

A Collection of Technical Trading Rules

Commentary on 54 rules and mathematical formulas

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This version : 01 May, 2018

This is a compilation of the author's doctoral thesis supplementary material, which is presented in the link below.

<http://minerva.mq.edu.au:8080/vital/access/manager/Repository/mq:50823>

1. Explanation on Technical Trading Rules Applied on this Thesis

A contribution of this thesis is that it introduces many technical trading rules that are known by practitioners, but have not previously appeared in the academic literature. This appendix provides a description of each rule. Throughout the explanations, n is period parameter. For example, if $n=10$, then $SMA(n)$ means moving average for 10 days period. In addition, for time series data, $Close(t)$ means closing price of today and accordingly $Close(t-1)$ indicates yesterday's closing price. In addition to the following explanations, these websites which provides many technical trading rules.

- <https://mahifx.com/indicators/>
- <http://www.binarytribune.com/forex-trading-indicators>
- <http://www.metastock.com/Customer/Resources/TAAZ/?c=3&p=6>
- http://www.barchart.com/education/std_studies.php
- https://www.instaforex.com/forex_indicators.php?p=2
- <http://www.mesasoftware.com/papers/>
- <https://www.linnssoft.com/indicators-list>

2. Alligator(ALLE)

Williams (1995) introduced the Alligator indicator, a moving average-based trading system in 1995. It consists of three lines that represent the jaw, the teeth and the lips of the alligator, and was created to help the trader confirm the presence of a trend and its direction, using smoothed moving average (SSMA)¹.

- The Alligator's Jaw (Line1) is a 13-period Smoothed Moving Average and the slowest indicator;
- The Alligator's Teeth (Line2) is an 8-period Smoothed Moving Average

¹See section 34 of Appendix for detailed explanation of SSMA

- The Alligator's Lips (Line3) is a 5-period Smoothed Moving Average and the fastest indicator
 - $\text{MEDIAN PRICE} = (\text{HIGH} + \text{LOW}) / 2$
 - Alligator's Jaw = SMMA (MEDEAN PRICE, 13, 8)
 - Alligator's Teeth = SMMA (MEDEAN PRICE, 8, 5)
 - Alligator's Lip = SMMA (MEDEAN PRICE, 5, 3)

Like moving average cross-over, buy signal is generate if fastest MA (5)> middle MA(8). Furthermore, if fastest MA(5)> middle MA(8)> slowest MA(13), then this signals holding the position until the generation of the new signal. As action is taken, the alligator starts sleeping. If slowest MA (13)> middle MA(8), this means selling signal and alligator is awakening for feeding using lip, teeth and jaw. If slowest MA (13)> middle MA(8)> fastest MA(3), then he is full and ready for sleeping, meaning holding the position until buying signal is generated.

3. Aroon Indicator(ARN)

The Aroon indicator developed by attempts to identify starting trends. The name Aroon means "dawn's early light" in Sanskrit and the aim of Chande (1995) is to find an early changes in trend. The indicator consists of two lines, "Aroon Up" and "Aroon Down" to show market direction, which measures the number of days of highest/lowest since the last n period. For example, a 25-day (n=25) "Aroon Up (Down)" measures the number of days since a 25 day high (low). The Aroon is oscillate between 100 and 0. If today's price is a new high (low), then "Aroon Up (Down)" will be 100. If there is no new record of high(low), then it decreased $(1 / n) \times 100$ by each sequent day and at 25th day, the Aroon beacome 0. Following is sample calculation of 25 days Aroon.

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

- $\text{Aroon Up} = \frac{25 - \# \text{of days since 25 Day High}}{25} \times 100$

- $\text{Aroon Down} = \frac{25 - \# \text{of days since 25 Day Low}}{25} \times 100$

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

- Strategy

- ★ Up (Down) trends are indicated when the Aroon Up(Down) is between 70 and 100.
- ★ Aroon Up(Down) below 50 indicates weakening of current trend.
- ★ Buy when Aroon Up(Down) is above 70 while the Aroon Down(Up) is below 30.
- ★ Sell when Aroon Down(Up) is above 70 while the Aroon Up(Down) is below 30.

4. Average Directional Movement Index(ADX)

The ADX indicator of Wilder (1978a) is moving average of directional movement index (DX) and it indicate the strength of the trend, but not the direction of the trend (ie,up trend or down).The index values range from 0 to 100 and bigger number means strong in trend. Additional two indicators, Plus Directional Indicator (+DI) and Minus Directional Indicator (-DI) are complement to ADX indicator to generate the trend strength.

- $ADX = \frac{\text{Current Close} - 5 \text{ (or x) days Lowest Low}}{(5 \text{ (or x) days Highest High} - 5 \text{ (or x) days Lowest Low})} \times 100$
- $DX = \frac{(\text{Close} - \text{Low})}{(\text{High} - 5 \text{ Low})}$
- $+DI = 3 \text{ (or n) days Moving Average of K lines.}$
- $-DI = 3 * D - 2 * K$ and the value of J can go beyond [0, 100].
- **Strategy**
 - ★ Buy when $+DI > -DI$ and $ADX > 25$
 - ★ Sell when $+DI < -DI$ and $ADX > 25$

5. Average True Range(ATR)

Introduced by Wilder (1978b), the Average True Range (ATR) is an indicator to measure volatility. Higher ATR means trending and lower ATR indicates a consolidation in price.

- Total Range(TR)
 - Method 1: Current High - Current Low
 - Method 2: |Current High - Previous Close|
 - Method 3: |Current Low - Previous Close|
 - $TR = \text{Max}[\text{Method1}, \text{Method2}, \text{Method3}]$
- $ATR(1) = \text{Average}[\text{Method1}, \text{Method2}, \text{Method3}]$
- $ATR(t) = [ATR(t-1) * (n-1) + TR(t)] / 14$
- **Strategy**
 - ★ Buy when $\text{Price} > ATR$
 - ★ Sell when $\text{Price} < ATR$

6. Bollinger Band(BOLL)

Developed by Bollinger (1992), Bollinger Bands consist of three bands that can be overlayed over a normal price chart or an indicator. The first, the middle band is a simple moving average and the default period (n) is 20.

- Bollinger Band
 - Middle Band = 20-day simple moving average (SMA)
 - Upper Band = 20-day SMA + (20-day standard deviation of price × 2)
 - Lower Band = 20-day SMA - (20-day standard deviation of price × 2)
- Strategy
 - ★ Buy if the price moves below the lower band,
 - ★ Sell if the price moves above the upper band.

7. Commodity Channel Index(CCI)

Commodity Channel Index (CCI) of Lambert (1980) is to identify a new trend or warn of extreme conditions. CCI measures the current price level relative to an average price level over a given period of time and indicate the weakening of a trend. CCI is relatively high when prices are far above their average. CCI is relatively low when prices are far below their average.

- Price=(High + Low + Close)/3
- Mean Deviation(MD)= Gap between SMA and each day Price =

$$\frac{\sum_{i=1}^n (\text{SMA}(n) - \text{Price}(i))}{n}$$

- CCI =
$$\frac{\text{Price} - \text{SMA}}{0.015 * \text{MD}}$$

- Strategy
 - ★ A CCI reading above +100 can indicate that an asset has been overbought, and a reading below -100 can indicate that an asset has been oversold.
 - ★ Buy when CCI turns up from below -100.
 - ★ Sell if the CCI turns down from above 100.

8. Center of Gravity Oscillator(CGO)

The Center of Gravity is an oscillator developed by Ehlers (2004a). In Physics, the Center of Gravity (CG) means its balance point and CG oscillator seek the CG of prices over the window of observation to identify the turning points of the price.

- Price = (High+Low)/2

- $x = 0, \dots, n-1$

- CGO(t) =

$$\frac{\sum_{i=0}^n ((x_i + 1) \times \text{Price}_i)}{\sum_{i=0}^n \text{Price}_i}$$

- Trigger=CGO(t-1)

- Strategy

- ★ The crossing of CGO and Trigger lines serves as the indicator's major trading signal.
- ★ Sell when CGO line crosses the Trigger to the downside.
- ★ Buy if the CGO line crosses over the Trigger line.

9. Chande Momentum Oscillator(CMO)

The Chande (1994) is momentum indicator to seek the overbought and oversold levels by using sum of up movement (S_u) and down movement(S_d) over n periods.

- CMO =

$$\frac{\text{Sum of all positive changes in price}(S_u) - \text{Absolute sum of all negative changes in price}(S_d)}{\text{Sum of all positive changes in price}(S_u) + \text{Absolute sum off all negative changes in price}(S_d)} \times 100$$

- positive change = Close(t)-Close(t-1) > 0
- negative changes = Close(t)-Close(t-1) < 0

- Strategy

- ★ The CMO oscillates between 100 and -100,
- ★ Sell when the CMO is above 50 (overbought)
- ★ Buy when the CMO is below -50 (oversold).

10. Coppock Indicator(COPP)

Coppock (1962) is long term indicator and is to identify the commencement of bull markets. It is weighted moving average(WMA) of the differences between two Rate of Changes (ROC).

- $\text{Coppock} = \text{WMA}(10) \text{ of } (\text{ROC}(14) + \text{ROC}(11))$
- $\text{WMA}(10) = 10 \text{ day Weighted moving average}$
- $\text{ROC}(14) = 14 \text{ day Rate-of-Change (see section 31)}$
- $\text{ROC}(11) = 11 \text{ day Rate-of-Change}$
- Strategy
 - ★ The key aspect of the COPP is the zero line.
 - ★ Sell when the COPP is moving below the zero line
 - ★ Buy when the COPP is moving above the zero line

11. Cyber Cycle Indicator (CYC)

Cyber Cycle Indicator developed by Ehlers (2004b) is an responsive trend following system and it generate entry and exit signal.

- $\text{Price} = (\text{High} + \text{Low}) / 2$
- $\alpha = 0.05$
- $\text{Smooth}(t) = (\text{Price}(t) + 2 * \text{Price}(t-1) + 2 * \text{Price}(t-2) + \text{Price}(t-3)) / 6;$
- $\text{CYC} = (1 - 0.5 * \alpha) * (1 - 0.5 * \alpha) * (\text{Smooth}(t) - 2 * \text{Smooth}(t-1) + \text{Smooth}(t-2)) + 2 * (1 - \alpha) * \text{Cycle}(t-1) - (1 - \alpha) * (1 - \alpha) * \text{Cycle}(t-2);$
- $\text{Trigger}(t) = 2 * \text{ITrend}(t) - \text{ITrend}(t-2);$
- Strategy
 - ★ The crossing of CYC and Trigger lines serves as the indicator's major trading signal.
 - ★ Sell when CYC line crosses the Trigger to the downside.
 - ★ Buy if the CYC line crosses over the Trigger line.

12. Double Exponential Moving Average(DEMA)

The Mulloy (1994a) is a calculation based on both a single exponential moving average (EMA) and a double EMA. Double exponential moving average (DEMA) is a measure of a security's trending average price that gives the most weight to recent price data to give more faster signal than simple moving average, which is good for short term investor.

- $EMA1 = EMA(n, Close)$
- $EMA2 = EMA(n, EMA1)$
- $DEMA = 2 * EMA1 - EMA2$
- Strategy
 - ★ Sell when Price is below DEMA.
 - ★ Buy when Price is above DEMA.

13. DeMark's Range Expansion Index (DREI)

The DeMark (1997) is a momentum oscillator to measure relative velocity and magnitude of directional price movements. The REI shows overbought/oversold price conditions by measuring the relation based on the comparison of the recent price changes and the overall price changes for the period. DREI use two type of summations, SUM1 and SUM2.

- $$SUM1 = \sum_{j=1}^n k(j)m(j)s(j)$$
 - $SUM1 = \sum_{j=1}^n k(j)m(j)s(j)$
 - $k(j) = 0$, if $High(j-2) < Close(j-7) \ \&\& \ High(j-2) < Close(j-8) \ \&\& \ High(j) < High(j-5) \ \&\& \ High(j) < High(j-6)$
 - $k(j) = 1$, otherwise
 - $m(j) = 0$, if $Low(j-2) > Close(j-7) \ \&\& \ Low(j-2) > Close(j-8) \ \&\& \ Low(j) > Low(j-5) \ \&\& \ Low(j) > Low(j-6)$
 - $m(j) = 1$, otherwise
 - $s(j) = 0$, $High(j-2) - High(j-2) + Low(j) - Low(j-2)$

- $$SUM2 = \sum_{j=1}^n (High(j) - High(j-2) + Low(j) - Low(j-2))$$

- $DREI = 100 \times SUM1/SUM2$;
- Strategy
 - ★ REI changes on a scale from -100 to +100
 - ★ Sell if REI is greater than 60 (overbought)
 - ★ Buy if REI is below -60 (oversold).

14. DeMark's DeMarker(DMark)

This indicator was introduced by DeMark (1997) as a tool to identify emerging buying and selling opportunities. It demonstrates the price depletion phases which usually correspond with the price highs and bottoms. The DeMarker indicator proved to be efficient at identifying trend break-downs as well as spotting intra-day entry and exit points.

- If $high(t) > high(t-1)$, then $DeMax(t) = high(t)-high(t-1)$, otherwise $DeMax(t) = 0$
- If $low(t) < low(t-1)$, then $DeMin(t) = low(t-1)-low(t)$, otherwise $DeMin(t) = 0$
- $DMark(t) = SMA(DeMax,N)/(SMA(DeMax,N)+SMA(DeMin,N))$
- Strategy
 - ★ DeMarker changes on a scale from 0 to 1
 - ★ Sell if DeMarker is greater than 0.7 (overbought)
 - ★ Buy if DeMarker is below 0.3 (oversold).

15. Detrended Price Oscillator(DPO)

The DPO of Achelis (2001a) is an indicator designed to remove trend element of price and identifies cycles by comparing a price to a simple moving average(SMA).

- $DPO = Price(n/2 + 1) - SMA(n)$
- default of n is 20 or 30 periods.
- Strategy
 - ★ Decision making is based on a horizontal 0 line.
 - ★ Sell when DPO hits zero line from below or even crosses above zero for a while and then turns back below zero. (overbought)
 - ★ Buy when DPO hits zero from above zero for a while and then goes up above zero(oversold).

16. Exponential Moving Average(EMA)

Haurlan (1968) is alternative type of SMA and it weight more on current price movement.

- Sample calculatrion for 10 days EMA
- $EMA = Close(t) - EMA(t-1) \times Multiplier + EMA(t-1)$
– $Multiplier = (2 / (n + 1)) = (2 / (10 + 1)) = 0.1818$.
- Strategy
 - ★ Sam as Moving Averaage Crossover
 - ★ Sell if short term EMA < long term EMA.
 - ★ Buy if short term EMA > long term EMA.

17. Easy of Movement(EMV)

EMV, developed by Arms (1996) use both of price and volume data to identify the relationship between volume and price changes and is particularly useful for assessing the strength of a trend.

- $Distance\ Moved = ((High(t) + Low(t))/2 - (High(t-1) + Low(t-1))/2)$
- $Box\ Ratio = ((Volume/10,000)/((High - Low)/8))$
- $EMV(1) = ((High(t) + Low(t))/2 - (High(t-1) + L(t-1))/2) / ((Volume/100,000,000)/(High(t) - Low(t)))$
- $EMV(n) = SMA(EMV(1),n)$, which is n period SMA of EMV(1)
- Strategy
 - ★ Buy when EMV crosses to above zero,from below.
 - ★ Sell when EMV crosses to below zero,from above.

18. Entropy(ETPY)

Ehlers (2002a) The indicator that demonstrates the power of price changes entropy. In Physics, the entropy is the measure of the disorder of the system and higher entropy means less predictive ability. The entropy is calculated using the Maximum Entropy Method, which is minimising a smoothness of entropy and this is to enhance the predictive power when market is in disorder.

For more understanding the concept of entropy and maximum entropy method, following links provide some more explanations. <http://mathworld.wolfram.com/Entropy.html>
<http://mathworld.wolfram.com/MaximumEntropyMethod.html>

- SUM1 =

$$\sum_{t=1}^n \log(P(t)/P(t-1))$$

- SUM2 = SUM1*SUM1
- AVG = SUM1/n
- MAX = $\sqrt{SUM2}$
- P = AVG/MAX
- ETPY = $P \cdot \log(1+MAX) + (1-P) \cdot \log(1-MAX)$
- Strategy
 - ★ The key aspect of the COPP is the zero line.
 - ★ Buy when the ETPY is below zero
 - ★ Sell when the ETPY is above zero

19. Elder Ray Indicator (ERI)

ERI of Elder (1993a) measures the amount of buying and selling pressure in the market. This indicator consists of two separate indicators known as "bull power" and "bear power". These figures allow a trader to determine the position of the price relative to a certain exponential moving average (EMA).

- Bull Power = Daily High - n period EMA Bear Power = Daily Low - n period EMA

Using exponential moving average(EMA), Elder Ray Indicator (ERI), developed by Dr. Alexander Elder to check the buy and selling pressure in the market. developed

- Market Consensus (MC) = 13 (or n) day EMA

- Bull power = Daily High -MC
- Bear power = Daily Low- MC
- Strategy
 - ★ Sell if Bull Power is above zero (or Today's Low <MC)
 - ★ Buy if Bear Power is below zero(or Today's high>MC).

20. Force Index(FI)

Using both of price and volume data, the Force Index of Elder (1993b) is to identify the possible of turning points. FI collects the market sentiment information by calculating the average level of the daily price changes and market volume to measure the buying and selling pressure.

- Force Index(1)= $(\text{Close}(t) - \text{Close}(t-1)) \times \text{Volume}(t)$
- Force Index(n)= n period EMA of Force Index(1)
- Strategy
 - ★ sell if the Force index is above zero.
 - ★ buy if the Force index is below zero .

21. Keltner Channel Indicator(KELT)

Keltner Channels Keltner (1960) are volatility-based envelopes set above and below an exponential moving average. Instead of using the standard deviation, Keltner Channels use the Average True Range (ATR) to set channel distance. The channels are typically set two Average True Range values above and below the 20-day EMA

- Middle Line: 20-day exponential moving average
- Upper Channel Line: $20\text{-day EMA} + (2 \times \text{ATR}(10))$
- Lower Channel Line: $20\text{-day EMA} - (2 \times \text{ATR}(10))$
- Strategy
 - ★ sell when price turns down at or above the upper band. Close your position if price turns up near the lower band or crosses to above the moving average.
 - ★ buy when prices turn up at or below the lower band. Close your position if price turns down near the upper band or crosses to below the moving average.

22. Laguerre Relative Strength Index(LRSI)

The Laguerre Relative Strength Index of Ehlers (2004c) is to upgrade RSI² by applying Laguerre filter. LRSI uses a 4-Element Laguerre filter to provide a "time warp" such that the low frequency components are delayed much more than the high frequency components. This enables much smoother filters to be created using shorter amounts of data.

- $\gamma=0.5$;
- CU= Closes up
- CD= Closes down
-
- $L_0(t)=((1-\gamma)*Close(t)) + (\gamma*L_0(t-1))$;
- $L_1(t)=(-\gamma*L_0(t)) + L_0(t-1) + (\gamma*L_1(t-1))$;
- $L_2(t)=(-\gamma*L_1(t)) + L_1(t-1) + (\gamma*L_2(t-1))$;
- $L_3(t)=(-\gamma*L_2(t)) + L_2(t-1) + (\gamma*L_3(t-1))$;
- If $L_0 \geq L_1$, CU=L0-L1, CD=L1-L0
- If $L_1 \geq L_2$, CU=CU+L1-L2, CD=CD+L2-L1
- If $L_2 \geq L_3$, CU=CU+L2-L3, CD=CD+L3-L2
- $LRSI = CU / (CU + CD)$
- Strategy
 - ★ Buy when LRSI crosses upwards above 0.15.
 - ★ Sell when LRSI crosses down below 0.85.

²see section 32

23. Linear Regression Indicator (LRI)

Using least squares slope as a fair value, the LSI of Chande (1992) identify trend and generates trend following signals similar to a moving average. If current price line moves below (over) the LRI line, this indicates price is cheaper (expensive) compare to fair value so signal to buy(sell) the stock.

- $i=1:\text{length}(\text{Close})$
- $x=\text{Close}(i:n)$
- $Y = \beta_0 + \beta_1 x$ and get
- $\hat{\beta}_1 = \frac{\overline{xy} - \bar{x}\bar{y}}{x^2 - (\bar{x})^2}$
- $\text{LSMA} = \text{SMA}(Y_t, n)$
- $\text{LRS} = \hat{\beta}_1 / \text{LSMA}$
- **Strategy**
 - ★ sell if the price line cross down LRI.(Death Cross)
 - ★ buy if the price line cross over LRI.(Golden Cross) .

24. Moving Average Convergence & Divergence(MACD)

MACD is one of the simplest and popular indicators developed by Appel (1979) Using two moving averages, the indicator calculate trend-following characteristics by subtracting the longer moving average from the shorter moving average.

The MACD is calculated by subtracting the 26-day exponential moving average (EMA) from the 12-day EMA. A nine-day EMA of the MACD, called the "signal line", is then plotted on top of the MACD, functioning as a trigger for buy and sell signals.

- **MACD Line:** (12 period EMA - 26 period EMA)
- **Signal Line:** (9 period EMA of MACD Line)
- **MACD Histogram:** MACD Line – Signal
- **EMA = Exponential Moving Average.**
- **Strategy**
 - ★ The Stochastic Oscillator is bound between 0 and 100.
 - ★ sell when stochastic index is over 80.
 - ★ buy when stochastic index is below 20.

25. MACD with 4 Parameters (MACD4)

MACD4 add one more parameter MACD and it's firstly introduced as PhD thesis of John (2010).

Sample application is `macd4(Close, params = c(12, 26, 1, 9))`, where params are

- ★ First parameter - the “fast” average parameter
- ★ Second parameter - the “slow” average parameter
- ★ Third parameter - the new parameter, indicating a 'fast' averaging of the MACD line instead of the typical choice of the MACD line itself
- ★ Fourth parameter - the 'slow' averaging for the MACD signal line

- Strategy

- ★ The key aspect of the COPP is the zero line.
- ★ Sell when the COPP is moving below the zero line
- ★ Buy when the COPP is moving above the zero line

26. Money Flow Index(MFI)

Quong (1989) is an oscillator to measures the strength of money flowing in and out toward a equity and using both price and volume, it calculate the buying and selling pressure. As MFI both pirce and volume, it is also known as volume-weighted RSI. The example below is based on a 14-period MFI.

- $\text{Price} = (\text{High} + \text{Low} + \text{Close})/3$
- $\text{Raw Money Flow} = \text{Typical Price} \times \text{Volume}$
- $\text{Money Flow Ratio} = (14\text{-period Positive Money Flow}) / (14\text{-period Negative Money Flow})$
- $\text{Money Flow Index} = 100 - 100 / (1 + \text{Money Flow Ratio})$

- Strategy

- ★ The key aspect of the COPP is the zero line.
- ★ Sell when the MFI is over 80
- ★ Buy when the COPP is below 20

27. Pentuple EMA (PEMA)

PEMA of Eremee and Kositsin (2010) is Pentuple Exponential Moving Average. It is combinations of QEMA, Quadruple EMA (see Section 30) and TEMA, Triple EMA (see Section 41)

- $PEMA = QEMA(Close, n) + TEMA(Close - QEMA, n)$
- Strategy
 - ★ Sell when the Close is moving below the PEMA line
 - ★ Buy when the Close is moving above the PEMA line

28. Price Momentum Oscillator (PMO)

Swenlin (1997) is to seek the up and down strength using the two times averaging of market price movement and give overbought or oversold signal.

- Smoothing Multiplier = $(2 / \text{Time period})$
- Custom Smoothing Function = $\text{Close} - \text{Smoothing Function}(\text{previous day}) * \text{Smoothing Multiplier} + \text{Smoothing Function}(\text{previous day})$
- PMO Line = 20-period Custom Smoothing of $(10 * 35\text{-period Custom Smoothing of } ((\text{Today's Price} / \text{Yesterday's Price}) * 100) - 100)$
- PMO Signal Line = 10-period EMA of the PMO Line
- Strategy
 - ★ Sell when the PMO is moving below the PMO Signal line
 - ★ Buy when the PMO is moving above the PMO Signal line

29. Percentage Price Oscillator(PPO)

The PPO of Achelis (2001b) is a momentum oscillator that measures the difference between short and long term moving averages as a percentage of the larger moving average. Standard PPO is based on the 12-day Exponential Moving Average (EMA) and the 26-day EMA, but these parameters can be changed according to investor or trader preferences. A 9-day EMA of PPO is plotted as a signal line to identify upturns and downturns in the indicator.

- PPO =
$$\frac{12 \text{ day EMA} - 26 \text{ day EMA}}{26 \text{ day EMA}} \times 100$$
 - Signal Line = 9 day EMA of PPO.
 - PPO Histogram = PPO - Signal Line
- Strategy
 - ★ Sell when the PPO Histogram is negative value
 - ★ Buy when the PPO Histogram is positive value

30. Quadruple EMA (QEMA)

Lebeau (1991) is combination of DEMA(see section 12)and TEMA(see section 42) and this indicator is to give more weight on current market movement while removing noises of price movement.

- QEMA = TEMA + DEMA(Close - TEMA)
- Strategy
 - ★ Buy when the shorter term QEMA crosses above the longer term QEMA (golden cross).
 - ★ Sell when the shorter term QEMA crosses below the longer term QEMA (dead cross).

31. Rate of Change (ROC)

ROC of Murphy (1998) measure the price change of current price with the price n periods ago. The ROC indicator can be used to confirm price moves or detect divergences; it can also be used as a guide for determining overbought and oversold conditions.

If momentum (>0) and periods with negative momentum (<0).

- ROC =

$$\frac{(\text{Close today} - \text{Close } n \text{ periods ago})}{\text{Close } n \text{ periods ago}} \times 100$$

- Strategy

★ Buy when ROC crosses to below the -10% level and then rises.

★ Sell when ROC crosses to above the 10 % then falls back.

32. Relative Strength Index (RSI)

the RSI of Wilder (1978c) is a momentum oscillator to measure the velocity and magnitude of directional price movements.

- RSI =

$$\frac{100}{1 + RS}$$

- RS =

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

- First Average Gain =

$$\frac{\text{Sum of Gains over the last 14 periods}}{14}$$

- First Average Loss =

$$\frac{\text{Sum of Losses over the last 14 periods}}{14}$$

The second, and subsequent calculations are based on prior averages and the current gain/loss.

- Average Gain = $[(\text{previous Average Gain}) * 13 + \text{current Gain}] / 14$

- Average Gain =

$$\frac{\text{previous Average Gain} * 13 + \text{current Gain}}{14}$$

- Average Loss =
$$\frac{\text{previous Average Loss} \times 13 + \text{current Loss}}{14}$$

- Strategy
 - ★ Sell when the RSI rises above 70
 - ★ Buy when the RSI falls below 30.

33. Relative Vigor Index (RVI)

Developed by Ehlers (2002b), RVI compares power of the today's market open compare to yesterday's close (Close-Open) relative to its price range(High-Low). Accordingly the higher(lower) the RVI climbs, the stronger is the current price increase(decrease);

- $RVI(1) = \frac{\text{Close-Open}}{\text{High-Low}}$
- $RVI(n) = n\text{-period SMA of } RVI(1)$
- signal = 4-period SMA of $RVI(1)$
- Strategy
 - ★ Sell when RVI crossing the signal line from above,
 - ★ Buy when RVI crossing the signal line from below.

34. Stochastic Cyber Cycle (SCYC)

Ehlers (2004d)'s Stochastic Cyber Cycle is a combination of standard Stochastic oscillator (see section 41) with its values calculated not based on price series but on Cyber Cycle (see section 11) indicator values.

- $SCYC = \frac{CYC(n) - CYC \text{ Lowest Low}(n)}{CYC \text{ Highest High}(n) - CYC \text{ Lowest Low}(n)}$
- Strategy
 - ★ Same as RSI, SCYC values are between 0 and 100.
 - ★ Buy when SCYC is below 20
 - ★ Sell when SCYC os over 80 level.

35. Stochastic Center of Gravity(SCGO)

Ehlers (2004e)'s Stochastic Center of Gravity is a combination of standard Stochastic oscillator (see section 41) with its values calculated not based on price series but on Center of Gravity (see section 8) indicator values.

- SCGO =
$$\frac{\text{CGO}(n) - \text{CGO Lowest Low}(n)}{\text{CGO Highest High}(n) - \text{CGO Lowest Low}(n)}$$
- Strategy
 - ★ SCGO values are between 0 and 100.
 - ★ Buy when SCGO is below 20
 - ★ Sell when SCGO is over 80 level.

36. Stochastic KDJ (KDJ)

? ³ upgrades stochastic oscillator ⁴ by adding one more extra line called J line. The role for J line is to double confirm the trading signal of the stochastic indicator.

- %K line =
$$\frac{\text{Current Close} - 5 \text{ (or x) days Lowest Low}}{(5 \text{ (or x) days Highest High} - 5 \text{ (or x) days Lowest Low})} \times 100$$
- %D line = 3 (or n) days Moving Average of K lines.
- %J line = 3*D - 2*K

The trading strategy of the stochastic oscillator is simple. To sell when the two lines (K, D) reached 80% or higher level and to buy when two line reached 20% or below level. KDJ strategy is to buy when stochastic signals buy and J line lies below zero and sell when stochastic signals sell and J line lies over 100 level.

- Strategy
 - ★ the value of J can go beyond [0, 100].
 - ★ Sell when J goes above 100 when K and D are above 80 area.
 - ★ Buy when J goes under 0 when K and D are in below 20.

³I have been spent more than one year to find the direct reference of KDJ indicator but we finally fail to find the source of the journal/book. However, our finding are outcome from our best effort and introduction of the indicator via web-source is another way of practitioner's publication

⁴see section 36

37. SONAR Momentum Indicator(SNR)

SONAR momentum chart of Okamoto (1978) was developed by Japanese Technical Analyst Okamoto when he was work for Nomura Securities. This is one of the popular Japan and Korea and the aim for SONAR momentum indicator is to seek the momentum of price cycle via slope.

- SNR =
$$\frac{\text{Close- n previous day's Close}}{\text{n previous day's Close}}$$
- (n) = number of periods used in the calculation
- Strategy
 - ★ Buy when SNR is above 0 and crossover of $\text{SNR} > \text{SMA}(\text{SNR}, n)$
 - ★ Sell when SNR is below 0 and crossover $\text{SNR} < \text{SMA}(\text{SNR}, n)$

38. Stochastic RSI(SRSI)

SRSI of Ehlers (2004f) is a combination of Stochastic indicator (see section 41) and RSI(see section 32). Instead of Close price, StochasticRSI apply RSI values to Stochastic Indicator formulae to seek the market is overbought or oversold.

- SRSI =
$$\frac{\text{RSI}(n) - \text{RSI Lowest Low}(n)}{\text{RSI Highest High}(n) - \text{RSI Lowest Low}(n)}$$
- Strategy
 - ★ SRSI values are between 0 and 100.
 - ★ Buy when SRSI is below 20
 - ★ Sell when SRSI is over 80 level.

39. Stochastic RVI(SRVI)

Ehlers (2004g)'s Stochastic RVI is a combination of standard Stochastic oscillator (see section 41) with its values calculated not based on price series but on RVI (see section 33) indicator values.

- SRVI =
$$\frac{\text{RVI}(n) - \text{RVI Lowest Low}(n)}{\text{RVI Highest High}(n) - \text{RVI Lowest Low}(n)}$$
- Strategy
 - ★ SRVI values are between 0 and 100.
 - ★ Buy when SRVI is below 20
 - ★ Sell when SRVI is over 80 level.

40. Smoothed Moving Average(SMMA)

?⁵ Moving averages smooth past price data to form trend following indicators. The SMMA gives recent prices an equal weighting to historic prices. The calculation takes all available data series into account rather than referring to a fixed period. This is achieved by subtracting the prior periods SMMA from the current periods price. Adding this result to yesterday's Smoothed Moving Average gives today's Moving Average.

- The first value
 - $SUM1 = \text{SUM}(\text{CLOSE}, N)$
 - $SMMA1 = SUM1 / N$
- The second and subsequent moving average
- $SMMA(i) = (SUM1 - SMMA1 + \text{CLOSE}(i)) / N$
 - SUM1 is the total sum of closing prices for N periods
 - SMMA1 is the smoothed moving average of the first bar;
 - CLOSE is the current closing price;
 - N is the smoothing period.
- Strategy
 - ★ Buy when the shorter term SSMA crosses above the longer term SSMA (golden cross).
 - ★ Sell when the shorter term SSMA average crosses below the longer term SSMA (dead cross).

41. Stochastic(STO)

Lane (1984) developed stochastic indicators to measure the relationship between closing price and its price range over a n period. The default value of n is 14. The indicator measured the %K line and the %D line to identify the level of the close relative to the high-low range.

- Fast Stochastic
 - $\%K = (\text{Current Close} - \text{Lowest Low}) / (\text{Highest High} - \text{Lowest Low}) * 100$
 - $\%D = 3\text{-day SMA of \%K}$

⁵Despite our best effort to find the author for this indicator for longer than one year, I have not received any confirmation of the answer from trader's website which contains this indicator. Instead, we use MahiFX as a interim author because the institution provides the best explanation for the indicator, among others.

- Slow Stochastic
 - Slow %K = Fast %K smoothed with a 3-period SMA (i.e. %D above)
 - Slow %D = 3-period SMA of Slow %K

- Strategy
 - ★ The Stochastic Oscillator is bound between 0 and 100.
 - ★ sell when stochastic index is over 80.
 - ★ buy when stochastic index is below 20.

42. Triple EMA (TEMA)

Mulloy (1994b) consist of triple EMAs (Single EMA, Double EMA and Triple EMA) to lessen the possibility of the false signals commonly encountered in the SMA cross-over, while weighting more on recent market movement. Popular parameters for TEMA are 10 EMA (fast), 25 EMA (medium) and 50 EMA (slow).

- $EMA1 = EMA(n, Close)$
- $EMA2 = EMA(n, EMA1)$
- $EMA3 = EMA(n, EMA2)$
- $TEMA = (3 * EMA1) - (3 * EMA2) + EMA3$
- Strategy
 - ★ Buy when the fast TEMA (n=10) crosses over the medium TEMA (n=25), and then through the slow TEMA (n=50), enter in the direction of the fast EMA.
 - ★ Sell when the fast TEMA touches the medium TEMA or Exit when the fast TEMA crosses over the medium TEMA.

43. Triple Smoothed EMA(TRIX)

Developed by Hutson (1984), the TRIX indicator calculates the rate of change of a triple exponential moving average.

- $M = \text{EMA}(n)(\text{EMA}(n)(\text{EMA}(n, \text{Close})))$

- $\text{TRIX} =$

$$\frac{M_t - M_{t-1}}{M} * 100$$

- Strategy

- ★ Buy/sell signals are generated when the TRIX crosses above/below zero.
- ★ Sell when TRIX cross down over zero line.
- ★ Buy when TRIX cross up over zero line.

44. TRUE RVI(TRVI)

True RVI of Ereemeev (2010) is adding volume information into RVI (see section 33) to confirm the price movement.

- $\text{TRVI}(1) =$

$$\frac{(\text{Close} - \text{Open})}{\text{High} - \text{Low}} \times \text{Volume}$$

- $\text{TRVI}(n) = n\text{-period SMA of TRVI}(1)$

- $\text{signal} = 4\text{-period SMA of TRVI}(1)$

- Strategy

- ★ Sell when TRVI crossing the signal line from above,
- ★ Buy when TRVI crossing the signal line from below.

45. True Strength Index(TSI)

TSI of Blau (1991) double smoothing the price to capture more filtered and stable data series with less noises.

- $PC = \text{Today's Close} - \text{Yesterday's Close}$
- First EMA = 25-period EMA of PC
- Second EMA = 13-period EMA of First EMA
- $ABS\ PC = |\text{Today's Close} - \text{Yesterday's Close}|$
- First Absolute EMA = 25-period EMA of ABS
- Second Absolute EMA = 13-period EMA of First Absolute EMA
- $TSI = 100 \times (\text{Second EMA} / \text{Second Absolute EMA})$

- Strategy
 - ★ TSI ranges -100 to +100.
 - ★ Sell when the TSI is above +25
 - ★ Buy when the TSI is below -25

46. Ultimate(ULTI)

the Ultimate Oscillator of Williams (1985) is a momentum oscillator designed to capture momentum across three different time frames.

This example is based on the default settings (7,14,28).

- Ultimate =
$$\frac{(4 \times \text{Average}7) + (2 \times \text{Average}14) + \text{Average}28}{(4+2+1)} \times 100$$
- $BP = \text{Close} - \text{Minimum}(\text{Low or Prior Close})$
- $TR = \text{Maximum}(\text{High or Prior Close}) - \text{Minimum}(\text{Low or Prior Close})$
 - * Average 7 =
$$\frac{(\text{7 period BP Sum})}{(\text{7 period TR Sum})}$$
 - * Average 14 =
$$\frac{(\text{14 period BP Sum})}{(\text{14 period TR Sum})}$$

* Average 28 =

$$\frac{(28 \text{ period BP Sum})}{(28 \text{ period TR Sum})}$$

- Strategy

- ★ The Ulitmate Oscillator is bound between 0 and 100.
- ★ sell when Ulitmate is over 70.
- ★ buy when Ulitmate is below 30.

47. Vortex Index(VI)

Developed by Botes (2010), the Vortex Indicator consists of two oscillators that capture positive and negative trend movement. This version of the Vortex Indicator plots the difference between the VI+ and VI- lines as a histogram that oscillates around the zero line.⁶

- Positive and negative trend movement
 - +VM = Current High less Prior Low (absolute value)
 - -VM = Current Low less Prior High (absolute value)
 - +VM14 = 14-period Sum of +VM
 - -VM14 = 14-period Sum of -VM
- True Range (TR) is the greatest of:
 - Current High less current Low
 - Current High less previous Close (absolute value)
 - Current Low less previous Close (absolute value)
 - TR14 = 14-period Sum of TR
- Normalize the positive and negative trend movements:
 - +VI14 = +VM14/TR14
 - -VI14 = -VM14/TR14
- Strategy
 - ★ sell when +VI < -VI
 - ★ buy when +VI > -VI.

⁶We sourced relevant functions from http://stockcharts.com/school/doku.php?id=chart_school:technical_indicators:vortex_indicator

48. Volatility Ratio(VR)

Volatility Ratio (VR) of Schwage (1997) is to identify current price ranges and possibility of the range breakouts. The indicator is calculated based on a current true price range and a previous true price range.

- Current True Range (CTR) = $\max(\text{today's (high-low)}, (\text{today's high} - \text{yesterday's close}), (\text{today's low} - \text{yesterday's close}))$
- Previous True Range (PTR) over n days = HIGH (=highest price over n days) - LOW (the lowest price over n days)
- Volatility Ratio(VR) = $\text{CTR}/\text{PTR}(n)$
- n=14 by default

If value of volatility ratio is greater than 0.5 it means the start of breakout (reversal) and if VR is greater than 2.0, it is regarded as wide movement and suggests the high change of reversal. VR generate trading signal together with Aroon(ARN) indicator.

- Strategy
 - ★ Sell if $\text{ARN}(t)=1$ & $\text{VR}(t)> 0.5$;
 - ★ Buy if $\text{ARN}(t)=-1$ & $\text{VR}(t)> 0.5$;

49. Wilder's Moving Average(WDMA)

Wilder (1978d) uses a variation of the standard Exponential Moving Average formula, which has a significant impact when choosing suitable time periods for his indicators.

- $\text{EMA} = \text{price today} * K + \text{EMA yesterday} * (1-K)$
where N = the number of periods,
 $K = 2 / (N+1)$
- Wilder MA = $\text{price today} * K + \text{EMA yesterday} (1-K)$
where $K = 1/N$
- Strategy
 - ★ Buy when the shorter term moving average crosses above the longer term moving average (golden cross).
 - ★ Sell when the shorter term moving average crosses below the longer term moving average (dead cross).

50. William's Percent R(WPR)

Williams (1967)'s WPR is a momentum indicator measuring overbought and oversold levels, similar to a stochastic oscillator. WPR compares a stock's close to the high-low range over a certain period of time, usually 14 days. It is used to determine market entry and exit points. The Williams %R produces values from 0 to -100, a reading over 80 usually indicates a stock is oversold, while readings below 20 suggests a stock is overbought. The indicator chart typically has lines drawn at both the -20 and -80 values as warning signals.

- $W\%R = \frac{\text{Highest High} - \text{Close}}{\text{Highest High} - \text{Lowest Low}} \times -100$

where Lowest Low is lowest low for the look-back period and Highest High is highest high for the look-back period %R is multiplied by -100 correct the inversion and move the decimal.

- **Strategy**

- ★ Values between -80 and -100 are interpreted as a strong oversold condition, or selling signal,
- ★ and between -20 and 0.0, as a strong overbought condition, or buying signal.

- **Strategy**

same as moving average strategy

51. Additional Five STW Rules

I recommend the summary prepared by (Sullivan et al., 1999, pp.1654–1657) for detailed explanations for following five classical rules.

- **Filter Rules (Filter)**
- **Simple Moving Averages(SMA)**
- **Support and Resistance(SAR)**
- **Channel Breakouts(CBO)**
- **On-Balance Volume(OBV)**

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