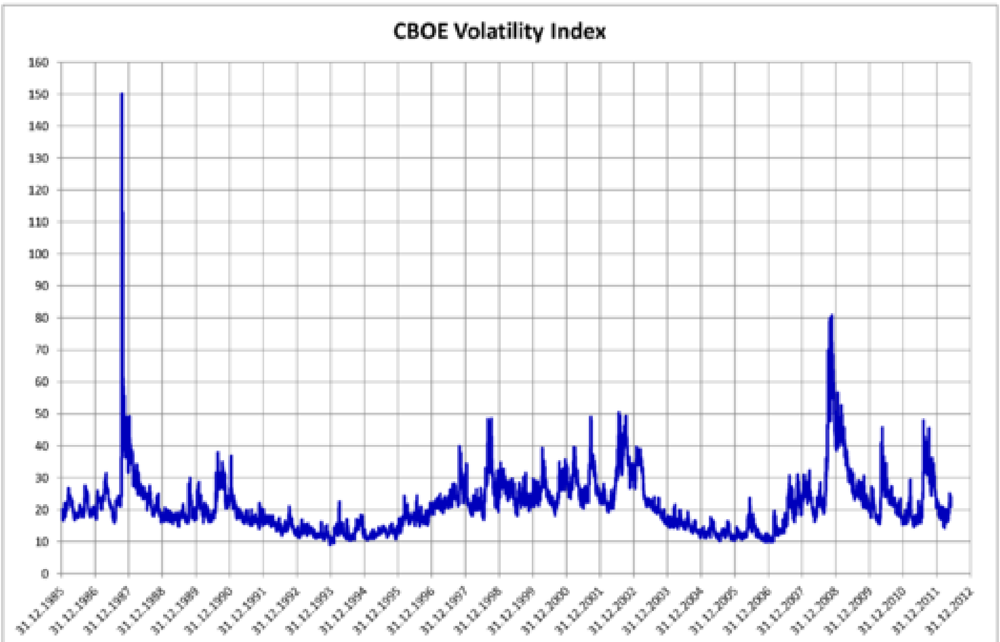
11.5.2 References

- Titans Of Technical Analysis, letter by Don Jones to Technical Analysis of Stocks and Commodities magazine, February 2003
- Trader.Online.pl – MetaStock Zone – Keltner Channels, describing 10-day SMA
- Discovering Keltner Channels and the Chaikin Oscillator, article from Investopedia

11.6 VIX

For other uses, see Vix (disambiguation).

VIX is a trademarked ticker symbol for the **CBOE Volatility Index**, a popular measure of the implied volatility



CBOE Volatility Index (VIX) 1985–2012.

of S&P 500 index options; the VIX is calculated by the Chicago Board Options Exchange (CBOE). Often referred to as the *fear index* or the *fear gauge*, the VIX represents one measure of the market's expectation of stock market volatility over the next 30-day period.

The idea of a volatility index, and financial instruments based on such an index, was first developed and described by Professor Menachem Brenner and Prof. Dan Galai in 1986. Professors Brenner and Galai published their research in the academic article "New Financial Instruments for Hedging Changes in Volatility," which appeared in the July/August 1989 issue of Financial Analysts Journal.*[1]

In a subsequent paper, Professors Brenner and Galai proposed a formula to compute the volatility index.*[2]

Professors Brenner and Galai wrote "Our volatility index, to be named Sigma Index, would be updated frequently and used as the underlying asset for futures and options... A volatility index would play the same role as the market index play for options and futures on the index."

In 1992, the CBOE retained Vanderbilt University Professor Robert Whaley to develop a tradable stock market volatility index based on index option prices. At a January 1993 news conference, Prof. Whaley provided his recommendations, and subsequently, the CBOE has computed VIX on a real-time basis. Based on the history of index option prices, Prof. Whaley computed daily VIX levels in a data series commencing January 1986, available on the CBOE website. Prof. Whaley's research for the CBOE appeared in the Journal of Derivatives.*[3]

The VIX is quoted in percentage points and translates, roughly, to the expected movement in the S&P 500 index over the upcoming 30-day period, which is then annualized. "VIX" is a registered trademark of the CBOE.*[4]

11.6.1 Specifications

The VIX is calculated and disseminated in real-time by the Chicago Board Options Exchange. Theoretically it is a weighted blend of prices for a range of options on the S&P 500 index. On March 26, 2004, the first-ever trading in futures on the VIX began on CBOE Futures Exchange (CFE). As of February 24, 2006, it became possible to trade VIX options contracts. Several exchange-traded funds seek to track its performance. The formula uses a kernel-smoothed estimator that takes as inputs the current market prices for all out-of-the-money calls and puts for the front month and second month expirations.*[5] The goal is to estimate the implied volatility of the S&P 500 index over the next 30 days.

The VIX is calculated as the square root of the par variance swap rate for a 30 day term initiated today. Note that the VIX is the volatility of a variance swap and not that of a volatility swap (volatility being the square root of variance, or standard deviation). A variance swap can be perfectly statically replicated through vanilla puts and calls whereas a volatility swap requires dynamic hedging. The VIX is the square root of the risk-neutral expectation of the S&P 500 variance over the next 30 calendar days. The VIX is quoted as an annualized standard deviation.

The VIX has replaced the older VXO as the preferred volatility index used by the media. VXO was a measure of implied volatility calculated using 30-day S&P 100 index at-the-money options.

Statistician Salil Mehta of Statistical Ideas shows the distribution of the VIX.*[6]

11.6.2 Interpretation

The VIX is quoted in percentage points and represents the expected range of movement in the S&P 500 index over the next year, at a 68% confidence level (i.e. one standard deviation of the normal probability curve). For example, if the VIX is 15, this represents an expected annualized change, with a 68% probability, of less than 15% up or down. One can calculate the expected volatility range for a single month from this figure by dividing the VIX figure of 15 not by 12, but by $\sqrt{12}$ which would infer a range of +/- 4.33% over the next 30-day period. *[7] Similarly, expected volatility for a week would be 15 divided by $\sqrt{52}$, or +/- 2.08%.

The price of call and put options can be used to calculate implied volatility, because volatility is one of the factors used to calculate the value of these options. Higher (or lower) volatility of the underlying security makes an option more (or less) valuable, because there is a greater (or smaller) probability that the option will expire in the money (i.e., with a market value above zero). Thus, a higher option price implies greater volatility, other things being equal.

Even though the VIX is quoted as a **percentage** rather than a **dollar** amount there are a number of VIX-based derivative instruments in existence, including:

- VIX futures contracts, which began trading in 2004
- exchange-listed VIX options, which began trading in February 2006.
- VIX futures based exchange-traded notes and exchange-traded funds, such as:
  - S&P 500 VIX Short-Term Futures ETN (NYSE: VXX) and S&P 500 VIX Mid-Term Futures ETN (NYSE: VXZ) launched by Barclays iPath in February 2009.
  - S&P 500 VIX ETF (LSE: VIXS) launched by Source UK Services in June 2010.
  - VIX Short-Term Futures ETF (NYSE: VIXY) and VIX Mid-Term Futures ETF (NYSE: VIXM) launched by ProShares in January 2011.

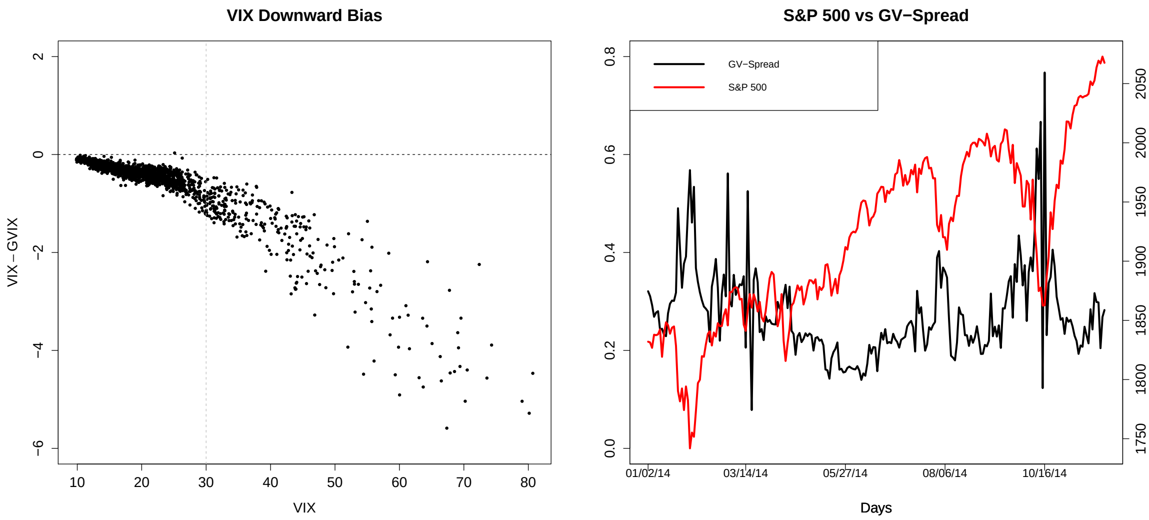
Similar indices for bonds include the MOVE, LBPX indices.

Although the VIX is often called the "fear index", a high VIX is not necessarily bearish for stocks.*[8] Instead, the VIX is a measure of market perceived volatility in either direction, including to the upside. In practical terms, when investors anticipate large upside volatility, they are unwilling to sell upside call stock options unless they receive a large premium. Option buyers will be willing to pay such high premiums only if similarly anticipating a large upside move. The resulting aggregate of increases in upside stock option call prices raises the VIX just as does the aggregate growth in downside stock put option premiums that occurs when option buyers and sellers anticipate a likely sharp move to the downside. When the market is believed as likely to soar as to plummet, writing any option that will cost the writer in the event of a sudden large move in either direction may look equally risky.

Hence high VIX readings mean investors see significant risk that the market will move sharply, whether downward or upward. The highest VIX readings occur when investors anticipate that huge moves in either direction are likely. Only when investors perceive neither significant downside risk nor significant upside potential will the VIX be low.

The Black–Scholes formula uses a model of stock price dynamics to estimate how an option's value depends on the volatility of the underlying assets.

11.6.3 Limitation and GVIX



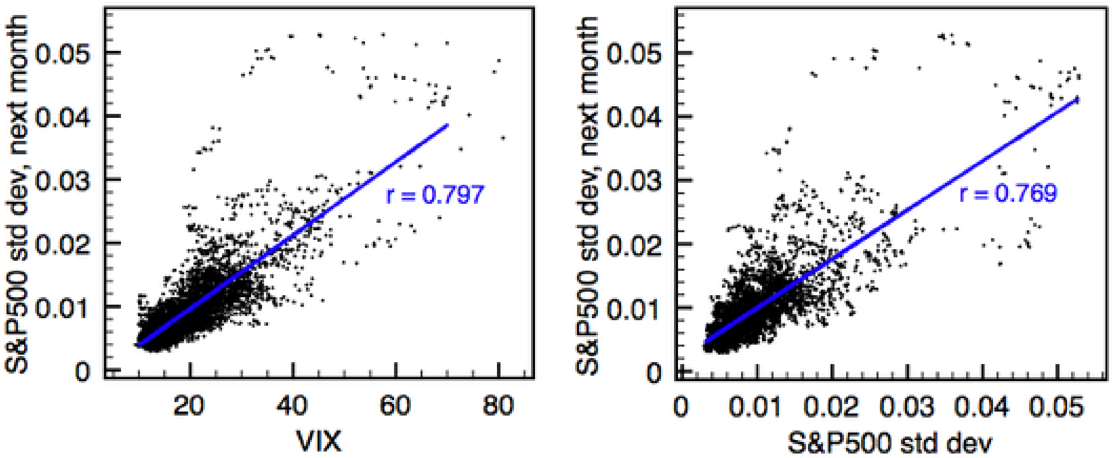
VIX Downward Bias. *(left) This figure plots the VIX downward bias, measured by daily (VIX − GVIX) from Jan 2005 - May 2014, corresponding to different levels of VIX values. It has been widely viewed that VIX values greater than 30 are generally associated with a large amount of volatility as a result of investor fear, while values below 20 generally correspond to less stressful times in the markets.*

Chow, Jiang and Li (2014) *[9] demonstrate that without imposing any structure on the underlying forcing process, the model-free CBOE volatility index (VIX) does not measure market expectation of volatility but that of a **linear moment-combination**. Particularly, VIX undervalues (overvalues) volatility when market return is expected to be negatively (positively) skewed. Alternatively, they develop a model-free **generalized volatility index** (**GVIX**). With no diffusion assumption, GVIX is formulated directly from the definition of log-return variance, and VIX is a special case of the GVIX. Empirically, VIX generally understates the true volatility, and the estimation errors considerably enlarge during volatile markets. In addition, the spread between GVIX and VIX (GV-Spread) follows a mean-reverting process.

11.6.4 Criticisms

VIX is sometimes criticized in terms of it being a prediction of future volatility. It is a measure of the current price of index options.

Despite their sophisticated composition, critics claim the predictive power of most volatility forecasting models is similar to that of plain-vanilla measures, such as simple past volatility.*[10]*[11] However, other works have coun-



Performance of VIX (left) compared to past volatility (right) as 30-day volatility predictors, for the period of Jan 1990-Sep 2009. Volatility is measured as the standard deviation of S&P500 one-day returns over a month's period. The blue lines indicate linear regressions, resulting in the correlation coefficients r *shown. Note that VIX has virtually the same predictive power as past volatility, insofar as the shown correlation coefficients are nearly identical.*

tered that these critiques failed to correctly implement the more complicated models.*[12]

Some practitioners and portfolio managers seem to completely ignore or dismiss volatility forecasting models. For example, Nassim Taleb famously titled one of his Journal of Portfolio Management papers *We Don't Quite Know What We are Talking About When We Talk About Volatility*.*[13]

In a similar note, Emanuel Derman expressed his disillusion with the enormous supply of empirical models unsupported by theory.*[14] He argues that, while *"theories are attempts to uncover the hidden principles underpinning the world around us, as Albert Einstein did with his theory of relativity"*, we should remember that *"models are metaphors -- analogies that describe one thing relative to another"*.

Michael Harris has argued that VIX just tracks the inverse of price and it has no predictive power as a result.*[15]*[16]

VIX should have predictive power as long as the prices computed by the Black-Scholes equation are - best guess - assumptions about the volatility predicted for the future lead time, the remaining time to maturity. Robert J. Shiller sees even the VIX as a proof for the B-S-formula: Comparing the VIX with the actual (historical) volatility. Referring to a diagram he states : „...(they) line up fairly well...and this shows the strength of the Black-Scholes formula "*[17] However, this is circular reasoning. During 2000 til 2008 a strong correlation can be observed. The question is, what is the independent and the dependant variable? The VIX "knows" the historical data (or the dealer setting the prices for their option orders) - the historical data don't "know" the market prices enabling the CBOE to compute the next VIX quotation.

11.6.5 History

Here is a timeline of some key events in the history of the VIX Index:

- 1987 - The Sigma Index was introduced in an academic paper by Professor Menachem Brenner and Professor Dan Galai, published in Financial Analysts Journal, July/August 1989. Brenner and Galai wrote, "Our volatility index, to be named Sigma Index, would be updated frequently and used as the underlying asset for futures and options... A volatility index would play the same role as the market index play for options and futures on the index."

- 1992 - The American Stock Exchange announced it is conducting a feasibility study on a volatility index, proposed as the "Sigma Index." "SI would be an underlying asset for futures and options that investors would use to hedge against the risk of volatility changes in the stock market."

- 1993 - On January 19, 1993, the Chicago Board Options Exchange held a press conference to announce the launch of real-time reporting of the CBOE Market Volatility Index or VIX. The original formula for VIX was developed for the CBOE by Prof. Robert Whaley and was based on CBOE S&P 100 Index (OEX) option prices.

- 2003 - The CBOE introduced a more detailed methodology for the VIX. Working with Goldman Sachs, the CBOE developed further computational methodologies, and changed the underlying index the CBOE S&P 100 Index (OEX) to the CBOE S&P 500 Index (SPX).
- 2004 - On March 26, 2004, the first-ever trading in futures on the VIX Index began on the CBOE Futures Exchange (CFE). Nowadays the VIX is proposed on different trading platforms, like XTB.
- 2006 - VIX options were launched in February 2006.
- 2008 - On October 24, 2008, the VIX reached an intraday high of 89.53.

Between 1990 and October 2008, the average value of VIX was 19.04.

In 2004 and 2006, VIX Futures and VIX Options, respectively, were named *Most Innovative Index Product* at the Super Bowl of Indexing Conference.*[18]

11.6.6 See also

- Hindenburg Omen
- Market trend
- IVX, volatility index
- S&P/ASX 200 VIX, volatility index
- Greed and fear

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[4] Introduction to VIX Options and Futures

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[6] http://statisticalideas.blogspot.com/2015/07/volatility-in-motion.html

[7] Note that the divisor for a single month is √12, and not 12. See the definition volatility for a discussion of computing inter-period volatility.

[8] http://www.wallstreetdaily.com/2011/08/10/picture-perfect-trade-this-market/

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[13] http://papers.ssrn.com/sol3/papers.cfm?abstract_id=970480 We Don't Quite Know What We are Talking About When We Talk About Volatility

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[17] Robert Shiller, Yale Courses 23, „Options Markets “2008 (position 58. min. following) Course material containin the diagram:

[18] “Index Product Awards” . Retrieved 2008-01-05.

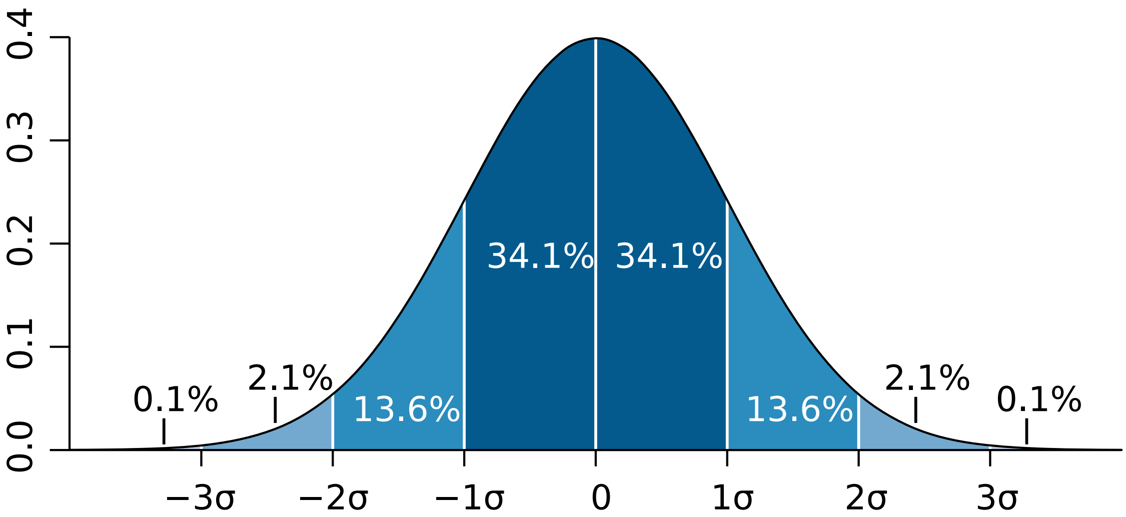
11.6.9 External links

- Bloomberg page for VIX:IND
- Yahoo! Finance page for ^VIX

11.7 Standard deviation

For other uses, see Standard deviation (disambiguation).

In statistics, the **standard deviation** (**SD**, also represented by the Greek letter sigma **σ** or ***s***) is a measure that is used

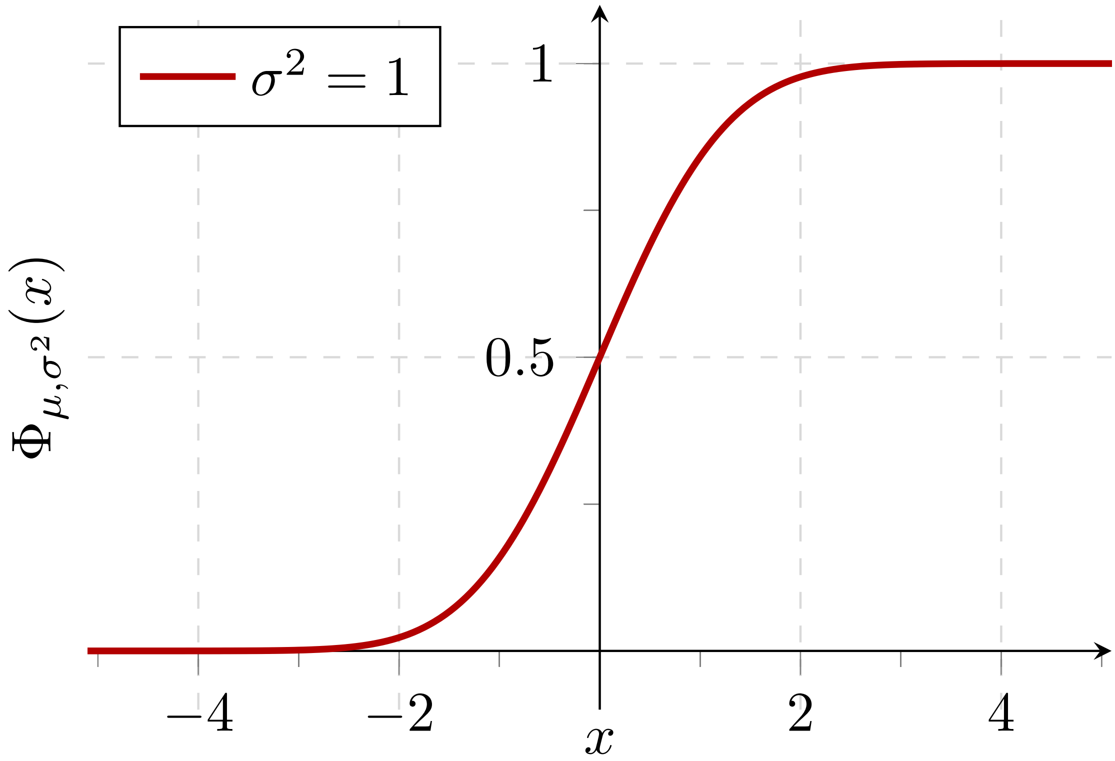


A plot of a normal distribution (or bell-shaped curve) where each band has a width of 1 standard deviation – See also: 68–95–99.7 rule

to quantify the amount of variation or dispersion of a set of data values.*[1] A standard deviation close to 0 indicates that the data points tend to be very close to the mean (also called the expected value) of the set, while a high standard deviation indicates that the data points are spread out over a wider range of values.

The standard deviation of a random variable, statistical population, data set, or probability distribution is the square root of its variance. It is algebraically simpler, though in practice less robust, than the average absolute deviation.*[2]*[3] A useful property of the standard deviation is that, unlike the variance, it is expressed in the same units as the data. There are also other measures of deviation from the norm, including mean absolute deviation, which provide different mathematical properties from standard deviation.*[4]

In addition to expressing the variability of a population, the 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. This derivation of a standard deviation is often called the "standard error" of the estimate or "standard error of the mean" when referring to a mean. It is computed as the standard deviation of all the means that would be computed from that population if an infinite number of samples were drawn and a mean for each sample were computed. It is very important to note that the standard deviation of a population and the standard error of a statistic derived from that population (such as the mean) are quite different but related (related by the inverse of the square root of the number of observations). The reported margin of error of a poll is computed from the standard error of the mean (or alternatively from the product of the standard deviation of the population and the inverse of the square root of the sample size, which is the same thing) and is typically about twice the standard deviation—the half-width of a 95 percent confidence interval. In science, researchers commonly report the standard deviation of experimental data, and only effects that fall much farther than two standard deviations away from what would have been expected are considered statistically significant—normal random error or variation in the measurements is in this way distinguished from causal variation. The 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.



Cumulative probability of a normal distribution with expected value 0 and standard deviation 1.

When only a sample of data from a population is available, the term **standard deviation of the sample** or **sample standard deviation** can refer to either the above-mentioned quantity as applied to those data or to a modified quantity that is a better estimate of the **population standard deviation** (the standard deviation of the entire population).

11.7.1 Basic examples

For a finite set of numbers, the standard deviation is found by taking the square root of the average of the squared deviations of the values from their average value. For example, the marks of a class of eight students (that is, a **population**) are the following eight values:

$2,\ 4,\ 4,\ 4,\ 5,\ 5,\ 7,\ 9.$

These eight data points have the mean (average) of 5:

$$\frac{2+4+4+4+5+5+7+9}{8} = 5.$$

First, calculate the deviations of each data point from the mean, and square the result of each:

$$\begin{array}{ll} (2-5)^2 = (-3)^2 = 9 & (5-5)^2 = 0^2 = 0 \\ (4-5)^2 = (-1)^2 = 1 & (5-5)^2 = 0^2 = 0 \\ (4-5)^2 = (-1)^2 = 1 & (7-5)^2 = 2^2 = 4 \\ (4-5)^2 = (-1)^2 = 1 & (9-5)^2 = 4^2 = 16. \end{array}$$

The variance is the mean of these values:

$$\frac{9+1+1+1+0+0+4+16}{8} = 4.$$

and the *population* standard deviation is equal to the square root of the variance:

$$\sqrt{4} = 2.$$

This formula is valid only if the eight values with which we began form the complete population. If the values instead were a random sample drawn from some larger parent population (for example, they were 8 marks randomly chosen from a class of 20), then we would have divided by 7 (which is $n-1$) instead of 8 (which is n) in the denominator of the last formula, and then the quantity thus obtained would be called the *sample* standard deviation. Dividing by $n-1$ gives a better estimate of the population standard deviation for the larger parent population than dividing by n, which gives a result which is correct for the sample only. This is known as *Bessel's correction*.*[5]

As a slightly more complicated real-life example, the average height for adult men in the United States is about 70 inches, with a standard deviation of around 3 inches. This means that most men (about 68%, assuming a normal distribution) have a height within 3 inches of the mean (67–73 inches) – one standard deviation – and almost all men (about 95%) have a height within 6 inches of the mean (64–76 inches) – two standard deviations. If the standard deviation were zero, then all men would be exactly 70 inches tall. If the standard deviation were 20 inches, then men would have much more variable heights, with a typical range of about 50–90 inches. Three standard deviations account for 99.7% of the sample population being studied, assuming the distribution is normal (bell-shaped).

11.7.2 Definition of population values

Let X be a random variable with mean value μ:

$$\mathrm{E}[X] = \mu.$$

Here the operator E denotes the average or expected value of X. Then the **standard deviation** of X is the quantity

$$\begin{aligned}
\sigma &= \sqrt{\mathrm{E}[(X-\mu)^2]} \\
&= \sqrt{\mathrm{E}[X^2] + \mathrm{E}[(-2\mu X)] + \mathrm{E}[\mu^2]} = \sqrt{\mathrm{E}[X^2] - 2\mu\,\mathrm{E}[X] + \mu^2} \\
&= \sqrt{\mathrm{E}[X^2] - 2\mu^2 + \mu^2} = \sqrt{\mathrm{E}[X^2] - \mu^2} \\
&= \sqrt{\mathrm{E}[X^2] - (\mathrm{E}[X])^2}
\end{aligned}$$

(derived using the properties of expected value).

In other words, the standard deviation σ (sigma) is the square root of the variance of X; i.e., it 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 μ is undefined.

Discrete random variable

In the case where X takes random values from a finite data set x_1, x_2, ..., x_N, with each value having the same probability, the standard deviation is

$$\sigma = \sqrt{\frac{1}{N}\left[(x_1-\mu)^2 + (x_2-\mu)^2 + \cdots + (x_N-\mu)^2\right]}, \text{ where } \mu = \frac{1}{N}(x_1 + \cdots + x_N),$$

or, using summation notation,

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^N (x_i-\mu)^2}, \text{ where } \mu = \frac{1}{N}\sum_{i=1}^N x_i.$$

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

$$\sigma = \sqrt{\sum_{i=1}^{N} p_i(x_i - \mu)^2}, \text{ where } \mu = \sum_{i=1}^{N} p_i x_i.$$

Continuous random variable

The standard deviation of a continuous real-valued random variable X with probability density function $p(x)$ is

$$\sigma = \sqrt{\int_{\mathbf{X}} (x - \mu)^2 \, p(x) \, dx}, \text{ where } \mu = \int_{\mathbf{X}} x \, p(x) \, dx,$$

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 μ and σ^2, the standard deviation is [(exp(σ^2) − 1)exp(2μ + σ^2)]* 1/2.

11.7.3 Estimation

See also: Sample variance
Main article: Unbiased estimation of standard deviation

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 σ is estimated by examining a random sample taken from the population and computing a statistic of the sample, which is used as an estimate of the population standard deviation. Such a statistic is called an estimator, and the estimator (or the value of the estimator, namely the estimate) is called a **sample standard deviation,** and is denoted by s (possibly with modifiers). However, unlike in the case of estimating the population mean, for which the sample mean is a simple estimator with many desirable properties (unbiased, efficient, maximum likelihood), there is no single estimator for the standard deviation with all these properties, and unbiased estimation of standard deviation is a very technically involved problem. Most often, the standard deviation is estimated using the *corrected sample standard deviation* (using N − 1), defined below, and this is often referred to as the "sample standard deviation", without qualifiers. However, other estimators are better in other respects: the uncorrected estimator (using N) yields lower mean squared error, while using N − 1.5 (for the normal distribution) almost completely eliminates bias.

Uncorrected sample standard deviation

Firstly, the formula for the *population* standard deviation (of a finite population) can be applied to the sample, using the size of the sample as the size of the population (though the actual population size from which the sample is drawn may be much larger). This estimator, denoted by s_N, is known as the **uncorrected sample standard deviation**, or sometimes the **standard deviation of the sample** (considered as the entire population), and is defined as follows:

$$s_N = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (x_i - \overline{x})^2},$$

where $\{x_1, x_2, \ldots, x_N\}$ are the observed values of the sample items and $\overline{x}$ is the mean value of these observations, while the denominator N stands for the size of the sample: this is the square root of the sample variance, which is the average of the squared deviations about the sample mean.

This is a consistent estimator (it converges in probability to the population value as the number of samples goes to infinity), and is the maximum-likelihood estimate when the population is normally distributed. However, this is a biased estimator, as the estimates are generally too low. The bias decreases as sample size grows, dropping off as $1/n$, and thus is most significant for small or moderate sample sizes; for $n > 75$ the bias is below 1%. Thus for very large sample sizes, the uncorrected sample standard deviation is generally acceptable. This estimator also has a uniformly smaller mean squared error than the corrected sample standard deviation.

Corrected sample standard deviation

If the *biased sample variance* (the second central moment of the sample, which is a downward-biased estimate of the population variance) is used to compute an estimate of the population's standard deviation, the result is

$$s_N = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (x_i - \overline{x})^2}.$$

Here taking the square root introduces further downward bias, by Jensen's inequality, due to the square root being a concave function. The bias in the variance is easily corrected, but the bias from the square root is more difficult to correct, and depends on the distribution in question.

An unbiased estimator for the *variance* is given by applying Bessel's correction, using $N - 1$ instead of N to yield the *unbiased sample variance,* denoted s^2:

$$s^2 = \frac{1}{N-1} \sum_{i=1}^{N} (x_i - \overline{x})^2.$$

This estimator is unbiased if the variance exists and the sample values are drawn independently with replacement. $N - 1$ corresponds to the number of degrees of freedom in the vector of deviations from the mean, $(x_1 - \overline{x}, \ldots, x_n - \overline{x})$.

Taking square roots reintroduces bias (because the square root is a nonlinear function, which does not commute with the expectation), yielding the **corrected sample standard deviation,** denoted by *s:*

$$s = \sqrt{\frac{1}{N-1} \sum_{i=1}^{N} (x_i - \overline{x})^2}.$$

As explained above, while s^2 is an unbiased estimator for the population variance, s is still a biased estimator for the population standard deviation, though markedly less biased than the uncorrected sample standard deviation. The bias is still significant for small samples (N less than 10), and also drops off as $1/N$ as sample size increases. This estimator is commonly used and generally known simply as the "sample standard deviation".

Unbiased sample standard deviation

For unbiased estimation of standard deviation, there is no formula that works across all distributions, unlike for mean and variance. Instead, s is used as a basis, and is scaled by a correction factor to produce an unbiased estimate. For the normal distribution, an unbiased estimator is given by s/c_4, where the correction factor (which depends on N) is given in terms of the Gamma function, and equals:

$$c_4(N) = \sqrt{\frac{2}{N-1}} \frac{\Gamma\left(\frac{N}{2}\right)}{\Gamma\left(\frac{N-1}{2}\right)}.$$

This arises because the sampling distribution of the sample standard deviation follows a (scaled) chi distribution, and the correction factor is the mean of the chi distribution.

An approximation can be given by replacing $N - 1$ with $N - 1.5$, yielding:

$$\hat{\sigma} = \sqrt{\frac{1}{N-1.5}\sum_{i=1}^{n}(x_i-\bar{x})^2},$$

The error in this approximation decays quadratically (as $1/N^2$), and it is suited for all but the smallest samples or highest precision: for n = 3 the bias is equal to 1.3%, and for n = 9 the bias is already less than 0.1%.

For other distributions, the correct formula depends on the distribution, but a rule of thumb is to use the further refinement of the approximation:

$$\hat{\sigma} = \sqrt{\frac{1}{n-1.5-\frac{1}{4}\gamma_2}\sum_{i=1}^{n}(x_i-\bar{x})^2},$$

where γ_2 denotes the population excess kurtosis. The excess kurtosis may be either known beforehand for certain distributions, or estimated from the data.

Confidence interval of a sampled standard deviation

See also: Margin of error, Variance § Distribution of the sample variance and Student's_t-distribution § Robust_parametric_modeling

The standard deviation we obtain by sampling a distribution is itself not absolutely accurate, both for mathematical reasons (explained here by the confidence interval) and for practical reasons of measurement (measurement error). The mathematical effect can be described by the confidence interval or CI. To show how a larger sample will make the confidence interval more narrow, consider the following examples: For a small population of N=2, the 95% CI of the SD is from 0.45*SD to 31.9*SD. In other words, the standard deviation of the distribution in 95% of the cases can be larger by a factor of 31 or smaller by a factor of 2. For a larger population of N=10, the CI is 0.69*SD to 1.83*SD. So even with a sample population of 10, the actual SD can still be almost a factor 2 higher than the sampled SD. For a sample population N=100, this is down to 0.88*SD to 1.16*SD. To be more certain that the sampled SD is close to the actual SD we need to sample a large number of points.

11.7.4 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:

$$\sigma(c) = 0$$

$$\sigma(X+c) = \sigma(X),$$

$$\sigma(cX) = |c|\sigma(X).$$

The standard deviation of the sum of two random variables can be related to their individual standard deviations and the covariance between them:

$$\sigma(X+Y) = \sqrt{\text{var}(X)+\text{var}(Y)+2\ \text{cov}(X,Y)}.$$

where $\text{var} = \sigma^2$ and 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. In the following formula, the letter E is interpreted to mean expected value, i.e., mean.

$$\sigma(X) = \sqrt{E[(X-E(X))^2]} = \sqrt{E[X^2]-(E[X])^2}.$$

The sample standard deviation can be computed as:

$$\sigma(X) = \sqrt{\frac{N}{N-1}}\sqrt{E[(X - E(X))^2]}.$$

For a finite population with equal probabilities at all points, we have

$$\sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \overline{x})^2} = \sqrt{\frac{1}{N}\left(\sum_{i=1}^{N} x_i^2\right) - \overline{x}^2} = \sqrt{\left(\frac{1}{N}\sum_{i=1}^{N} x_i^2\right) - \left(\frac{1}{N}\sum_{i=1}^{N} x_i\right)^2}.$$

This means that the standard deviation is equal to the square root of the difference between the average of the squares of the values and the square of the average value. See computational formula for the variance for proof, and for an analogous result for the sample standard deviation.

11.7.5 Interpretation and application

Further information: Prediction interval and Confidence interval
A large standard deviation indicates that the data points can spread 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. 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 gives 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.

While the standard deviation does measure how far typical values tend to be from the mean, other measures are available. An example is the mean absolute deviation, which might be considered a more direct measure of average distance, compared to the root mean square distance inherent in the standard deviation.

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).

Experiment, industrial and hypothesis testing Standard deviation is often used to compare real-world data against a model to test the model.

For example, in industrial applications the weight of products coming off a production line may need to legally be some value. By weighing some fraction of the products an average weight can be found, which will always be slightly different to the long term average. By using standard deviations a minimum and maximum value can be calculated that the averaged weight will be within some very high percentage of the time (99.9% or more). If it falls outside the range then the production process may need to be corrected. Statistical tests such as these are particularly important when the testing is relatively expensive. For example, if the product needs to be opened and drained and weighed, or if the product was otherwise used up by the test.

In experimental science a theoretical model of reality is used. Particle physics uses a standard of "5 sigma" for the declaration of a discovery.*[6] At five-sigma there is only one chance in 3.5 million that a random fluctuation would yield the result. This level of certainty was required in order to assert that a particle consistent with the Higgs boson had been discovered in two independent experiments at CERN.*[7]

Weather 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.

Finance In finance, standard deviation is often used as a measure of the risk associated with price-fluctuations of a given asset (stocks, bonds, property, etc.), or the risk of a portfolio of assets*[8] (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 fundamental concept of risk is that as it increases, the expected return on an investment should increase as well, an increase known as the risk premium. In other words, investors should expect a higher return on an investment when that investment carries a higher level of risk or uncertainty. 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 (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.

Financial time series are known to be non-stationary series, whereas the statistical calculations above, such as standard deviation, apply only to stationary series. To apply the above statistical tools to non-stationary series, the series first must be transformed to a stationary series, enabling use of statistical tools that now have a valid basis from which to work.

Geometric interpretation

To gain some geometric insights and clarification, 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:

$$M = (\overline{x}, \overline{x}, \overline{x})$$

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) $\sqrt{\sum_i (x_i - \overline{x})^2}$ 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

Main article: 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.

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:

$$f(x;\mu,\sigma^2) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$$

where μ is the expected value of the random variables, σ equals their distribution's 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:

$$\operatorname{erf}\left(\frac{z}{\sqrt{2}}\right)$$

where erf is the error function. The proportion that is less than or equal to a number, x, is given by the cumulative distribution function:

$$\text{Proportion} \le x = \frac{1}{2}\left[1 + \operatorname{erf}\left(\frac{x-\mu}{\sigma\sqrt{2}}\right)\right] = \frac{1}{2}\left[1 + \operatorname{erf}\left(\frac{z}{\sqrt{2}}\right)\right].$$ [*][10]

If a data distribution is approximately normal then about 68 percent of the data values are within one standard deviation of the mean (mathematically, μ ± σ, where μ is the arithmetic mean), about 95 percent are within two standard deviations (μ ± 2σ), and about 99.7 percent lie within three standard deviations (μ ± 3σ). 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:

11.7.6 Relationship between standard deviation and mean

The mean and the standard deviation of a set of data are descriptive statistics 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, ..., 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 σ(r) has a unique minimum at the mean:

$$r = \overline{x}.$$

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.

Standard deviation of the mean

Main article: Standard error of the mean

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. Assuming statistical independence of the values in the sample, 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 observations in the sample used to estimate the mean. This can easily be proven with (see basic properties of the variance):

$$\begin{aligned} \text{var}(X) &\equiv \sigma_X^2 \\ \text{var}(X_1 + X_2) &\equiv \text{var}(X_1) + \text{var}(X_2) \\ \text{var}(cX_1) &\equiv c^2\ \text{var}(X_1) \end{aligned}$$

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:

$$\sigma_{\text{mean}} = \frac{\sigma}{\sqrt{N}}.$$

It should be emphasized that in order to estimate standard deviation of the mean σ_{mean} it is necessary to know standard deviation of the entire population σ beforehand. However, in most applications this parameter is unknown. For example, if series of 10 measurements of previously unknown quantity is performed in laboratory, it is possible to calculate resulting sample mean and sample standard deviation, but it is impossible to calculate standard deviation of the mean.

11.7.7 Rapid calculation methods

See also: Algorithms for calculating variance

The following two formulas can represent a running (repeatedly updated) standard deviation. A set of two power sums s_1 and s_2 are computed over a set of N values of x, denoted as x_1, ..., x_N:

$$s_j = \sum_{k=1}^{N} x_k^j.$$

Given the results of these running summations, the values *N*, s_1, s_2 can be used at any time to compute the *current* value of the running standard deviation:

$$\sigma = \frac{\sqrt{Ns_2 - s_1^2}}{N}$$

Where N, as mentioned above, is the size of the set of values.

Similarly for sample standard deviation,

$$s = \sqrt{\frac{Ns_2 - s_1^2}{N(N-1)}}.$$

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.*[11] This is a "one pass" algorithm for calculating variance of *n* samples without the need to store prior data during the calculation. Applying this method to a time series will result in successive values of standard deviation corresponding to *n* data points as *n* grows larger with each new sample, rather than a constant-width sliding window calculation.

For $k = 1, ..., n$:

$$A_0 = 0$$
$$A_k = A_{k-1} + \frac{x_k - A_{k-1}}{k}$$

where A is the mean value.

$$Q_0 = 0$$
$$Q_k = Q_{k-1} + \frac{k-1}{k}(x_k - A_{k-1})^2 = Q_{k-1} + (x_k - A_{k-1})(x_k - A_k)$$

Note: $Q_1 = 0$ since $k - 1 = 0$ or $x_1 = A_1$

Sample variance:

$$s_n^2 = \frac{Q_n}{n-1}$$

Population variance:

$$\sigma_n^2 = \frac{Q_n}{n}$$

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 for each *k* from 1 to *n*:

$$\begin{aligned}
W_0 &= 0 \\
W_k &= W_{k-1} + w_k
\end{aligned}$$

and places where $1/n$ is used above must be replaced by w_i/W_n:

$$\begin{aligned}
A_0 &= 0 \\
A_k &= A_{k-1} + \frac{w_k}{W_k}(x_k - A_{k-1}) \\
Q_0 &= 0 \\
Q_k &= Q_{k-1} + \frac{w_k W_{k-1}}{W_k}(x_k - A_{k-1})^2 = Q_{k-1} + w_k(x_k - A_{k-1})(x_k - A_k)
\end{aligned}$$

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.

11.7.8 Combining standard deviations

Main article: Pooled standard deviation

Population-based statistics

The populations of sets, which may overlap, can be calculated simply as follows:

$$\begin{aligned}
& & N_{X\cup Y} &= N_X + N_Y - N_{X\cap Y} \\
X \cap Y = \varnothing &\Rightarrow & N_{X\cap Y} &= 0 \\
&\Rightarrow & N_{X\cup Y} &= N_X + N_Y
\end{aligned}$$

Standard deviations of non-overlapping ($X \cap Y = \varnothing$) sub-populations can be aggregated as follows if the size (actual or relative to one another) and means of each are known:

$$\begin{aligned}
\mu_{X\cup Y} &= \frac{N_X\mu_X + N_Y\mu_Y}{N_X + N_Y} \\
\sigma_{X\cup Y} &= \sqrt{\frac{N_X\sigma_X^2 + N_Y\sigma_Y^2}{N_X + N_Y} + \frac{N_X N_Y}{(N_X + N_Y)^2}(\mu_X - \mu_Y)^2}
\end{aligned}$$

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 women. Then the mean and standard deviation of heights of American adults could be calculated as:

$$\begin{aligned}\mu &= \frac{N\cdot 70 + N\cdot 65}{N+N} = \frac{70+65}{2} = 67.5\\ \sigma &= \sqrt{\frac{3^2+2^2}{2} + \frac{(70-65)^2}{2^2}} = \sqrt{12.75} \approx 3.57\end{aligned}$$

For the more general case of *M* non-overlapping populations, X_1 through X_M, and the aggregate population $X = \bigcup_i X_i$:

$$\begin{aligned}\mu_X &= \frac{\sum_i N_{X_i}\mu_{X_i}}{\sum_i N_{X_i}}\\ \sigma_X &= \sqrt{\frac{\sum_i N_{X_i}\sigma^2_{X_i}}{\sum_i N_{X_i}} + \frac{\sum_{i<j} N_{X_i}N_{X_j}(\mu_{X_i}-\mu_{X_j})^2}{\left(\sum_i N_{X_i}\right)^2}}\end{aligned}$$

where

$$X_i \cap X_j = \varnothing, \quad \forall\, i<j.$$

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:

$$\begin{aligned}\mu_{X\cup Y} &= \frac{1}{N_{X\cup Y}}\left(N_X\mu_X + N_Y\mu_Y - N_{X\cap Y}\mu_{X\cap Y}\right)\\ \sigma_{X\cup Y} &= \sqrt{\frac{1}{N_{X\cup Y}}\left(N_X[\sigma^2_X+\mu^2_X] + N_Y[\sigma^2_Y+\mu^2_Y] - N_{X\cap Y}[\sigma^2_{X\cap Y}+\mu^2_{X\cap Y}]\right) - \mu^2_{X\cup Y}}\end{aligned}$$

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:

$$\sigma_X = \sqrt{\sum_i \sigma^2_{X_i} + \sum_{i,j}\operatorname{cov}(X_i, X_j)}$$

For the special case where no correlation exists between any pair of data sets, then the relation reduces to the root-mean-square:

$$\begin{aligned}&\operatorname{cov}(X_i, X_j) = 0, \quad \forall i<j\\ \Rightarrow\ &\sigma_X = \sqrt{\sum_i \sigma^2_{X_i}}.\end{aligned}$$

Sample-based statistics

Standard deviations of non-overlapping ($X \cap Y = \varnothing$) sub-samples can be aggregated as follows if the actual size and means of each are known:

$$\mu_{X\cup Y} = \frac{1}{N_{X\cup Y}}\left(N_X\mu_X + N_Y\mu_Y\right)$$
$$\sigma_{X\cup Y} = \sqrt{\frac{1}{N_{X\cup Y}-1}\left([N_X-1]\sigma_X^2 + N_X\mu_X^2 + [N_Y-1]\sigma_Y^2 + N_Y\mu_Y^2 - [N_X+N_Y]\mu_{X\cup Y}^2\right)}$$

For the more general case of M non-overlapping data sets, X_1 through X_M, and the aggregate data set $X = \bigcup_i X_i$:

$$\mu_X = \frac{1}{\sum_i N_{X_i}}\left(\sum_i N_{X_i}\mu_{X_i}\right)$$
$$\sigma_X = \sqrt{\frac{1}{\sum_i N_{X_i}-1}\left(\sum_i\left[(N_{X_i}-1)\sigma_{X_i}^2 + N_{X_i}\mu_{X_i}^2\right] - \left[\sum_i N_{X_i}\right]\mu_X^2\right)}$$

where:

$$X_i \cap X_j = \varnothing, \quad \forall i < j.$$

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:

$$\mu_{X\cup Y} = \frac{1}{N_{X\cup Y}}\left(N_X\mu_X + N_Y\mu_Y - N_{X\cap Y}\mu_{X\cap Y}\right)$$
$$\sigma_{X\cup Y} = \sqrt{\frac{[N_X-1]\sigma_X^2 + N_X\mu_X^2 + [N_Y-1]\sigma_Y^2 + N_Y\mu_Y^2 - [N_{X\cap Y}-1]\sigma_{X\cap Y}^2 - N_{X\cap Y}\mu_{X\cap Y}^2 - [N_X+N_Y-N_{X\cap Y}]\mu_{X\cup Y}^2}{N_{X\cup Y}-1}}$$

11.7.9 History

The term *standard deviation* was first used*[12] in writing by Karl Pearson*[13] 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*.*[14] It may be worth noting in passing that the mean error is mathematically distinct from the standard deviation.

11.7.10 See also

- 68–95–99.7 rule
- Accuracy and precision
- Chebyshev's inequality An inequality on location and scale parameters
- Cumulant
- Deviation (statistics)
- Distance correlation Distance standard deviation
- Error bar
- Geometric standard deviation
- Mahalanobis distance generalizing number of standard deviations to the mean
- Mean absolute error
- Percentile

- Raw score
- Relative standard deviation
- Robust standard deviation
- Root mean square
- Sample size
- Samuelson's inequality
- Six Sigma
- Standard error
- Standard score
- Volatility (finance)
- Yamartino method for calculating standard deviation of wind direction

11.7.11 References

[1] Bland, J.M.; Altman, D.G. (1996). "Statistics notes: measurement error". *Bmj, 312(7047), 1654.* **312** (7047): 1654. doi:10.1136/bmj.312.7047.1654. PMC 2351401. PMID 8664723.

[2] Gauss, Carl Friedrich (1816). "Bestimmung der Genauigkeit der Beobachtungen". *Zeitschrift für Astronomie und verwandte Wissenschaften* **1**: 187–197.

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[5] Weisstein, Eric W., "Bessel's Correction", *MathWorld*.

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[8] "What is Standard Deviation". Pristine. Retrieved 2011-10-29.

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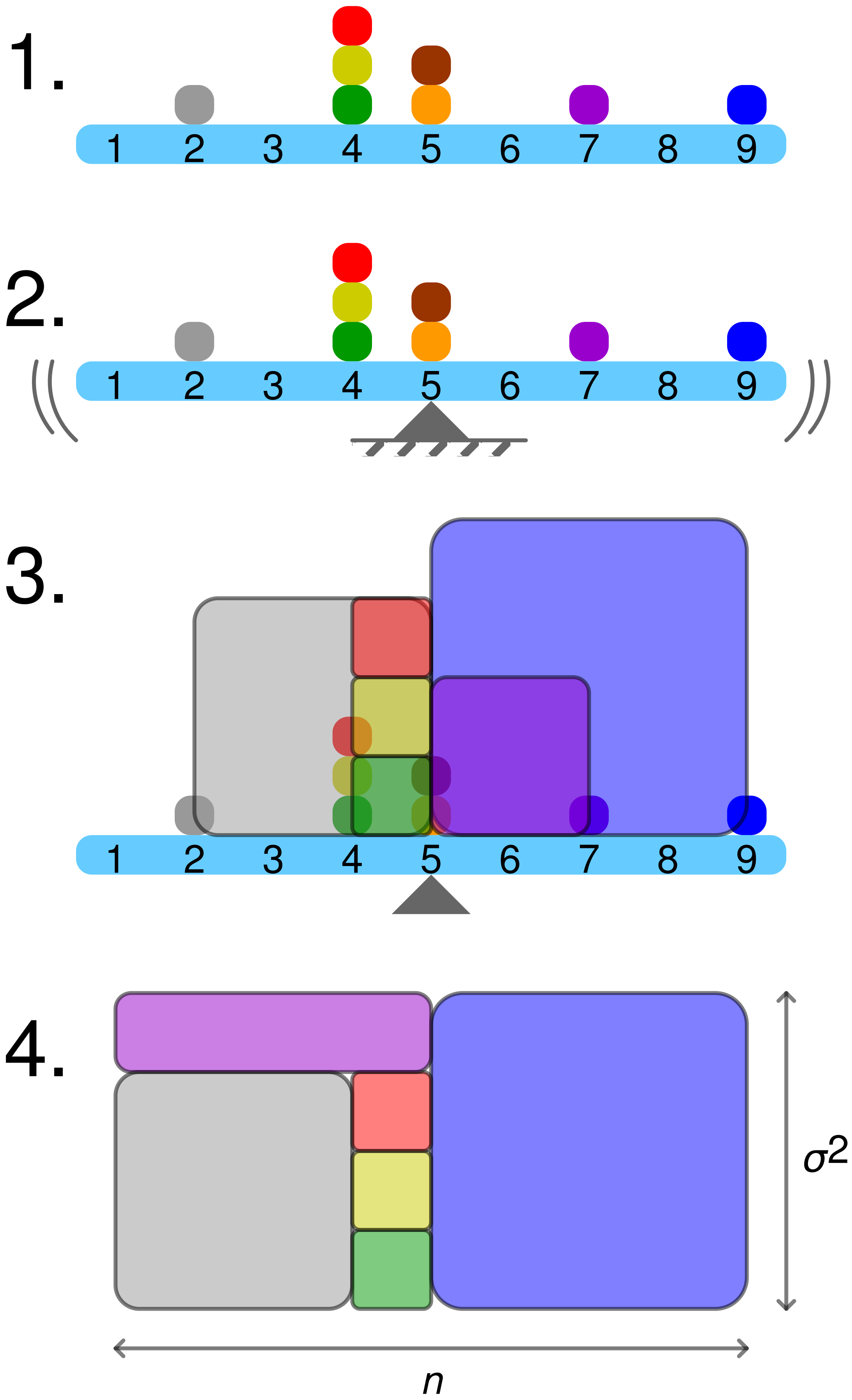
[12] Dodge, Yadolah (2003). *The Oxford Dictionary of Statistical Terms*. Oxford University Press. ISBN 0-19-920613-9.

[13] Pearson, Karl (1894). "On the dissection of asymmetrical frequency curves". *Philosophical Transactions of the Royal Society A* **185**: 71–110. doi:10.1098/rsta.1894.0003.

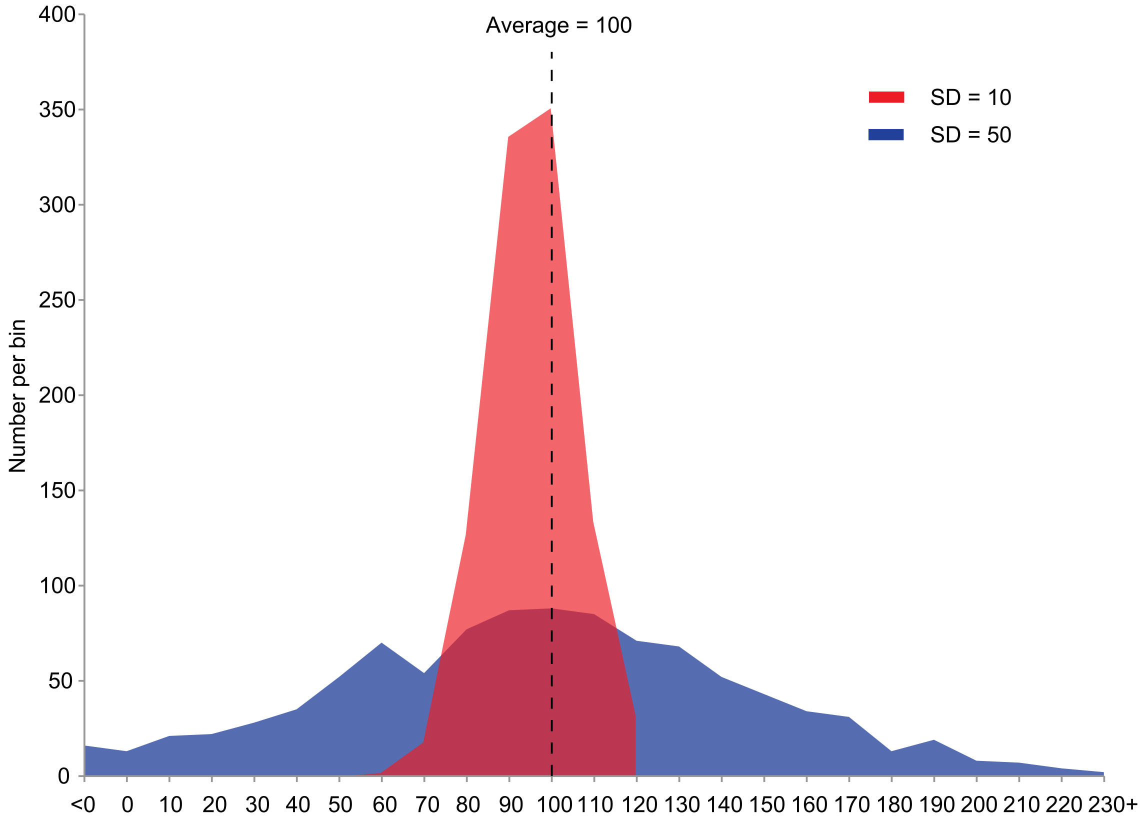
[14] Miller, Jeff. "Earliest Known Uses of Some of the Words of Mathematics".

11.7.12 External links

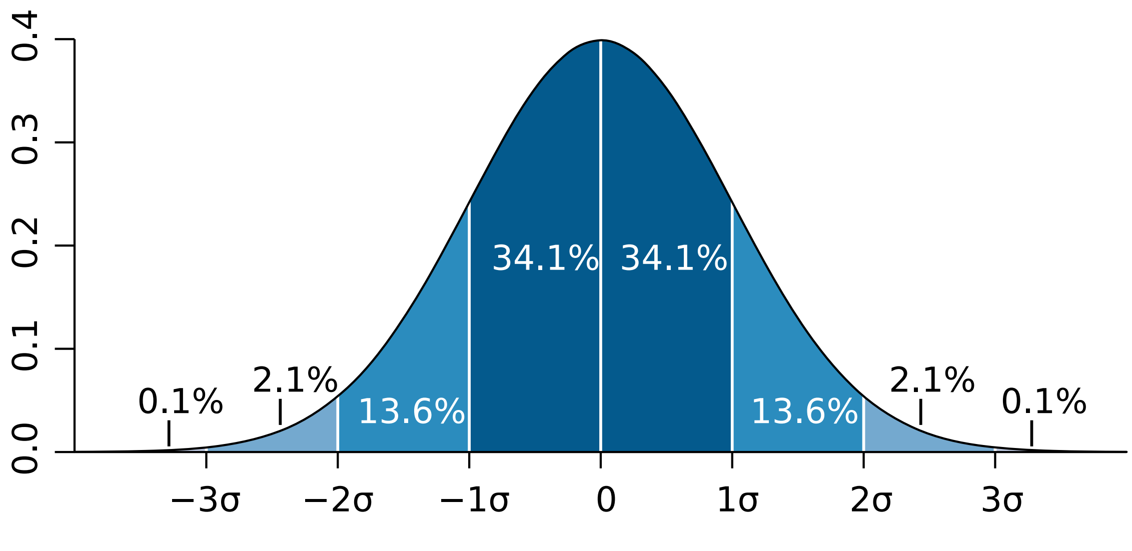
- Hazewinkel, Michiel, ed. (2001), "Quadratic deviation", *Encyclopedia of Mathematics*, Springer, ISBN 978-1-55608-010-4
- A simple way to understand Standard Deviation
- Standard Deviation – an explanation without maths
- The concept of Standard Deviation is shown in this 8-foot-tall (2.4 m) Probability Machine (named Sir Francis) comparing stock market returns to the randomness of the beans dropping through the quincunx pattern. on YouTube from Index Funds Advisors IFA.com



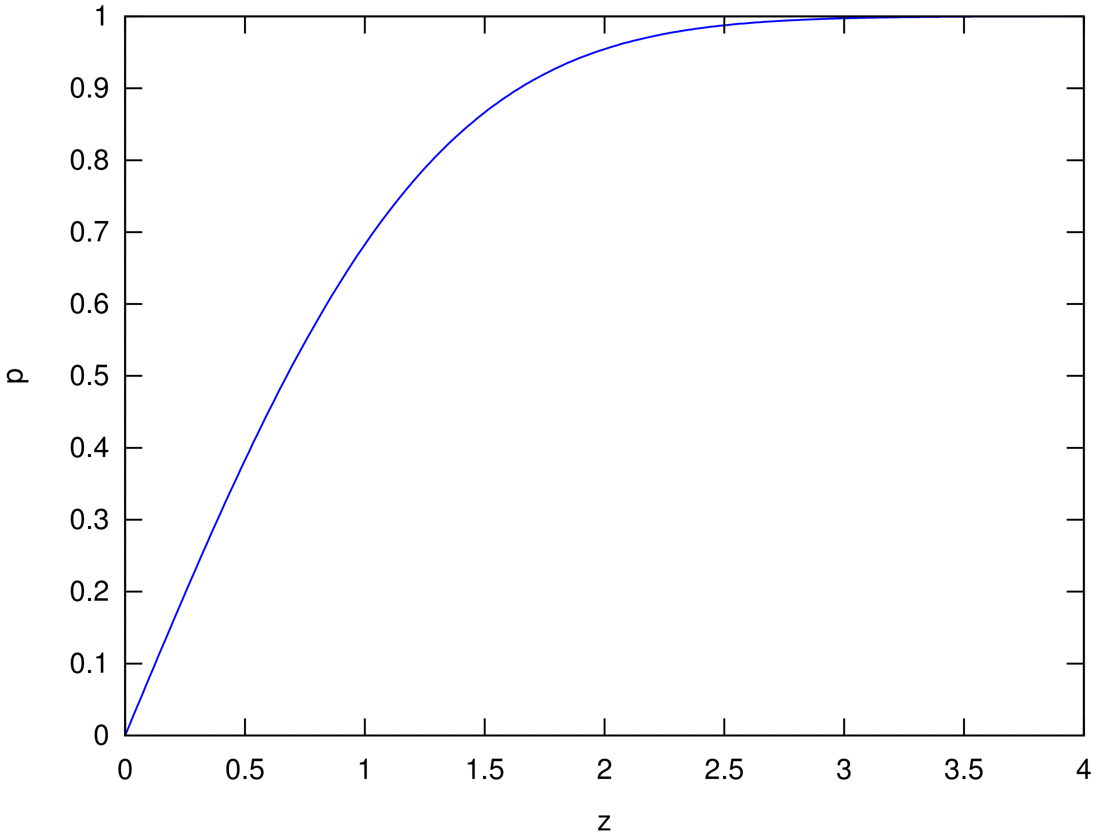
Geometric visualisation of the variance of the example distribution:
1. A frequency distribution is constructed.
2. The centroid of the distribution gives its mean.
3. A square with sides equal to the difference of each value from the mean is formed for each value.
4. Arranging the squares into a rectangle with one side equal to the number of values, n*, results in the other side being the distribution's variance,* σ^2.



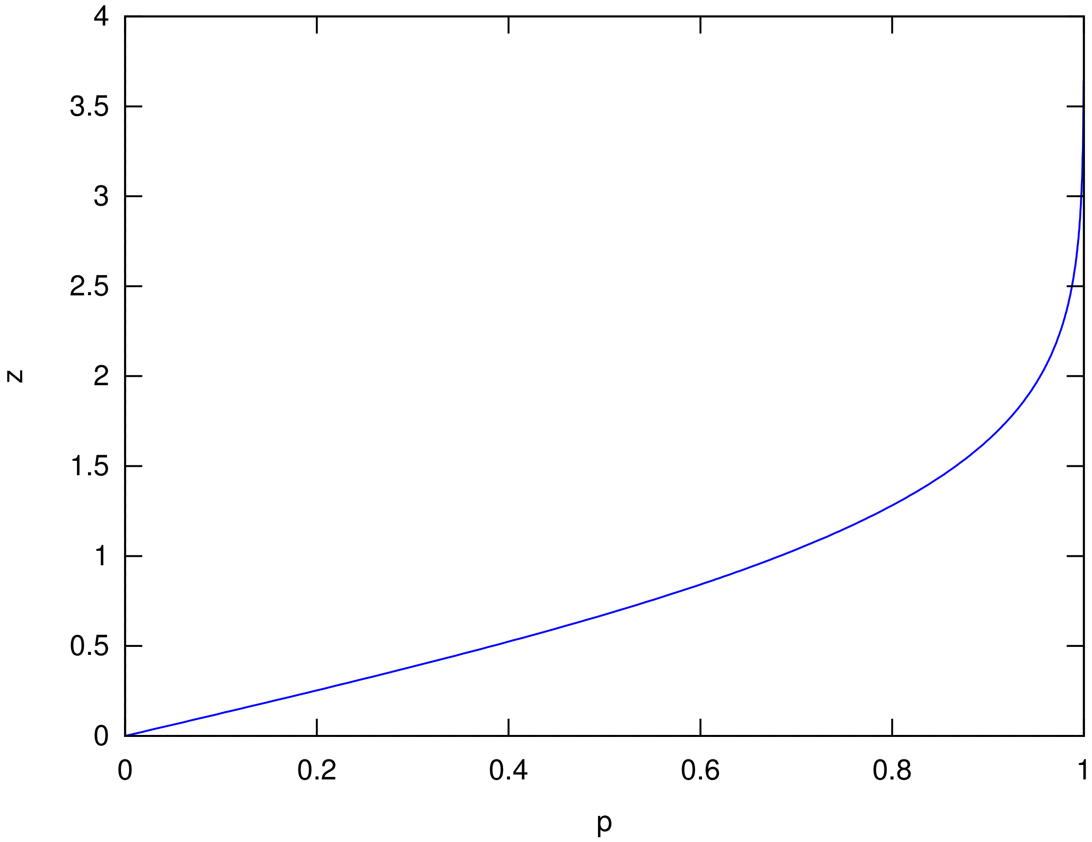
Example of samples from two populations with the same mean but different standard deviations. Red population has mean 100 and SD 10; blue population has mean 100 and SD 50.



Dark blue is one standard deviation on either side of the mean. For the normal distribution, this accounts for 68.27 percent of the set; while two standard deviations from the mean (medium and dark blue) account for 95.45 percent; three standard deviations (light, medium, and dark blue) account for 99.73 percent; and four standard deviations account for 99.994 percent. The two points of the curve that are one standard deviation from the mean are also the inflection points.



Percentage within(z)



z(Percentage within)

Chapter 12

Breadth Indicators

12.1 Breadth of market

Breadth of market is an indicator used in security analysis. In its simplest form it is computed on a stock market by taking the ratio of the number of advancing stocks to declining stocks.*[1]

12.1.1 Bibliography

- *The complete guide to market breadth indicators* by Gregory L. Morris 2005 ISBN 0-07-144443-2

12.1.2 References

[1] *Technical Analysis* by Charles D. Kirkpatrick, Julie R. Dahlquist 2010 ISBN 0-13-705944-2 page 133

12.2 Advance–decline line

The **advance–decline line** is a stock market technical indicator used by investors 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:*[1]

$$ADline = today's\ advancing\ stocks - today's\ declining\ stocks + yesterday's\ AD\ line\ value$$

The Advance/Decline Line formula could be applied to volume of the advancing and declining stocks.

$$AD\ volume\ line = Advanced\,Volume - Declined\,Volume + yesterday's\ AD\ volume\ line$$ *[2]

The ADL is one of the oldest indicators based on the Advance-Decline Data and it was the most popular of all internal indicators.*[1]

12.2.1 Divergence

"Divergence" is when the stock market index moves in one direction while the ADL on that index moves in the opposite direction.*[3] 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,*[4] 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 1972 at the height of the Nifty Fifty market,*[5] and starting in March 2008 before the late-2008 market collapse.*[6]

12.2.2 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.*[7]

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.

Advance–decline numbers can be also used in your daily observations of the trades 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.

12.2.3 Example of market breadth chart

- NASDAQ Breadth
- DAX Breadth
- FTSE Breadth
- STI Breadth

12.2.4 References

[1] "Market Breadth: Advance/Decline Indicators". Investopedia. 2010. Archived from the original on 24 September 2010. Retrieved 2013-01-05.

[2] "Advance Decline Line". MarketVolume. 2009. Archived from the original on 27 March 2009. Retrieved 2009-03-27.

[3] http://www.trade10.com/advanceDecline.html

[4] http://blogs.stockcharts.com/chartwatchers/2006/09/the-importance-of-the-ny-a-d-line.html

[5] http://www.lewrockwell.com/orig5/duffy4.html

[6] http://www.marketoracle.co.uk/Article4754.html

[7] "Advance/Decline Ratio Basics". Stock-Market-Investors.com. 2008. Archived from the original on 1 September 2010. Retrieved 2010-09-12.

12.3 TRIN (finance)

The **TRIN**, or **Arms** index, developed by Richard Arms in the 1970s, is a short-term technical analysis stock market trading indicator based on the Advance-Decline Data.*[1] The name is short for **TR**ading **IN**dex. The index is calculated as follows:

$$TRIN = \frac{advancing\ issues/declining\ issues}{advancing\ volume/declining\ volume}$$

A value below 1 usually indicates bullish sentiment, and a value above 1 – bearish. A reading reaching 1.5 is very bearish. The index was introduced by Richard Arms, and is continuously displayed during trading hours, among other indices, on the New York Stock Exchange's central wall display for the stocks traded on that exchange.

The index is calculated based on number of shares traded, not their dollar value. Therefore, a highly traded stock with a low share price will affect the index more than the same dollar volume traded in a higher-priced stock.

12.3.1 References

[1] Richard Arms (1996). *The Arms Index (Trin Index): An Introduction to Volume Analysis*. Marketplace Books. ISBN 978-1883272159.

12.3.2 External links

- How to interpret the TRIN technical indicator at OnlineTradingConcepts.com
- Investopedia - Arms Index - TRIN
- Article by Mr. Richard W. Arms, Jr.
- Description and Chart of the TRIN

12.4 McClellan oscillator

The **McClellan oscillator** is a market breadth indicator used in technical analysis 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.*[1] The McClellan oscillator is based on the Advance-Decline Data and it could be applied to stock market exchanges, indexes, portfolio of stocks or any basket of stocks.

12.4.1 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.

12.4.2 How it works

The simplified formula for determining the oscillator is:

$$Oscillator = (\text{declines minus advances of EMA day 19}) - (\text{declines minus advances of EMA day 39})$$

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:

- When above zero it is considered to be bullish (positive growth).
- When 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.*[1]

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.

12.4.3 References

[1] Illustrative description by McClellan Publications of the McClellan Oscillator

12.4.4 External links

- Investopedia description of the McClellan oscillator
- Current NYSE McClellan Oscillator and Summation Index at StockCharts.com
- Description and Charts of the McClellan Oscillator

Chapter 13

Other Indicators

13.1 Coppock curve

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.*[1]

The indicator is designed for use on a monthly time scale. It is the sum of a 14-month rate of change and 11-month rate of change, smoothed by a 10-period weighted moving average.

$$Coppock = WMA[10]\ of\ (ROC[14] + ROC[11])$$

Coppock, the founder of Trendex Research in San Antonio, Texas, 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.*[2]

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" *[1]) for the S&P 500 index, and it has been applied to similar stock indexes like the Dow Jones Industrial Average. It is not regarded as well-suited to commodity markets, since bottoms there are more rounded than the spike lows found in stocks.*[3]

13.1.1 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.*[4]

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.*[5]

Jerry Samet has successfully used the Coppock indicator using weekly close data vs. monthly close. This indicator greatly helps with the definition of the intermediate term market moves of 6-weeks to 12-month duration. Mike Scott has determined that the weekly Coppock used in conjunction with Investor's Business Daily Market Direction calls that a Coppock buy signal that occurs within plus or minus 2 weeks of an IBD Follow-Through Day correctly identifies successfully rallies 79% of the time in bull markets and 45% of the time in bear markets. Success here is defined by a NASDAQ market that rallies at least 9 or 10% over at least a 5 or 6 week period.

13.1.2 References

[1] Donald J. Durham Jr. (1964). "An Analysis of Stock Market Indicators". *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*. |chapter= ignored (help)

[2] Coppock Indicator at the Global-Investor Glossary

[3] Coppock Curve Interpretation page at Topline Investment Graphics

[4] Coppock Indicator page at Incredible Charts

[5] IC/Coppock: Sell, sell, sell from Investors Chronicle

13.1.3 External links

13.2 Ulcer index

The **ulcer index** is a stock market risk measure or technical analysis indicator devised by Peter Martin in 1987,*[1] 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.*[2] Shellans index is not described in this article.

13.2.1 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

$$R_i = 100 \times \frac{price_i - maxprice}{maxprice}$$

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.

$$Ulcer = \sqrt{\frac{R_1^2 + R_2^2 + \cdots R_N^2}{N}}$$

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.

13.2.2 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

$$Sharpe\,ratio = \frac{Return - RiskFreeReturn}{standard\,deviation}$$

The ulcer index can replace the SD to make an ulcer performance index (UPI) or Martin ratio,

$$UPI = \frac{Return - RiskFreeReturn}{ulcer\, index}$$

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.*[3] As with the Sharpe Ratio, a higher value is better than a lower value (investors prefer more return for less risk).

13.2.3 References

[1] Peter Martin's Ulcer Index page

[2] Pankin Managed Funds, client newsletter 3rd Quarter 1996, Questions and Answers

[3] Discovering the Absolute-Breadth Index and the Ulcer Index at Investopedia.com

13.2.4 Further reading

Related topics

- Hindenburg Omen
- The Gilt Dragon” Omen

Books

- *The Investor's 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 .

13.2.5 External links

- Peter Martin's web site

Chapter 14

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14.1 Text

- **Technical analysis** *Source:* https://en.wikipedia.org/wiki/Technical_analysis?oldid=702143927 *Contributors:* The Anome, Alex.tan, Mswake, Heron, Edward, Michael Hardy, Willsmith, Kwertii, Kku, Wapcaplet, Axlrosen, Pcb21, Ronz, Kricke, JVBraun, Susurrus, Rob Hooft, MichaelHiggins, Mydogategodshat, Charles Matthews, Jfeckstein, DJ Clayworth, Tempshill, Robbot, Nurg, Seglea, Gandalf61, Chris Roy, Academic Challenger, Hadal, BenFrantzDale, Fastfission, Cool Hand Luke, Marcika, Everyking, St3vo, Patsup, Junkyardprince, Neilc, Tony C, Jonel, Quarl, Karol Langner, RayBirks, Elroch, Pgreenfinch, Vitaleyes, Klemen Kocjancic, Shotwell, RedWordSmith, Discospinster, Rich Farmbrough, Rhobite, Leibniz, Vapour, ESkog, Filur, BrokenSegue, Maurreen, Jerryseinfeld, Peterpudaite, Anul, Nsaa, Mdd, HasharBot~enwiki, Danski14, Silver hr, Denoir, Nealcardwell, Andrewpmk, John Quiggin, InShaneee, Wdfarmer, Benna, RussAbbott, Stemonitis, Bobrayner, Rdangi, Hnjvr, OwenX, Blair P. Houghton, -oo0(GoldTrader)0oo-, Liface, Mandarax, Rjwilmsi, Buldri, Lhclin, Golden Eternity, Bfigura, Renaissance Man, Eck~enwiki, Co94, RexNL, Goudzovski, Chobot, Volunteer Marek, Bgwhite, YurikBot, Borgx, Elapsed, Akamad, Shell Kinney, Gaius Cornelius, ENeville, Nirvana2013, Yahya Abdal-Aziz, Darkmeerkat, JulesH, BOT-Superzerocool, Georgewilliamherbert, 21655, 2over0, Jm546, GraemeL, Shawnc, Finell, DocendoDiscimus, SmackBot, Masparasol, Zoogod, Brick Thrower, Veesicle, Gilliam, Ohnoitsjamie, Amatulic, MalafayaBot, Kevin Ryde, Ampere~enwiki, A. B., Gijsdereeper, Rama's Arrow, Smallbones, JonHarder, Xiner, Bbands, Zeninubasho, Nakon, Mcduffodonnell, Rbbrain, Valwen, Sgcook, Dnavarro, Neil9327, G-Bot~enwiki, BrownHairedGirl, TJ36, Kuru, KenFehling, JethroElfman, Vgy7ujm, Breno, Aleator, Gregorydavid, NongBot~enwiki, RomanSpa, Paradoxsociety, Snoopyjc, Dicklyon, MrArt, TastyPoutine, Stephen B Streater, DabMachine, Quaeler, Levineps, Typelighter, Dacamic, Trade2tradewell, CmdrObot, Ezgoing85018, Sir Vicious, Chrumps, Shantris Te'Amdoraja, Page Up, Bill.albing, THF, Chrisahn, Cydebot, Clovis Sangrail, Roberta F., Rdls01, Diabloblue, Mastertrader, Kilva, Www.crossprofit.com, Wai Wai, KevinWho, Mfortier, Seaphoto, JLW777, Jmcgoo, Hardeeps, Daytona2, Ioeth, JAnDbot, Husond, Davewho2, MER-C, Victoria Madden, Greensburger, Beaumont, Andreas Toth, Sensatus, Shaharyarrao, OmriN, MartinDK, Froid, Destynova, Rgfolsom, Cisum.ili.dilm, Allstarecho, D.h, CliffC, Tautkusm, Fxdealer, R'n'B, Fconaway, Mbhiii, J.delanoy, PWdiamond, Fatherdagon, Drewwiki, Vision3001, Nevron, RIPSAW1986, Dangermouse72, DMCer, Pgrieg, Idioma-bot, JLBernstein, Cashexpert, Sergivs-en, Soultrader, Pleclech, VolkovBot, Alexandria, Gene Hobbs, Filmnight, Fillmnnight, Hqb, Rei-bot, Troed, Anna Lincoln, Nexus501, Samiharris, Tranbryant, WebScientist, Madhero88, Lamro, Df747jet, Lova Falk, Harrimanpr, Cindamuse, Attics, Sposer, Kbrose, Jonwickmann, SieBot, Motorracer, TrulyBlue, Bagatelle, Redmercury82, Happytech, Melcombe, ImageRemovalBot, Ministry of random walks, Lars Ingebrigtsen, Stocksnet, Jonkozer, ImperfectlyInformed, Zafaridi, Niceguyedc, Excirial, Relata refero, Jimstromberg, Arjayay, AnshumanF, EGMichaels, Cybershore, Chakreshsinghai, Apparition11, Yetzoz, DumZiBoT, XLinkBot, AgnosticPreachersKid, SilvonenBot, IgorLaurelli, Addbot, DOI bot, Maria C Mosak, TradingBands, Aboctok, ItosLemma, Diptanshu.D, MrOllie, Inves20, Gymsim, Lightbot, Romaioi, Narnia205, Chartguy, Lcannady, Legobot, Luckas-bot, Yobot, Themfromspace, All We Have To Fear Is Me, Ptbotgourou, Nikosguard, IMSFX, AnomieBOT, Keithbob, AdjustShift, Ulric1313, Keller1125, Citation bot, Xqbot, Tripodian, Urbansuperstar~enwiki, FL Geezer, Kithira, Omnipaedista, Shirik, Shadowjams, FrescoBot, Mark Renier, JJLudemann, Rooster edits, Yusufhgmail, Ahardy66, Citation bot 1, Silviamenini, Mgcalhoun, MarquezComelab, Skyerise, Hindahinda, Oktogon12, Ctt3716, Trappist the monk, RANJINAP, Time9, Jonkerz, Krassotkin, ItayGolan, Safesanctuary, Globex78, Diannaa, Pozytyv, Tomjones999, Panayiotis Markou, RjwilmsiBot, Sargdub, Superbull, EmausBot, Vickypedia30, Alanwaltman, Tedtick, Dewritech, Racerx11, RogerBabson, Ctatlantic, Thecheesykid, DeeDeeKerby, MRBigdeli, Wayne Slam, Dsornette, Vincentangeles, ChuispastonBot, Peter681, AndyTheGrump, Tututumuch, SorenLanng, ClueBot NG, Bodyofknowledge, Toomanywordstoolittletime, Ramillav, Zdbuckley, Harsh321, Chartsonly, Biosketch, Widr, Nbros, Ronstar111, Orlydumitrescu, Helpful Pixie Bot, BG19bot, AvocatoBot, Jmasiulewicz, CitationCleanerBot, Eidenberger, Nammik, Timepricer, Elgingreen, Jfccmt, Smartfx, Jackwhite1940, Investorhenry, Dexbot, Unbaratocha, Jasonbrohanson, Seaman4516, Nawalkam, Desantis11, Minhnhh, Bw7712, Joonneess, Bufet, Jonas33h, RJSutter, Technological Engineers, ChrHabKas, Sam lyon fr, AstroEconomist, Monkbot, Lklincoln, Ketex, Jupiter 56, Rmh789, Levonav, CV9933, Chartswale, Mattpeterscmt, Bartsi125, Bizmaveric and Anonymous: 416
- **Breakout (technical analysis)** *Source:* https://en.wikipedia.org/wiki/Breakout_(technical_analysis)?oldid=684616693 *Contributors:* Karol Langner, -oo0(GoldTrader)0oo-, AndrewWatt, SmackBot, Kevin Ryde, Meco, JohnCJWood, OccamzRazor, Erik9bot, Altafqadir, Time9, Dewritech and Anonymous: 5
- **Dead cat bounce** *Source:* https://en.wikipedia.org/wiki/Dead_cat_bounce?oldid=699544163 *Contributors:* The Anome, Pcb21, Billdakelski, Furrykef, Merovingian, Desmay, UtherSRG, ALargeElk, OldakQuill, MisfitToys, CanisRufus, John Quiggin, Grenavitar, -oo0(GoldTrader)0oo-, Eyreland, Rjwilmsi, Koavf, Afterwriting, Avocado, Crazycomputers, Vidkun, RussBot, Anomalocaris, Nirvana2013, Ilmari Karonen, SmackBot, Thumperward, Robofish, Nolte, A. Parrot, Joseph Solis in Australia, Phoenixrod, Eastlaw, Ketorin, Perfect

Proposal, DumbBOT, Thijs!bot, Heroeswithmetaphors, Sidasta, Qwerty Binary, Ingolfson, Magioladitis, Kask, CliffC, SharkD, Phaux, Adamgpope, HughGRex, VanishedUserABC, Tpb, Bigdaddy1981, Mapoftasmania, Sentriclecub, Hotcrocodile, Rror, Addbot, Laaknor-Bot, SB Willie, SpBot, Lightbot, Yobot, AnomieBOT, Piano non troppo, Keithbob, SupermanML, HsiehLi, BoomerAB, FrescoBot, Pinethicket, Time9, Traderookie, Noelvginnity, ZéroBot, EdoBot, ClueBot NG, Lucasoutloud, Lowercase sigmabot, Harizotoh9, Whileworth, Poponuro, Bad Dryer, Sta064, Frazer1234 and Anonymous: 75

- **Dow theory** *Source:* https://en.wikipedia.org/wiki/Dow_theory?oldid=697019208 *Contributors:* Eloquence, SimonP, Michael Hardy, Kwertii, Dcljr, Dpbsmith, King brosby, Sam Hocevar, DMG413, AdamAtlas, Officiallyover, Arthena, Ricky81682, Kdau, Versageek, Richard Arthur Norton (1958-), Ylem, Isnow, Dgphilli, Vegaswikian, Alphachimp, Bgwhite, YurikBot, Splash, Mweymar, Tony1, Mtcedar, Katieh5584, SmackBot, Ohnoitsjamie, Amatulic, Kevin Ryde, DoctorW, Smallbones, Dicklyon, Fdssdf, OS2Warp, CmdrObot, SomeNumpty, Markhu, Escarbot, Leuko, Albany NY, Brusegadi, DerHexer, Drewwiki, ThinkBlue, A4bot, WikipedianYknOK, Martin451, ClueBot, ImperfectlyInformed, Nycjay, OccamzRazor, Edl1-wiki, DumZiBoT, XLinkBot, Addbot, Lightbot, Luckas-bot, Kggucwa, Washburnmav, Karris76, Andrius.kvaraciejus, EdoDodo, Petit Djul, Time9, Jastaruk, Slightsmile, ClueBot NG, Borkificator, AndyNemo, Stockdude, RobSchannep, Timepricer, SPECIFICO, Jack Schannep, Mtr98, Manuel Blay and Anonymous: 75
- **Elliott wave principle** *Source:* https://en.wikipedia.org/wiki/Elliott_wave_principle?oldid=697652655 *Contributors:* The Anome, Edward, Michael Hardy, Ahoerstemeier, DavidWBrooks, Mydogategodshat, Nurg, Alerante, Giftlite, Orangemike, Marcika, Tbjablin, Karol Langner, Pgreenfinch, Monkeyman, Loganberry, Bender235, Jburt1, Cje~enwiki, Jerryseinfeld, Anthony Appleyard, John Quiggin, Oleg Alexandrov, Bobrayner, OwenX, SDC, Cww, Brighterorange, Exeunt, Roboto de Ajvol, YurikBot, Ksyrie, Nirvana2013, Alextangent, JulesH, Amakuha, Semperf, Crasshopper, DocendoDiscimus, SmackBot, KelleyCook, Timotheus Canens, Amatulic, Jprg1966, Kevin Ryde, Medlongj, Smallbones, Bejnar, Lambiam, Robofish, Sancarr, Hu12, Ebrenner8, Iridescent, OnlyTron, Philip ea, RookZERO, Trade2tradewell, JForget, Punanimal, THF, Z10x, Spirit Of Truth, Seaphoto, Tjmayerinsf, MER-C, Suryadas, Greensburger, Pauljlamont, Magioladitis, Brusegadi, Rgfolsom, ArmadilloFromHell, Gudea~enwiki, D.h, S3000, Drewwiki, Maproom, LordAnubisBOT, Aforallie, KylieTastic, Jasonsullivan, Robertknyc, Pleclech, AlnoktaBOT, Ticklemygrits, JayC, Nematalla, AllGloryToTheHypnotoad, Wassermann~enwiki, Sposer, Kbrose, SieBot, Jamesclunie, Azazyel, Finconsult, Tradermatt, Denisarona, ImageRemovalBot, A man in space, Ministry of random walks, WikiBotas, OccamzRazor, Lbertolotti, Jeliasen, Psinu, Sakuragi indofx, DumZiBoT, GKantaris, XLinkBot, SilvonenBot, ICouldBeWrong, Chaiim, Addbot, ItosLemma, Diptanshu.D, Kyle1278, TapeReader, Yobot, AmeliorationBot, Jean.julius, AnomieBOT, Citation bot, Ekwos, Rusnak1961, Anotherwebeditor, Freedomusa, Green Cardamom, FrescoBot, PVTPoint, AMH-DS, Skyerise, Time9, RjwilmsiBot, Vasildakov~enwiki, Shamir Islam, GaryLKaplan, Redninjatwo, ClueBot NG, Ramillav, Helpful Pixie Bot, Eidoan, Kgm326, Get.thee.down.babylon, Wavetimes, Zimzeb, Timepricer, TSHennessy, LaraIriarte, MntlnrgW, Ainazak, GlePa, David Andel, Tradge au, Mikeblakely, Wanderlust19019, Rmh789, CV9933 and Anonymous: 125
- **Market trend** *Source:* https://en.wikipedia.org/wiki/Market_trend?oldid=700875307 *Contributors:* Fredbauder, Edward, Michael Hardy, Mic, Pcb21, Ronz, Nikai, John K, Choster, Furrykef, Taxman, Samsara, Pakaran, King brosby, Robbot, Popageorgio, Nurg, Alan Liefting, Everyking, Masken, Utcursch, Pgan002, Andycjp, Calm, Antandrus, ALE!, Quarl, Karol Langner, DNewhall, JimWae, Pgreenfinch, Oceanhahn, DanielCD, Ma'ame Michu, Yaoleilei, Rhobite, Leibniz, Notinasnaid, Bender235, Mwanner, Polluks, Foobaz, Angie Y., Nsaa, Knucmo2, Gary, John Quiggin, Caesura, RussAbbott, Versageek, Barrylb, -oo0(GoldTrader)0oo-, Robert K S, Dancurranjr, Tabletop, Bluemoose, Umofomia, Pfalstad, Jclemens, Renaissance Man, FayssalF, Gurch, TheDJ, Tedder, Wavelength, Hairy Dude, Clinevol98, Hede2000, Hydrargyrum, Stephenb, Gaius Cornelius, Bachrach44, Nirvana2013, Mr. Delayer, Dbfirs, Lockesdonkey, DeadEyeArrow, Avraham, Closedmouth, Zoolook, DoriSmith, Tiger888, Teryx, One, SmackBot, Brick Thrower, Mauls, Gilliam, Amatulic, Al Pereira, EncMstr, Darth Panda, A. B., Smallbones, Death2, Addshore, Normxxx, Jmnbatista, HeteroZellous, Downtown dan seattle, Dsarokin, Arielco, Peterbubik, Attys, Kuru, Pthag, Tktktk, Ckatz, Beetstra, MrArt, TastyPoutine, Bnagra, Wikixoox, Hu12, DabMachine, Quaeler, Levineps, Iridescent, Joseph Solis in Australia, Tmangray, Trade2tradewell, AA Pilot16, 1122334455, CBM, Page Up, Jesse Viviano, Logical2u, Wikipeder, Jasperdoomen, Porsche997SBS, EvaK, Jayaramkasi, Epbr123, Kahastok, Blathnaid, Mmortal03, WinBot, MECU, Mdz, JAnDbot, Husond, MER-C, Curious Violet, Coolhandscot, PhilKnight, Magioladitis, VoABot II, Mbc362, KirkL, Adavies42, Mediamon, Olikea, Rgfolsom, Timprophet, Gjd001, CliffC, Bifflum, WynnQuon, Bogey97, Amitm.iimi, Thegreedytrader, Oliver.hessling, Jorfer, Student7, Tanaats, Bonadea, Gosteve, JLBernstein, Mdweisbeck, Philip Trueman, Ask123, Tglacour, Netsumdisc, Twistinaround, Ferengi, Don4of4, LeaveSleaves, Ben Ward, Kacser, Eubulides, Lamro, VanishedUserABC, Fleela, Spinningspark, HybridBoy, Kbrose, Testing times, Tiddly Tom, Exert, Taemyr, Ddxc, Yone Fernandes, Shakespeare2, StaticGull, Anchor Link Bot, HighInBC, Rishu ag, Denisarona, Trappem, Happybp, ClueBot, Trackerseal, Rabmemari, CounterVandalismBot, Erudecorp, Ottawahitech, Anthm76, Excirial, Danausi, NFLDolphinsGuy, Patricius Augustus, OekelWm, Americanjoe1776, SchreiberBike, Chakreshsinghai, Bjdehut, Versus22, SoxBot III, Scxnwa, DumZiBoT, Nepenthes, SilvonenBot, Amindsaleh, Majorsheisskopf, Addbot, Atethnekos, Weisbeck, Npalumbo58, Fieldday-sunday, Diptanshu.D, MrOllie, Download, Ehrenkater, Cagarland, Lightbot, Romaioi, Yobot, Fraggle81, AnnalisaShanghai, Hairy poker monster, Caseyjonz, Radiopathy, Examtester, AnomieBOT, VanishedUser sdu9aya9fasdsopa, Lodha.ankur, Jim1138, Westcoastbiker, Keithbob, Bluerasberry, Materialscientist, RobertEves92, Teeninvestor, Vividesigns, LilHelpa, Tcw8048, Brunonar, Jangirke, Smallman12q, BoomerAB, Poppabear1, Mitchbing, At close range, Newly h, Billiob, Marchartnett, Pinethicket, Portraitsketch, Chatfecter, Clay Solomon, Time9, Wikielwikingo, ItayGolan, L2blackbelt, Stroppolo, Reach Out to the Truth, Tiramisuloverr, Steverexman, DavePeters44, Opticburst, Immunize, Investor Boot Camp, Dewritech, Prenigmamann, Bull Market, Jim Michael, Mshanleysr, Solomonfromfinland, Exaltedangel09, Ejs96, Derekleungtszhei, Nicepirate, Mayur, RockMagnetist, Brianamaronjitwill, Targaryen, ResidentAnthropologist, Photoframesplus, ClueBot NG, Egg Centric, Rezabot, Ryan Vesey, Helpful Pixie Bot, Dionysodorus, MusikAnimal, AwamerT, Altaïr, Harizotoh9, Snow Blizzard, Cliff12345, Chip123456, Cyberbot II, Mzsapi, Kurper, Whileworth, Webclient101, Corn cheese, Mogambo4, Mel Wiebe, Courage respect, Stormmeteo, Monkbot, Coolabahapple and Anonymous: 365
- **Candlestick chart** *Source:* https://en.wikipedia.org/wiki/Candlestick_chart?oldid=699543792 *Contributors:* Booyabazooka, Cyde, Den fjättrade ankan~enwiki, Mydogategodshat, Charles Matthews, Sbwoodside, Slawojarek, BenFrantzDale, Yanik Crépeau~enwiki, Jeshii, Karol Langner, Gene s, Discospinster, Rhobite, Smalljim, Dreish, CKlunck, Mdd, Gary, Arthena, Craigy144, Felixpeters, Tbower, Avenue, OwenX, LeonWhite, SDC, Yug, Fred Bradstadt, Lmatt, Zaxios, RussBot, Ksyrie, Persianlor, Retired username, Vivaldi, Misza13, Johndburger, GraemeL, Allens, Shakura~enwiki, SmackBot, Ohnoitsjamie, Amatulic, Kevin Ryde, Antonrojo, A. B., Jmlk17, Michael-Billington, Bigmantonyd, Ceoil, Attys, Kuru, Robofish, Hu12, Ezgoing85018, Timothylord, Old Guard, Underpants, Mastertrader, Qwyrxian, Leon7, Deipnosophista, Mfortier, JAnDbot, MER-C, Albany NY, Rgfolsom, Johan214~enwiki, JaGa, Flowanda, CliffC, Rob200, Mynameiscurtis, Nevron, Tekmatic38, Brian Pearson, STBotD, DMCer, Bonadea, Enivid, Pleclech, Aesopos, VadZ, Filmnight, Fillmnnight, Rei-bot, Jjputz, Lamro, Eve Teschlemacher, Motorracer, Znmeb, ThomasMark, Melcombe, Mhdeaton, Wikievil666, Niceguyedc, OccamzRazor, BOTarate, Mikhailov Kusserow, XLinkBot, Nasubi, Jabberwoch, Addbot, T.c.w7468, Ucanreply, Fluffernutter, Download, Daytraders~enwiki, Yobot, TaBOT-zerem, JacobRoberts2, AnomieBOT, AdjustShift, Camiflower, Xqbot, ColdPopTart, Commontrader, Armcharles, Joxemai, FrescoBot, Abhijit daksh, Andrius.kvaraciejus, Time9, Diannaa, Alph Bot, Dewritech, Othaln,

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- **Line chart** *Source:* https://en.wikipedia.org/wiki/Line_chart?oldid=689183382 *Contributors:* Maury Markowitz, Bueller 007, Dcoetzee, Beland, Mdd, WadeSimMiser, The wub, Fred Bradstadt, DVdm, Lucasreddinger, Ageekgal, GraemeL, Henrikb4, Octahedron80, Nbarth, Ashawley, Richard001, Kuru, LightYear, CmdrObot, Alaibot, Epbr123, Marek69, Silver Edge, JAnDbot, Appraiser, Nevron, WarddrBOT, Lova Falk, SieBot, Svick, ClueBot, Qwfp, WikHead, Thebestofall007, Addbot, Fgnievinski, Yobot, Fraggle81, Materialscientist, LouriePieterse, J04n, FrescoBot, Jakesyl, Time9, EmausBot, WikitanvirBot, ZéroBot, Trinidade, Stringybark, Rocketrod1960, Cgt, ClueBot NG, Novusuna, Xftan, TheGeneralUser, Mark Arsten, Canoe1967, Joaolnsa, Mdann52, Mervat Salman, Allibeepbeep, Eyesnore, Yardimsever, Tentinator, Blythwood, EvgenyAzaroff, Kedzik, Alex zlobin0, Aksios, Jaderea and Anonymous: 61
- **Open-high-low-close chart** *Source:* https://en.wikipedia.org/wiki/Open-high-low-close_chart?oldid=701648357 *Contributors:* D6, Avenue, SmackBot, Dgw, MER-C, SHCarter, Mike V, VolkovBot, Rubo77, OccamzRazor, Addbot, Yobot, Twish, AnomieBOT, Wagneryotov, Time9, Ripchip Bot, GoingBatty, ClueBot NG, BG19bot, Andreykh, Mayankbpandya, Poponuro, Carlabrown619 and Anonymous: 5
- **Point and figure chart** *Source:* https://en.wikipedia.org/wiki/Point_and_figure_chart?oldid=702268669 *Contributors:* Rdrozd, Curps, Architeuthis, RayBirks, Rhobite, Bender235, ESkog, Benna, Gene Nygaard, -oo0(GoldTrader)0oo-, Bluemoose, Conscious, Gaius Cornelius, Rsrikanth05, Closedmouth, Fawad313, SmackBot, Vugluskr, Amatulic, Chris the speller, Fplay, Kevin Ryde, Smallbones, JzG, Avitya, Skapur, Billw2, CmdrObot, Thepatriots, JodyB, Wai Wai, Barek, Quentar~enwiki, Mnruxter, Kraftlos, Enivid, TXiKiBoT, Rjm at sleepers, Sposer, TYLER, Znmeb, Melcombe, Helenabella, OccamzRazor, Addbot, Ocdnctx, Xqbot, TheAMmollusc, Papercutbiology, Ilovetotrade, Time9, AvicAWB, Music Sorter, Puma12a, ClueBot NG, Bodyofknowledge, Helpful Pixie Bot, Happypantsmcgee, Janmoritz, Timepricer, Nunyamaximus, LeavemealoneNSA, Wallstreet1234, Bizmaveric and Anonymous: 34
- **Chart pattern** *Source:* https://en.wikipedia.org/wiki/Chart_pattern?oldid=672149219 *Contributors:* Karol Langner, Sam Hocevar, Rich Farmbrough, Kappa, John Quiggin, RJFJR, -Ril-, JoshuacUK, KharBevNor, Davidraajan, Gaius Cornelius, Nirvana2013, SmackBot, Amatulic, Bluebot, Natebailey, Kuru, Hu12, Alaibot, MER-C, Greensburger, MartinDK, CliffC, Twigletmac, Fatherdagon, Klip game, Mild Bill Hiccup, Ticmarc, Yawalkar, Saurabh.nova, Addbot, Arthurium, AnomieBOT, Commontrader, Shadowjams, Erik9bot, Altafqadir, Haeinous, Ahardy66, Time9, Mlowrey5, Othaln, Marishik88, Majon10, Astellix, Duttywine, Timepricer, JoeQi, Xaucian and Anonymous: 15
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- **Cup and handle** *Source:* https://en.wikipedia.org/wiki/Cup_and_handle?oldid=668976607 *Contributors:* Alan Liefting, Jorge Stolfi, John Quiggin, Bgwhite, Yahya Abdal-Aziz, Arthur Rubin, SmackBot, Jimmy Pitt, Stephen B Streater, Miyomiyo1050, Maghnus, Calliopejen1, Gonzonoir, MatthewVanitas, Time9, Frontiercowboy, Mlowrey5, GeneralMSG, Druidjaidan, Salubrious Toxin, ChamithN and Anonymous: 5
- **Double top and double bottom** *Source:* https://en.wikipedia.org/wiki/Double_top_and_double_bottom?oldid=672149532 *Contributors:* Radiojon, John Quiggin, Woohookitty, Josh Parris, Vegaswikian, Nirvana2013, Arthur Rubin, SmackBot, Kuru, Optimist on the run, MER-C, Lamro, Kbrose, Triwbe, Mild Bill Hiccup, Alexius08, Fyrael, Yobot, AnomieBOT, Altafqadir, Time9, Majon10, Senator2029, ClueBot NG, ChrisGualtieri, Andrea edits, Xaucian and Anonymous: 7
- **Flag and pennant patterns** *Source:* https://en.wikipedia.org/wiki/Flag_and_pennant_patterns?oldid=643948655 *Contributors:* John Quiggin, Arthur Rubin, SmackBot, Enivid, Sposer, Mild Bill Hiccup, OccamzRazor, Addbot, JackieBot, Commontrader, Time9, Frontiercowboy, Majon10, ChrisGualtieri and Anonymous: 2
- **Gap (chart pattern)** *Source:* https://en.wikipedia.org/wiki/Gap_(chart_pattern)?oldid=646460538 *Contributors:* Radiojon, John Quiggin, Tabletop, BD2412, Josh Parris, Arthur Rubin, AndrewWTaylor, SmackBot, Amatulic, DangerousPanda, Sensatus, VolkovBot, OccamzRazor, Addbot, Diptanshu.D, Luckas-bot, Yobot, Altafqadir, Haeinous, Time9, Akerans, Everington f, DASHBotAV, Jacob van Maerlant and Anonymous: 8
- **Head and shoulders (chart pattern)** *Source:* https://en.wikipedia.org/wiki/Head_and_shoulders_(chart_pattern)?oldid=672147640 *Contributors:* Rich Farmbrough, John Quiggin, Arthur Rubin, Tim Parenti, Geoffrey.landis, SmackBot, Bigbluefish, Amatulic, A. B., Kuru, Minna Sora no Shita, RomanSpa, Davost, CliffC, Christian424, VolkovBot, Flyer22 Reborn, Kidmercury, OccamzRazor, Excirial, Chakreshsinghai, Saurabh.nova, Addbot, Arthurium, 松岡明芳, AnomieBOT, Camiflower, Materialscientist, 完全処方マニュアル, Commontrader, Altafqadir, DrilBot, MastiBot, StocksDoc, Time9, Frontiercowboy, ClueBot NG, Curb Chain, Xaucian and Anonymous: 20
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- **Triangle (chart pattern)** *Source:* https://en.wikipedia.org/wiki/Triangle_(chart_pattern)?oldid=672146595 *Contributors:* John Quiggin, Arthur Rubin, Kuru, Jimmy Pitt, Fabrictramp, OccamzRazor, Commontrader, Time9, EmausBot, Jim Michael, Majon10, DBigXray, ChrisGualtieri, Xaucian and Anonymous: 7
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- **Wedge pattern** *Source:* https://en.wikipedia.org/wiki/Wedge_pattern?oldid=686562886 *Contributors:* Radiojon, YUL89YYZ, Bender235, NetJohn, John Quiggin, Woohookitty, Josh Parris, Arthur Rubin, SmackBot, Amatulic, Dgw, Prestonmag, OccamzRazor, Commontrader, Altafqadir, Time9, Frontiercowboy, Sargdub and Anonymous: 12

- **Candlestick pattern** *Source:* https://en.wikipedia.org/wiki/Candlestick_pattern?oldid=689419997 *Contributors:* Bkell, Raymm, McGeddon, Amatulic, Kuru, Protious, Sensatus, Fconaway, Sposer, Yintan, ConradParker, Download, Ettrig, Yobot, Altafqadir, Andrius.kvaraciejus, Hessamnia, Time9, Yusiang1998, Sargdub, EmausBot, John of Reading, Donner60, Frietjes, Helpful Pixie Bot, Pmagu, Moarlongcatplox, Minhnhh, Zed8~enwiki, Neodojistar, Opencooper, Anton Valich and Anonymous: 20
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- **Hammer (candlestick pattern)** *Source:* https://en.wikipedia.org/wiki/Hammer_(candlestick_pattern)?oldid=619759594 *Contributors:* Bkell, Amatulic, MER-C, Sensatus, Fabrictramp, OccamzRazor, Addbot, Commontrader, Commoner1, Time9, Ripchip Bot, EmausBot, Moswento, Enis220, Tholme and Anonymous: 9
- **Hanging man (candlestick pattern)** *Source:* https://en.wikipedia.org/wiki/Hanging_man_(candlestick_pattern)?oldid=575134041 *Contributors:* Bkell, Addbot, Time9, WikitanvirBot, Moswento, Enis220, Tholme and Anonymous: 5
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- **Shooting star (candlestick pattern)** *Source:* https://en.wikipedia.org/wiki/Shooting_star_(candlestick_pattern)?oldid=687740572 *Contributors:* GregorB, Pleiotrop3, SmackBot, MER-C, Swpb, Uncle Dick, OccamzRazor, Dmarquard, Commoner1, Time9, EmausBot, Enis220, Tholme and Anonymous: 4
- **Spinning top (candlestick pattern)** *Source:* https://en.wikipedia.org/wiki/Spinning_top_(candlestick_pattern)?oldid=522684573 *Contributors:* SmackBot, MER-C, Magioladitis, R'n'B, Lamro, OccamzRazor, Commontrader, GainLine, Time9 and Anonymous: 3
- **Hikkake pattern** *Source:* https://en.wikipedia.org/wiki/Hikkake_pattern?oldid=618777009 *Contributors:* Cmdrjameson, Giraffedata, RHaworth, BD2412, JulesH, PM Poon, Tony1, DocendoDiscimus, SmackBot, Zoogod, Commander Keane bot, Gogo Dodo, Wai Wai, AntiVandalBot, MER-C, Magioladitis, Enivid, Lamro, Rosiestep, Yobot, AnomieBOT, Time9, Candlestick.es, Appletrader, Benienhau, Duttywine and Anonymous: 31
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- **Three white soldiers** *Source:* https://en.wikipedia.org/wiki/Three_white_soldiers?oldid=545899830 *Contributors:* Ceoil, Rgfolsom, Fences and windows, Lamro, OccamzRazor, Addbot, Time9, WikitanvirBot, Candlestick.es, Xtzou, JA(000)Davidson, John Aplessed and Anonymous: 1
- **Support and resistance** *Source:* https://en.wikipedia.org/wiki/Support_and_resistance?oldid=697857293 *Contributors:* Edward, Charles Matthews, Tony C, Pgreenfinch, Rhobite, Eric Shalov, John Quiggin, RJFJR, -oo0(GoldTrader)0oo-, Mandarax, Ronnotel, Stoph, Eraserhead1, Gaius Cornelius, Arthur Rubin, DocendoDiscimus, SmackBot, Amatulic, Bluebot, Hu12, Ezgoing85018, Wai Wai, Sensatus, Destynova, CliffC, StockWrap, VolkovBot, AlleborgoBot, Navin gupt, Niceguyedc, OccamzRazor, Bklyntech, Ticmarc, Chakreshsinghai, Thingg, Anticipation of a New Lover's Arrival, The, Addbot, Zentrader, AnomieBOT, ArthurBot, JenyaTsoy, FrescoBot, Aamarx, HRoestBot, Hessamnia, Time9, Krassotkin, RamallahCC, Solarra, K6ka, Technicalanalyst1, ClueBot NG, Helpful Pixie Bot, Loopylip, Virtuscience, Altaïr, Onlymuks, BattyBot, GregorStocks, Grimm575, Klusterlinda, Swapneshpanda17 and Anonymous: 42
- **Bottom (technical analysis)** *Source:* https://en.wikipedia.org/wiki/Bottom_(technical_analysis)?oldid=674558174 *Contributors:* Macrakis, Rhobite, Maurreen, Pearle, -oo0(GoldTrader)0oo-, AndrewWatt, Feco, Tonywalton, SmackBot, Hu12, JohnCJWood, Lamro, Ticmarc, Addbot, Erik9bot, Cnwilliams, Midas02 and Anonymous: 1
- **Fibonacci retracement** *Source:* https://en.wikipedia.org/wiki/Fibonacci_retracement?oldid=699169396 *Contributors:* Michael Hardy, Jérôme, Ohnoitsjamie, Nirgle, Kuru, CBM, Andyjsmith, Destynova, TJRC, Melcombe, Mhdeaton, XLinkBot, Addbot, Luckas-bot, Yobot, AnomieBOT, Bellerophon, Time9, Jonkerz, Safesanctuary, JohnnyJr, Shamir Islam, Netheril96, ZéroBot, Bxj, AManWithNoPlan, Sparatokos, Forextc, Linkinmonkey, Zdbuckley, Theopolisme, Helpful Pixie Bot, BG19bot, Dr Juggernaut, Mastull, ChrisGualtieri, Jdobelman, Paum89, AttainCaptial, Gronk Oz and Anonymous: 24
- **Pivot point (technical analysis)** *Source:* https://en.wikipedia.org/wiki/Pivot_point_(technical_analysis)?oldid=665891744 *Contributors:* Ronz, TenOfAllTrades, Vegaswikian, SmackBot, Ohnoitsjamie, Amatulic, Kuru, Ezgoing85018, Euku, Maghnus, Sposer, Kbrose, Canopus1, OccamzRazor, Anon lynx, TheRedPenOfDoom, Addbot, Diptanshu.D, AnomieBOT, Abhijit daksh, Time9, Pozytyv, Zenntrader, Kunduanirban, AvicAWB, Glennho, ClueBot NG, Hersko915, Zdbuckley, Strike Eagle, BG19bot, I am One of Many, Mhofmaier, Jonmcfarlane, Tkwiki38, Fritskuijk, Kiwanis2015 and Anonymous: 12
- **Top (technical analysis)** *Source:* https://en.wikipedia.org/wiki/Top_(technical_analysis)?oldid=674558158 *Contributors:* Michael Hardy, Rhobite, RJFJR, -oo0(GoldTrader)0oo-, DocendoDiscimus, SmackBot, Amatulic, Kukini, Hu12, Iridescent, ShelfSkewed, Wai Wai, Lamro, Ticmarc, Chakreshsinghai, FrescoBot, Cnwilliams, RamallahCC, Midas02 and Anonymous: 2
- **Average directional movement index** *Source:* https://en.wikipedia.org/wiki/Average_directional_movement_index?oldid=697421169 *Contributors:* Tony1, Ohnoitsjamie, Amatulic, JHunterJ, Dicklyon, Mild Bill Hiccup, Saurabh.nova, Addbot, Faithprice, Commontrader, HRoestBot, MarketTechnician, FoxBot, Time9, Krassotkin, Dewritech, Lucamasio, Tousleso, Majon10, Donner60, Glennho, ChuispastonBot, MarkDavidFunk, Kirill Borisenko, Ericsheldon, Lowercase sigmabot, Duttywine, JYBot, Catbait5, Monkbot, Mementix, Meekv and Anonymous: 22
- **Commodity channel index** *Source:* https://en.wikipedia.org/wiki/Commodity_channel_index?oldid=682401581 *Contributors:* Skysmith, Wmahan, Karol Langner, VilleAine, NicM, -oo0(GoldTrader)0oo-, Ronnotel, YurikBot, Interactii, Welsh, Tony1, Wknight94, SmackBot, Amatulic, Kevin Ryde, Beetstra, Hu12, Trade2tradewell, CmdrObot, B, Satori Son, Lgauthie, CommonsDelinker, VolkovBot, Flyingtoaster1337, Jozue, TechAnalyster, AlleborgoBot, Wikinotforcommercialuse, Tradermatt, Phill.f, Beetstra public, Mild Bill Hiccup, XLinkBot, Bobknowitall, Addbot, Trading watchdog, Diptanshu.D, Lightbot, JenyaTsoy, Abductive, Time9, Krassotkin, Tsx11, Majon10, ChuispastonBot, Thibaut120094 and Anonymous: 24

- **Detrended price oscillator** *Source:* https://en.wikipedia.org/wiki/Detrended_price_oscillator?oldid=667173846 *Contributors:* Karol Langner, Avraham, SmackBot, Stifle, Kevin Ryde, EGGS, SMasters, Brusegadi, Addbot, Erik9bot, Time9, Sargdub, Cwmhiraeth, Fianca and Anonymous: 5
- **KST oscillator** *Source:* https://en.wikipedia.org/wiki/KST_oscillator?oldid=684616332 *Contributors:* Brighterorange, Bgwhite, Tony1, Mikiemike, Headbomb, Melcombe, Addbot, Diptanshu.D, Time9, Krassotkin, Dewritech, EleferenBot, Skoot13, DasKapital1867 and Anonymous: 4
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- **MACD** *Source:* https://en.wikipedia.org/wiki/MACD?oldid=653219235 *Contributors:* Boson, Jorge Stolfi, Wmahan, Karol Langner, Kelson, Rhobite, Gunark, Atlant, -oo0(GoldTrader)0oo-, Hdante, FlaBot, TheSpook, Gaius Cornelius, Grafen, Tony1, Merosonox, Nlu, GraemeL, JLaTondre, DocendoDiscimus, SmackBot, Brick Thrower, Dpwkbw, Vvarkey, Amatulic, Kevin Ryde, A. B., Ssnseawolf, ArglebargleIV, Beetstra, Stainedglasscurtain, Hu12, Lukasz rostek~enwiki, Trade2tradewell, Mikiemike, Thijs!bot, Sukisuki, Daytona2, MER-C, Greensburger, Lgauthie, Brusegadi, Esanchez7587, Hech~enwiki, Uriel8, D Auletta, STBotD, Pleclech, Philip Trueman, Crowne, Cremepuff222, TechAnalyster, Lamro, Chikichiki~enwiki, Wikinotforcommercialuse, Barkeep, SieBot, Tradermatt, Sean.hoyland, Pinkadelica, Escape Orbit, Kidmercury, Collinseow, Enerelt, JoelDick, Hghlight, Chewheng, XLinkBot, Saurabh.nova, Addbot, Robinsenior, Inodotcom, Diptanshu.D, Jefflithe, MrOllie, Lightbot, Yobot, Helvcn, Citation bot, أحمد.غامدي.24, ArthurBot, LilHelpa, Dickreuter, JenyaTsoy, Foobarhoge, Noloop, Chepurko, Khai42, Time9, UweD, Jackieannpatterson, Airsplit, RamallahCC, EmausBot, WikitanvirBot, Ocaasi, Thine Antique Pen, Majon10, Calculus1985, Contextmatters, Gmstanley, MelbourneStar, Widr, Helpful Pixie Bot, HimanshuJains, Jonny.allason, Timepricer, NewBridge11, Drmay, Justincahoon, Bitz1282, AnTho-aR and Anonymous: 107
- **Mass index** *Source:* https://en.wikipedia.org/wiki/Mass_index?oldid=684619019 *Contributors:* Wmahan, Karol Langner, Kevin Ryde, Beetstra, Jimmy Pitt, Severo, Lgauthie, Brusegadi, TechAnalyster, Addbot, Basilicofresco, Time9, Krassotkin, Xomyork, Josve05a and Anonymous: 3
- **Moving average** *Source:* https://en.wikipedia.org/wiki/Moving_average?oldid=699166474 *Contributors:* William Avery, Heron, Michael Hardy, Kwertii, Dcljr, Nikai, Grin, Daniel Quinlan, Toreau, Gakmo, Robbot, Mazin07, Gandalf61, Giftlite, Tristanreid, Utcursch, Karol Langner, Fenice, Teorth, R. S. Shaw, Towel401, Landroni, Arthena, VladimirKorablin, Rabarberski, Netkinetic, Oleg Alexandrov, Sid1138, Hdante, Btyner, Mandarax, Feco, SLi, Ramorum, Roboto de Ajvol, Wavelength, DragonHawk, Yahya Abdal-Aziz, Tony1, Merosonox, Cjs, Ninly, GraemeL, Naught101, Thelb4, JLaTondre, Tonyho, A bit iffy, SmackBot, Rentier, Btm, Gleb~enwiki, Amatulic, Kevin Ryde, Nbarth, Bil1, Berland, Kazov, Mwtoews, Lambiam, Wikiolap, Sambot, Ckatz, Beetstra, Hu12, דניאל צבי, Siebrand, CmdrObot, Falk Lieder, Makeemlighter, Requestion, HenningThielemann, Amitchaudhary, Neurowiki, Satori Son, Thijs!bot, Epbr123, Wikid77, Edupedro, Wai Wai, AntiVandalBot, Widefox, Seaphoto, Richard n, Sitethief, PhilKnight, Glennimoss, Robomojo, Mir76, Esanchez7587, Ekotkie, CliffC, Euku, TomyDuby, Manicstreetpreacher, Alan012, Ron shelf, Carmitsp, USTUNINSEL, Pleclech, VolkovBot, Philip Trueman, Jitendralovekar, Jamelan, TechAnalyster, Lamro, Chikichiki~enwiki, Petergans, Wikinotforcommercialuse, Kbrose, Maxlittle2007, SieBot, Mathaddins, Paradoctor, Tradermatt, Melcombe, Rdhettinger, PlantTrees, ImageRemovalBot, ClueBot, The Thing That Should Not Be, Stocksnet, Naveensakhamuri, DerBorg, Adouglass, Qwfp, DumZiBoT, XLinkBot, Dark Mage, WikHead, Addbot, Soluch, Fgnievinski, Econotechie, MrVanBot, Rjmartinator, AndersBot, Cemsbr, Alex Kofman, Luckas-bot, Yobot, DeluxNate, Rainypearl, AnomieBOT, Fender0107401, Materialscientist, ArthurBot, Dickreuter, Jianingy, Lenrius, JenyaTsoy, Mkacholia, Foobarhoge, MilfordMark, Pim2009, Wa03, Gaba p, Pisquared8, Time9, Diannaa, Oliver H, DARTH SIDIOUS 2, Martinkv, EmausBot, WikitanvirBot, Keilandreas, Mz7, Wayne Slam, Ain92, Knneth, Chipmunck, Mentibot, ClueBot NG, Helpful Pixie Bot, HimanshuJains, BG19bot, MusikAnimal, Nanzeng, Mehtagauravs, Lukas227~enwiki, Leszek0140, Investorhenry, Thisrunson, SoledadKabocha, Mogism, Lugia2453, Jonmcfarlane, Gkhanna1, Paulcaplin, Dreq~enwiki, Tooth557, Falkonstar, SilaDey, DrAndrewP, Maksudul Islam, Druzac, Saikat Laskar, David finesse, Su9204, Mementix, Sudhirreddy123 and Anonymous: 211
- **Parabolic SAR** *Source:* https://en.wikipedia.org/wiki/Parabolic_SAR?oldid=652941548 *Contributors:* Hike395, Fredrik, Wmahan, Karol Langner, Sentinel.ru~enwiki, -oo0(GoldTrader)0oo-, Josh Parris, VKokielov, Tedder, Bgwhite, GraemeL, DocendoDiscimus, SmackBot, Brick Thrower, Amatulic, Beetstra, Studerby, Lgauthie, CliffC, AstonG, Chikinsawsage, TechAnalyster, ImageRemovalBot, ClueBot, Mild Bill Hiccup, Sun Creator, Gundersen53, Addbot, Download, Luckas-bot, Danno uk, Commontrader, Time9, Krassotkin, Wikiwinky, AsceticRose, Donner60, Crazyfirex, ClueBot NG, Helpful Pixie Bot, CopiousNoteTaker, Mhofmaier, Bw7712, Sheharyar395, Davidfashions, Monkbot, Inloveross, Threatt 74 and Anonymous: 26
- **Smart money index** *Source:* https://en.wikipedia.org/wiki/Smart_money_index?oldid=695698049 *Contributors:* Tony1, Magioladitis, Lamro, Download, AnomieBOT, LilHelpa and Anonymous: 5
- **Trend line (technical analysis)** *Source:* https://en.wikipedia.org/wiki/Trend_line_(technical_analysis)?oldid=685069700 *Contributors:* Mulad, Pascal666, Utcursch, Elroch, Stoph, Goudzovski, SmackBot, Ohnoitsjamie, Amatulic, Bluebot, Jameboy, MER-C, Sensatus, CliffC, Gowish, Madhero88, Wuhwuzdat, Sean.hoyland, Dkostiuk, Addbot, Arthurium, MrOllie, Yobot, Rubinbot, Coretheapple, Ahardy66, Time9, Dewritech, Glennho, DharmikTeam, Helpful Pixie Bot, Lemnaminor, Spxalpha, AntonJahja, Monkbot, Crystallizedcarbon, Loraof and Anonymous: 16
- **Trix (technical analysis)** *Source:* https://en.wikipedia.org/wiki/Trix_(technical_analysis)?oldid=659000945 *Contributors:* Texture, Bender235, Dandv, That Guy, From That Show!, Crystallina, Kevin Ryde, Fuhghettaboutit, InedibleHulk, Wai Wai, Brusegadi, Grammarmonger, Lamro, Wikinotforcommercialuse, Addbot, Lightbot, Lenrius, Time9, Krassotkin, Fxwriter and Anonymous: 5
- **Vortex indicator** *Source:* https://en.wikipedia.org/wiki/Vortex_indicator?oldid=685070260 *Contributors:* Rich Farmbrough, Tony1, SmackBot, Theroadislong, Lamro, JL-Bot, Yobot, FrescoBot, Time9, Sargdub, Vickypedia30, Dewritech and Anonymous: 1
- **Momentum (finance)** *Source:* https://en.wikipedia.org/wiki/Momentum_(finance)?oldid=690740933 *Contributors:* Gabbe, JASpencer, Pascal666, Longhair, Rjwilmsi, Amatulic, Sslevine, Robofish, ShelfSkewed, Alaibot, Lamro, Fadesga, PigFlu Oink, Time9, Veggito, Pszoldan, ChrisGualtieri, YiFeiBot, Monkbot, Hklevy, Acmeinvest and Anonymous: 10
- **Money flow index** *Source:* https://en.wikipedia.org/wiki/Money_flow_index?oldid=677993506 *Contributors:* Wmahan, Karol Langner, Kjkolb, Landroni, Dandv, Kashtrader, Vegaswikian, Rsrikanth05, Tony1, Theodolite, SmackBot, Vugluskr, Kevin Ryde, Beetstra, CmdrObot, Lgauthie, Kgeis, StockWrap, TechAnalyster, OccamzRazor, XLinkBot, Addbot, Lihaas, Favonian, Macroeng, Omnipaedista, Erik9bot, Time9, Krassotkin, John of Reading, ClueBot NG, DangerouslyPersuasiveWriter and Anonymous: 11

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- **Stochastic oscillator** *Source:* https://en.wikipedia.org/wiki/Stochastic_oscillator?oldid=671437769 *Contributors:* Giftlite, Karol Langner, Drbreznjev, Dandv, -oo0(GoldTrader)0oo-, BD2412, Rjwilmsi, Salix alba, Bgwhite, Bhny, Grafen, Harksaw, Finell, SmackBot, McGeddon, Dpwkbw, Amatulic, Hu12, Mrdthree, Woodshed, Trade2tradewell, Thijs!bot, JustAGal, MER-C, Brusegadi, Equitymanager, R'n'B, TimPendragon, Yannick56, Agamemnus, Pleclech, VolkovBot, McM.bot, Lamro, Bodhi.root, 4wajzkd02, Tradermatt, Wuhwuzdat, Sean.hoyland, ImageRemovalBot, Niceguyedc, The Last Heretic, Tmonzenet, WikHead, Addbot, Diptanshu.D, MrOllie, Numbo3-bot, Lightbot, Ettrig, Luckas-bot, Yobot, DSisyphBot, Commontrader, Foobarhoge, FrescoBot, Time9, Krassotkin, TraderTalk, Alfonse3839, EmausBot, GoingBatty, Calculus1985, Cwmhiraeth, DharmikTeam, Hn3000, HimanshuJains, IraChesterfield, Wallstreet1234, Marek.antozi, Mnmsha and Anonymous: 47
- **True strength index** *Source:* https://en.wikipedia.org/wiki/True_strength_index?oldid=607562567 *Contributors:* Tony1, Amatulic, Dicklyon, Kvng, DumbBOT, Mike Cline, Binksternet, Tbhotch, Sargdub, Helpful Pixie Bot, BattyBot and ChrisGualtieri
- **Ultimate oscillator** *Source:* https://en.wikipedia.org/wiki/Ultimate_oscillator?oldid=612635348 *Contributors:* Wmahan, SchuminWeb, Tony1, ColinFine, Kevin Ryde, Beetstra, Lgauthie, Brusegadi, YoavD, TechAnalyster, Addbot, Gracefoo, Time9, Krassotkin, Shamir Islam and Anonymous: 5
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- **Accumulation/distribution index** *Source:* https://en.wikipedia.org/wiki/Accumulation/distribution_index?oldid=646742259 *Contributors:* Andrewman327, Karol Langner, SmackBot, Rentier, Vugluskr, Kevin Ryde, Beetstra, Brusegadi, Kgeis, StockWrap, TechAnalyster, Lamro, Malcolmxl5, Cyclopediafixer, Addbot, Pessimist2006, Yobot, Gkofman, Time9 and Anonymous: 7
- **Ease of movement** *Source:* https://en.wikipedia.org/wiki/Ease_of_movement?oldid=562608679 *Contributors:* Karol Langner, Rich Farmbrough, Tabletop, EGGS, Jimmy Pitt, Monkeyflower, Severo, Brusegadi, Kgeis, VolkovBot, Lamro, Anameofmyveryown, Addbot, Yobot, Erik9bot, Time9, Krassotkin, Brad22dir, Jesse V. and Anonymous: 1
- **Force index** *Source:* https://en.wikipedia.org/wiki/Force_index?oldid=493095867 *Contributors:* Karol Langner, Akhristov, Avraham, SmackBot, Jfingers88, EGGS, Beetstra, Jimmy Pitt, Dicklyon, Doug Weller, Nick Number, TechAnalyster, Canis Lupus, Time9, Endian675 and Anonymous: 2
- **Negative volume index** *Source:* https://en.wikipedia.org/wiki/Negative_volume_index?oldid=551570237 *Contributors:* Karol Langner, Jimmy Pitt, Vanished user ty12kl89jq10, M3tsrule, Addbot, Time9, Krassotkin, Huachuca and Anonymous: 1
- **On-balance volume** *Source:* https://en.wikipedia.org/wiki/On-balance_volume?oldid=646186411 *Contributors:* Wmahan, Karol Langner, Tony1, GraemeL, SmackBot, Vugluskr, Sebesta, Amatulic, Kevin Ryde, Beetstra, Graham Hurley, Hu12, Lgauthie, VolkovBot, Have Gun, Will Travel, TechAnalyster, Lamro, 0goodiegoodie0, Tradermatt, Hghlight, Addbot, Lightbot, Yobot, ArthurBot, Gumruch, SassoBot, Full-date unlinking bot, Time9, Krassotkin, Huachuca, Jacob van Maerlant and Anonymous: 7
- **Put/call ratio** *Source:* https://en.wikipedia.org/wiki/Put/call_ratio?oldid=694448563 *Contributors:* Trlovejoy, Dicklyon, Cydebot, Lamro, Addbot, Yobot, Sargdub, Optiontradingtalk and Anonymous: 6
- **Volume–price trend** *Source:* https://en.wikipedia.org/wiki/Volume%E2%80%93price_trend?oldid=682025571 *Contributors:* Phatsphere, Wmahan, Tony1, SmackBot, Vugluskr, Kevin Ryde, Beetstra, Lgauthie, Brusegadi, Kgeis, TechAnalyster, Lamro, SieBot, OccamzRazor, Addbot, Yobot, Time9, Krassotkin, DaveJacks and Anonymous: 8
- **Volatility (finance)** *Source:* https://en.wikipedia.org/wiki/Volatility_(finance)?oldid=693586481 *Contributors:* Taral, Fredbauder, Enchanter, William Avery, Ryguasu, Michael Hardy, Pcb21, Emperorbma, Charles Matthews, Tpbradbury, Phil Boswell, Brw12, ShaunMacPherson, Christofurio, Karol Langner, Pgreenfinch, Bender235, Calair, Andrewpmack~enwiki, BrokenSegue, Jerryseinfeld, John Fader, Landroni, Orzetto, Eric Kvaalen, Arthena, Walkerma, SKL, Pontus, Oleg Alexandrov, LARS, KKramer~enwiki, Btyner, Ronnotel, Yurik, Rjwilmsi, Baeksu, FlaBot, Ground Zero, Margosbot~enwiki, Wongm, Tedder, YurikBot, Canadaduane, Gareth Jones, Cleared as filed, Lajiri, GraemeL, Allens, Infinity0, That Guy, From That Show!, DocendoDiscimus, KnightRider~enwiki, SmackBot, Jphillips, Rtc, Honza Záruba, Martinp, Ohnoitsjamie, Chris the speller, Nbarth, Complexfinance, RJN, Byelf2007, Kuru, Jimmy Pitt, Babakmd, Hu12, Quaeler, Fvasconcellos, CmdrObot, Innohead, PeterM~enwiki, Volatility Professor, JAnDbot, Barek, A quant, Mtd2006, Ehdr, Pt johnston, Helon, Jewzip, Showeropera, Nburden, Ask123, UnitedStatesian, Zhenqinli, Lamro, Bdemeshev, Wushi-En, S.Örvarr.S, Thobitz, Melcombe, Finnancier, Denisarona, Cumulant, Eeekster, Qwfp, XLinkBot, Addbot, Catofgrey, Favonian, Tassedethe, Yobot, KamikazeBot, Bearas, Merube 89, Kingpin13, Kyng, Biem, FrescoBot, Hobsonlane, Tarc87, Trappist the monk, Time9, UweD, Swerfvalk, DominicConnor, Mayerwin, D15724C710N, AvicAWB, Marishik88, PaulTheOctopus, ClueBot NG, Qarakesek, Statoman71, Helpful Pixie Bot, Volatiller, SteSus85, BG19bot, Pablete85, Alfazagato, IraChesterfield, Berklabsci, OccamTheRazor, Rrenicker1, FinancePublisher, Tradedia, EnzaiBot, 3awil, Docirish7, Lawrenceradburn, Shearflyer, Kind Tennis Fan, Mtr98, ChinnarajaC Nithisa and Anonymous: 152
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