MACD-V

VOLATILITY NORMALISED MOMENTUM

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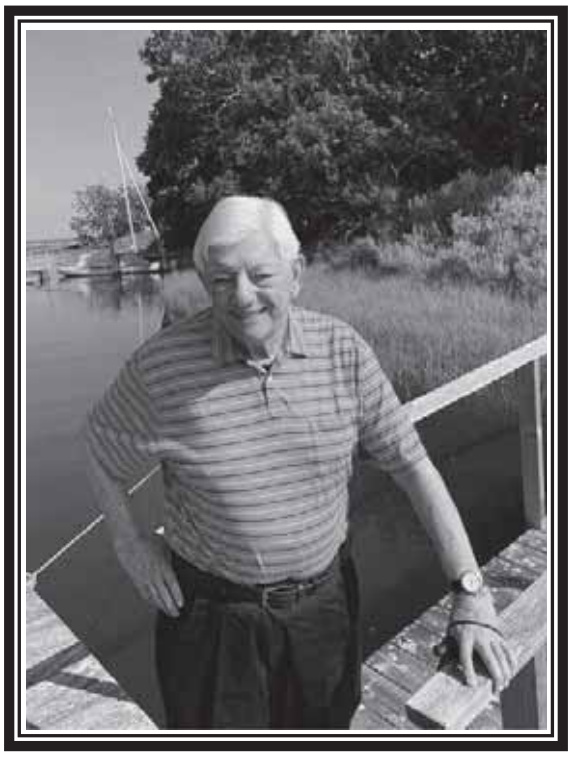
This research paper is dedicated to my wife, parents
and in memory of Gerald Appel
(June 2, 1933 – February 13, 2020)



1. INTRODUCTION: What & Why…

1.1 What is this topic about ?

This paper will focus on the study of momentum using a very popular technical analysis indicator, the Moving Average Convergence Divergence (MACD), created by one of the most respected analysts of our time - Gerald Appel.[1]

This paper is comprised of 6 parts.

In the first section we will focus on the MACD itself. We will do a brief description of its construction, the most elementary ways to use it and then a review of the five limitations it has. This is a section that is familiar territory to all technicians.

In the second section, we will show a widely known suggestion to deal with these limitations, that does improve one, but does not solve all of them.

In the third and fourth sections we will present our own solution, which remedies the shortcomings, while creating unique advantages (edges) that would not be possible to obtain via the classic MACD.

In the last two sections, we will use our framework to improve existing tools in TA literature and explore new techniques

1.2 Why does this topic matter to us ?

Most price-based momentum indicators fall into -roughly- two camps:

(i) *Range Bound Oscillators*

These operate within a finite range of values, usually 0 – 100 (eg. RSI, Stochastics, Williams %R, etc). They offer the advantage of having objectively defined momentum readings, while at the same time making these readings uniform across securities for cross market comparison purposes. On the other hand, the very fact that these tools can only obtain a limited range of values, presents problems during extended price trends, as their extreme readings (aka "overbought/overbought") remain at high (or low) levels for a prolonged period of time, thereby giving many false signals. In fact some analysts have created some counterintuitive techniques, based on this phenomenon, whereby "overbought" is a sign of future strength, and "oversold" is a sign of future weakness.[2] Oscillators are not trend

[1] Gerald Appel – "Technical Analysis: Power tools for active investors", p. 165 - 200
[2] Tom Demark - "The New Science of Technical Analysis", p. 89

friendly, and one could argue that these are not *truly* momentum measuring yardsticks, but range identification indicators. For example a 14 period stochastic oscillator states where you are, as a %, in a 14 period Donchian channel, and does not measure price momentum per se. Thus the terms "overbought, oversold" become a bit of a misnomer.

(ii) *Trend-following Indicators*
These measure price change over some period of time, and usually are boundless indicators (but not exclusively), as their readings can be increasing (or decreasing) along with price trends (eg. RoC, MACD, etc). Their very freedom makes it almost impossible to have objectively defined "overbought", "oversold" levels, or have meaningful momentum comparisons between different asset classes (eg. individual equites vs currencies)

Of course the aforementioned categorization of indicators is not a fully detailed taxonomy, but a rather broad distinction for definitional purposes…

Irrespective of which family (category) of momentum tool is used, it would appear that in Technical Analysis literature, there is certainly no shortage of indicators. One could even argue that there are more indicators than traders….

So, why attempt to build another tool ?

It is not the author's intention to simply design yet "another" indicator, that would provide approximately the same informational value as numerous ones already do so, thus resulting in a tool that exacerbates the already existent issue of indicator multicollinearity.

Our goal is to improve an existing tool (MACD), so that - by eliminating its shortcomings - we will be creating a **unique** type of hybrid "***boundless oscillator***", that opens the doors for several pattern recognition opportunities which would not be definable using the classic MACD.

We are big believers in creating new techniques rather than new tools, thus we will use the improved MACD to define a general Momentum Lifecycle RoadMap (framework), new entry & exit techniques, and versatile cross asset (intermarket) strategies, among other uses, that would not be achievable via the venerable MACD.

2. MACD: A measure of Momentum

2.1 Construction:

One of the available tools to define momentum, is the Moving Average Convergence Divergence (MACD) indicator. The MACD was created by Gerald Appel in the late 1970's. It is a trend-following momentum indicator that shows the relationship between two moving averages of prices.

The MACD is constructed in 4 steps :
1> Calculate a 12 bar Exponential Moving Average
2> Calculate a 26 bar Exponential Moving Average
3> MACD Line = 12 bar EMA – 26 bar EMA
4> Signal Line = 9 bar EMA of the MACD Line

Further to the MACD, Thomas Aspray in 1986 created the MACD Histogram, which is constructed as follows:
5> MACD Histogram = Signal Line – MACD Line

Thus in essence:
> The 12 & 26 EMA's are the 1st derivative of price
> The MACD Line is the 2nd derivative of price
> The Signal Line is the 3rd derivative of price
> The MACD-H is the 4th derivative of price.

The MACD is a versatile tool with many non-conventional uses, but it nevertheless has 5 key shortcomings. Three of them are regarding the MACD *values* themselves and two have to do with *signal line crossovers*. Let's see these in detail.

What is momentum ?

Momentum is closely tied to Physics, and is the rate (speed) that prices change (velocity = d/t, where d = distance, t = time)

Momentum in market prices is a direct challenge to the Efficient Market Hypothesis (EMH), as it implies that prices trend and are not randomly distributed, thus it is possible to outperform the broad market.

Momentum Strategies are broadly distinguished between (i) Time Series (absolute) Momentum - establish long (short) positions by determining the trend of each asset individually (e.g go long positive 12-month price return)

(ii) Cross Sectional (Relative) Momentum Strategies - ranking assets and going long top and shorting bottom performers.

2.2 LIMITATION 1 – The MACD across time

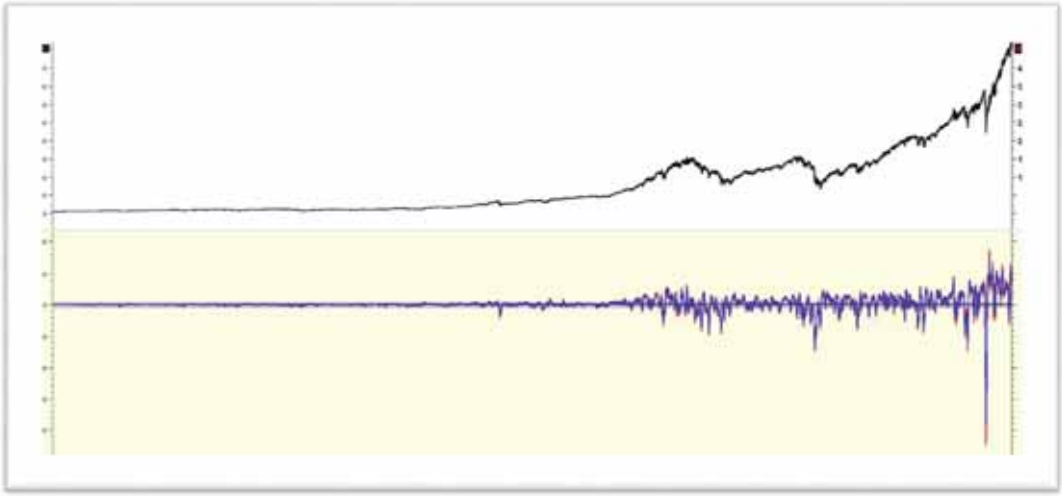
By way of design, the MACD is an "*absolute price indicator*", as it takes absolute price inputs (price MA's), and produces an output (spread of raw price MA's), without any kind of normalisation. This creates the following situation:
Although the MACD in 2020 has a bigger value than in 1957, that does not imply that the market has more momentum. That was simply a function of the underlying security having a larger *absolute* value when it was calculated in the second instance (2020) than the first (1978). The problem is exacerbated the further one goes back in time.

TABLE 1: **MACD Ranges**

S&P 500	1957- 1971	2019 - 2021
MACD Maximum	1.56	86.31
MACD Minimum	-3.3	-225.40

The implication of this is that MACD (and MACD Histogram) readings are not comparable across time for the same security, especially if the market in question has had substantial price appreciation or depreciation.

CHART 1: S&P 500 & MACD (1957 - 2021)



The MACD is not time stable (comparable across time)

2.3 LIMITATION 2– The MACD across markets

The second limitation of the MACD and MACD Histogram are that they are not comparable across securities. Any differences in the indicator readings, are attributable to comparing securities that have different absolute values, rather than depicting varying levels of momentum strength.

For example, the MACD for the S&P 500 at the time of writing is 65 and for the Euro currency is -0.0070.

Again, this does not mean that the S&P has more momentum than the Euro, but its bigger MACD reading is a function of the bigger absolute price of the underlying security.

Cross market momentum comparisons are not possible, as it would be the case with -say- using a (0-100) scaled indicator. The RSI for the S&P and Euro in this instance would be directly comparable, but not for the MACD.

The MACD is not comparable across securities

2.4 LIMITATION 3 – MACD Momentum LifeCycle

The MACD is an improved version of a moving average crossover system. When a market is trending in a particular direction, the shorter term EMA responds quicker to price than the longer term EMA, moving away from (closer to) it, and consequently their difference / spread increases (decreases). Thus the MACD indicates the *direction of momentum* (bullish if above the signal line or bearish if below the signal line). When this is viewed against the prevailing trend, it highlights momentum *acceleration* or *deceleration,* and the beginning and end of this process can be identified via signal line cross overs. Moreover the further away the MACD is from the equilibrium line, the stronger momentum is (please refer to Chart #4, bottom panel).

However since MACD values are not comparable across time and across securities, it is impossible to standardize the *intensity (strength)* of (MACD-defined) momentum, into an objectively and quantitatively defined framework, where "High (fast) vs Low (slow)" and/or "overbought vs oversold" levels would exist.

The MACD momentum readings cannot be objectively scaled

2.5 LIMITATION 4– Signal line accuracy

When directional strength is low, the MACD will be near the equilibrium line and/or close to the signal line. As such, signal line crossovers will be frequent, giving many (false) signals. This phenomenon is one of the "Achille's heels" of trend-following system behavior in low momentum environments in general.
The MACD is no exception.

In chart #5, this is easily observed during the May to August 2016 period, where 6 loss producing crossovers signals occurred in a range bound, low momentum environment. As a consequence of limitation #3 (lack of momentum level scaling), these cannot be avoided by way of -say- rejecting the signals that occur within an objectively and quantitatively defined low momentum environment.

CHART 2: MACD behavior in low momentum - FTSE 100 (February – August 2014)

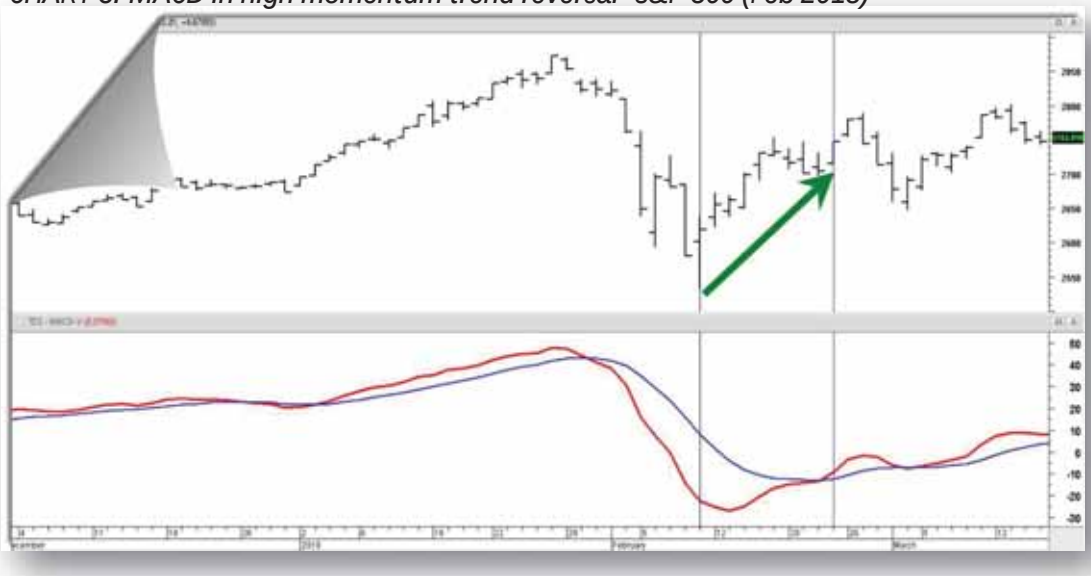
MACD signal line crossovers are unreliable in low momentum environments

2.6 LIMITATION 5– Signal line timing

When momentum is high, MACD signal accuracy is (one) of its main strengths.
However, when the market is pushing higher (lower) with too much force - to the point where the MACD line has built significant distance from the signal line- but then changes its trend to the downside (upside) *abruptly*, it takes some time before the lagging MA's catchup to the new data (raw price), which translates into a directionally correct (accurate), but late (from a timing point of view) signal.

This phenomenon is more often observed in fast bearish trends, which then proceed to form a V-shaped bottom (when a counter-trend bounce occurs). Given the trend-following nature of the MACD, it is guaranteed that it will signal the turn, but it will produce a signal line cross over that maybe some distance away from the actual price bottom itself.
For example the S&P 500 bottomed at 2532.69 on the 9th of February2018, but the MACD signaled the turn at 2747.30 on the 23rd of February, which means it was "late" by 8.47%!!

CHART 3: MACD in high momentum trend reversal- S&P 500 (Feb 2018)



Again as a direct consequence of limitation #3 (and the lagging nature of the signal line), it is impossible to improve signal timing by first identifying a high momentum environment.

MACD Crossover signals are late in high momentum trend reversals

3. PPO: An improvement, but not a solution..

3.1 Construction

A solution to deal with Limitations #1 & #2, is to normalize the readings of the MACD, so as to become comparable across time & securities.

A well-known suggestion is to place the raw MA spread as a function of the absolute price of the underlying security, so that momentum (MACD) is placed in context. This is then multiplied by 100, to obtain the output on a percent (%) basis.

Thus the formula for the MACD Line now becomes:

[(12 period EMA - 26 period EMA) / (close)] x 100
Or
[(12 period EMA - 26 period EMA) / (26 period EMA)] x 100

This resulting indicator is commonly known as the PPO (percent price oscillator).

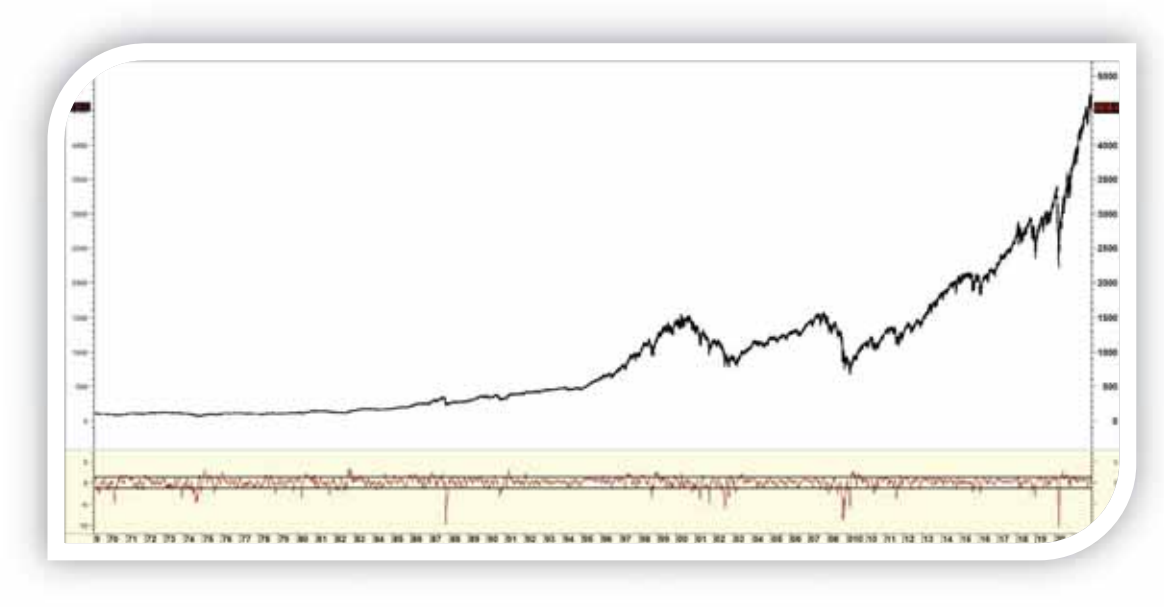
Let's see what is the effect of the PPO on the MACD limitations.

CHART 4: MACD & PPO - FTSE 100 (February to October 2016)

3.2 Limitation 1 – The PPO across time

Since the PPO readings are expressed on a percent basis, that means that they should be comparable across time for the same security on a "apples to apples" basis. Let's confirm this by revisiting the S&P 500

CHART 5: S&P 500 & PPO (1970 - 2021)



Although specific stationarity tests could be employed to prove the point, we can easily observe that the range of fluctuation (variable's dispersion around zero) is more stable, as the MA spread is normalized on a percentage basis. In fact if we set lower and upper boundaries in such a way that it contains 95% of the observations, since the 3rd of Feb 1975, the PPO has oscillated within 2% and -2%.

TABLE 2: **PPO Ranges (S&P 500)**

PPO Ranges	> 2%	2% to -2%	< - 2%
% of time	2.2%	94.3%	3.5%

The PPO retains all of the advantages that the MACD has, but also adds reading uniformity across time for the same security. It would appear that Limitation #1 is solved.

PPO readings are time stable (comparable across time)

3.3 Limitation 2– The PPO across markets

One would be tempted to assume that since the PPO is expressed on a percent (%) basis and it is comparable across time, then cross market comparisons would be also be feasible. However, upon closer inspection, it would appear that the PPO fails the test. Let's see this via an example:

CHART 6: German Bund and PPO (1991 - 2021)

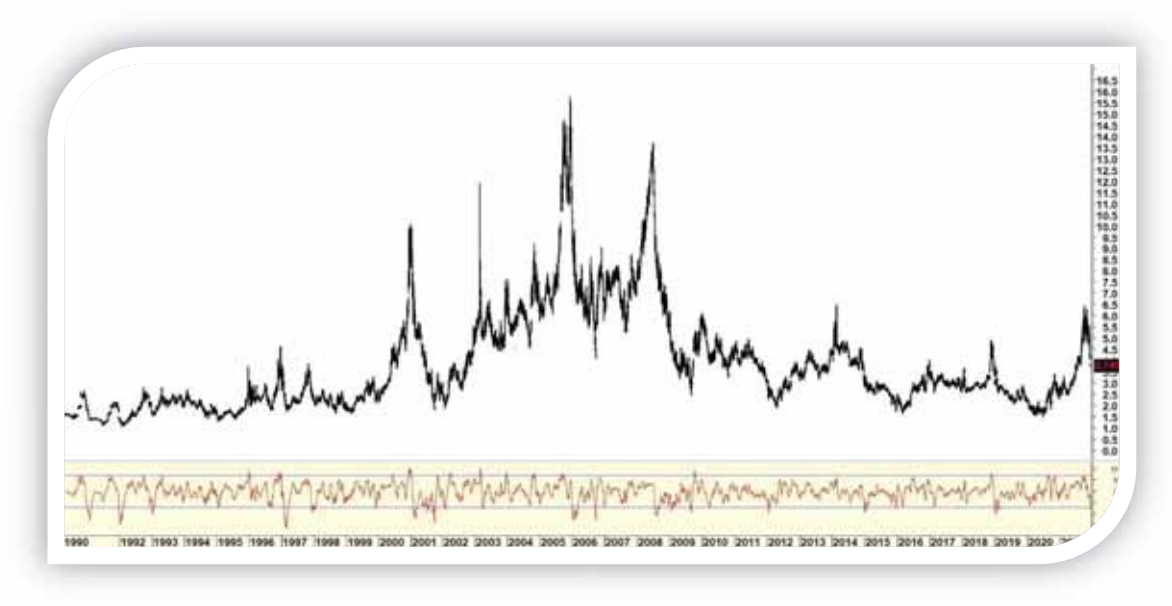
Using the aforementioned upper/lower boundaries used for the S&P 500, it would appear that the Bund has never traded above the upper level of 2% and never below the lower -2% level, in its entire history. It is evident that there is considerable variation in the data and in order to see where 95% of the PPO values for the Bund reside we would need to establish different levels.

TABLE 3: **PPO Ranges (German Bund futures)**

PPO Ranges	> 0.7%	0.7% to -0.7%	< - 0.7%
% of time	3.5%	93.6%	2.9%

Thus a PPO reading higher than 0.5% for the Bund would constitute a strongly trending environment. The same reading for the S&P would be indicative of an almost range bound market. What constitutes "high momentum" in one market, may very well be classified as "low momentum" in another……

CHART 7: Natural Gas futures and PPO (1990 - 2021)



The aforementioned differences become more pronounced as we examine a very volatile market such as Natural Gas futures. Chart 7 depicts the PPO ranging most of the time (94.2%) from +7% to -7%.

TABLE 4: **PPO Ranges (across markets)**

NG - PPO Ranges	> 7%	7% to -7%	< - 7%
% of time	1.4%	94.2%	4.4%
SP 500 - PPO Ranges	> 2%	2% to -2%	< - 2%
% of time	2.2%	94.3%	3.5%
BUND – PPO Ranges	> 0.7%	0.7% to -0.7%	< - 0.7%
% of time	3.5%	93.6%	2.9%

Thus it appears that the PPO is not a **truly** normalized momentum comparison tool for cross market purposes, as it fails to provide uniform benchmarks levels due to fact that markets may have significantly different volatility structures.

The PPO is not comparable across securities

3.4 Limitation 3 – PPO Momentum Framework

Since the PPO cannot be standardized both across time AND securities, it is then not possible to deal with momentum level definition in a uniform framework.

It would be perhaps feasible on a - *per individual market basis* - to create levels where historically each market in question is deemed as "overstretched" or with adequate levels of trend strength, but this would not be practical as it would require massive amounts of optimization for an almost limitless universe of securities and the findings for each market would not be transferable to another.

3.5 Limitations 4, 5 – PPO Signal Line accuracy & Timing

Consequently, the lack of a uniform "high/low" momentum definitions, renders Limitations #4 & #5 unsolved under the PPO as well, as cross over signal filtering is not feasible.

The PPO improves some,
but not all of the MACD shortcomings

4. MACD-V: Volatility Normalised Momentum

4.1 Construction

Since "normalization by price" results in cross market momentum valuation discrepancies due to differences in volatility, then it would be preferable to *normalize by volatility itself*.

As the tool for the measurement of volatility, we will be using Welles Wilder's Average True Range (ATR)

Thus the MACD line formula now becomes:

[(12 bar EMA - 26 bar EMA) / ATR(26)] * 100

The output of the indicator is
the amount of momentum a security has,
that is in excess of its average volatility,
expressed as a percentage.
We are measuring directional strength,
"purified" from volatility fluctuations

In order to distinguish the new indicator from the classic MACD, I will name it by adding a "V" at the end of the original name ("MACD-V") and refrain from creating a completely new name altogether, so as to honour the original inventor.

What is ATR ?

Average true range (ATR) is a technical analysis volatility indicator originally developed by J. Welles Wilder, Jr. for commodities.

The true range indicator is taken as the greatest of the following: current high less the current low; the absolute value of the current high less the previous close; and the absolute value of the current low less the previous close.

The indicator does not provide an indication of price trend, simply the degree of price fluctuation.

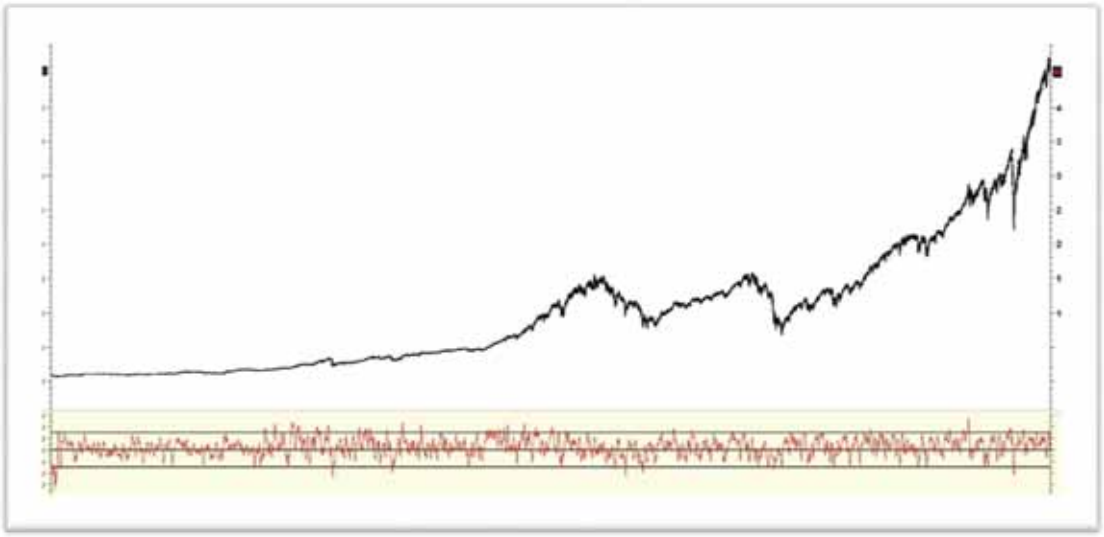
The average true range is an N-period smoothed moving average (SMMA) of the true range values.

Let's examine now, how MACD-V measures against the five shortcomings of the classic MACD.

4.2 The MACD-V across time

We will be firstly checking how MACD-V behaves across time for the S&P 500.

CHART 8: S&P 500 and the MACD-V (1975 - 2021)



It is easily observable that MACD-V fluctuates within a finite range of a values around its equilibrium line (similar to the PPO's behaviour). Any indicator reading discrepancies across time have been eliminated, - again - due to normalization.

If we try to find the range where 95% of the data fluctuate, and define the rest as "extremes", then since February 1975, for the S&P 500 the MACDv oscillates between 150 and -150.

TABLE 5: **MACD-V Ranges (S&P 500)**

MACDv Ranges	> 150	150 to -150	< - 150
% of time	4.4%	95%	0.6%

MACD-V readings are time stable (comparable across time).

4.3 The MACD-V across markets

Will the MACD-V succeed where the PPO failed ?
Does the range of 150 to -150, also hold 95% of the MACD-V values for other markets ?
Below we feature the charts of the German Bund and Natural Gas futures and the levels.

The range of fluctuations for the two MACD-V's is considerably more uniform than when comparing the equivalent ones for the two PPO's. They essentially oscillate the same amount around the equilibrium line, as differences in volatility have been eliminated. Slight & sporadic extremes are strictly attributable to strong momentum (prolonged moves in a particular direction), since the MACD -at its core- is a boundless indicator.

CHART 9: German Bund and the MACD-V (1990 - 2021)

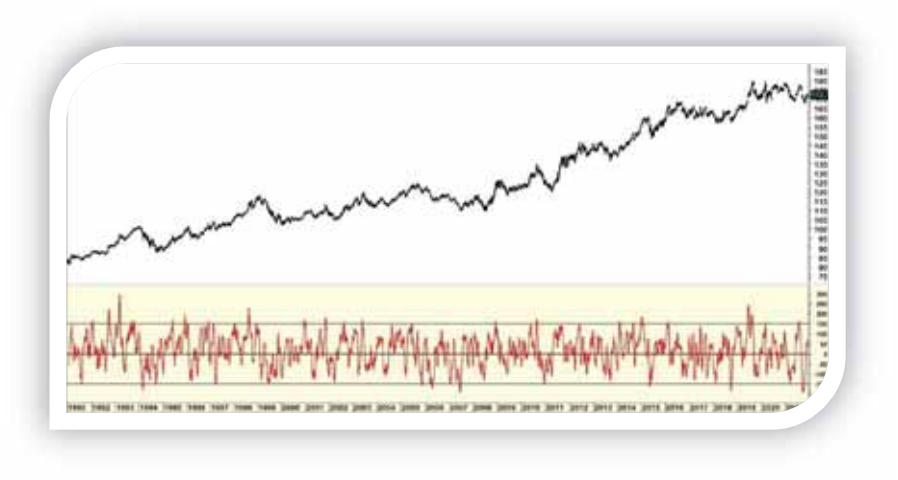


CHART 10: Natural gas and the MACD-V (1990 - 2021)

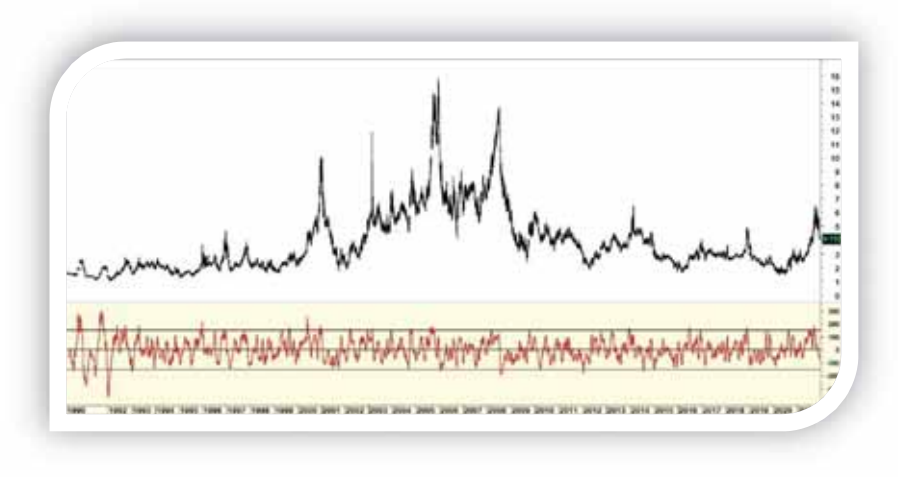


TABLE 6: MACD-V Extreme Ranges (S&P 500, 1975 – 2021)

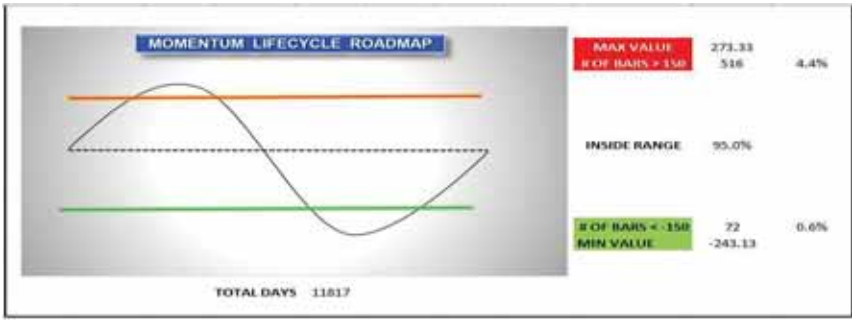
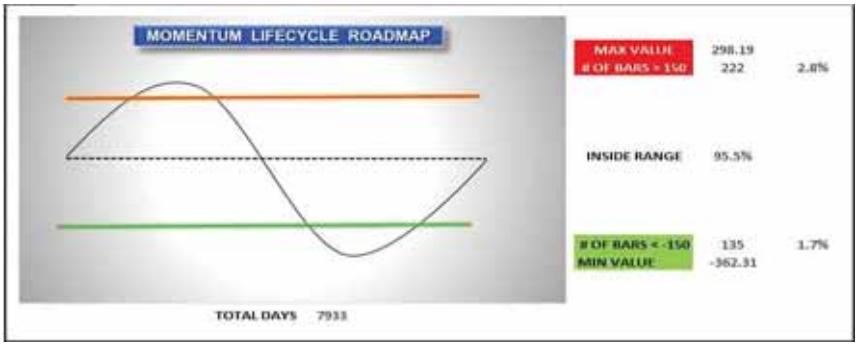


TABLE 7: MACD-V Extreme Ranges (Bund, 1991 – 2021)

TABLE 8: MACD-V Extreme Ranges (Natural Gas, 1990 – 2021)



All 3 markets share similar exhaustion levels (when momentum is 1.5 times its volatility), despite the fact that they have completely different absolute volatilities in general. In addition the Min and Max values differ for each market since the MACD-V is a boundless indicator, and not constrained by a –say 0 to 100- scale.

MACD-V values are comparable across securities.

4.4.1 MACD-V Ranges

Since MACD-V readings are comparable across time and markets, that means that we can create a Momentum Lifecycle RoadMap, that will rank both momentum's direction ("bullish" or "bearish"), and strength as well ("low" vs "high" momentum, and "overbought" vs "oversold"). However the MACD-V since is an unbounded indicator it will have the added advantage that it will not be limited by the scaling boundaries (0-100) of conventional oscillators, and thus will avoid the problem of "pegging" at high levels.

OBOS (extreme) Momentum: When the market has advanced too far, too fast, the EMA spread will have reached a point where historically it becomes unstainable to progress any further in the short to intermediate term. This should be around 5% of the data, and is located when momentum is 1.5 or -1.5 times its volatility.

Strong (High) Momentum: When the market begins to gain some directional strength, then distance between the 2 EMA's (12 & 26) begins to increase, as the shorter EMA is being driven away from the longer one, and thus the MACD-V would move significantly away from the equilibrium line. This should be around 35%-40% of the data, and is located when momentum is over +0.5 or -0.5 times its volatility.

Weak (Low) Momentum Range: When there is little directional conviction (low momentum), the MA's (12 & 26) should be relatively close, and thus their spread (MACD-V) should be close to zero, the equilibrium line. This should be around 45% - 50% of the data, and is when momentum is between 0.5 or -0.5 times its volatility

Based on this framework, we can test the objective momentum levels that would hold across securities, using the MACD-V.

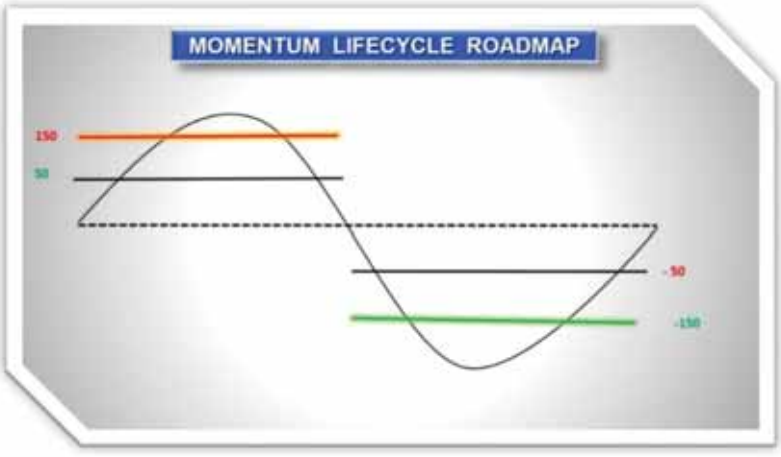
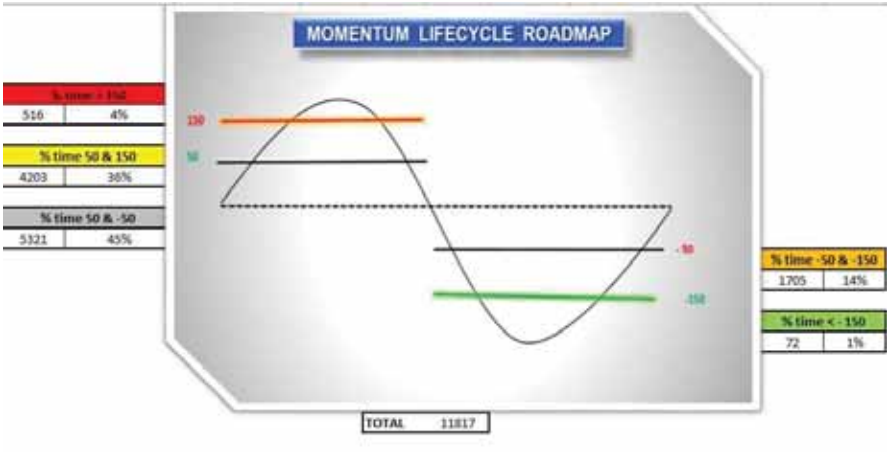
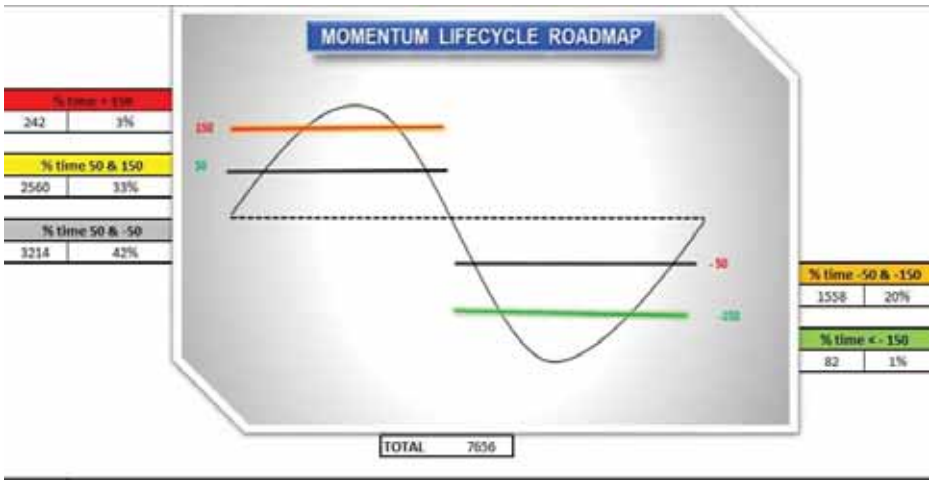


TABLE 9: MACD-V Ranges (S& 500, 1975 – 2021)



Using data since 1975 (11,817 days) for the S&P 500, we observe that the index has been above the overbought benchmark (>150) around 4% of the time and below the oversold level (-150) around -1% of the time, reflecting the "upward drift" (bullish bias) of the market. The time spent between the "neutral zone" that is close to the equilibrium line (50 to -50) is around 45% of the time. Finally, time spent on the strong momentum zone (50<x<150 & -150<x<-50) is respectively 36% and 14%, reflecting the bullish bias for the S&P 500.

TABLE 10: MACD-V Ranges (Bund, 1991 – 2021)



Using data on the German Bund (a fixed income market with different volatility characteristics) we observe that the data that fall into the aforementioned brackets are roughly the same with the S&P 500.

TABLE 11: MACD-V Ranges (Natural gas, 1991 – 2021)

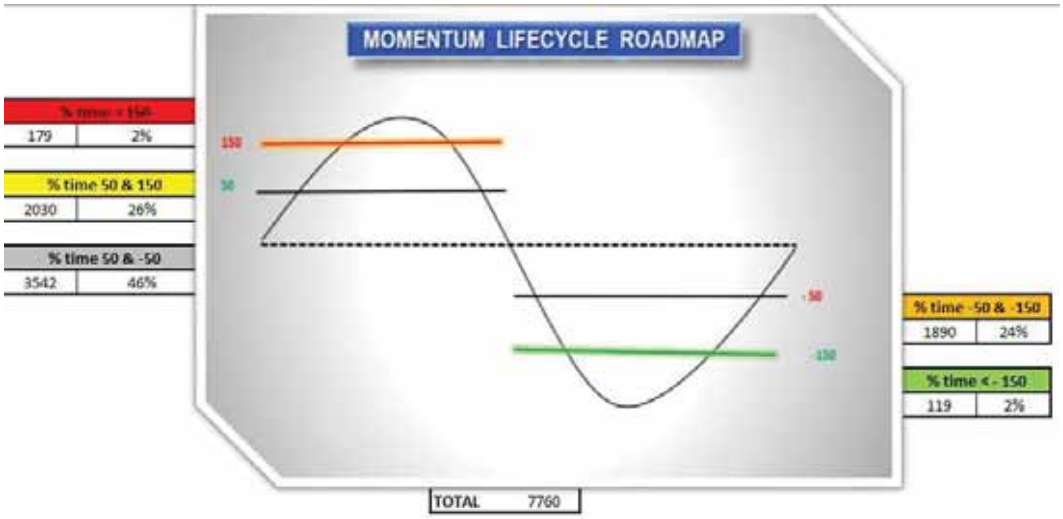


Table #11 reflects the data for Natural gas. A market with completely different trend and volatility DNA. However the data support that again we have achieved a unified definition of "fast vs slow vs overbought/oversold" without having presented boundaries to the values that the indicators can have (eg. RSI, etc) .
The extreme levels (>150 & <-150) capture roughly 5% of the data in the market again, while the "fast" range (50-150 & -50 to -150) is around 50% of the data.

Based on this framework, we can test the objective momentum levels under different Trend Regimes and across markets.

4.4.2 MACD-V Ranges and Trend Regime Filter v.1

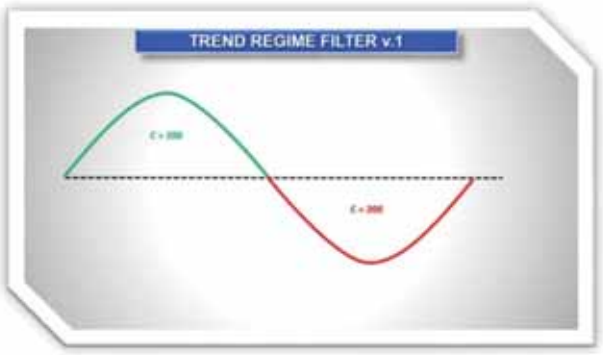


TABLE 12: MACD-V Ranges and Trend Regime Filter v.1 (S&P 500, 1975 – 2021)

% C > 200 EMA	9006	76%	of total time
% MACD-V > 150	516	100%	of total occurences
% MACD-V 150 > x > 50	4021	45%	of the total time in this Stage
% MACD-V 50 > x > -50	4007	44%	of the total time in this Stage
% MACD-V -50 > x > -150	462	5%	of the total time in this Stage
% MACD-V < -150	0	0%	of total occurences
% MACD-V x > -100	8951	99.4%	of the total time in this Stage

% C < 200 EMA	2811	24%	of total time
% MACD-V > 150	0	0%	of total occurences
% MACD-V 150 > x > 50	182	6%	of the total time in this Stage
% MACD-V 50 > x > -50	1314	47%	of the total time in this Stage
% MACD-V -50 > x > -150	1243	44%	of the total time in this Stage
% MACD-V < -150	72	100%	of total occurences
% MACD-V x < 100	2806	99.8%	of the total time in this Stage

If we were to dissect the MACD-V data by a basic trend rule (above or below a 200 EMA), we would see that the S&P 500 stands above the EMA 76% of the time, (i.e having an "upward drift", bullish bias) and 24% below. Let's examine how the MACD-V behaves in each of these conditions. A similar concept (observation) has been suggested by Andrew Cardwell (RSI range rules). Thus I will keep the same term (range rules) to study the behavior of the MACD-V.

All of the occurrences (100%) of the MACD-V reaching the overbought range have been recorded in the Bullish Stage, and it has never reached the oversold level while over the 200 EMA. While in the Bullish Stage, **99.4%** of market action is contained with readings of the MACD-V > -100. If we observe the data more closely, 5% of the data on the downside are captured within the -50 to -150 range, thus becoming the "new" oversold level while the market stands above the 200 EMA. As long as the market stays above the 200 EMA, we would not expect it to fall below the – 100 range of the MACD-V.

Analogous behavior is observed on the Bearish Stage (< 200 EMA) as there are zero occurrences of the indicator reaching the overbought range (>150), and 100% readings of the oversold range. While in the Bearish Stage, **99.8%** of market action is contained with readings of the MACD-V < 100, which is a quite similar number to the Bulls (99.4%). Thus while the market is bearish (< 200 EMA) we would expect a maximum stretch, until the MACD-V reaches the 100 level (Bear Market Rally)

TABLE 13: MACD-V Ranges and Trend Regime Filter v.1 (Bund, 1991 – 2021)

% C > 200 EMA	5156	67%	of total time
% MACD-V > 150	242	100%	of total occurences
% MACD-V 150 > x > 50	2384	46%	of the total time in this Stage
% MACD-V 50 > x > -50	2151	42%	of the total time in this Stage
% MACD-V -50 > x > -150	379	7%	of the total time in this Stage
% MACD-V < -150	0	0%	of total occurences
% MACD-V x >- 100	5097	98.9%	of the total time in this Stage

% C < 200 EMA	2500	33%	of total time
% MACD-V > 150	0	0%	of total occurences
% MACD-V 150 > x > 50	176	7%	of the total time in this Stage
% MACD-V 50 > x > -50	1063	43%	of the total time in this Stage
% MACD-V -50 > x > -150	1179	47%	of the total time in this Stage
% MACD-V < -150	82	100%	of total occurences
% MACD-V x < 100	2496	99.8%	of the total time in this Stage

Table #13 displays the data for the Bund. A market with different trend characteristics (i.e. > 200 EMA 67% of the time vs 76% of the time for the S&P 500) and certainly different volatility DNA. However the same observations (range rules) can be made.

While the market is in the Bullish Stage (> 200 EMA) it has 100% of the occurrences of overbought readings (>150), 0% of the oversold readings (<-150), and **98.9%** of the data are captured by the >-100 level. Thus –similarly to the S&P 500 – any Bull Market decline can be expected to stop at the -100 MACD-V level (if the market is to stay above the 200 EMA).

Symmetrically for the Bearish Stage, it has 100% of the occurrences of oversold readings (<-150), 0% of the overbought readings (>150), and **99.8%** of the data are captured by the <100 level. Thus –similarly to the S&P 500 – any Bear Market rally can be reasonably expected to stop at the 100 MACD-V level (if the market is to stay below the 200 EMA).

CHART 11: Bund and extreme MACD-V readings (1994 - 2021)

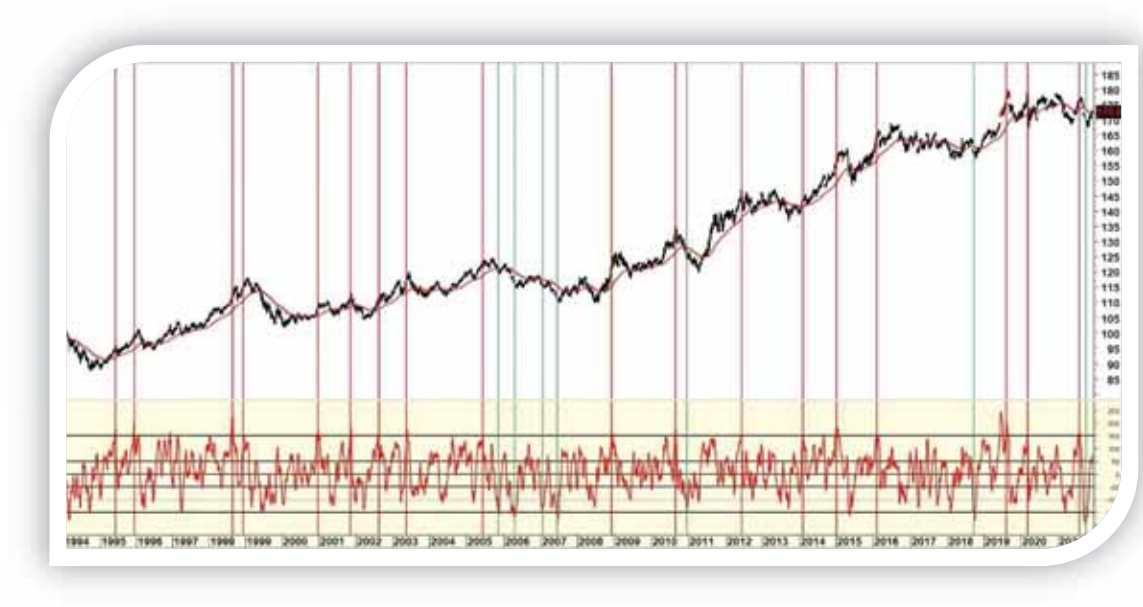


TABLE 14: MACD-V Ranges and Trend Regime Filter v.1 (Natural Gas, 1991 – 2021)

% C > 200 EMA	3878	50%	of total time
% MACD-V > 150	179	100%	of total occurences
% MACD-V 150 > x > 50	1835	47%	of the total time in this Stage
% MACD-V 50 > x > -50	1679	43%	of the total time in this Stage
% MACD-V -50 > x > -150	185	5%	of the total time in this Stage
% MACD-V < -150	0	0%	of total occurences
% MACD-V x > -100	3869	99.8%	of the total time in this Stage

% C < 200 EMA	3882	50%	of total time
% MACD-V > 150	0	0%	of total occurences
% MACD-V 150 > x > 50	195	5%	of the total time in this Stage
% MACD-V 50 > x > -50	1863	48%	of the total time in this Stage
% MACD-V -50 > x > -150	1705	44%	of the total time in this Stage
% MACD-V < -150	119	100%	of total occurences
% MACD-V x < 100	3861	99.5%	of the total time in this Stage

The data for NG are even more compelling, as this market has completely different trend characteristics (spends an equal amount of time in Bullish/Bearish Stages, each one is 50% of the data) and is considerably more volatile than the aforementioned ones. However the exact same observations (range rules) can be made.

While the market is in the Bullish Stage (> 200 EMA) it has 100% of the occurrences of overbought readings (>150), 0% of the oversold readings (<-150), and **99.8%** of the data are captured by the >-100 level. Thus –similarly to the S&P 500 – any Bull Market decline can be expected to stop at the -100 MACD-V level (if the market is to stay above the 200 EMA).
Symmetrically for the Bearish Stage, it has 100% of the occurrences of oversold readings (<-150), 0% of the overbought readings (>150), and **99.5%** of the data are captured by the < 100 level. Thus –similarly to the S&P 500 – any Bear Market Rally can be reasonably expected to stop at the 100 MACD-V level (if the market is to stay below the 200 EMA).

CHART 12: Natural gas and the Bear Market Rallies (2014 - 2016)

4.4.3 MACD-V Ranges and Trend Regime Filter v.1 & Swing Filters

Another way to help study the data even further would be to create a swing line, as an additional price filter and then observe where market tops & bottoms occur.

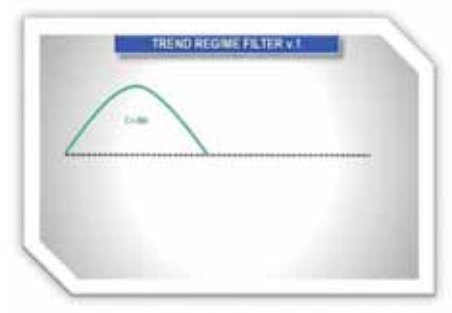
For the S&P 500, we will use a 3% swing line. Our personal preference for this type of filtering work is using swing based on ATR (not %'s), but for this study we will use percentage calculations, to keep things relatively simpler.

Table #15 records where these swing highs/lows are placed within the Trend Regime Filter v.1 . Since 1975 the S&P 500 has made 651 swings that had a magnitude of 3% or more. 233 swing highs were recorded in the Bullish Stage and 93 in the Bearish Stage.

TABLE 15: 3% Swing line Stats per Stage (S&P 500, 1975 – 2021)

We will provide more context to the total number of highs and lows per Stage, by relating them to the MACD-V

TABLE 16: 3% Swing line Stats per MACD-V Ranges (S&P 500, 1975 – 2021)



# of 3% SWING HIGHS	233	71.5%	of total occurences	# of 3% SWING LOWS	132	40.6%	of total occurences
% MACD-V > 150	19	8.2%	of total occurences	% MACD-V > 150	0	0.0%	of total occurences
% MACD-V 150 > x > 50	135	57.9%	of the total time in this Stage	% MACD-V 150 > x > 50	22	16.7%	of the total time in this Stage
% MACD-V 50 > x > -50	72	30.9%	of the total time in this Stage	% MACD-V 50 > x > -50	95	72.0%	of the total time in this Stage
% MACD-V -50 > x > -150	7	3.0%	of the total time in this Stage	% MACD-V -50 > x > -150	15	11.4%	of the total time in this Stage
% MACD-V < -150	0	0.0%	of total occurences	% MACD-V < -150	0	0.0%	of total occurences
% MACD-V x >- 100	231	99.1%	of the total time in this Stage	% MACD-V x >- 100	129	97.7%	of the total time in this Stage

Table #16 sheds more light. When the market is in the Bullish Stage, almost **60%** of swing highs occur in the "Strong Momentum" Range (50 to 150) and almost all (**99.1%**) above the -100 range of the MACD-V. Similarly **72%** of swing lows in the Bullish Stage occur in the weak momentum range (50 to -50), while almost all (**99.7%**) are above the -100 level for the MACD-V. This confirms the findings of tables #11 – #13, that should the market stay above the 200 EMA, then the "maximum" decline it can have should be around -100 of the MACD-V

TABLE 17: 3% Swing line Stats per MACD-V Ranges (S&P 500, 1975 – 2021)

# of 3% SWING HIGHS	93	28.5%	of total occurences	# of 3% SWING LOWS	193	59.4%	of total occurences
% MACD-V > 150	0	0.0%	of total occurences	% MACD-V > 150	0	0.0%	of total occurences
% MACD-V 150 > x > 50	10	10.8%	of the total time in this Stage	% MACD-V 150 > x > 50	5	2.6%	of the total time in this Stage
% MACD-V 50 > x > -50	39	41.9%	of the total time in this Stage	% MACD-V 50 > x > -50	58	30.1%	of the total time in this Stage
% MACD-V -50 > x > -150	38	40.9%	of the total time in this Stage	% MACD-V -50 > x > -150	116	60.1%	of the total time in this Stage
% MACD-V < -150	6	6.5%	of total occurences	% MACD-V < -150	14	7.3%	of total occurences
% MACD-V x < 100	92	98.9%	of the total time in this Stage	% MACD-V x < 100	193	100.0%	of the total time in this Stage

Table #16 shows the data for the Bearish Stage, and they are analogous to the Bulls

TABLE 18: Trend Regime Filter v.1, Swing line(1%) & MACD-V Stats (Bund, 1991 – 2021)

% C > 200 EMA	5156	67.3%	of total time
% MACD-V > 150	242	**100.0%**	of total occurences
% MACD-V 150 > x > 50	2384	46.2%	of the total time in this Stage
% MACD-V 50 > x > -50	2151	41.7%	of the total time in this Stage
% MACD-V -50 > x > -150	379	**7.4%**	of the total time in this Stage
% MACD-V < -150	0	**0.0%**	of total occurences
% MACD-V x >- 100	5097	**98.9%**	of the total time in this Stage

# of 3% SWING HIGHS	168	82.4%	of total occurences
% MACD-V > 150	17	10.1%	of total occurences
% MACD-V 150 > x > 50	94	56.0%	of the total time in this Stage
% MACD-V 50 > x > -50	46	27.4%	of the total time in this Stage
% MACD-V -50 > x > -150	11	6.5%	of the total time in this Stage
% MACD-V < -150	0	0.0%	of total occurences
% MACD-V x >- 100	167	99.4%	of the total time in this Stage

# of 3% SWING LOWS	92	45.3%	of total occurences
% MACD-V > 150	1	1.1%	of total occurences
% MACD-V 150 > x > 50	23	25.0%	of the total time in this Stage
% MACD-V 50 > x > -50	52	**56.5%**	**of the total time in this Stage**
% MACD-V -50 > x > -150	16	17.4%	of the total time in this Stage
% MACD-V < -150	0	0.0%	of total occurences
% MACD-V x > -100	90	97.8%	of the total time in this Stage

% C < 200 EMA	2500	32.7%	of total time
% MACD-V > 150	0	**0.0%**	of total occurences
% MACD-V 150 > x > 50	176	7.0%	of the total time in this Stage
% MACD-V 50 > x > -50	1063	42.5%	of the total time in this Stage
% MACD-V -50 > x > -150	1179	**47.2%**	of the total time in this Stage
% MACD-V < -150	82	**100.0%**	of total occurences
% MACD-V x < 100	2496	**99.8%**	of the total time in this Stage

# of 3% SWING HIGHS	36	17.6%	of total occurences
% MACD-V > 150	0	0.0%	of total occurences
% MACD-V 150 > x > 50	4	11.1%	of the total time in this Stage
% MACD-V 50 > x > -50	19	52.8%	of the total time in this Stage
% MACD-V -50 > x > -150	13	36.1%	of the total time in this Stage
% MACD-V < -150	0	0.0%	of total occurences
% MACD-V x < 100	35	97.2%	of the total time in this Stage

# of 3% SWING LOWS	111	55%	of total occurences
% MACD-V > 150	0	0%	of total occurences
% MACD-V 150 > x > 50	2	2%	of the total time in this Stage
% MACD-V 50 > x > -50	34	31%	of the total time in this Stage
% MACD-V -50 > x > -150	69	62%	of the total time in this Stage
% MACD-V < -150	6	5%	of total occurences
% MACD-V x < 100	111	100%	of the total time in this Stage

In order to study the Bund, we will use a 1% swing line, since the volatility for fixed income markets is considerably less than for their equity counterparts. However the results are very similar to the ones presented for the S&P 500. The range rules for one market are applicable across other markets as well.

TABLE 19: Trend Regime Filter v.1, Swing line(5%) & MACD-V Stats (NG, 1991 – 2021)

% C > 200 EMA	1878	50%	of total time

% MACD-V > 150	179	100%	of total occurences
% MACD-V 150 > x > 50	1835	47%	of the total time in this Stage
% MACD-V 50 > x > -50	1679	43%	of the total time in this Stage
% MACD-V -50 > x > -150	185	5%	of the total time in this Stage
% MACD-V < -150	0	0%	of total occurences
% MACD-V x >- 100	3869	99.8%	of the total time in this Stage

# of 5% SWING HIGHS	281	61%	of total occurences	# of 5% SWING LOWS	160	35%	of total occurences
% MACD-V > 150	28	10%	of total occurences	% MACD-V > 150	7	4%	of total occurences
% MACD-V 150 > x > 50	147	52%	of the total time in this Stage	% MACD-V 150 > x > 50	76	48%	of the total time in this Stage
% MACD-V 50 > x > -50	94	33%	of the total time in this Stage	% MACD-V 50 > x > -50	66	41%	of the total time in this Stage
% MACD-V -50 > x > -150	12	4%	of the total time in this Stage	% MACD-V -50 > x > -150	11	7%	of the total time in this Stage
% MACD-V < -150	0	0%	of total occurences	% MACD-V < -150	0	0%	of total occurences
% MACD-V x >- 100	281	100%	of the total time in this Stage	% MACD-V x >- 100	160	100%	of the total time in this Stage

% C < 200 EMA	1882	50.0%	of total time

% MACD-V > 150	0	0.0%	of total occurences
% MACD-V 150 > x > 50	195	5.0%	of the total time in this Stage
% MACD-V 50 > x > -50	1863	48.0%	of the total time in this Stage
% MACD-V -50 > x > -150	1705	43.9%	of the total time in this Stage
% MACD-V < -150	119	100.0%	of total occurences
% MACD-V x < 100	3861	99.5%	of the total time in this Stage

# of 3% SWING HIGHS	179	38.9%	of total occurences	# of 3% SWING LOWS	301.0	65%	of total occurences
% MACD-V > 150	0	0.0%	of total occurences	% MACD-V > 150	0.0	0%	of total occurences
% MACD-V 150 > x > 50	11	6.1%	of the total time in this Stage	% MACD-V 150 > x > 50	13.0	4%	of the total time in this Stage
% MACD-V 50 > x > -50	95	53.1%	of the total time in this Stage	% MACD-V 50 > x > -50	125.0	42%	of the total time in this Stage
% MACD-V -50 > x > -150	71	39.7%	of the total time in this Stage	% MACD-V -50 > x > -150	154.0	51%	of the total time in this Stage
% MACD-V < -150	2	1.1%	of total occurences	% MACD-V < -150	9.0	3%	of total occurences
% MACD-V x < 100	176	98.3%	of the total time in this Stage	% MACD-V x < 100	301.0	100%	of the total time in this Stage

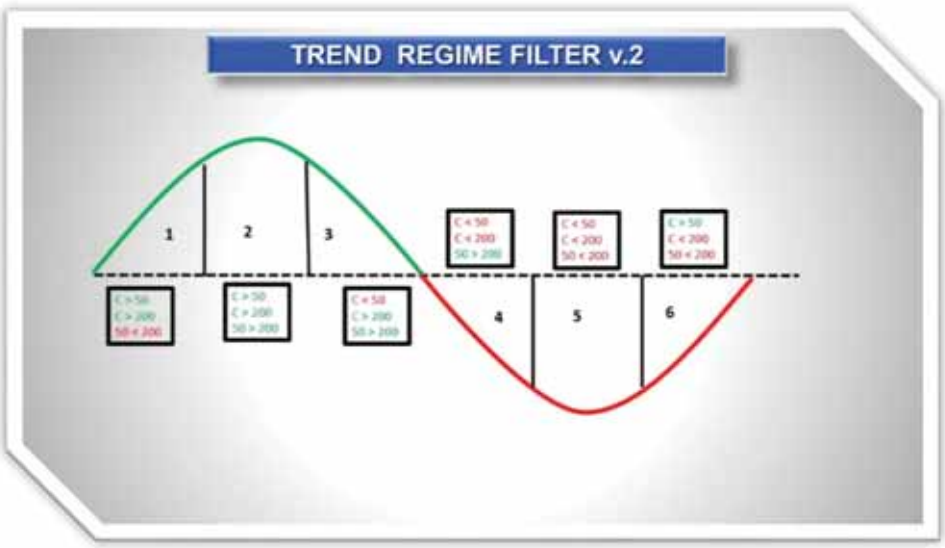
In order to complete our cross-market validation, we will present the same study for natural gas. The difference is with the swing line again. In this instance we employ a 5% swing filter, in order to deal with the elevated inherent volatility of this market. The rest of the data lead to the same results, which we will leave to the reader to validate and explore further.

4.4.4 MACD-V Ranges and Trend Regime Filter v.2

The numbers in tables #11- 13, could be more insightful by using a more detailed Trend Regime Filter. The rules for Trend Regime Filter v.2 (Chart #13) were created –to our knowledge - by Chuck Dukas[3]. We will examine the Bullish Stages (1,2,3)

The swing line percentages will remain the same for each market.

CHART 13: MACD-V Ranges and Trend Regime Filter v.2



[3] "The TrendAdvisor Guide to Breakthrough profits", Chuck Dukas

TABLE 20: MACD-V Ranges and Trend Regime Filter v.2, Stage 2 (S&P 500, 1975 – 2021)

% C > 50 EMA > 200 EMA	6894	58.3%	of total time
% MACD-V > 150	507	98.3%	of total occurences
% MACD-V 150 > x > 50	3695	53.6%	of the total time in this Stage
% MACD-V 50 > x > -50	2675	38.8%	of the total time in this Stage
% MACD-V -50 > x > -150	17	0.2%	of the total time in this Stage
% MACD-V < -150	0	0.0%	of total occurences
% MACD-V x > -50	6877	99.8%	of the total time in this Stage

These are the relevant numbers for the S&P 500, in Stage 2 (i.e. C >50>200). This time the maximum downside stretch of the MACD-V is **-50**, as the range 150 to -50 contains **99.8%** of the data.

Thus if one thinks that on any pullback the market will not break the 50 EMA, then any dive that would cause the MACD-V > -50 would provide a definition of a Stage specific oversold level.

TABLE 21: MACD-V Ranges, Trend Regime Filter v.2 (Stage 2) & 3% Swings (S&P 500, 1975 – 2021)

# of 3% SWING HIGHS	203	87.1%	of total occurences in this Stage	# of 3% SWING LOWS	29	22.0%	of total occurences in this Stage
% MACD-V > 150	19	9.4%	of total occurences	% MACD-V > 150	0	0.0%	of total occurences
% MACD-V 150 > x > 50	121	59.6%	of the total time in this Stage	% MACD-V 150 > x > 50	17	58.6%	of the total time in this Stage
% MACD-V 50 > x > -50	62	30.5%	of the total time in this Stage	% MACD-V 50 > x > -50	12	41.4%	of the total time in this Stage
% MACD-V -50 > x > -150	1	0.5%	of the total time in this Stage	% MACD-V -50 > x > -150	0	0.0%	of the total time in this Stage
% MACD-V < -150	0	0.0%	of total occurences	% MACD-V < -150	0	0.0%	of total occurences
% MACD-V x > -50	202	99.5%	of the total time in this Stage	% MACD-V x > -50	29	100.0%	of the total time in this Stage

The table above shows that out of the 233 swing highs above the 200 EMA, **87.1%** of these (203) have occurred in Stage 2 (C > 50 EMA > 200 EMA). The vast majority of these **(59.6%)** where in the 50-150 range of the MACD-V, while around 10% occurred while in the overbought range. Almost all of the highs (**99.5%)** where over the -50 range of the MACD-V.

Turning our attention to swing lows in Stage 2, these are really rare events as we have seen 29 occurrences, in the past 46 years. 100% of these were over the -50 range of the MACD-V.

It would seem that if one expects a larger than 3% correction, that would not extend below the 200 EMA, then the odds greatly favour that the S&P 500 would breach the 50 EMA (Stage 3) and the MACD-V to be in the -50 to -50 range (or -50 to -100 in the case of stronger corrections)

TABLE 22: MACD-V Ranges and Trend Regime Filter v.2, Stage 3 (S&P 500, 1975 – 2021)

% 50 EMA > C > 200 EMA	1646	13.9%	of total time
% MACD-V > 150	0	0.0%	of total occurences
% MACD-V 150 > x > 50	10	0.6%	of the total time in this Stage
% MACD-V 50 > x > -50	1191	72.4%	of the total time in this Stage
% MACD-V -50 > x > -150	445	27.0%	of the total time in this Stage
% MACD-V < -150	0	0.0%	of total occurences
% MACD-V x > -100	1591	96.7%	of the total time in this Stage

When the market has progressed into Stage 3, the vast majority of times (**72.4%**) the MACD-V is in the neutral range (50 to -50). In quite rare occurrences we may have a dip below the -100 level, but it would be an exception as **96.7%** of the values in the Stage are above that.

TABLE 23: MACD-V Ranges, Trend Regime Filter v.2 (Stage 3) & 3% Swings (S&P 500, 1975 – 2021)

# of 3% SWING HIGHS	11	4.7%	of total occurences in this Stage	# of 3% SWING LOWS	101	76.5%	of total occurences in this Stage
% MACD-V > 150	0	0.0%	of total occurences	% MACD-V > 150	0	0.0%	of total occurences
% MACD-V 150 > x > 50	0	0.0%	of the total time in this Stage	% MACD-V 150 > x > 50	3	3.0%	of the total time in this Stage
% MACD-V 50 > x > -50	5	45.5%	of the total time in this Stage	% MACD-V 50 > x > -50	83	82.2%	of the total time in this Stage
% MACD-V -50 > x > -150	6	54.5%	of the total time in this Stage	% MACD-V -50 > x > -150	15	14.9%	of the total time in this Stage
% MACD-V < -150	0	0.0%	of total occurences	% MACD-V < -150	0	0.0%	of total occurences
% MACD-V x > -100	9	81.8%	of the total time in this Stage	% MACD-V x > -100	98	97.0%	of the total time in this Stage

When the market has slided below the 50 EMA, in the vast majority of cases, the reversal swings associated in the Stage are lows (101) vs highs (11). A notable statistic is that **82.2%** of the swing lows that occur in this Stage are in the "neutral zone" of 50 to – 50 and a few extend to the -50 to -150 range. In total **97%** of swing lows in Stage 3, occur over the -100 range of the MACD-V.

Thus pullbacks into this Stage could end in the aforementioned ranges, for a possible resumption of the trend.

TABLE 24: MACD-V Ranges and Trend Regime Filter v.2, Stage 1 (S&P 500, 1975 – 2021)

% C > 200 EMA > 50 EMA	465	3.9%	of total time
% MACD-V > 150	9	1.7%	of total occurences
% MACD-V 150 > x > 50	316	68.0%	of the total time in this Stage
% MACD-V 50 > x > -50	140	30.1%	of the total time in this Stage
% MACD-V -50 > x > -150	0	0.0%	of the total time in this Stage
% MACD-V < -150	0	0.0%	of total occurences
% MACD-V x > -50	465	100.0%	of the total time in this Stage

Stage 1 does not occur very often, or rather does not register for long. It is usually an explosive move to the upside coming off of a low. Hence it is the only stage (except 2) that manages to drive the market into the overbought zone (>150). In the vast majority of cases the market is in the "fast" range of the MACD-V (50 to 150), and in **100%** of the cases the MACD-V stays above -50

TABLE 25: MACD-V Ranges, Trend Regime Filter v.2 (Stage 1) & 3% Swings (S&P 500, 1975 – 2021)

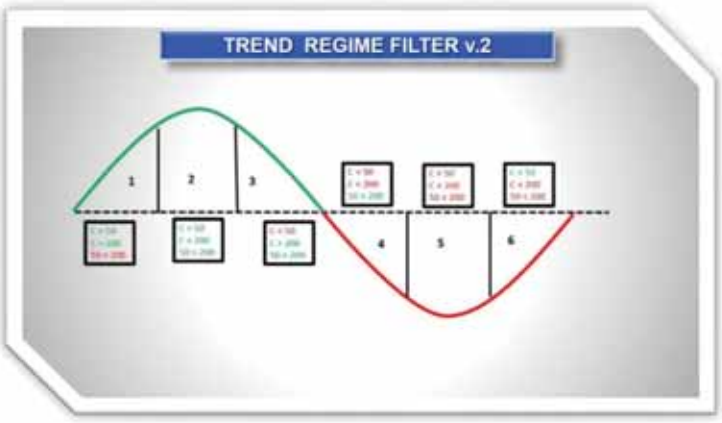
# of 3% SWING HIGHS	19	8.2%	of total occurences in this Stage	# of 3% SWING LOWS	2	1.5%	of total occurences in this Stage
% MACD-V > 150	0	0.0%	of total occurences	% MACD-V > 150	0	0.0%	of total occurences
% MACD-V 150 > x > 50	14	73.7%	of the total time in this Stage	% MACD-V 150 > x > 50	2	100.0%	of the total time in this Stage
% MACD-V 50 > x > -50	5	26.3%	of the total time in this Stage	% MACD-V 50 > x > -50	0	0.0%	of the total time in this Stage
% MACD-V -50 > x > -150	0	0.0%	of the total time in this Stage	% MACD-V -50 > x > -150	0	0.0%	of the total time in this Stage
% MACD-V < -150	0	0.0%	of total occurences	% MACD-V < -150	0	0.0%	of total occurences
% MACD-V x > -50	19	100.0%	of the total time in this Stage	% MACD-V x > -50	2	100.0%	of the total time in this Stage

There aren't many reversals (swings) occurring in this Stage and **almost all** are high (19) vs lows (2) in the 46 year history of the data. Notable stats are that these aforementioned highs occur in the 50 to 150 range of the MACD-V (**73.7%** of the occurrences)

NOTE:

In the following pages will display the same studies for the Bund and Natural Gas markets. They exhibit similar behavior, thus we will leave it up to the readers to dive deeper into the data, without our commentary. Please note that we used a 1% swing line for the Bund and a 5% swing line for natural gas, to account for different volatility levels. Moreover in our private work, we use ATR-based swing lines and more sophisticated Trend Regime Filters.

TABLE 26: Trend Regime Filter v.2 - Key statistics (Bund, 1991 – 2021)



% C > 50 EMA > 200 EMA	3647	47.6%	of total time
% MACD-V > 150	237	97.9%	of total occurences
% MACD-V 150 > x > 50	2075	56.9%	of the total time in this Stage
% MACD-V 50 > x > -50	1322	36.2%	of the total time in this Stage
% MACD-V -50 > x > -150	13	0.4%	of the total time in this Stage
% MACD-V < -150	0	0.0%	of total occurences
% MACD-V x > -50	3634	99.6%	of the total time in this Stage

# of 3% SWING HIGHS	117	81.5%	of total occurences in this Stage	# of 3% SWING LOWS	30	32.6%	of total occurences in this Stage
% MACD-V > 150	17	12.4%	of total occurences	% MACD-V > 150	1	3.3%	of total occurences
% MACD-V 150 > x > 50	78	56.9%	of the total time in this Stage	% MACD-V 150 > x > 50	19	63.3%	of the total time in this Stage
% MACD-V 50 > x > -50	39	28.5%	of the total time in this Stage	% MACD-V 50 > x > -50	10	33.3%	of the total time in this Stage
% MACD-V -50 > x > -150	3	2.2%	of the total time in this Stage	% MACD-V -50 > x > -150	0	0.0%	of the total time in this Stage
% MACD-V < -150	0	0.0%	of total occurences	% MACD-V < -150	0	0.0%	of total occurences
% MACD-V x > -50	134	97.8%	of the total time in this Stage	% MACD-V x > -50	30	100.0%	of the total time in this Stage

% 50 EMA > C > 200 EMA	1019	13.3%	of total time
% MACD-V > 150	0	0.0%	of total occurences
% MACD-V 150 > x > 50	12	1.2%	of the total time in this Stage
% MACD-V 50 > x > -50	641	62.9%	of the total time in this Stage
% MACD-V -50 > x > -150	366	35.9%	of the total time in this Stage
% MACD-V < -150	0	0.0%	of total occurences
% MACD-V x > -100	960	94.2%	of the total time in this Stage

# of 3% SWING HIGHS	11	6.5%	of total occurences in this Stage	# of 3% SWING LOWS	61	66.3%	of total occurences in this Stage
% MACD-V > 150	0	0.0%	of total occurences	% MACD-V > 150	0	0.0%	of total occurences
% MACD-V 150 > x > 50	0	0.0%	of the total time in this Stage	% MACD-V 150 > x > 50	3	4.9%	of the total time in this Stage
% MACD-V 50 > x > -50	3	27.3%	of the total time in this Stage	% MACD-V 50 > x > -50	42	68.9%	of the total time in this Stage
% MACD-V -50 > x > -150	8	72.7%	of the total time in this Stage	% MACD-V -50 > x > -150	16	26.2%	of the total time in this Stage
% MACD-V < -150	0	0.0%	of total occurences	% MACD-V < -150	0	0.0%	of total occurences
% MACD-V x > -100	10	90.9%	of the total time in this Stage	% MACD-V x > -100	59	96.7%	of the total time in this Stage

% C < 200 EMA < 50 EMA	490	6.4%	of total time
% MACD-V > 150	5	2.1%	of total occurences
% MACD-V 150 > x > 50	297	60.6%	of the total time in this Stage
% MACD-V 50 > x > -50	188	38.4%	of the total time in this Stage
% MACD-V -50 > x > -150	0	0.0%	of the total time in this Stage
% MACD-V < -150	0	0.0%	of total occurences
% MACD-V x > -50	490	100.0%	of the total time in this Stage

# of 3% SWING HIGHS	20	11.9%	of total occurences in this Stage	# of 3% SWING LOWS	1	1.1%	of total occurences in this Stage
% MACD-V > 150	0	0.0%	of total occurences	% MACD-V > 150	0	0.0%	of total occurences
% MACD-V 150 > x > 50	16	80.0%	of the total time in this Stage	% MACD-V 150 > x > 50	1	100.0%	of the total time in this Stage
% MACD-V 50 > x > -50	4	20.0%	of the total time in this Stage	% MACD-V 50 > x > -50	0	0.0%	of the total time in this Stage
% MACD-V -50 > x > -150	0	0.0%	of the total time in this Stage	% MACD-V -50 > x > -150	0	0.0%	of the total time in this Stage
% MACD-V < -150	0	0.0%	of total occurences	% MACD-V < -150	0	0.0%	of total occurences
% MACD-V x > -50	20	100.0%	of the total time in this Stage	% MACD-V x > -50	1	100.0%	of the total time in this Stage

TABLE 27: Trend Regime Filter v.2 - Key statistics (Natural gas, 1991 – 2021)

% C > 50 EMA > 200 EMA	2405	31.0%	of total time
% MACD-V > 150	148	82.7%	of total occurences
% MACD-V 150 > x > 50	1393	57.9%	of the total time in this Stage
% MACD-V 50 > x > -50	860	35.8%	of the total time in this Stage
% MACD-V -50 > x > -150	4	0.2%	of the total time in this Stage
% MACD-V < -150	0	0.0%	of total occurences
% MACD-V x > -50	2401	99.8%	of the total time in this Stage

# of 5% SWING HIGHS	188	66.9%	of total occurences in this Stage	# of 5% SWING LOWS	77	48.1%	of total occurences in this Stage
% MACD-V > 150	25	13.3%	of total occurences	% MACD-V > 150	5	6.5%	of total occurences
% MACD-V 150 > x > 50	100	53.2%	of the total time in this Stage	% MACD-V 150 > x > 50	62	80.5%	of the total time in this Stage
% MACD-V 50 > x > -50	61	32.4%	of the total time in this Stage	% MACD-V 50 > x > -50	10	13.0%	of the total time in this Stage
% MACD-V -50 > x > -150	2	1.1%	of the total time in this Stage	% MACD-V -50 > x > -150	0	0.0%	of the total time in this Stage
% MACD-V < -150	0	0.0%	of total occurences	% MACD-V < -150	0	0.0%	of total occurences
% MACD-V x > -50	186	98.9%	of the total time in this Stage	% MACD-V x > -50	77	100.0%	of the total time in this Stage

% 50 EMA > C > 200 EMA	803	10.3%	of total time
% MACD-V > 150	0	0.0%	of total occurences
% MACD-V 150 > x > 50	6	0.7%	of the total time in this Stage
% MACD-V 50 > x > -50	616	76.7%	of the total time in this Stage
% MACD-V -50 > x > -150	181	22.5%	of the total time in this Stage
% MACD-V < -150	0	0.0%	of total occurences
% MACD-V x > -100	794	98.9%	of the total time in this Stage

# of 5% SWING HIGHS	25	8.9%	of total occurences in this Stage	# of 5% SWING LOWS	68	42.5%	of total occurences in this Stage
% MACD-V > 150	0	0.0%	of total occurences	% MACD-V > 150	0	0.0%	of total occurences
% MACD-V 150 > x > 50	0	0.0%	of the total time in this Stage	% MACD-V 150 > x > 50	2	2.9%	of the total time in this Stage
% MACD-V 50 > x > -50	15	60.0%	of the total time in this Stage	% MACD-V 50 > x > -50	55	80.9%	of the total time in this Stage
% MACD-V -50 > x > -150	10	40.0%	of the total time in this Stage	% MACD-V -50 > x > -150	11	16.2%	of the total time in this Stage
% MACD-V < -150	0	0.0%	of total occurences	% MACD-V < -150	0	0.0%	of total occurences
% MACD-V x > -100	25	100.0%	of the total time in this Stage	% MACD-V x > -100	68	100.0%	of the total time in this Stage

% C > 200 EMA > 50 EMA	670	8.6%	of total time
% MACD-V > 150	31	17.3%	of total occurences
% MACD-V 150 > x > 50	436	65.1%	of the total time in this Stage
% MACD-V 50 > x > -50	203	30.3%	of the total time in this Stage
% MACD-V -50 > x > -150	0	0.0%	of the total time in this Stage
% MACD-V < -150	0	0.0%	of total occurences
% MACD-V x > -50	670	100.0%	of the total time in this Stage

# of 5% SWING HIGHS	68	24.2%	of total occurences in this Stage	# of 5% SWING LOWS	15	9.4%	of total occurences in this Stage
% MACD-V > 150	3	4.4%	of total occurences	% MACD-V > 150	2	13.3%	of total occurences
% MACD-V 150 > x > 50	47	69.1%	of the total time in this Stage	% MACD-V 150 > x > 50	12	80.0%	of the total time in this Stage
% MACD-V 50 > x > -50	18	26.5%	of the total time in this Stage	% MACD-V 50 > x > -50	1	6.7%	of the total time in this Stage
% MACD-V -50 > x > -150	0	0.0%	of the total time in this Stage	% MACD-V -50 > x > -150	0	0.0%	of the total time in this Stage
% MACD-V < -150	0	0.0%	of total occurences	% MACD-V < -150	0	0.0%	of total occurences
% MACD-V x > -50	68	100.0%	of the total time in this Stage	% MACD-V x > -50	15	100.0%	of the total time in this Stage

4.4.5 MACD-V Momentum Lifecycle RoadMap

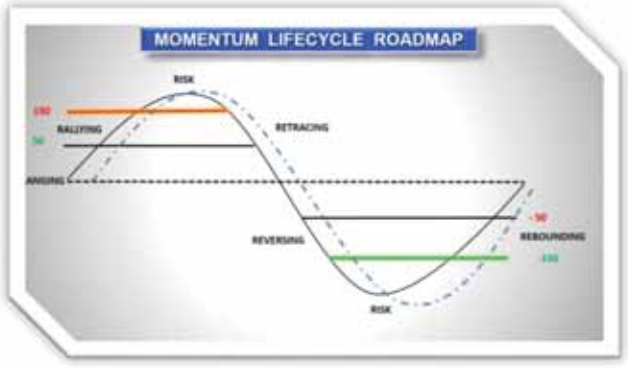
At this stage we can introduce the signal line (9 period EMA of the MACD line) as it is the tool that signals changes in momentum. The signal line is guaranteed to highlight momentum shifts, but its lagging nature does so at the expense of accuracy and timing sometimes (please refer to parts #2.5 and #2.6). Thus we chose to replace it with another tool, that deals (to some extent) with the aforementioned issues. However, we made a conscious choice not to present the modifications we have made on the signal line, and just focus on the MACD line, as the length of this paper would increase significantly in length. Therefore henceforth any mention of the signal line assumes that we would use the 9 period EMA.

Table #28 presents the Ranges and how the MACD-V line relates to the signal line. There are in total 8 ranges that the MACD-V can take, which can of course can be easily programmed in any language of your choice (python, amibroker AFL, etc).

TABLE 28: MACD-V & Signal Line combinations

RANGE	ABOVE SIGNAL LINE	BELOW SIGNAL LINE
> 150	Risk	
50 < x < 150	Rallying	Retracing (in price or time)
-50 < x < 50	Ranging	Ranging
-150 < x < -50	Rebounding	Reversing
-150 <	Risk	

CHART 14: MACD-V Momentum Lifecycle RoadMap



This opens up new and unexplored opportunities to use the MACD. Up until today the MACD could be used either in 2 ways, either above/below the signal line, and/or above/below the 0-line. The MACD-V now presents us with 8 different scenarios to explore, and of course these are multiplied in the case of cross asset comparisons.

5. MACD-VH: Volatility Normalised Histogram

Further to the MACD, Thomas Aspray in 1986 created the MACD Histogram, which is constructed as follows: *MACD Histogram = Signal Line – MACD Line.*

Since the MACD line has (now) been normalized, similar properties should also be shared by the 4th derivative of price, the MACD-V Histogram (MACD-VH). That means that it is possible to detect indicator levels which are associated with short term extreme price levels. This is a unique property of the MACD-VH, as thus far the applications of the MACD Histogram were confined to comparisons of the height of each bar of the histogram relative to the preceding ones (higher vs lower), and not relative to the absolute level that each bar has.

It appears that when the MACD-VH is above 40 (or below – 40), that would imply that the market is mildly stretched to the upside (downside)

CHART 15: MACD-VH Momentum Lifecycle RoadMap

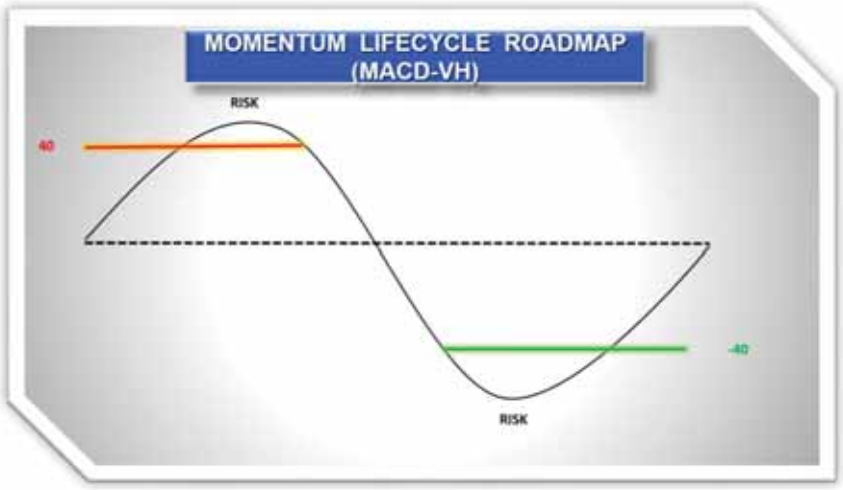


TABLE 29: MACD-VH extreme levels for 3 markets

S&P 500		NATURAL GAS		BUND	
% time > 40		% time > 40		% time > 40	
349	3%	296	4%	196	3%
% time < - 40		% time < - 40		% time < - 40	
502	4%	250	3%	346	5%

CHART 16: MACD-VH Mildly Overbought / oversold (>40, <-40)

(FTSE 100, 2014 - 2015)

CHART 17: MACD-VH Mildly Overbought / oversold (>40, <-40)

(FTSE 100, 2015 - 2016)

6. Teaching new tricks to old …"tools"

At the final part of the paper, I would like apply the concept of volatility normalization to other well known indicators, thus expanding their informational value.

6.1 LBR 3/10 Oscillator "Sardine"[4]

The first tool would be the LBR 3/10 oscillator, by the esteemed trader Linda Bradford Raschke. Linda has publically disclosed many trading setups using this tool ("Anti" setup, divergences, new momentum highs/lows). The oscillator is a MACD(3,10), thus it would be easy to create range rules for this indicator as well. The new formula would be: *[EMA(3,C) – EMA(10,C)] / ATR(10).*

The data in table #30, behave in a similar fashion as do for the MACD-V and MACD-VH

CHART 18: **LBR 3/10 Oscillator & 100/125 , -100/-125 levels (S&P 500)**

TABLE 30: LBR 3/10 Oscillator extreme levels for 3 markets

S&P 500	
% time > 125	
431	4%
% time < - 125	
187	2%

NATURAL GAS	
% time > 125	
220	3%
% time < - 125	
150	2%

BUND	
% time > 125	
197	3%
% time < - 125	
151	2%

[4] Name inspired by Linda's latest book "Trading Sardines"

6.2 Alex Elder Impulse "Plus" System

The "Elder Impulse System" was designed by Alexander Elder[5]. The system according to its creator "*identifies inflection points where a trend speeds up or slows down*". The price bars are colour coded as follows

Green: EMA(13,C) > previous (EMA(13,C) and (MACD-H> previous MACD-H)
Red : EMA(13,C) < previous (EMA(13,C) and (MACD-H< previous MACD-H)
Blue: in all other cases

In this particular case, additional rules could be added so as to warn the trader when a the market has been overstretched in the short term. Thus the rules could look like:

Green: EMA(13,C) > previous (EMA(13,C) and (MACD-VH> previous MACD-VH)
Red : EMA(13,C) > previous (EMA(13,C) and (MACD-VH> previous MACD-VH) and MACD-VH > 40

Blue: in all other cases

Red : EMA(13,C) < previous (EMA(13,C) and (MACD-VH< previous MACD-VH)
Green: EMA(13,C) < previous (EMA(13,C) and (MACD-VH< previous MACD-VH) and MACD-VH < - 40

Blue: in all other cases

There are certainly more possibilities to explore, but the point is to exhibit the additional value that volatility normalized momentum presents to the existing toolset

[5] *"Come Into My Trading Room", Alex Elder*

6.3 Chuck Dukas Diamond "Refined"

Chart #12 presented in brief the rules for the "Chuck Dukas Diamond", a trend classification system. Using volatility normalization, this can be improved in a few ways.

One possible solution to "refine" the Diamond would be the following:

1. Each of the EMA's would be expressed as a MACD-V.
   ie the 50 EMA would be MACD-V(1,50), the 200 EMA would be MACD-V(1,200) and the 50 EMA/200 EMA crossover rules would be MACD-V(50,200)

2. Create extreme levels for each of the MACD-V's
   i.e. for the MACD-V(1,50) we would use +/- 4, for the MACD-V(1,200) we would use +/- 8 and for the MACD-V(50,200) we would use +/-5.

3. Create a weighted condition scoring system, that would serve as an warning for overbought / oversold conditions within each of the 6 Stages
   i.e. MACD-V(1,50) > 4, 1 point
   MACD-V(1,200) > 8, 2 points
   MACD-V(50,200) > 5, 3 points

In addition to an OBOS warning system, another possible solution would be then to use the readings of the MACD-V(50,200) as a relative strength ranking tool for the universe of the markets classified by the system. Thus one would not just classify securities in a Stage, but also within that Stage. The higher (lower) the reading, the stronger (weaker) the market would be.

6.4 The 70 & 77 System (Strong Momentum Range Rules)

As mentioned in Section 4.4.5, the MACD-V Momentum Lifecycle Roadmap opens up opportunities that would not exist with the simple MACD.

One simple example would be to filter buy signals when a market enters high in the strong momentum range. The following equity curve was created by buying 1 DAX futures contract (long only) when the MACD-V is above 70 (market entry order), and selling at target exit of 2.85% (next bar limit) or after 15 days if in profit (but the target exit had not been reached) or after 77 days if neither of these conditions held true. (€25 per roundtrip trade were deducted for slippage and commissions)

CHART 19: 70 & 77 System Equity curve -(DAX, 1991 - 2021)

TABLE 31: 70 & 77 System Key Stats – (DAX, 1991 – 2021)

Starting Account	€ 100,000
Closed Trade Net Profit	€ 410,370.5
Profit Factor	2.58
Closed Trades	234
Winning	201
Losing	33
% Profitable	85.90%
Worst Drawdown	32.79%

Of the 201 profitable trades 95 trades managed to reach their target exit price (77.23% of all winning trades). Of course this is not a tradeable system on its own, but serves as inspiration for further strategy idea development

7. Epilogue

This paper is the definition of “standing on the shoulders of giants”, as it would not have been possible without the knowledge shared by esteemed technicians, past and present. I sincerely hope that we have added a small brick on the huge wall of the Body of Knowledge of Technical Analysis.