Technical Indicators

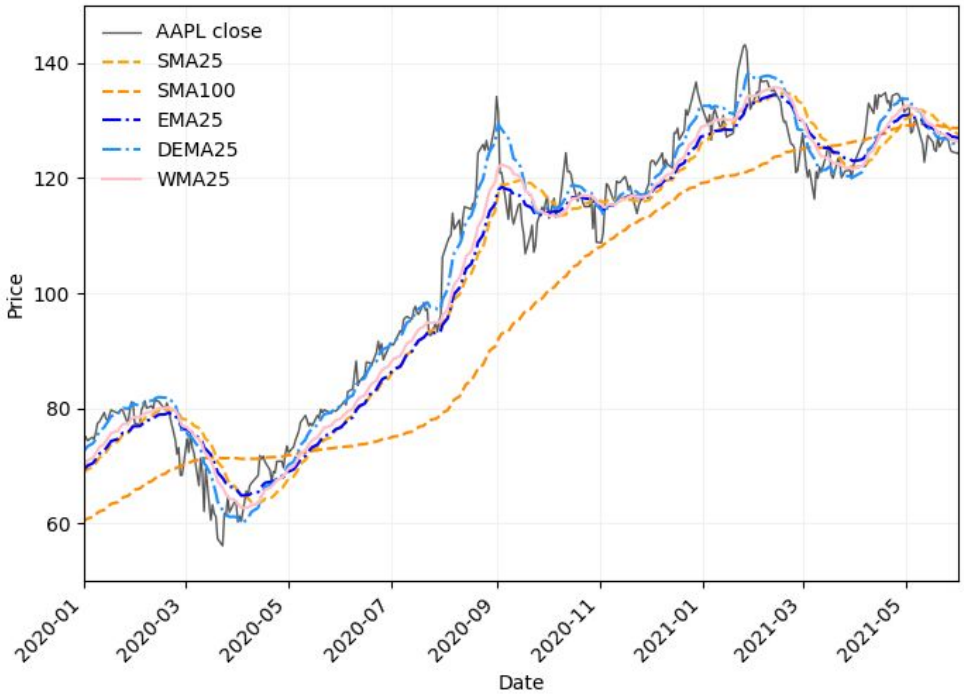
Moving Averages

Simple rolling averages taking into account the close prices in window of length *n* generalised by applying weights to different closes.

$$SMA_k = \frac{p_{n-k+1} + p_{n-k+2} + \cdots + p_n}{k}$$
$$= \frac{1}{k} \sum_{i=n-k+1}^{n} p_i$$

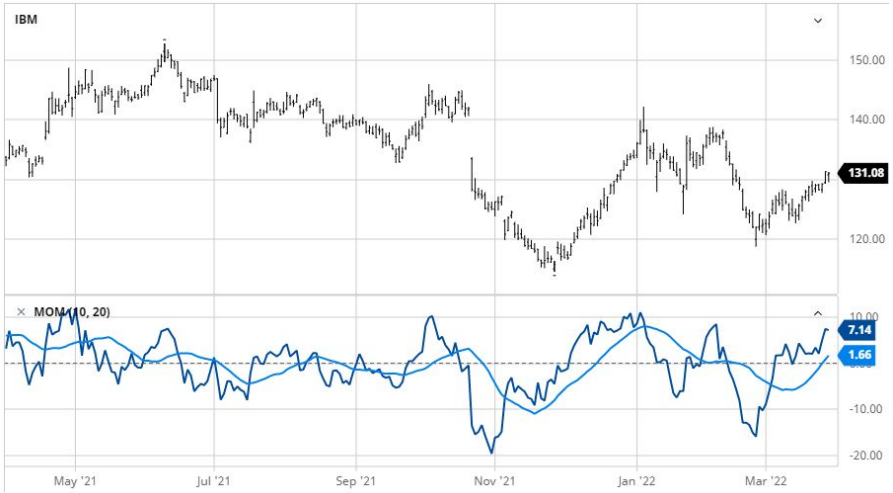
$$EMA = \frac{p_1 + (1-\alpha)p_2 + (1-\alpha)^2 p_3 + (1-\alpha)^3 p_4 + \cdots}{1 + (1-\alpha) + (1-\alpha)^2 + (1-\alpha)^3 + \cdots}$$

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



Momentum

Momentum monitors the change in prices. It tells you whether prices are increasing at an increasing rate or decreasing at a decreasing rate. The normal trading rule is simple. Buy when the momentum line crosses from below the zero line to above. Sell when the momentum line crosses from above the zero line to below. Also plots the moving average of the momentum.



$MOM_t = P_i - P_{i-n}$

P_i is the price of the i interval, P_{i-n} is the price n intervals ago, n is the number of intervals or length specified.

Average True Range

ATR is typically used to gauge volatility. One can use ATR to gauge the potential risk and adjust their trading strategies accordingly, with wider stop-loss and take-profit levels in high volatility environments and narrower ones in low volatility environments.

$$\text{ATR} = \frac{\text{Previous ATR}(n-1) + \text{TR}}{n}$$

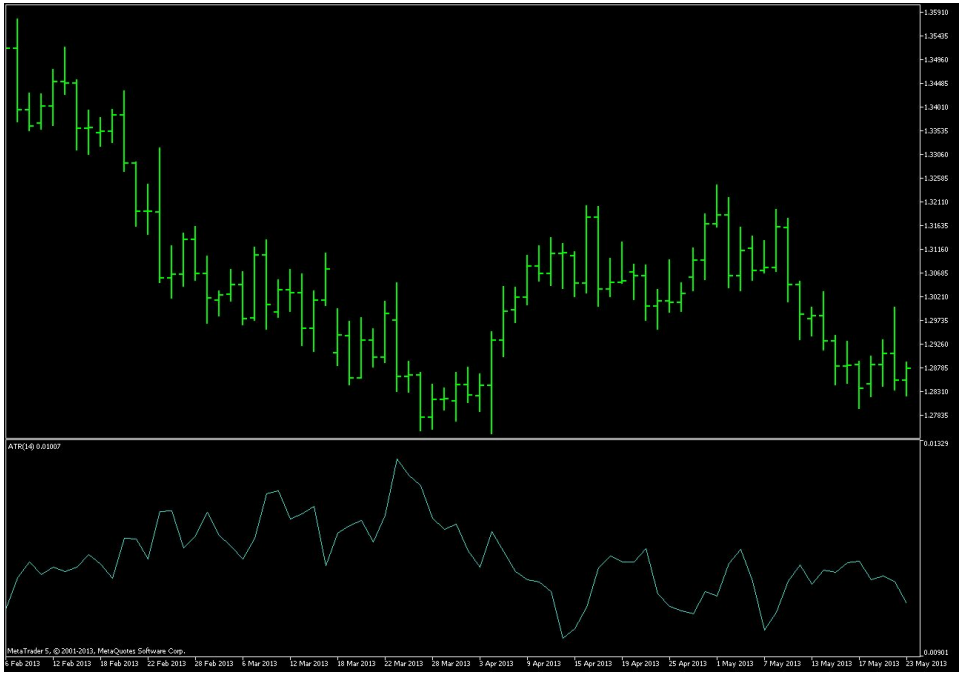
$$\text{TR} = \text{Max}\left[(\text{H} - \text{L}), |\text{H} - \text{C}_p|, |\text{L} - \text{C}_p|\right]$$

where:

$\text{H} = \text{Today's high}$

$\text{L} = \text{Today's low}$

$\text{C}_p = \text{Yesterday's closing price}$



Volatility Measures

$$V_{S,t} = \ln(H_t) - \ln(L_t)$$

$$V_{P,t} = 0.361 R_t^2 = 0.361 \left[\ln(H_t / L_t)\right]^2$$

$$V_{RS,t} = \left[\ln(H_t) - \ln(O_t)\right]\left[\ln(H_t) - \ln(C_t)\right] + \left[\ln(L_t) - \ln(O_t)\right]\left[\ln(L_t) - \ln(C_t)\right]$$

$$V_{GK,t} = \frac{1}{2}\left[\ln(H_t) - \ln(L_t)\right]^2 - \left[2\ln 2 - 1\right]\left[\ln(C_t) - \ln(O_t)\right]^2$$

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Modelling Volatility Using High, Low, Open and Closing Prices: Evidence from Four S&P Indices

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Abstract

This paper uses several models (Alizadeh, Brandt and Diebold, 1999; Parkinson, 1980; Garman and Klass, 1980; Rogers and Satchell, 1991) for the calculation of volatility based on high, low, open and closing prices. We use recent daily data from four S&P indices, namely S&P 100, S&P 400, S&P 500 and S&P Small Cap 600. The results show that a simple measure of volatility (defined as the first logarithmic difference between the high and low prices) overestimates the other three measures.

Relative Strength Index (RSI)

RSI measures the speed and magnitude of a security's recent price changes to evaluate overvalued or undervalued conditions in the price of that security. The relative strength index compares a security's strength on days when prices go up to its strength on days when prices go down.

$$RSI_{\text{step one}} = 100 - \left[\frac{100}{1+\frac{\text{Average gain}}{\text{Average loss}}}\right]$$

Once 14 days of data arrive:

$$RSI_{\text{step two}} = 100 - \left[\frac{100}{1+\frac{(\text{Previous Average Gain}\times 13)+\text{Current Gain}}{((\text{Previous Average Loss}\times 13)+\text{Current Loss})}}\right]$$

Average Directional Index (ADX)

ADX is used to quantify trend strength. ADX calculations are based on a moving average of price range expansion over a given period of time. The default setting is 14 bars. ADX is non-directional. When the +DMI is above the -DMI, prices are moving up, and ADX measures the strength of the uptrend. When the -DMI is above the +DMI, prices are moving down, and ADX measures the strength of the downtrend.

Current High - Previous High = UpMove
Previous Low - Current Low = DownMove
If UpMove > DownMove and UpMove > 0, then +DM = UpMove, else +DM = 0
If DownMove > Upmove and Downmove > 0, then -DM = DownMove, else -DM = 0
+DI = 100 times Exponential Moving Average of (+DM / Average True Range)
-DI = 100 times Exponential Moving Average of (-DM / Average True Range)

ADX = 100 times the Exponential Moving Average of the Absolute Value of (+DI - -DI) / (+DI + -DI)

Aroon Oscillator

The Aroon Oscillator measures the strength of a trend. It is constructed by subtracting Aroon Down from Aroon Up. When Aroon Up remains high from consecutive new highs, the oscillator value will be high, following the uptrend. When a security's price is on a downtrend with many new lows, the Aroon Down value will be higher resulting in a lower oscillator value.

$$\text{Aroon Oscillator} = \text{Aroon Up} - \text{Aroon Down}$$

$$\text{Aroon Up} = 100 * \frac{(25 - \text{Periods Since 25-Period High})}{25}$$

$$\text{Aroon Down} = 100 * \frac{(25 - \text{Periods Since 25-Period Low})}{25}$$

Parabolic Stop and Reverse (PSAR)

The PSAR indicator is used to determine trend direction and potential reversals in price. Establish trend first the, If the trend is up, buy when the indicator moves below the price. If the trend is down, sell when the indicator moves above the price. A buy signal occurs when the PSAR moves from above to below the price, while a sell signal occurs when the dots move from below to above the price.

$$\text{RPSAR} = \text{Prior PSAR} + [\text{Prior AF (Prior EP-Prior PSAR)}]$$

$$\text{FPSAR} = \text{Prior PSAR} - [\text{Prior AF (Prior PSAR-Prior EP)}]$$

where:

RPSAR = Rising PSAR

AF = Acceleration Factor, it starts at 0.02 and increases by 0.02, up to a maximum of 0.2, each time the extreme point makes a new low (falling SAR) or high (rising SAR)

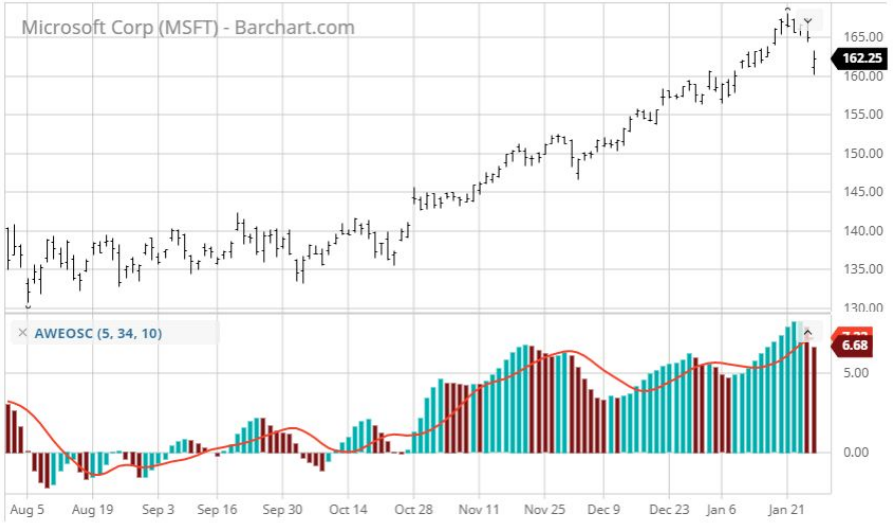
FPSAR = Falling PSAR

EP = Extreme Point, the lowest low in the current downtrend (falling SAR) or the highest high in the current uptrend (rising SAR)

Awesome Oscillator (AO)

AO gives a measure market momentum and identify potential reversals by comparing a 34-period simple moving average from a five-period simple moving average. The 34-period SMA, plotted through the middle points of the bars (H+L)/2, which is subtracted from the 5-period SMA, built across the central points of the bars (H+L)/2.

Median price = (HIGH+LOW)/2
AO = SMA(MEDIAN PRICE, 5)-SMA(MEDIAN PRICE, 34)



Ultimate Oscillator (UO)

UO measures the price momentum of an asset across multiple timeframes. By using the weighted average of three different timeframes the indicator has less volatility and fewer trade signals compared to other oscillators that rely on a single timeframe. Buy and sell signals are generated following divergences.

$$\text{UO} = \left[\frac{(\text{A}_7 \times 4) + (\text{A}_{14} \times 2) + \text{A}_{28}}{4 + 2 + 1}\right] \times 100$$

where:

$\text{UO} = \text{Ultimate Oscillator}$

$\text{A} = \text{Average}$

$\text{Buying Pressure (BP)} = \text{Close} - \text{Min}(\text{Low}, \text{PC})$

$\text{PC} = \text{Prior Close}$

$$\text{True Range (TR)} = \text{Max}(\text{High}, \text{Prior Close}) - \text{Min}(\text{Low}, \text{Prior Close})$$

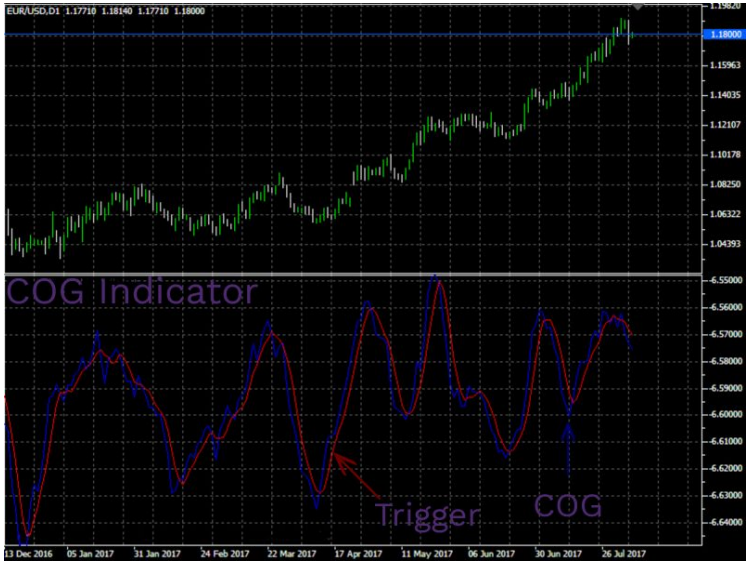
$$\text{Average}_7 = \frac{\sum_{p=1}^{7} \text{BP}}{\sum_{p=1}^{7} \text{TR}}$$

$$\text{Average}_{14} = \frac{\sum_{p=1}^{14} \text{BP}}{\sum_{p=1}^{14} \text{TR}}$$

$$\text{Average}_{28} = \frac{\sum_{p=1}^{28} \text{BP}}{\sum_{p=1}^{28} \text{TR}}$$

Centre of Gravity (COG)

The centre of gravity indicator measures the support and resistance levels in price movements. Support occurs when the downtrend starts to slow down and even pause. Resistance occurs when the uptrend starts to pause or slow down. The Centre of Gravity (COG) strategy is based on the premise that the market prices evolve around a "centre of gravity". As an oscillator, it offers two main benefits: a low lag in response to price and clear turning points.



$$COG = \frac{-\sum P_n \times (n+1)}{\sum P_n}$$

Coppock Curve

The Coppock Curve is a long-term price momentum indicator used primarily to recognize major downturns and upturns in a stock market index. When the indicator is above zero it indicates a hold. When the indicator drops below zero it indicates a sell, and when the indicator moves above zero it signals a buy.

The Coppock Curve is simply a smoothed momentum oscillator. Even though it was originally designed for monthly charts and long-term analysis, it can be used on intraday, daily or weekly charts.

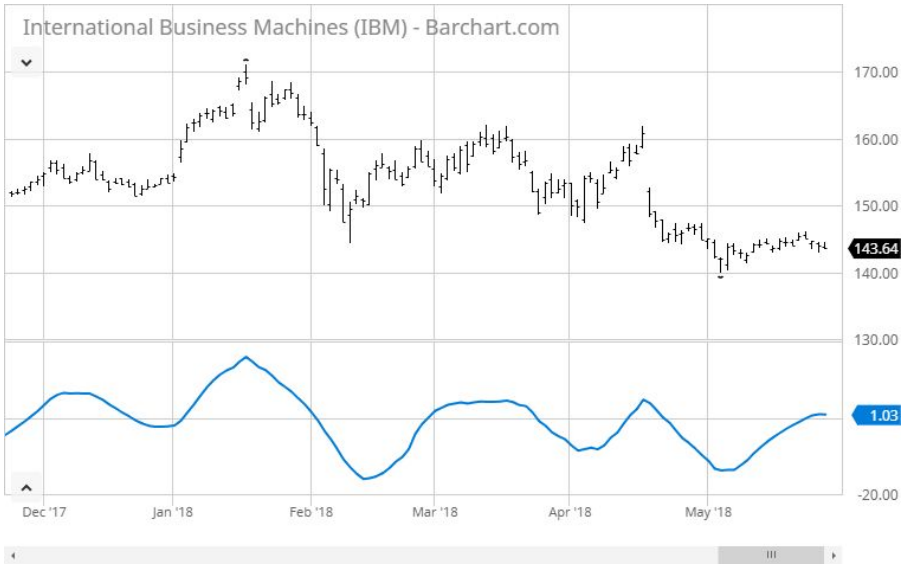
Coppock Curve = WMA_{10} of (ROC_{14} + ROC_{11})
ROC - Rate of change

$$\text{ROC} = \left(\frac{\text{Closing Price}_{p} - \text{Closing Price}_{p-n}}{\text{Closing Price}_{p-n}} \right) \times 100$$

where:

Closing Price_{p} = Closing price of most recent period

$\text{Closing Price}_{p-n}$ = Closing price n periods before most recent period



Inertia Indicator

The inertia indicator is momentum-based. This means that the indicator will show the moment of the price over time and a market reversal. Crossings of the inertia Indicator above and below the line indicate a trend reversal. This generates the entry and exit signals.

It is the Relative Vigor Index smoothed by the Least Squares Moving Average. Positive Inertia when values are greater than 50 and negative Inertia otherwise.

The inertia Indicator is constructed by first calculating the Relative Volatility Index and then smoothing the index by the Linear Regression Indicator. This indicator takes three parameters. The first two parameters are the standard deviation and smoothing Exponential Moving Average periods for the Relativity Volatility Index calculation. The third parameter is the period used with the Linear Regression Indicator.

$$\text{NUMERATOR} = \frac{a + (2 \times b) + (2 \times c) + d}{6}$$

$$\text{DENOMINATOR} = \frac{e + (2 \times f) + (2 \times g) + h}{6}$$

$$\text{RVI} = \frac{\text{SMA of NUMERATOR for } N \text{ periods}}{\text{SMA of DENOMINATOR for } N \text{ periods}}$$

$$\text{Signal Line } = \frac{\text{RVI} + (2 \times i) + (2 \times j) + k}{6}$$

where:

$a = \text{Close} - \text{Open}$

$b = \text{Close} - \text{Open One Bar Prior to } a$

$c = \text{Close} - \text{Open One Bar Prior to } b$

$d = \text{Close} - \text{Open One Bar Prior to } c$

$e = \text{High} - \text{Low of Bar } a$

$f = \text{High} - \text{Low of Bar } b$

$g = \text{High} - \text{Low of Bar } c$

$h = \text{High} - \text{Low of Bar } d$

$i = \text{RVI Value One Bar Prior}$

$j = \text{RVI Value One Bar Prior to } i$

$k = \text{RVI Value One Bar Prior to } j$

$N = \text{Minutes/Hours/Days/Weeks/Months}$

Schaff Trend Cycle (STC)

The Schaff Trend Cycle is an evolution of the popular MACD incorporating two cascaded stochastic calculations with additional smoothing. The STC has three (3) parameters: the fast period and the slow period. The fast period determines how quickly the indicator reacts to price changes, while the slow period smooths out the signal. The default values for the fast and slow periods tend to be 23 and 50, respectively. The third parameter is the smoothing parameter, which is usually set at 10.

The STC can be used to generate buy and sell signals by looking for crossovers of the STC line with the zero line.

EMA1 = EMA (Close, Short Length);
EMA2 = EMA (Close, Long Length);
MACD = EMA1 – EMA2.
Second, the 10-period Stochastic from the MACD values is calculated:
%K (MACD) = %KV (MACD, 10);
%D (MACD) = %DV (MACD, 10);
Schaff = 100 x (MACD – %K (MACD)) / (%D (MACD) – %K (MACD)).

Vortex Indicator

The vortex indicator (VI) is composed of two lines: an uptrend line (VI+) and a downtrend line (VI-). It is used to spot trend reversals and confirm current trends. A buy signal occurs when VI+ is below VI- and then crosses above VI-. A sell signal occurs when VI- is below VI+ and crosses above VI+.

Calculation → Parameter (1): n

1. True range:
   $$TR = max(H_t\text{-}L_t, H_t\text{-}C_{t-1}, H_t\text{-}C_{t-1})$$
2. Uptrend and downtrend movement
   $$VM+ = |H_t - L_{t-1}|$$
   $$VM- = |L_t - H_{t-1}|$$
3. Trendlines VI+, VI-: repeating daily
   $$VI+(n) = \sum_n VM+(n)/TR(n)$$
   $$VI-(n) = \sum_n VM-(n)/TR(n)$$

C: Close, L: Low, H: High

Fast Stochastic Indicator

During periods of price decreases, daily closes tend to accumulate near the extreme lows of the day, while during periods of price increases, they tend to accumulate near the extreme highs of the day. The stochastic indicator is designed to indicate oversold and overbought market conditions. The Fast Stochastic Indicator generates two lines: %K and %D. A market position should be initiated when the %K crosses the %D from the right-hand side.

$$\%K_t = \left(\frac{C_t - L_n}{H_n - L_n}\right) \cdot 100$$

$$\%D_t = \frac{((D_{t-1} \cdot 2) + \%K_t)}{3}$$

$\boldsymbol{C}$: Close, $\boldsymbol{L}$: Low, $\boldsymbol{H}$: High

Parameters (3):

- Number of periods used to determine the highest high for %K and %D (x2)
- Type of moving average (SMA, EMA, WMA)

MACD Oscillator

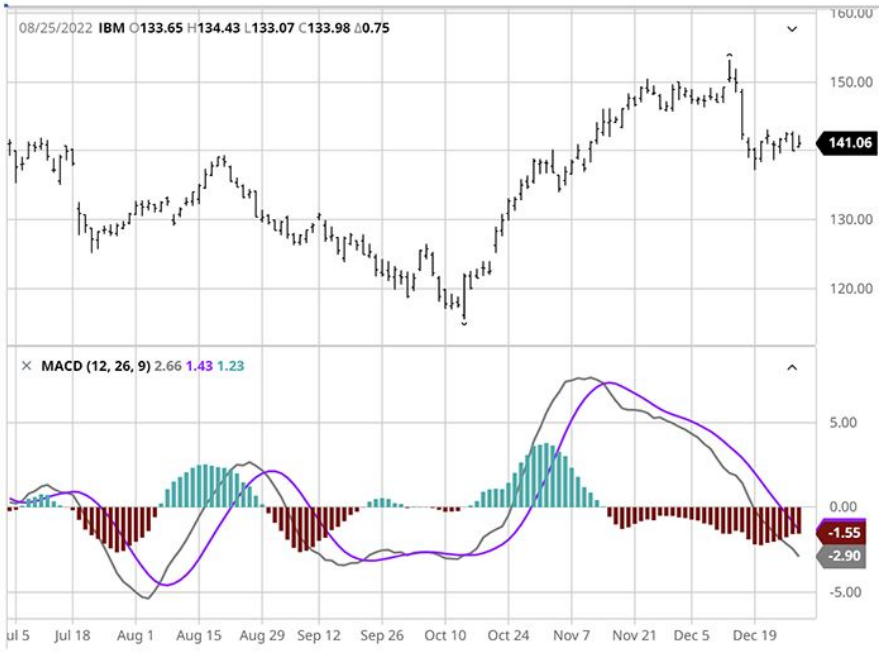
The MACD is an oscillator using EMAs. The buy signal is when the oscillator (OSC_t) crosses above the exponential moving average of the oscillator (EMA_{OSC}). The sell signal is when the oscillator crosses from above to below the exponential moving average of the oscillator. Divergence is possible with the MACD.

$$\mathrm{OSC_t} = \mathrm{EMA}(\mathrm{prices_t}, \mathrm{period_1}) - \mathrm{EMA}(\mathrm{prices_t}, \mathrm{period_2})$$

$$\mathrm{EMA_{osc}} = \mathrm{EMA}(\mathrm{OSC_t}, \mathrm{period_3})$$

Parameters (3):

- Number of periods used to determine the three EMAs (x3)



Price Distance

Evaluates the “distance” covered by price movements overnight and during the day. The PDIST indicator is a measure of price distance that combines information from both price range (high and low) and the differences between opening and closing prices.

Positive PDIST values suggest a significant upward price movement or bullish sentiment, while negative values indicate a significant downward movement.

PDIST = 2(high - low) - ABS(close - open) + ABS(open - close[drift])

Relative Volatility Index

The RVI is a volatility indicator that helps traders identify the direction of price volatility. RVI is based on the idea that when prices are trending higher, the trading range expands, while in downtrends, the trading range contracts. It ranges from 0 to 100, with values above 50 indicating an uptrend in volatility and values below 50 suggesting a downtrend in volatility.

While the RSI measures the magnitude of price changes, the RVI focuses on the standard deviation of price changes, making it a more suitable tool for gauging market volatility.

To calculate RVI use Standard Deviation values instead of closing price in the RSI formula.

RVI = 100 * Usum /(Usum + Dsum)

Where:

Usum is the averaged sum of STD for positive days
Dsum is the averaged sum of STD for negative days

If close price is above the previous close, then u = STD (n); otherwise, u = 0
If close is below the previous close, then d = STD (n); otherwise, d = 0

where **n** is bar period selected by a user

Usum = sum (u)/n
Dsum = sum (d)/n

Detrend Price Oscillator

A detrended price oscillator, used in technical analysis, strips out price trends in an effort to estimate the length of price cycles from peak to peak or trough to trough.

The DPO is not a momentum indicator. It instead highlights peaks and troughs in price, which are used to estimate buy and sell points in line with the historical cycle.

$$DPO = Price\ from\ \frac{X}{2} + 1\ periods\ ago - X\ period\ SMA$$

where:

X = Number of periods used for the look-back period

SMA = Simple Moving Average

Rolling Z-Score

Z-score is a statistical measurement that describes a value's relationship to the mean of a group of values. Z-score is measured in terms of standard deviations from the mean. If a Z-score is 0, it indicates that the data point's score is identical to the mean score

$$z = (x - \mu) / \sigma$$

Where:

- z = Z-score
- x = the value being evaluated
- μ = the mean
- σ = the standard deviation

Rolling Kurtosis

Kurtosis is the fourth standardized moment of a defined probability distribution. It is a statistical measure that quantifies the shape of a probability distribution's tail relative to that of a normal distribution. It provides information about the presence of extreme outliers or heavy tails in a dataset.

A positive kurtosis value indicates heavy tails or more outliers compared to a normal distribution, while a negative kurtosis value indicates lighter tails or fewer outliers. A kurtosis value of 0 represents a normal distribution.

$$Fischer's\ \ Kurtosis = \sum_{i=1}^{N} \frac{\frac{X_i - \bar{X}}{N}}{S^4} - 3$$

$$Where,$$

$$\bar{X} \quad is\ the\ mean,$$

$$N\ is\ sample\ size,$$

$$S\ is\ standard\ deviation$$

True Strength Indicator

The True Strength Index is a momentum indicator used to identify short-term swings while in the direction of the trend as well as determining overbought and oversold conditions.

$$\text{TSI} = (\text{PCDS}/\text{APCDS}) \text{ x } 100$$
$$\text{PC} = \text{CCP} - \text{PCP}$$
$$\text{PCS} = \text{25-period EMA of PC}$$
$$\text{PCDS} = \text{13-period EMA of PCS}$$
$$\text{APC} = \text{AVCCP} - \text{PCP}$$
$$\text{APCS} = \text{25-period EMA of APC}$$
$$\text{APCDS} = \text{13-period EMA of APCS}$$

where:

PCDS = PC double smoothed
APCDS = Absolute PC double smoothed
PC = Price change
CCP = Current close price
PCP = Prior close price
PCS = PC smoothed
EMA = Exponential moving average
APC = Absolute PC
APCS = Absolute PC smoothed

William’s Percent R

William's Percent R is a momentum oscillator similar to the RSI that attempts to identify overbought and oversold conditions.

The %R is based on a comparison between the current close and the highest high for a user defined look back period. %R Oscillates between 0 and -100 with readings close to zero indicating more overbought conditions and readings closer to -100 indicating oversold.

$$\text{Wiliams } \%R = \frac{\text{Highest High} - \text{Close}}{\text{Highest High} - \text{Lowest Low}}$$

where

Highest High = Highest price in the lookback period, typically 14 days.

Close = Most recent closing price.

Lowest Low = Lowest price in the lookback period, typically 14 days.

Vertical Horizontal Filter

VHF attempts to recognize periods when price is trending (up-trend or down-trend) or it is in the congestion phase (side-way trend). The VHF ranges from 0 to 1, with values close to 0 suggesting a congestion or sideways market and values close to 1 indicating a trending market.

When the VHF is near 1, it indicates a strong trending phase. When the VHF is near 0, it suggests a lack of trend and a range-bound or sideways market.

VHF = (HCP - LCP) / [Absolute value of SUM(Change, N)]

where
N - bar period selected by a user
HCP - highest close price in N periods
LCP - lowest close in N periods
SUM(Change, N) - is sum of absolute changes over **n** periods

QStick Indicator

The QStick indicator quantifies and identifies trends in candlestick charts. The indicator is a moving average calculation of the difference between the Open and Close prices over a specific period. A Qstick value greater than zero means that the majority of the last 'n' days have been up, indicating that buying pressure has been increasing.

$$\text{QSI} = \text{EMA or SMA of } (\text{Close} - \text{Open})$$

where:

$$\text{EMA} = \text{Exponential moving average}$$

$$\text{SMA} = \text{Simple moving average}$$

$$\text{Close} = \text{Closing price for period}$$

$$\text{Open} = \text{Opening price for period}$$

Choppiness Index

The Choppiness Index is a volatility indicator used to indicate whether a market is trending or ranging. A Choppiness Index value greater than 61.8 indicates signal consolidation. As the Choppiness Index increases, the market is considered to be more choppy, and the strength of the trend is diminished.A value less than 38.2 is often used to signal a trend.

$$CI = \frac{(100 * LOG10(\sum_{1}^{n} ATR))}{(MaxHigh(n) - MinLow(n))} \over LOG10(n)$$

where:

- n = User defined period length.
- LOG10(n) = base-10 LOG of *n*
- ATR(1) = Average True Range (Period of 1)
- SUM(ATR(1), n) = Sum of the Average True Range over past *n* bars
- MaxHigh(n) = The highest high over past *n* bars
- MinLow(n) = The lowest low over past *n* bars