

ExtremeHurst Scanner™ Guide for Bloomberg Users

ExtremeHurst Scanner v2.0

Parallax Financial Research, Inc. **EXTREME HURST**

SOURCE

- Single Security
- Securities List
- Index Holdings
- Portfolios

MODE

- Securities
- Ratio Spreads
- Options

SCALE

- Quarterly
- Monthly
- Weekly
- Daily

FILTERS

- Trade Quality
- All Prices
- All Liquidity
- More Signals
- Additional Settings...

Signal Search

Downloading Data: **STOP**

Computing Signals: Filtered

Signals

Security	Scale	Signal	Rank	Forecast	Valid From	Until
CVX UN Equity	WK	Extension Top Max	95	Expect lower prices	2026-04-03	2027-05-28
PG UN Equity	MO	Compression	99	Expect a new trend	2026-03-31	2028-12-31
MSFT UQ Equity	DY	Extension Bottom+3	96	Expect higher prices	2026-03-30	2026-05-05
CVX UN Equity	WK	Extension Top+1	96	Expect lower prices	2026-03-27	2026-10-30
HD UN Equity	DY	Extension Bottom+8	95	Expect higher prices	2026-03-23	2026-06-05
CVX UN Equity	WK	Extension Top+2	96	Expect lower prices	2026-03-20	2026-10-16
HD UN Equity	WK	Compression Dnl+3	97	Downtrend	2026-03-13	2028-04-07

Price Chart

EXTREMEHURST™ DAILY SCALE EXTENSION BOTTOM SIGNAL ON MICROSOFT CORP (MSFT UQ EQUITY)

Chart Zoom:

Save Signals Copy Signals Clear Signals Print Screen Copy Screen Analysis Chartbook Help

Parallax Financial Research, Inc

4/3/2026



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What is ExtremeHurst?

ExtremeHurst is a quantitative detector of extreme investor behavior that signals the end of a trend or a trendless period. Strong trend-persistent stock price movements are evidence of positive feedback (i.e., investors buying because the price is rising, driving prices higher), while extremes of mean reversion are evidence of negative feedback. Extremes of both trend persistency and mean reversion are quantified via multiple scale measurements of a band-limited Hurst exponent. Parallax found that Hurst extremes coupled with log-periodic converging cycles, signal critical market trend changes. ExtremeHurst signals are fully characterized by the presence of discrete scale invariance, accelerating price, log-periodic cycles, and volume anomalies.

This App allows the user to search global markets for signals on intraday, daily, weekly, monthly, and quarterly time scales. Signals have been found to persist for up to the time it took for the signal to build. Build times average 40 bars, which in the case of weekly or higher scale data, means signal duration is a highly significant investment factor.

ExtremeHurst exploits the science of non-linear dynamics to identify unique and predictive signals occurring in freely trading auction markets. There are two types of ExtremeHurst signals that we call “**Extensions**” and “**Compressions**”. These correspond to the extreme high and low ends of the Hurst exponent distribution.



Figure 1. This is an example of a weekly scale Extension top signal.

The Hurst Exponent

The Hurst exponent, as applied to a financial series, represents the degree of randomness which is present. Deviations from random take the form of mean-reversion or trend persistence. The picture

below shows five time series with different Hurst exponents. The topmost example is the most mean-reverting, while the bottom example shows the most trend persistence. The middle one is random.

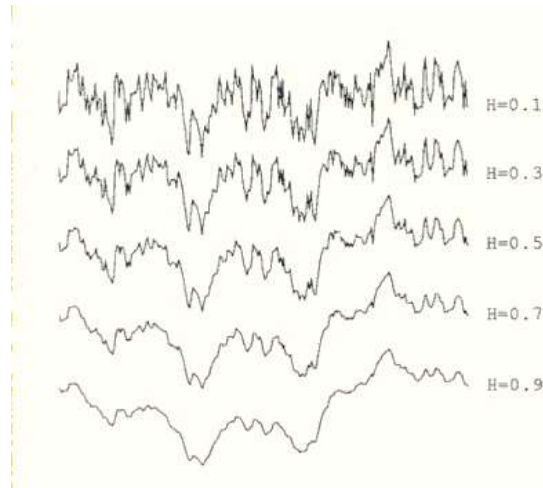


Figure 2. Time series generated with different Hurst exponent values

Extensions correspond to extreme levels of trend persistence on multiple scales, and mark the end of trend persistent periods, either at market tops or bottoms. The picture below shows multiple Hurst exponent measurements for a particular security at different scales. The shortest scales are on the bottom. **Red** represents persistent down trends. **Green** represents persistent up trends. **Gray** shows random price movement, and **blue** represents mean-reverting exponents. Note the column of red at almost the exact price low.

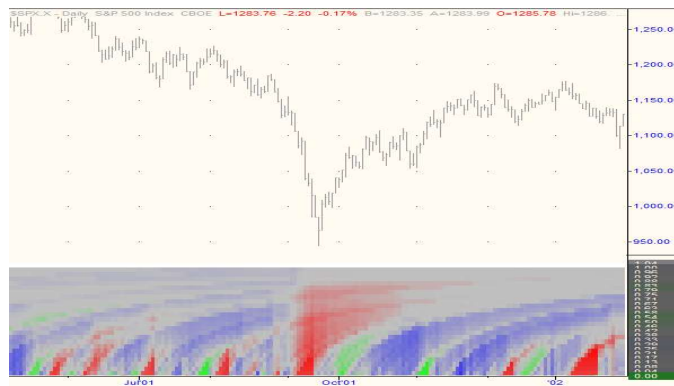


Figure 3. Color-coded Hurst exponents at multiple scales (graph not available on BB)

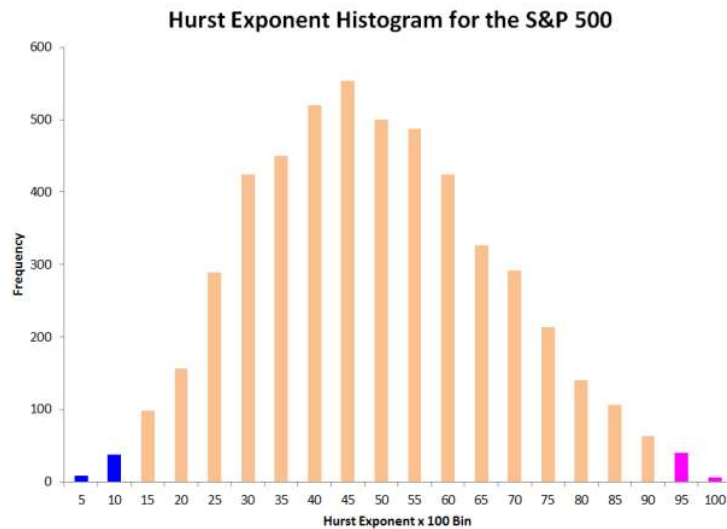


Figure 4. Histogram of band-limited Hurst exponent measurements taken from the S&P 500

Many factors influence investors, but we choose to focus on the extremes of competitive or cooperative behavior from a macro perspective. Feedback is at the heart of why ExtremeHurst works. Investors sometimes behave as herds, selling because the price is dropping, or buying because it's going up. Panics and manias are large scale examples of this. However, when most investors agree that stocks are going up or down, they've probably already acted on their belief, and the buying or selling dries up, leading to a reversal.

Panic



Mania

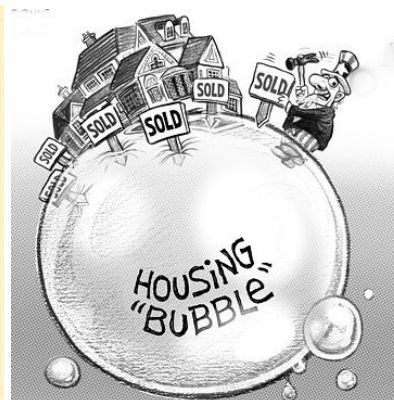


Figure 5. Extreme investor behavior.

Because these events are scientifically similar to critical failure points in materials, log periodic “foreshocks” are visible preceding most signals, as well as mirror image “aftershocks” following signals. Aftershocks are also log-periodic, but are expanding, which means the highs and lows are getting farther apart logarithmically over time. The picture below is a simulated example:

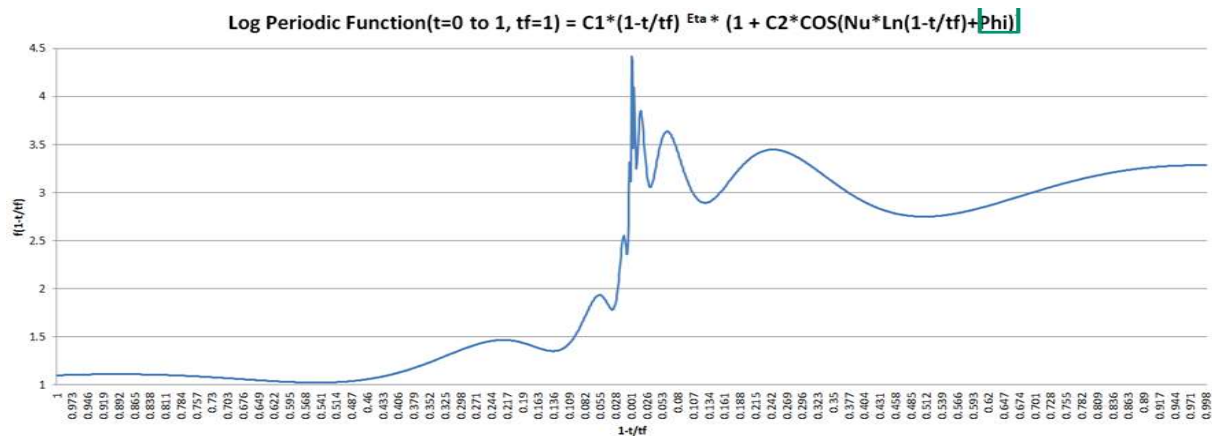


Figure 6. Simulated log-periodic oscillations culminating in a critical reversal point and then expanding away from the critical point (Top Extension). This is due to markets having a “complex numbered” fractal dimension.

Compressions correspond to extreme levels of mean-reversion, or investor competition, on multiple scales. These signals mark the end of trendless periods and the beginning of new trends by finding when the vigorous competition between supply and demand has reached a critical point. Price is expected to move very rapidly away from its current price following a compression.



Figure 7. Competition between supply and demand reaches a crescendo at compression signals

Another way to think of these signals is to envision a mass on a spring. When the spring is compressed, the system has high potential energy. When the mass is released, it will move very fast away from its starting position. In fact, it will then move too far. An extension occurs as the spring reaches its full extent, just before it settles back:

Compression

Extension

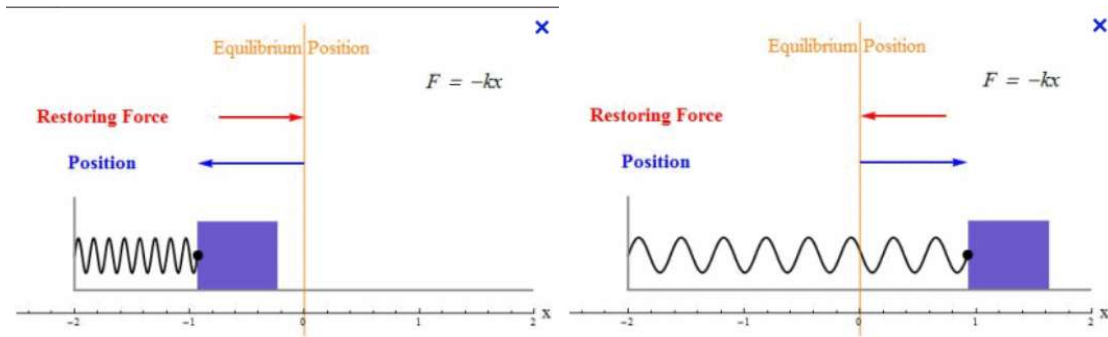


Figure 8. A harmonic oscillator is a great way to envision a compression and extension

How do I use ExtremeHurst?

The ExtremeHurst signals work on all freely traded securities and on all time scales, provided sufficient liquidity is present. For a “crowd effect” to occur, a crowd must be present.

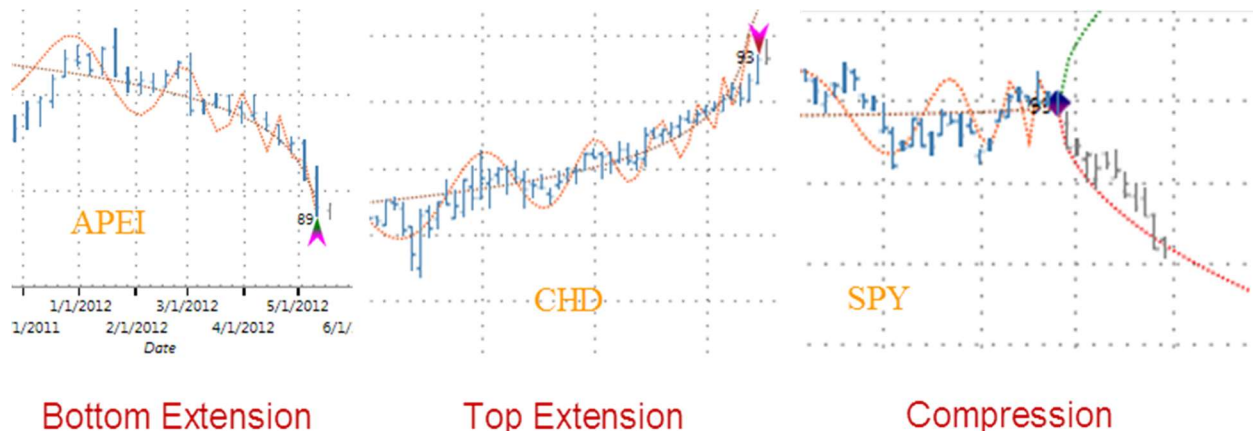


Figure 9. Examples of each ExtremeHurst signal type

The predictive edge in ExtremeHurst can be as large as 25% (See the appendix for a discussion of Edge vs Duration) and has a duration that doesn't see the edge going to zero until the “build time” is reached. On the pictures in Figure 9, the build time is the number of price bars leading into the signal which show the gray dotted line and red cycles. The point of maximum effect tends to be the first third of the duration. So in the SPY case in Figure 9, the build time is 27 bars into the Compression. That means you can expect a trend move lasting at least 9 bars.

The Extension signals predict retracement or sideways periods, so redeployment of capital may be the best strategic move. Aggressive speculators like to play the log-periodic cycles, so we have included the expected top and bottom timing marks on the charts and in the signal file.

Compressions mark the start of new trends, but we never know the direction, so a straddle or triggered L/S entry is required.

Signals have at least four important uses:

1. Trade positioning
2. Profit taking.
3. Identifying transitions from a trending to a sideways market or vice versa.
4. When the crowd runs a security too far up or down, prices can deviate significantly from a reasonable valuation and diminish portfolio performance. Having an idea about when these effects occur can be very valuable.

Signals are ranked from 1 to 100 depending on how closely they correspond to the ideal signal. An ideal signal exhibits four characteristics:

1. A price acceleration that deviates significantly from normal Gaussian expectations
2. Extreme Hurst Exponent measurements on multiple scales
3. Log-periodic price ripples which converge to a signal date
4. Unique price and volume sequencing

We combine factors using a pre-trained neural net to produce our final signal rank.

We have created the ExtremeHurst App on Bloomberg to enable users to search world markets for these predictive signals on intraday, daily, weekly, monthly, and even quarterly time scales.

The Scanner Application

The screenshot shows the ExtremeHurst Scanner v2.0 application window. The interface is divided into several sections:

- Security Group Selection:** Located at the top left, it includes sections for SOURCE (Single Security, Securities List, Index Holdings, Portfolios), MODE (Securities, Ratio Spreads, Options), SCALE (Quarterly, Monthly, Weekly, Daily), and FILTERS (Trade Quality, All Prices, All Liquidity, More Signals, Additional Settings...).
- Search Progress:** A section with a 'Signal Search' button and progress bars for 'Downloading Data' and 'Computing Signals'.
- Signals Found:** A table listing search results with columns for Security, Scale, Signal, Rank, Forecast, Valid From, and Until.
- Selected Signal Chart:** A price chart for Microsoft Corp (MSFT UQ EQUITY) showing the 'EXTREMEHURST™ DAILY SCALE EXTENSION BOTTOM SIGNAL'. The chart includes a candlestick price history and several colored trend lines.
- Zoom Output:** A 'Chart Zoom' slider and a row of buttons for 'Save Signals', 'Copy Signals', 'Clear Signals', 'Print Screen', 'Copy Screen', 'Analysis', 'Chartbook', and 'Help'.

<p>ExtremeHurst App Window</p>	<p>ExtremeHurst is a single Windows dialog box. It is divided into six sections from top to bottom that correspond to the workflow sequence. These sections include security and filter selection, the search progress bars, the signal list, the chart area, the zoom control, and the output options.</p>
<p>CPU Usage</p>	<p>ExtremeHurst performs millions of complex mathematical calculations including Fast Fourier Transforms, neural network math, and trigonometry calls during each run. You will notice a sharp increase in CPU usage during searches and on occasion the processing may even appear to halt. Be patient, it will complete.</p>

Bloomberg Data Limits

Bloomberg clients have monthly data usage limitations. We recommend that you carefully select a security universe, search once after the close each day for daily signals, once a week after the weekly close for weekly scale signals, etc., so you stay within your limits. ExtremeHurst reads 129 historical bars worth of OHLCV data for each security that passes through the filters.

Security & Filter Selection

Overview

Let's take a closer look at security and filter selection: The user can select which securities to search by either reading in a text file with one security name per line (for example "SPX INDEX" for S&P 500, "SPY US EQUITY" for S&P ETF, or "XAU CURRENCY" for silver), retrieving each security holding from an index, or by reading securities from a Bloomberg client portfolio (PRTU <Go>). The next step is to select the search mode, and time scale desired. Keep in mind that our signals remain active for about as long as it takes to build the signal, which is on average 40 bars (The biggest effect is in the first third of that time though). This means that a single quarterly signal may be predictive for years, while a daily scale event may last for weeks.



The next menu has a list of filters to apply:

1. Trade Quality: Three signal quality thresholds are provided. We have found that some researchers don't mind seeing less predictive signals, while others just want the few best ones. We recommend leaving this on "Trade".
2. Price Filter: Sets a minimum price level.
3. Liquidity Filter: Ensures that securities with volume actually have volume on every trading day. It also ensures a sufficient level of volume for reasonable investment.
4. Default Preferences:
5. **Additional Filters:**
 - a. **Data filter** guards against spikes, excessive gaps, missing data, or improperly sequenced data.
 - b. You may check "**New Signals Only**" to see only signals that just occurred, while if you leave it unchecked, you'll see older signals that are still active.
 - c. By checking "**Remember Filtered**", the program will remember which securities were excluded and not search them again.

Setting Details

SOURCE

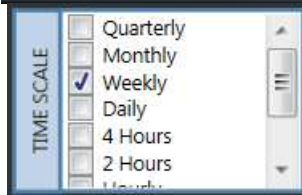
Single Security
 Securities List
 Index Holdings
 Portfolio Holdings

Single Security	Enter any single security, for example "MSFT US EQUITY"
Securities List	<p>A text file created using Notepad or other text editor with a list of securities, one per line, in the following format: <security name> space <exchange code> space <yellow-key>. For example:</p> <pre>AH US Equity KAR US Equity MSFT US Equity IBM US Equity EURUSD Curncy USDCAD Curncy GC1 Comdty CA1 Comdty</pre>
Index or ETF Holdings	<p>Search the securities that make up an index by typing the Bloomberg index or ETF name at the prompt. For example, SPX or SPY US EQUITY for the S&P 500 index:</p> 
Client Portfolio	<p>Bloomberg offers clients the ability to keep portfolios on their system using PRTU <go>. If you wish to search only your portfolio securities, then enter your portfolio name at the prompt. It should be in the following format: U1234567-1</p> 

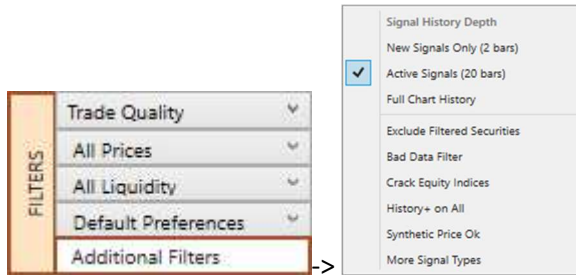
MODE

Securities
 Ratio Spreads
 Options

Securities	Search for ExtremeHurst signals on simple securities
Ratio Spreads	Search for ExtremeHurst signals on ratio spreads to a common denominator
Options	Same as "Securities" except daily in-the-money option series are also searched



Time Scale	Select which time scale to search for ExtremeHurst signals
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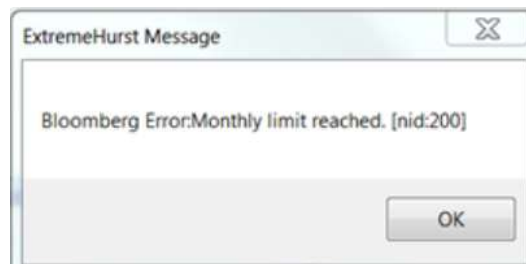
Trade Quality	Set the minimum rank for signals, where the higher the better the performance. Max=99, Trade=95+, High=90+, Medium=80+, and Explore 0+ (unfiltered)
Price Filter	This option limits the minimum allowable price of an equity or index
Liquidity Filter	With this option checked, the average daily dollar trading volume for Indices and equities must exceed a minimum limit to be considered.
Preferences	The default searches only the bars shown, while more also searches double length bars.
New Signals Only	Check this option to search for new signals only
Active Signals	Check this to search the most recent 20 bars
Full Chart History	Check this to see the full chart history (very slow but good for macro analysis)
Exclude Filtered Securities	Check this option for the program to remember all the securities that have been disqualified for signal search. This memory will persist even when the program is closed
Data Filter	Check this option to filter out securities with missing data, recent data spikes, inactive bars, insufficient history, excessive gapping, or improper sequencing
Crack Equity Indices	If you run an index like SPX INDEX by itself and have this checked, all the holdings will also be scanned individually
History+ on All	If this is checked then when the "History+" button is pressed, history will be added to all listed resulting charts
Synthetic Prices	For weekly, monthly and all higher scales. This causes bars to form based on bars ending on the current date.
More Signal Types	If this is selected, more Parallax signal types will also be searched for. These include SmartChannel breakouts and reflections, and Price-Volume crosses

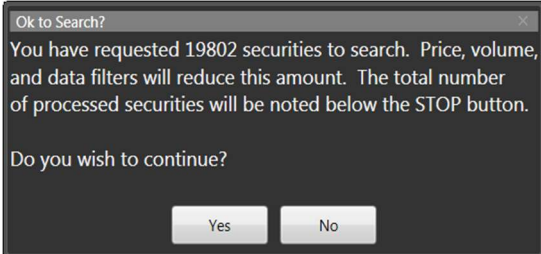
Signal Search and Progress



Functions

<p>Search for Signals</p>	<p>Press the search button to download historical price data from Bloomberg for the selected securities and then search that data for ExtremeHurst signals. The download procedure first checks that the average daily dollar volume is greater than the limit before requesting additional data. Look at the “Filtered” section below the STOP button to find out how many securities passed all the filters and have finished being run through the ExtremeHurst signal processor. In the example above, we show the search section before and during a search of S&P 500 stocks. Note that the search button is grayed-out until all downloading and calculations are complete. As shown in the example above, out of 275 securities downloaded, 228 had been passed to the processor, and 27 had completed so far.</p>
<p>STOP</p>	<p>The search procedure gathers data in chunks and then processes that data before gathering the next chunk. Press STOP to break the cycle and stop the processor from gathering additional data. It will complete the signal search using the data already downloaded however.</p>
<p>Note on CPU Usage</p>	<p>ExtremeHurst performs millions of complex mathematical calculations including Fast Fourier transforms, neural network math, and trigonometry calls during each run. You will notice a sharp increase in CPU usage during searches and on occasion the processing may even appear to halt. Be patient, it will complete.</p>
<p>Note on Data Usage</p>	<p>Bloomberg clients have monthly data usage limitations. We recommend that you carefully select a security universe, search for “New Signals” only, and then search once after the close each day for daily signals, once a week after the weekly close for weekly signals, etc., so you stay within your limits. ExtremeHurst reads 129 historical bars worth of OHLCV data for each security that passes through the filters. If you uncheck the New Signals button the application will take longer to run and require 15% more data. If you hit your limits you’ll see:</p>



<p>Note on Data Warning</p>	<p>If you ask for more than 1000 securities then this message comes up. As an example, In the US, the almost 20,000 listed equities are cut down to less than 2,000 by the filters. If you are unsure, press the STOP button part way through, or just make a security list in a text file and read it in.</p>	 <p>A dialog box titled "Ok to Search?" with a close button (X) in the top right corner. The text inside reads: "You have requested 19802 securities to search. Price, volume, and data filters will reduce this amount. The total number of processed securities will be noted below the STOP button. Do you wish to continue?" At the bottom, there are two buttons: "Yes" and "No".</p>
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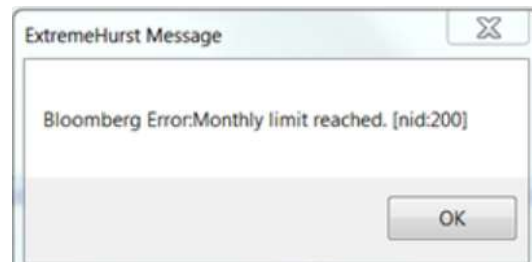
Considerations

CPU Usage

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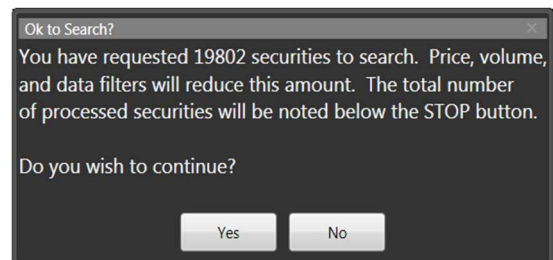
Data Usage

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Data Warning

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ExtremeHurst Signal List

Signals are listed in the window as the search progresses. The list has one signal per line, and each is described by the following: symbol name, exchange, security type, time scale, signal type, quality rank, forecast, and active dates. The button marked “More” is used to find historical signals and do a statistical test on them. A yellow box indicates that insufficient data was present to do this test. Green means the test was significant, while red means the opposite. Use the scroll bars to move through the signal list.

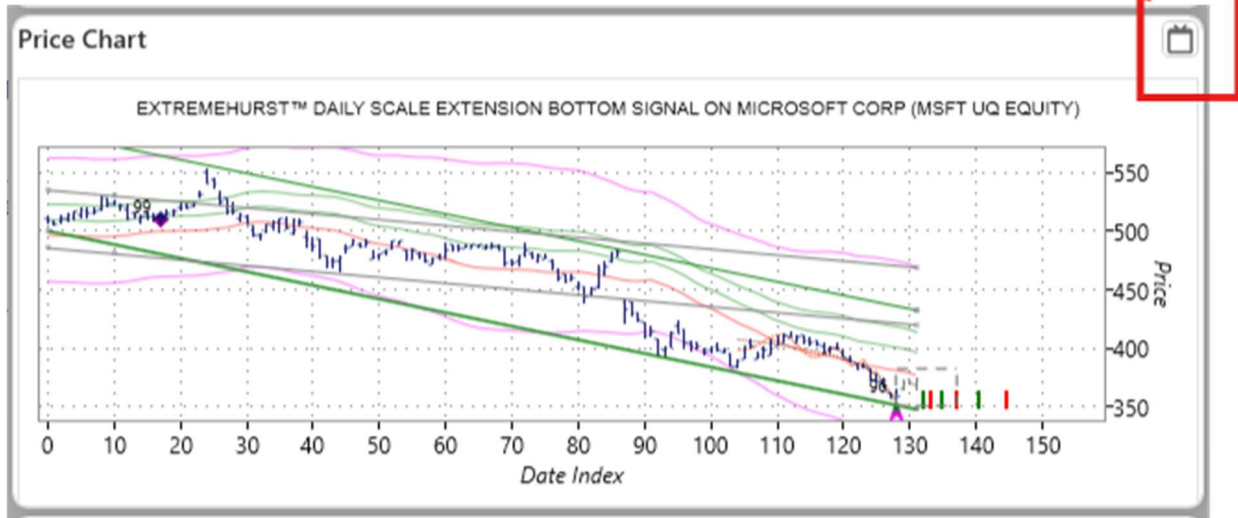
Security	Exch	Type	Scale	Signal	Rank	Forecast	Valid From	Until
AAPL UW Equity	UW	EQ	DY	Extension Bottom	87	Expect higher prices	2012-11-08	2012-12-06
AIV UN Equity	UN	EQ	DY	Extension Bottom	93	Expect higher prices	2012-11-14	2012-12-12
APA UN Equity	UN	EQ	DY	Extension Bottom	99	Expect higher prices	2012-11-16	2012-12-14
BF/B UN Equity	UN	EQ	DY	Extension Top	86	Expect lower prices	2012-11-27	2012-12-25
BMJ UN Equity	UN	EQ	DY	Extension Bottom	93	Expect higher prices	2012-11-15	2012-12-13
BXP UN Equity	UN	EQ	DY	Extension Bottom	93	Expect higher prices	2012-11-15	2012-12-13
BXP UN Equity	UN	EQ	DY	Extension Bottom	87	Expect higher prices	2012-11-14	2012-12-12
CHK UN Equity	UN	EQ	DY	Extension Bottom	84	Expect higher prices	2012-11-09	2012-12-07

Signal Attributes

Symbol	The Bloomberg symbol for this security	
Exch	The Bloomberg composite exchange where the security is listed	
Type	Abbreviation for the Bloomberg yellow key. EQ=Equity, CM=Commodity, CR=Currency, IN=Index, ET=Exchange traded fund	
Scale	Abbreviation for the sampling frequency, DY=Daily, WK=Weekly, MO=Monthly, and QT=Quarterly	
Signal	<p>There are two types of ExtremeHurst signals that we call “Extensions” and “Compressions”. These correspond to the extreme high and low ends of the Hurst Exponent distribution. There are two types of Extensions, top and bottom. Extensions mark the end of trends on that scale. Compressions are points of high potential energy that occur just before a new trend erupts.</p>	
Rank	Rank varies from 0 to 100 corresponding to the signal quality. To be a high quality signal, extreme high or low consistent Hurst Exponents, log-periodic oscillations (Sornette), and expected volume behavior need to be easily distinguishable once data corrections and filters are applied. The higher the rank, the better the signal’s expected outcome.	
Forecast	Abbreviation for the behavior we expect from the three signal types.	

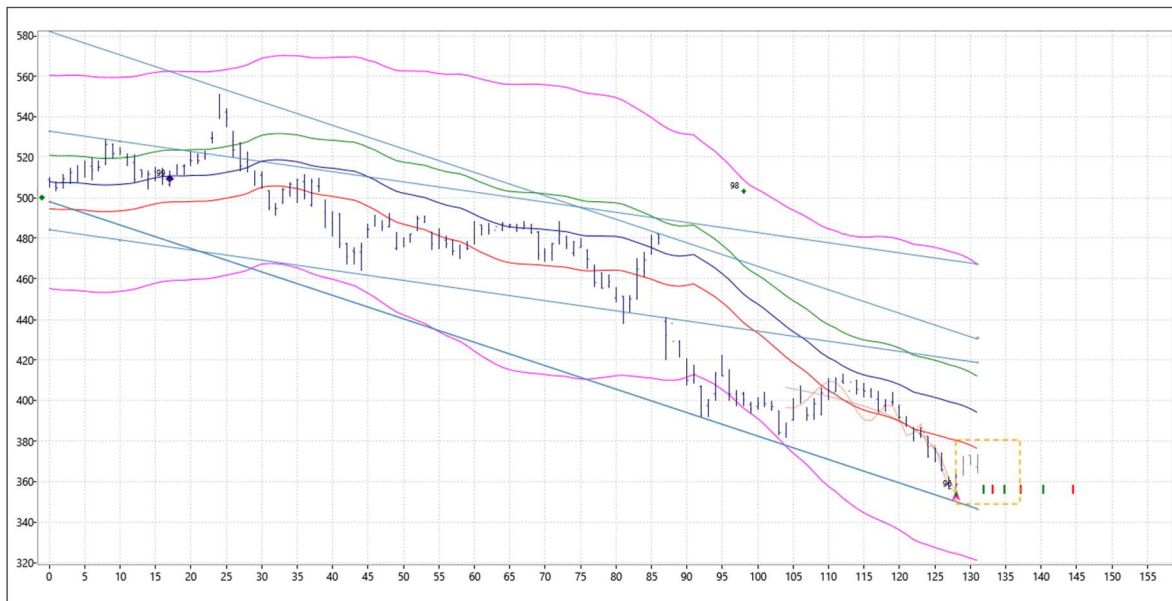
Valid From	Date from which the forecasted behavior should start to appear.
Until	This is the Date after which it is unlikely that signal effects will be evident. Note here that this is set at 20 bars currently. Expect signals that had longer build-up times to have effects lasting longer, and vice versa.

Chart of Selected Signal











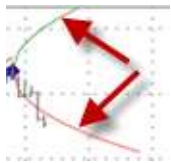


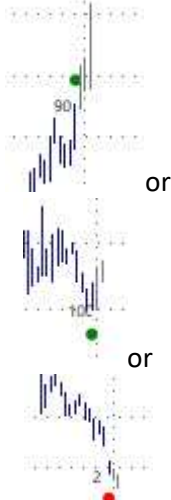
The red box above contains a link to pop out a bigger chart:

EXTREMEHURST™ DAILY SCALE EXTENSION BOTTOM SIGNAL ON MICROSOFT CORP (MSFT UQ EQUITY)
Analysis as of April 03, 2026



Symbol Explanations

Marker	Symbol	On Mouse Hover
Extension Top marker		Active Signal Date: 8/28/2012 Type: Extension Top Price: 58.3 Scale: daily Rank: 86
Compression marker		Active Signal Date: 9/4/2012 Type: Compression Price: 423.61 Scale: daily Rank: 89
Extension Bottom marker		Active Signal Date: 8/10/2012 Type: Extension Bottom Price: 31.67 Scale: daily Rank: 92
Price bars		Price Data Date: 8/6/2012 Open: 32.8 High: 32.8 Low: 32.53 Close: 32.59
Extension Cycle Top markers		Extension Cycles Date: 9/7/2012 Type: Top expected Price: 33.5 Scale: daily Rank: 92
Extension Cycle Bottom markers		Extension Cycles Date: 8/31/2012 Type: Bottom expected Price: 32.74 Scale: daily Rank: 92

Accelerating Trend (Extensions only)		Price
Log-Periodic Oscillations		Price
Average Compression trend path		<div style="border: 1px solid gray; padding: 2px; width: fit-content;">Average Post-Compression Uptrend Path</div> <p>or</p> <div style="border: 1px solid gray; padding: 2px; width: fit-content;">Average Post-Compression Downtrend Path</div>
Price Volume Cross Sell		<div style="border: 1px solid gray; padding: 2px;"> <p>PV Cross Sell</p> <p>Date: 3/30/2012</p> <p>Type: PVX</p> <p>Price: 93.34</p> <p>Scale: daily</p> <p>Rank: -8.54</p> </div>
Price Volume Cross Buy		<div style="border: 1px solid gray; padding: 2px;"> <p>PV Cross Buy</p> <p>Date: 4/19/2012</p> <p>Type: PVX</p> <p>Price: 71.5</p> <p>Scale: daily 30</p> <p>Rank: 8.61</p> </div>
SmartChannel Breakout Buys & Sells (Upside false break sell not shown)	 <p style="text-align: center;">or</p> <p style="text-align: center;">or</p>	<div style="border: 1px solid gray; padding: 2px;"> <p>Low Break Buy</p> <p>Date: 11/30/2021</p> <p>Time: 4:00 PM</p> <p>Type: Break</p> <p>Price: 198.74</p> <p>Scale: monthly</p> <p>Rank: 100</p> </div>

<p>SmartChannel External Reflections (External reflection sell not shown)</p>		<p>Ext Support Buy Date: 1/25/2022 Time: 4:00 PM Type: Support Price: 5.8432112689023317 Scale: daily Rank: 96</p>	
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ExtremeHurst Output Options

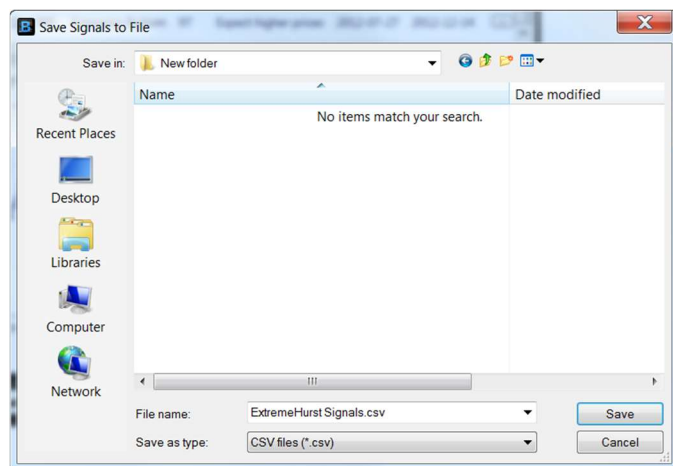


There are seven output-related buttons across the bottom:

1. **Save Signals:** write the signals to a CSV file.
2. **Copy Signals:** place the signal data in the clipboard, so it can be pasted into a spreadsheet or other compatible document.
3. **Clear Signals:** wipe the signal list clean.
4. **Print Screen:** send an image of the current dialog box to the printer.
5. **Copy Screen:** send an image of the current dialog box to the clipboard.
6. **Analysis v:**
 - a. **Add History:** add historical signals and other studies to the chart.
 - b. **Macro Analysis:** perform an historical analysis of persistent trends and extreme behavior (new).
7. **Chartbook v:**
 - a. Add current signal chart image to a document for printing.
 - b. Automate adding all the most recent signals for each security to a booklet for printing.

Details and Examples

Save Signals Press this button to save the signal list to a comma delimited text file.



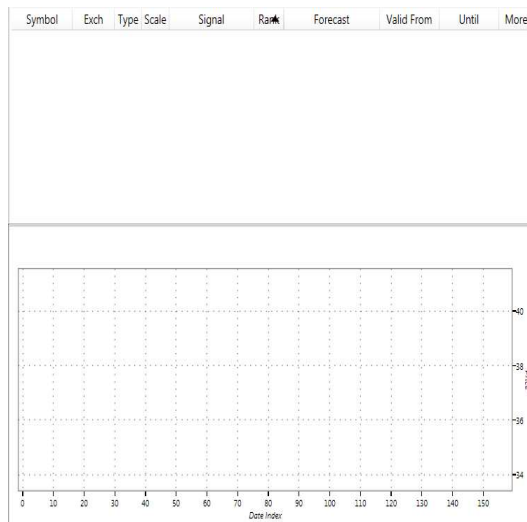
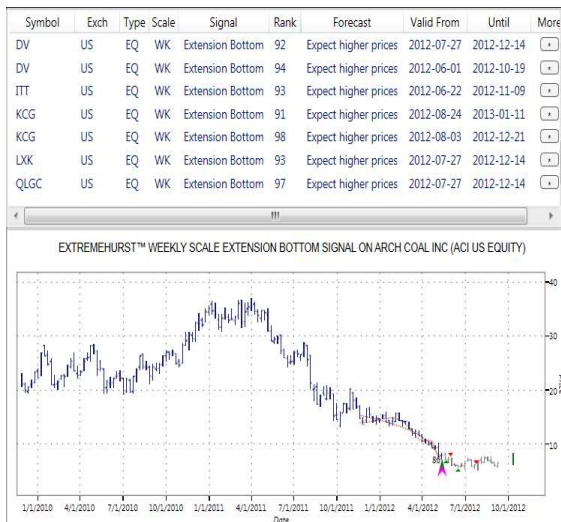
Copy Signals

Press this button to save the signal list to the Windows clipboard. Below is the signal list pasted into EXCEL.

	A	B	C	D	E	F	G	H	I	N	O	P	Q	R
1	Symbol	Region	Type	Scale	Signal	Rank	Forecast	ValidFrom	Until	Name	Sector	Industry	Cycle1_Date	Cycle1_Dir
2	DLTR	UN	EQ	WK	Extension Top	95	Expect lower prices	4/27/2012	9/14/2012	DOLLAR TREE INC	Consumer Cyclical	Retail	5/30/2012	Top
3	FTI	UN	EQ	WK	Extension Bottom	87	Expect higher prices	6/1/2012	10/19/2012	FMC TECHNOLOGIES INC	Energy	Oil&Gas Services	7/5/2012	Top
4	KMB	UN	EQ	WK	Extension Top	86	Expect lower prices	7/27/2012	12/14/2012	KIMBERLY-CLARK CORP	Consumer Non-cyclical	Household Products/Wares	8/7/2012	Top
5	LXK	UN	EQ	WK	Extension Bottom	90	Expect higher prices	7/27/2012	12/14/2012	LEXMARK INTERNATIONAL INC-A	Technology	Computers	8/7/2012	Bottom
6	ORLY	UN	EQ	WK	Extension Top	87	Expect lower prices	4/27/2012	9/14/2012	O'REILLY AUTOMOTIVE INC	Consumer Cyclical	Retail	5/14/2012	Bottom
7	RAI	UN	EQ	WK	Compression	99	Breakout w/trend	6/8/2012	10/26/2012	REYNOLDS AMERICAN INC	Consumer Non-cyclical	Agriculture	7/3/2012	Bottom
8	RAI	UN	EQ	WK	Compression	99	Breakout w/trend	6/1/2012	10/19/2012	REYNOLDS AMERICAN INC	Consumer Non-cyclical	Agriculture	6/28/2012	Top
9	ROST	UN	EQ	WK	Extension Top	89	Expect lower prices	5/4/2012	9/21/2012	ROSS STORES INC	Consumer Cyclical	Retail	5/16/2012	Top
10	SHW	UN	EQ	WK	Extension Top	96	Expect lower prices	6/8/2012	10/26/2012	SHERWIN-WILLIAMS CO/THE	Basic Materials	Chemicals	6/18/2012	Top
11	VLO	UN	EQ	WK	Extension Top	87	Expect lower prices	9/7/2012	1/25/2013	VALERO ENERGY CORP	Energy	Oil&Gas	9/21/2012	Bottom

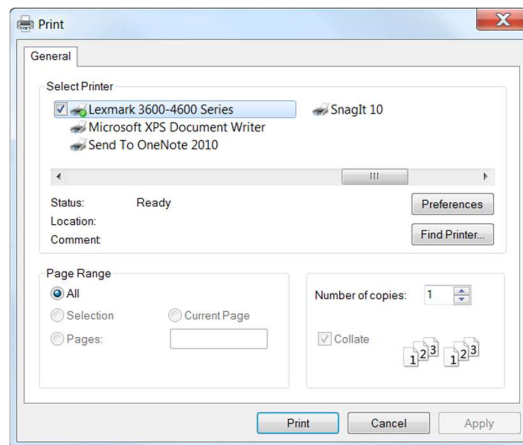
Clear Signals

Press this button to clear the signal list and chart.



Print Screen

Press this button to print a copy of the screen image.



Copy Screen


Press this button to copy an image of the screen to the windows clipboard. This allows you to paste the image in a report or email.

The screenshot displays the Parallax Extreme Hurst software interface. At the top, the Parallax Financial Research, Inc. logo and the Extreme Hurst™ branding are visible. Below the header, there are several filter panels: SOURCE (Securities List selected), SECURITY (Equity selected), SCALE (Monthly and Weekly selected), and FILTERS (Trade Quality, All Prices, Liquidity above \$1M, More Signals, and Additional Filters). A 'Signal Search' section shows 'Downloading Data' and 'Computing Signals' progress bars. The main area features a table of search results:


Security	Exch	Type	Scale	Signal	Rank	Forecast	Valid From	Until
BP1	Curncy	Curncy	WK	Compression	99	Expect a new trend	2019-05-10	2020-01
CC1	Comdty	eNYB	Comd	WK	99	Expect a new trend	2019-05-17	2020-05
CD1	Curncy	Curncy	WK	Compression	99	Expect a new trend	2019-06-21	2020-01
S 1	Comdty		WK	Extension Bottom	97	Expect higher price	2019-05-17	2019-11
XAG	Curncy	Curncy	WK	Extension Top	98	Expect lower price	2019-09-06	2020-03
XAU	Curncy	Curncy	WK	Extension Top	97	Expect lower price	2019-09-20	2020-06
XAU	Curncy	Curncy	WK	Extension Top	95	Expect lower price	2019-09-13	2020-06

Below the table is a chart titled 'EXTREMEHURST™ WEEKLY SCALE COMPRESSION SIGNAL ON GENERIC 1ST 'BP' FUTURE (BP1 CURNCY)'. The chart shows a price history from 1/1/2017 to 10/1/2019. A blue dot on the chart indicates the signal date (May 10, 2019). A green dashed line shows an upward trend, and a red dashed line shows a downward trend, both originating from the signal point.

At the bottom of the interface, there are several buttons: Save Signals, Copy Signals, Clear Signals, Print Screen, Copy Screen, History +, Chartbook +, and Help.

 Add History

Analysis ▾

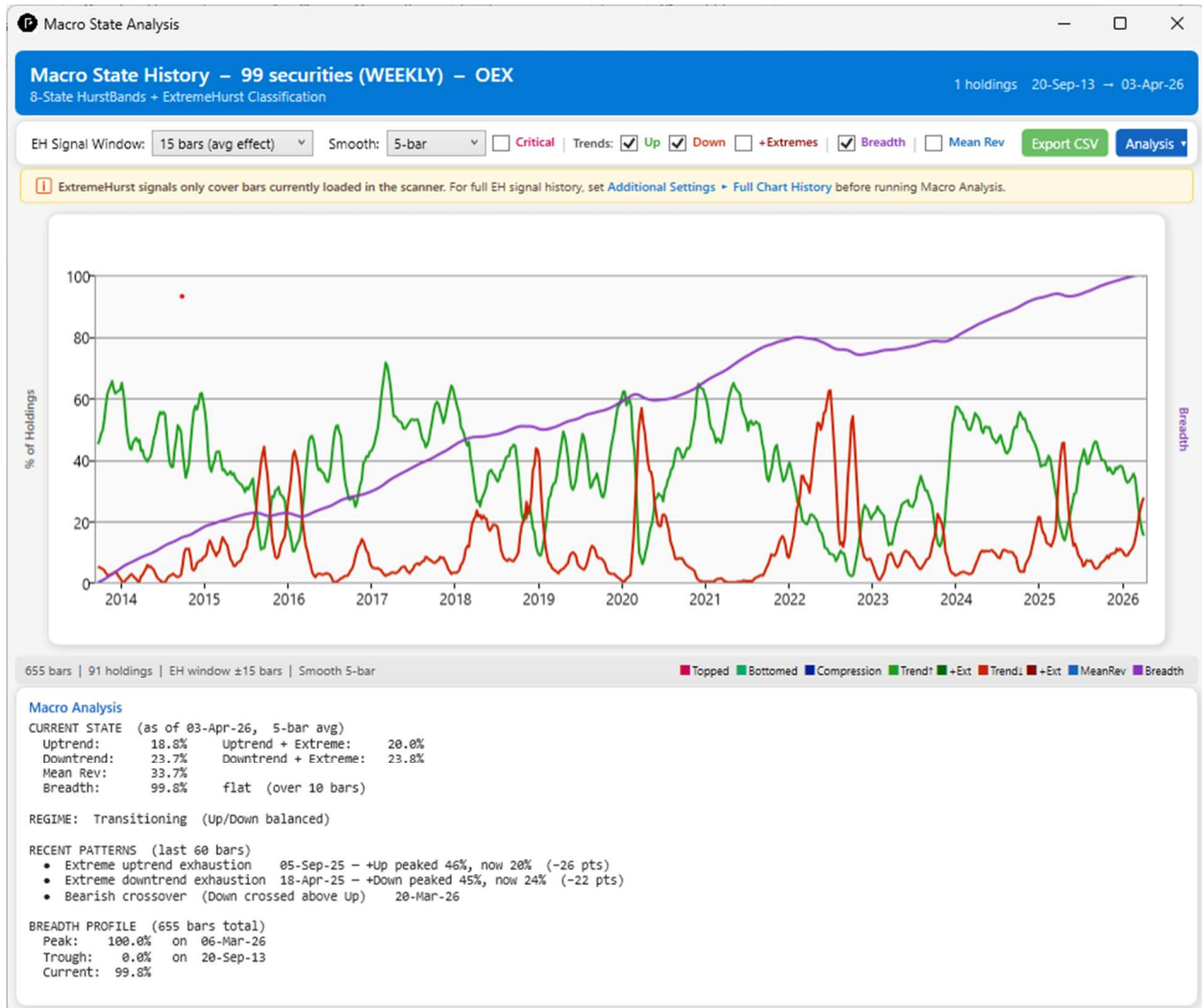
 Macro Analysis

Press the “Add History” button to add historical signals and additional studies to each chart. Once pressed, we gather additional data for the particular security and do a statistical calculation to see if other ExtremeHurst signals in the past behaved as expected. We also add two other signal types, SmartChannel (Custom Study “PFSC”) and Price-Volume Crossovers (Custom Study “PPVC”). The Price-Volume crossover signals are useful bottom and top indications that last for about up to 6 bars.

EXTREMEHURST™ 60 MIN SCALE EXTENSION TOP SIGNAL ON GOOGLE INC-CLA (GOOG UW EQUITY)

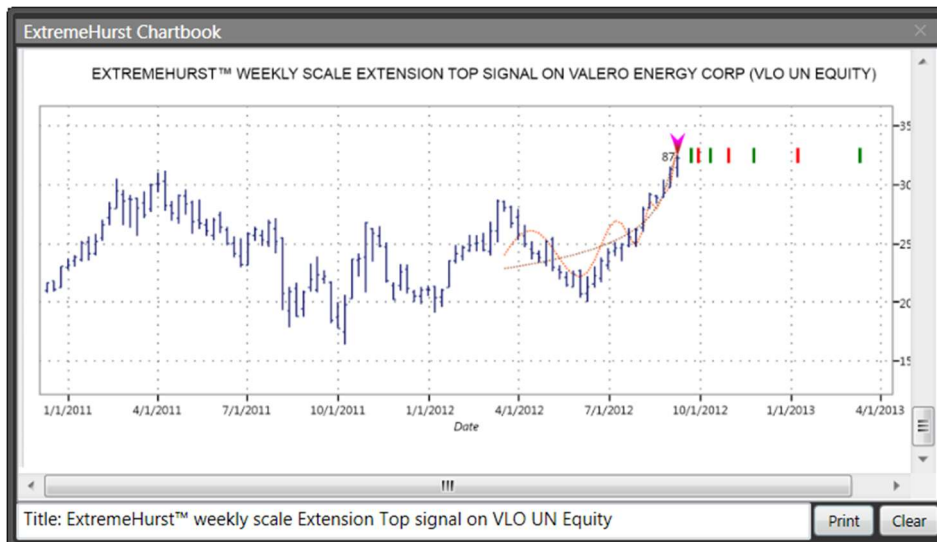


Macro Analysis is a new tool to make a historical chart showing the number of index or etf holdings in different dynamic states, such as persistent up or down trends, mean-reverting, at critical points. Here is an example from the OEX:



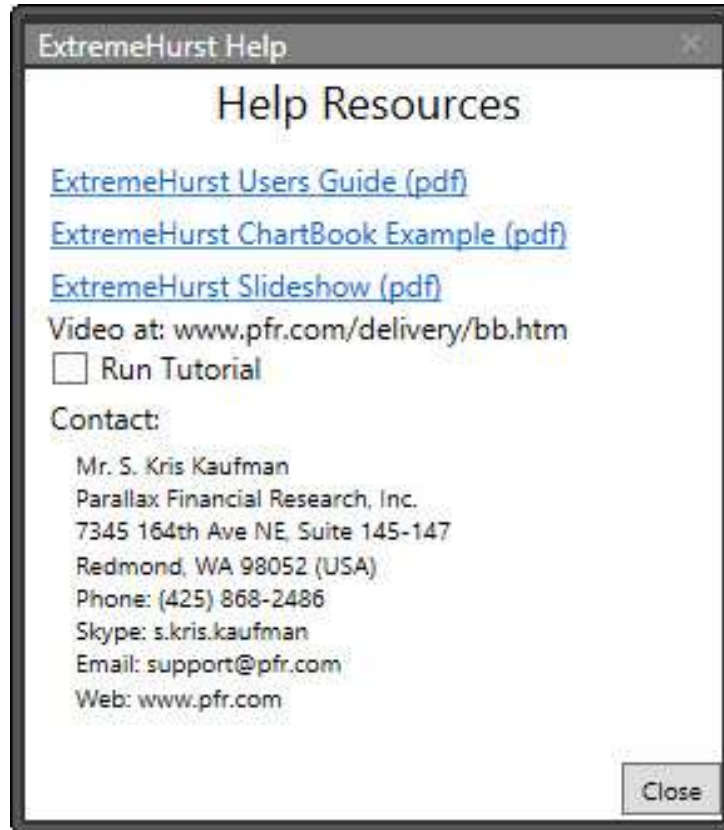
Chartbook +

Press this button to accumulate the current chart image to a book for later printing and review.



Help

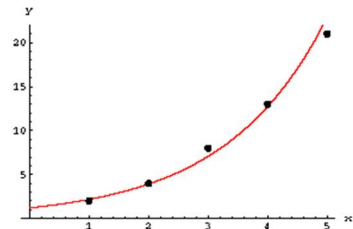
Our Help screen is shown below.



ExtremeHurst Science

This section covers the basic science behind and the empirical results from our ExtremeHurst™ market predictor model. Our research started in the late 80's with the observation that market series appeared to have no unique trend. An uptrend on a 5-minute chart might be embedded in a daily scale downtrend, and a monthly scale uptrend, etc. It also made intuitive sense that no unique trend exists. After all, if it did, then all investors would quickly exploit it for profit. So, following this line of thought, we wondered what would happen next if a financial series simultaneously showed a measurably strong trend on at least two adjacent time scales, or even three. This is a deceptively simple question, but how is trend measured? How much trend is a strong trend? Are there preferred time scales? How much data is needed to evaluate trends? The answers to these questions led eventually to the discovery that elements of complexity theory, namely **self-organized criticality** and **discrete scale invariance** (discovered independently and named by Didier Sornette), have a statistically significant predictive power in financial markets and elsewhere. Here are the highlights of the journey.

Most scientists and engineers graduating in the 80's or earlier were trained in the idea that experimental data usually approximated some smooth function, but with a bit of random measurement error. To the untrained eye, stock price data looks very similar to a smoothly trending signal covered up by a large amount of random noise. Even the price return distribution resembles a normal distribution, which implies a random process. The standard engineering approach in cases like this would be to fit a regression curve to the market series and write off the remainder to random noise¹. Once a smooth curve was found that fit prices well enough, one would just find the slope ("trend") at each point. The trend would be unique, and its direction would dictate the trade direction.

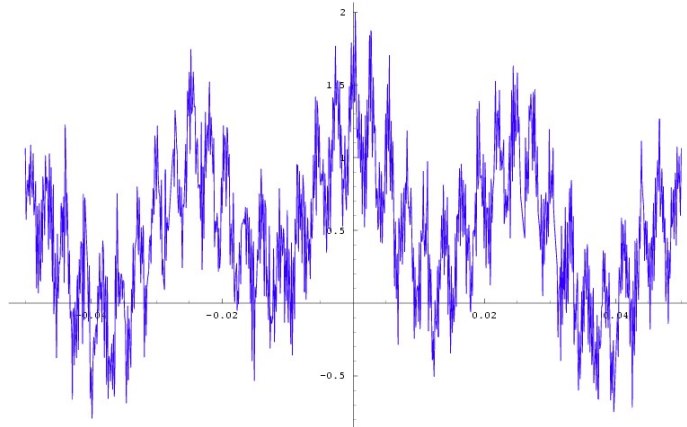


The figure above shows a typical regression curve fitted to data with the remainder attributed to random sources.

If this sounds too simple to be true, you have graduated to the rest of the story.

Chaos theory covers the dynamics of feedback systems and is a subset of Complexity theory. In the financial markets we can imagine that price movement, news, or possibly influential people produce investment bias "output" that is fed into the brains of the investor community, who then produce new outputs in the form of buy and sell decisions. If this bias is positive, buying occurs, which leads to higher prices and more positive bias, etc. Feedback systems exhibit certain characteristics, which strangely enough, seem to match the kinds of phenomena that market technical analysts have attributed to markets over the last 100 years. The primary example of this is called **self-similarity**.

Financial series appear to have the same “look” on many different time scales. This is called self-similarity, and it happens to be one of the best ways to confirm that a series is governed by the rules of chaos theory. Put another way, the market appears to be what Mandelbrot called a “fractal.” Not quite like a fern or a snowflake, but more of a statistical fractal, like a shoreline. We chose a fractal function developed by Weierstrass to model a market series. Weierstrass functions are continuous, meaning you can draw one without lifting your pencil, but they have no unique slope. They look like a cycle inside a cycle inside a cycle, as shown in the next figure. Market technicians call this effect the “Elliot Wave”, but self-similarity has a much deeper theoretical meaning, one firmly based in non-linear dynamics.



Weierstrass functions[8] show nested cycle patterns. It has no unique slope at any point. Equation:

$$f(t) = \sum_{k=1}^{\infty} \lambda^{(s-2)k} \sin(\lambda^k t), \quad 1 < s < 2, \quad \lambda > 1$$

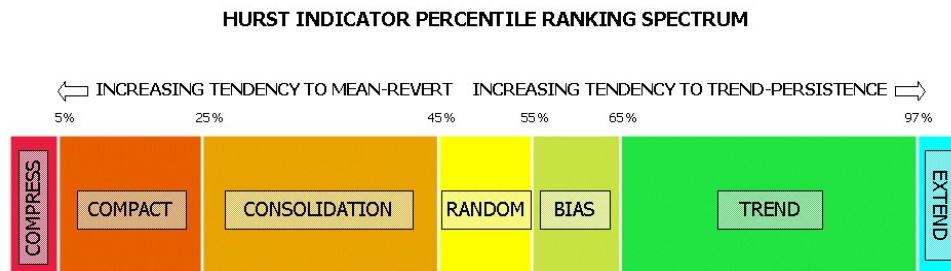
According to our model, a 5-minute chart will exhibit a different slope at a given moment than the same chart viewed on a 60 minute, daily, weekly, or monthly scale. It all depends on the length of your time sampling. Again, this is nothing new to traders, but it represents a radical shift for scientists and engineers. Faced with a non-unique trend, we decided to make multiple measures of trend on different scales. Eventually, this led to the research question of what might happen if all the time scales agreed.

Theoretical Considerations:

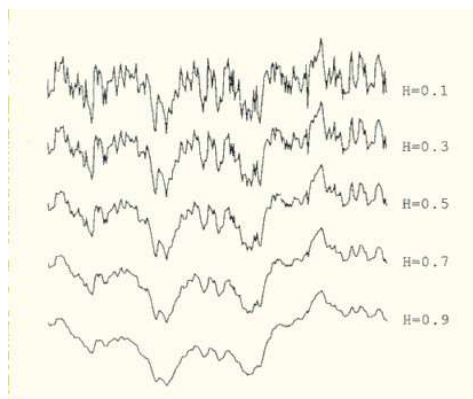
To measure trend, we used a special scale-limited form of the Hurst exponent. The Hurst exponent has a simple formula and ranges in value between 0 and 1. Values above ½ indicate that there is a trend to events, with very high values (towards 1) corresponding to strong trends, with a marked tendency to persist. Values below ½ correspond to mean-reverting behavior, which becomes more and more tightly constrained as the exponent approaches 0. The formula for the exponent is:

$$\left(\frac{R}{S} \right)_N = (cN)^H$$

Where $(R/S)_N$ is the range of the cumulative deviations from the mean divided by the standard deviation, c is a constant and H is the Hurst exponent. The following picture shows the Hurst exponent placed on a percentile rank scale of our choosing:

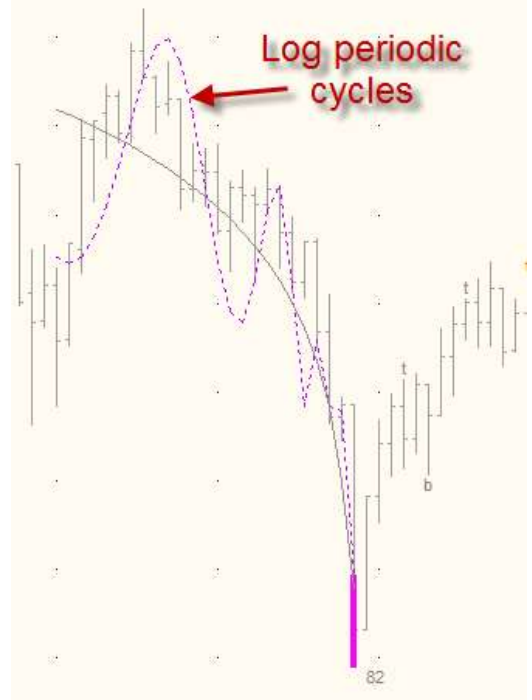
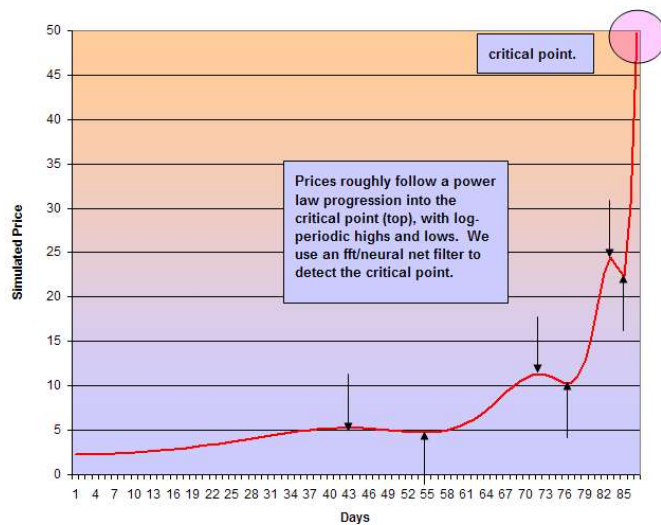


The following picture is an example of what a time series might look like using different Hurst exponents:



Using the Hurst exponent, we can identify price swings which have high autocorrelation and resemble power law upswings or downswings such as the ones shown in the following pictures:

Simulated Log-Periodic Price Extension (Positive Feedback)



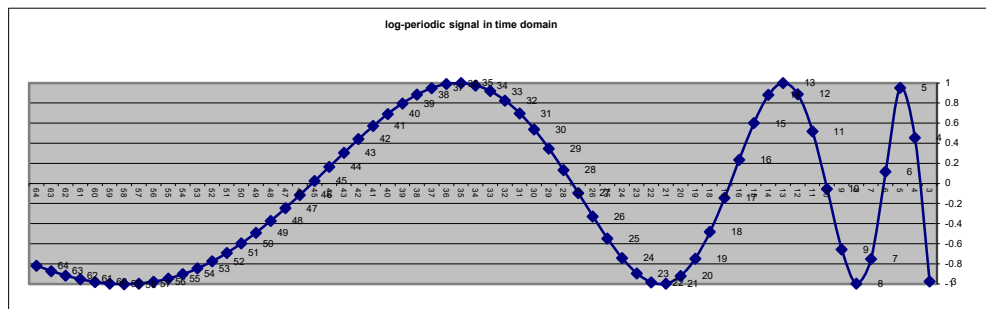
There was another key timing factor in addition to the parabolic price move, one which we literally stumbled upon while trying to limit our scale sampling size for calculating the Hurst exponent. **Cycles** were present during these parabolic moves, and by exploiting them, we were better able to time the critical points. These cycles were the key to confirming that **markets are actually complex-numbered fractals** instead of the real-numbered fractals of Mandelbrot. Real numbered fractals look the same at all magnifications, while complex-numbered fractals do exhibit this property only occasionally.

Extremes of investor behavior are most evident in large scale market manias or crashes, but like earthquakes, significantly more low magnitude events occur than large ones. It is our contention **that markets set themselves up in critical states through feedback**, like earthquakes, and then we see tremor-like activity of all sizes and scales at both highs and lows. This area of scientific research is called "Self-Organized Criticality" or SOC for short. Bak, Tang, and Weisenfeld (BTW) first introduced SOC in 1987 by studying the occurrences of avalanches in sand pile models. It was their contention that large systems with many constituent parts, organize themselves into states that resemble systems in equilibrium at critical points.

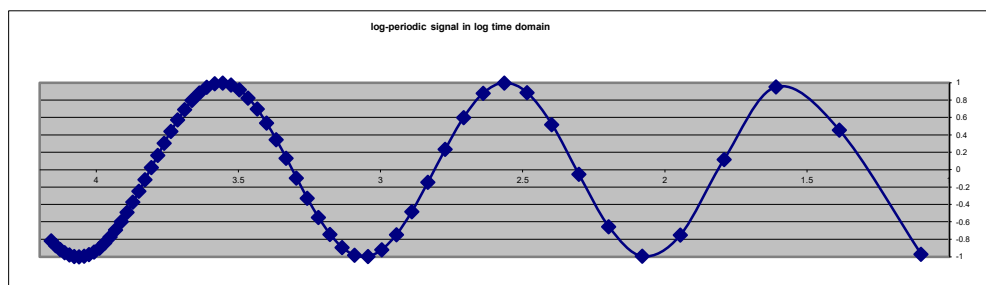
In the case of the markets, investors are influenced by news, price changes, and other investors within their social network. This influence conditions their willingness to buy or sell, which in turn affects price and influences others, and so on. One of the methods used to understand the dynamics of large critical systems is called the Renormalization Group Method this method uses scaling to make sense of complex systems. Temperature is an example of this idea. We wouldn't think of tracking each air molecule to calculate heat, so we characterize the behavior of a large group of molecules by their

temperature instead. We have applied this same method to learn some basic principles about markets: First, **it takes very few net buyers or sellers to trigger or end a buying or selling trend**. Second, the buildup to a critical point resembles a power law function and thus can be mathematically anticipated. Thirdly, price movements exhibit the dynamics predicted from a complex-numbered fractal solution. In the natural world, diffusion-limited aggregation, or crystal growth exhibits the same dynamics. The complex part of the fractal dimension yields a log-periodic **ripple in price that converges to the critical point**, and then diverges away from it¹.

In the time domain the small ripple signal² we search for looks like this:



While in the log time domain it becomes a sine wave:

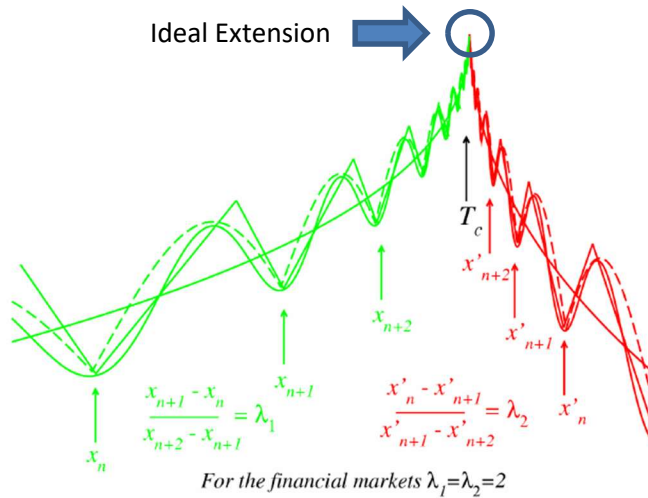


The filter we have created finds these critical points at the end of power law advances and declines. These are called **“extensions.”**

¹ The function for this behavior is $1+C2*\cos[p*\ln(1-t/tc)+q]$, where $\ln(x)$ is the natural log function, $\cos(x)$ is the cosine function, and $C2$, p , and q are real constants⁵⁵.

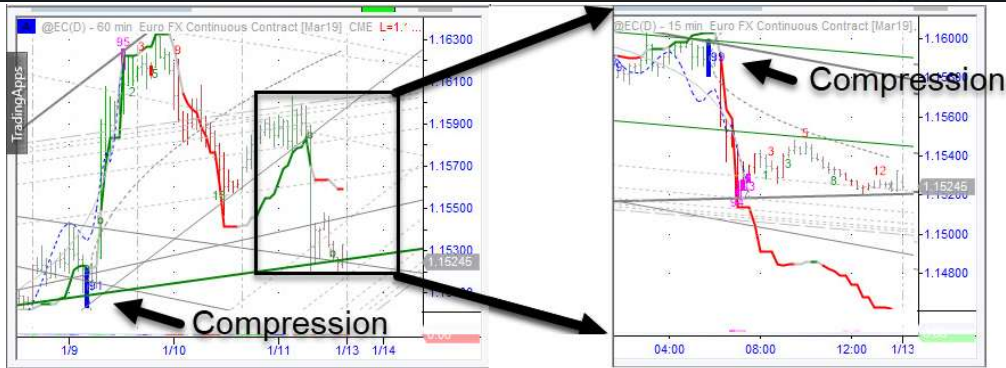
² Sornette⁵⁵ attributes this ripple to what he has called “discrete scale invariance” which means that the price series is only scale invariant at certain discrete times. He attributes this effect to fractal dimensions being complex numbers instead of real numbers. Translation: Discrete scale invariance occurs when all trend measurements at all scales agree with each other. Our filter is designed to find these critical points.

Log-Periodic View



There is another critical point not yet written about in the literature that we call “**compressions.**” A compression has the same log periodic behavior shown above, but without the power law advance or decline. A compression occurs at points of extreme mean reversion and is followed by the start of a new trend.

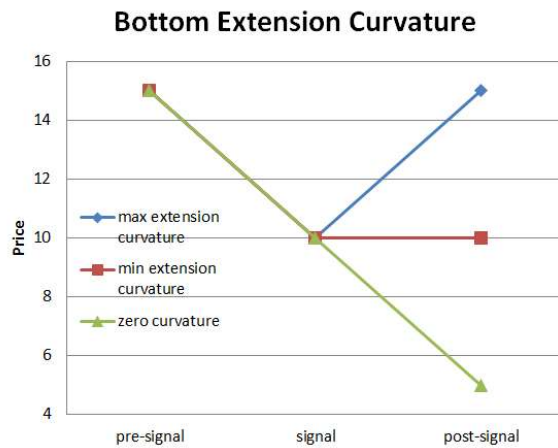
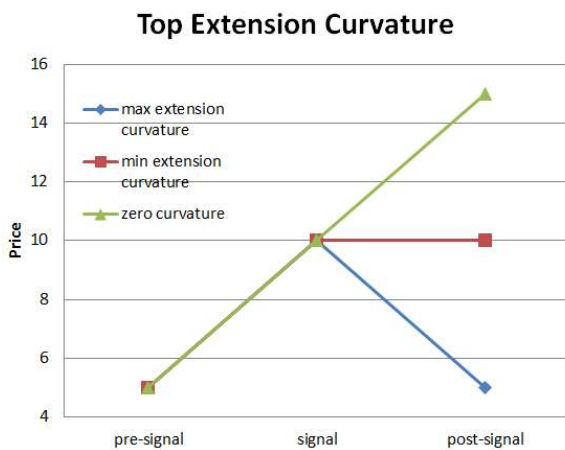




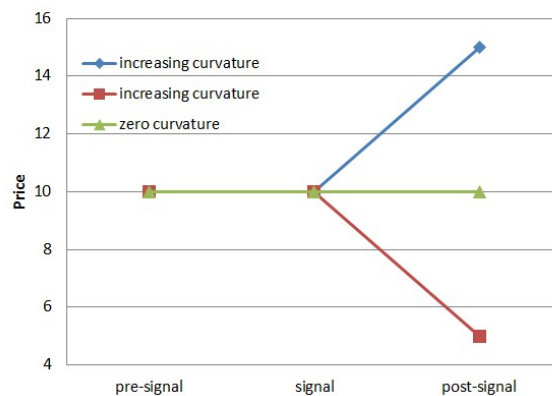
60 minute and 15-minute scale compressions

Turn Measurement Index (TMI)

ExtremeHurst signals predict market critical points which mark a change in trend, or in mathematical terms, increasing price curvature. There are three types of ExtremeHurst signals: Top and Bottom Extensions and Compressions. The predicted price behavior following a top extension is for price to cease moving up. Likewise, for bottom extensions we expect price to cease moving down. Compressions are preceded by flat periods, so the post-signal period must see price move away from current price and begin to trend:



Compression Curvature



These charts show the simulated periods before and after each of our signal types. The green lines show no trend change across the signal. We have created a tool to measure curvature called the Turn Measurement Index (TMI) which approximates the second derivative of a series using the following differential formula from Calculus:

2nd Order Central

$$f''(x) \approx \frac{\delta_h^2[f](x)}{h^2} = \frac{f(x+h) - 2f(x) + f(x-h)}{h^2}.$$

We have manipulated the formula to work with financial data on all scales using a “random walk” assumption. The final form looks like this (Taken from a Parallax research document):

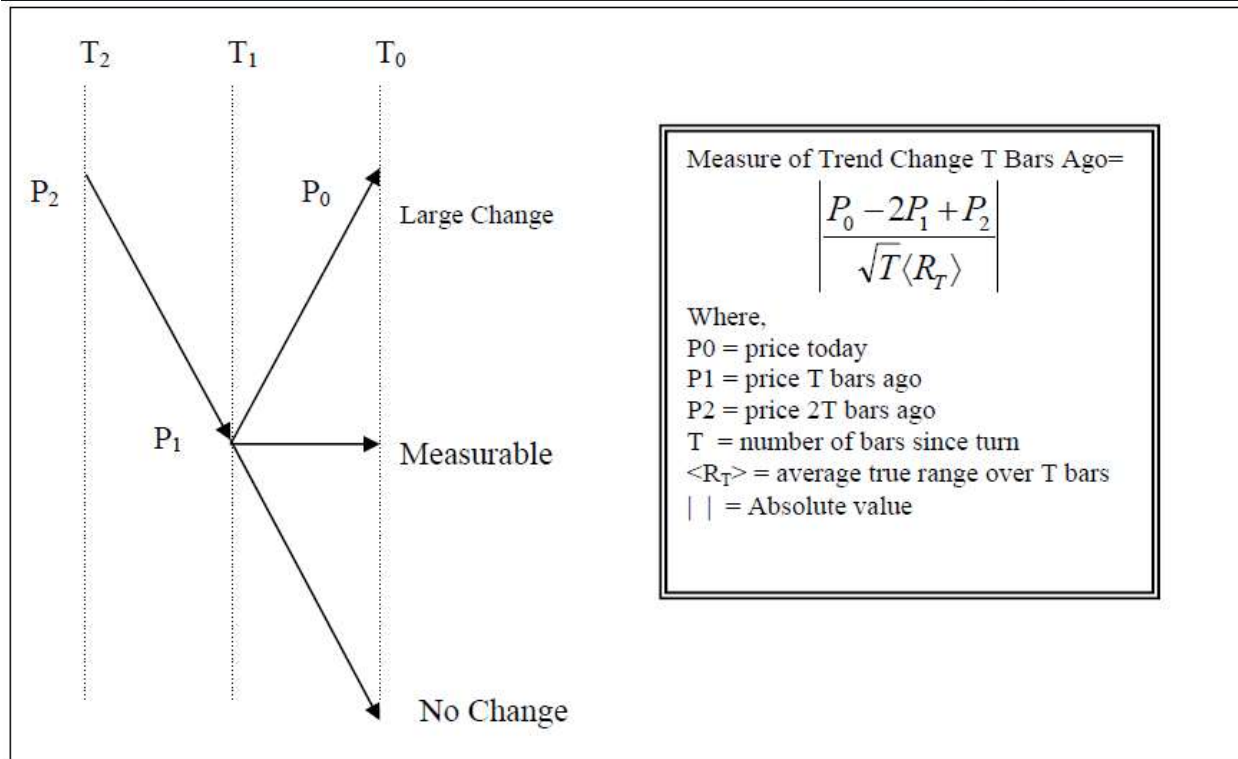


Figure 1. The Turn Measurement Index (“TMI”)

The graphic in Figure 1 illustrates how the **TMI** is calculated. When prices form a straight line, then the numerator goes to zero, meaning that there is no change in trend between the P2 to P1 segment, and the P1 to P0 segment. The $\langle R_T \rangle$ factor refers to the average true range over the whole period. Regular range is simply the change in price between today's high and low. The "true" range fills any gaps from the prior day. If yesterday's close is higher than the high today, then it is used in place of the high, likewise yesterday's close is used if it's lower than today's low. The length of time for this measurement can be varied, and different **TMI**s be compared with each other.

The next picture is an example of the TMI formula applied to Microsoft stock prices over lengths of 7 and 15 days:

TMI Calculation Example: Microsoft Price Series

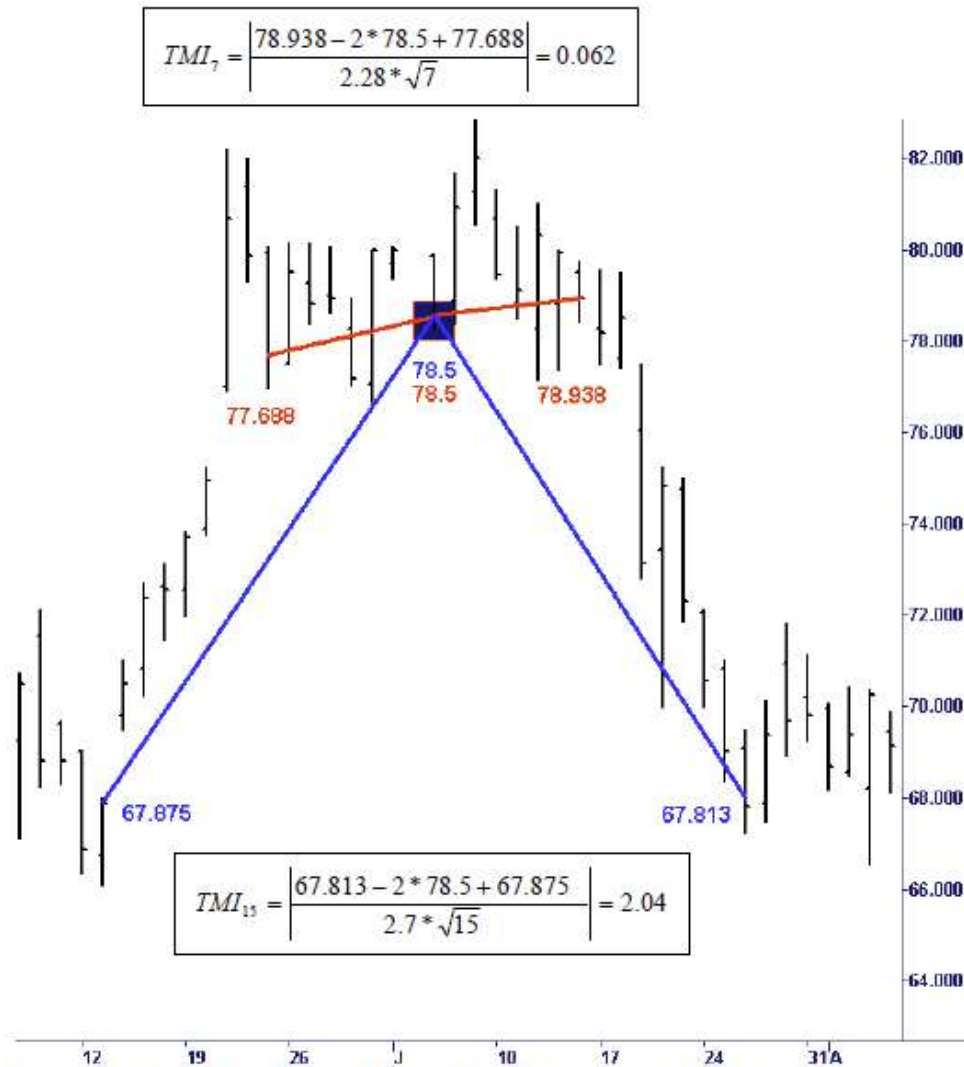


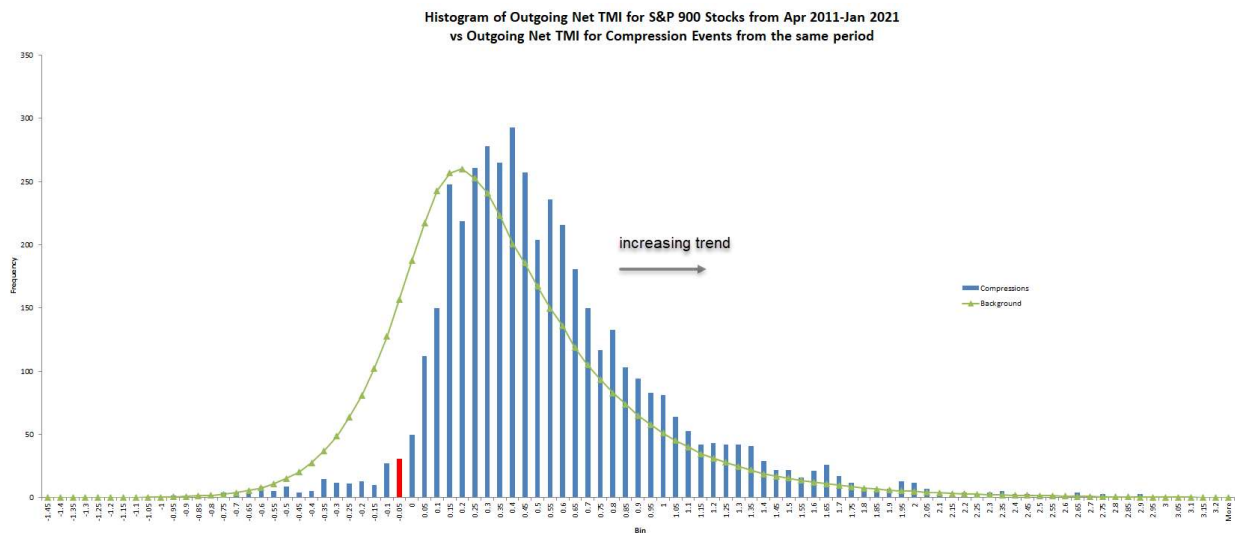
Figure 2. The TMI calculation for two different time intervals (7 and 15 days) surrounding the price of Microsoft stock on July 5, 2000 yields very different answers. We will use the maximum number to express “how much” trend-change occurred that day.

ExtremeHurst Testing Using the Turn Measurement Index (TMI)

Our ExtremeHurst product produces two signal types, Extensions, which mark the end of trends and the beginning of consolidations, and Compressions, that mark the end of consolidations and the beginning of new trends. In either case there is change in market price behavior. To better see the significance of that change we use the TMI indicator, which is a scale-independent measure of price curvature (absolute value of the 2nd derivative of price). To do these tests, we seek to measure the curvature contribution following a signal, both as an absolute number, and as a percentage of total curvature, and then compare these measures to a background of all bars (days in this case).

TMI numbers were calculated on daily scale S&P 900 (500 + 400) stocks from April 2011 through Jan 2021. ExtremeHurst events were generated using the latest distributed software on TradeStation with the default parameter settings (ranks >= 95). Overall more than 25k signals were found to study.

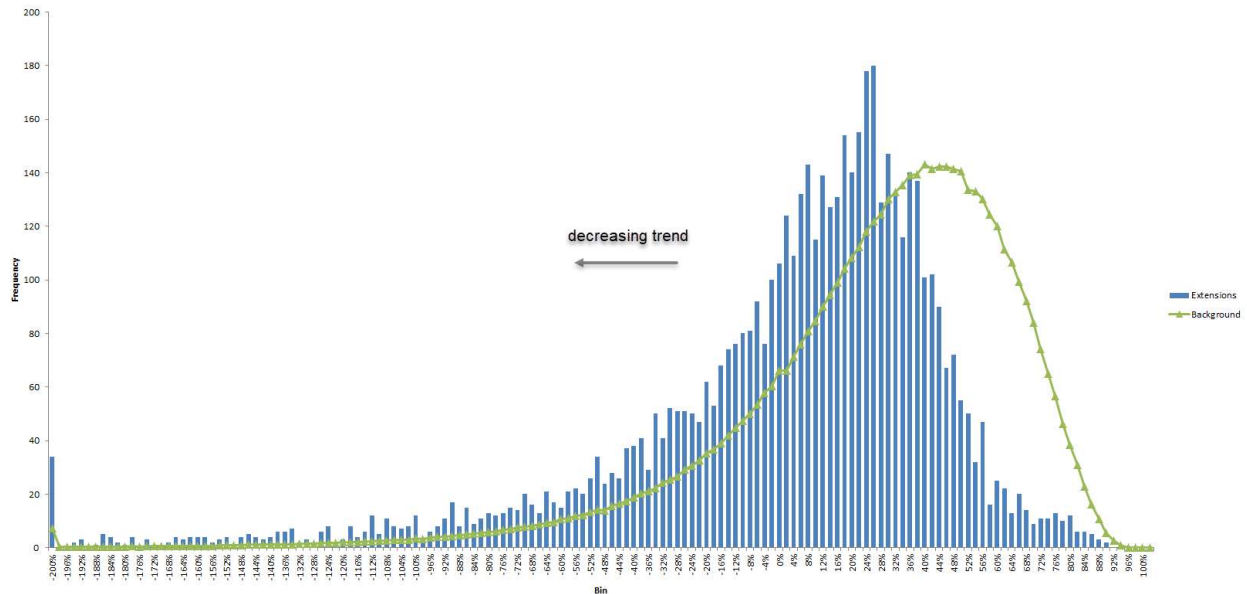
In the case of Compression events, our contention is that absolute curvature significantly increases immediately following signal. The histogram below shows this to be true and significant compared to the background of all days:



The green line shows the background distribution normalized to our signal count, while the blue bars show the distribution of our signals. The bins represent the net curvature following the signal. A number greater than zero (red bar) indicates a net increase in curvature. Clearly a significant (Chi-squared $p < 1.27 \times 10^{-177}$) increase in trend follows the compression signal.

Testing Extensions is a bit harder using TMI, as they mark the end of a trend period and the beginning of a consolidation. During the consolidation, expanding log-periodic cycles will be present, and there should be a significant reduction in overall trend. We therefore examine the curvature following the signal as a percentage of the overall curvature using the (TMI outgoing/full TMI) ratio for both types of Extensions.

Histogram of Outgoing TMI/Full TMI as a Percentage for S&P 900 Stocks from Apr 2011-Jan 2021 for All Extension Events within the period



Clearly, the overall curvature is significantly reduced following an Extension signal as compared with the background expectation that peaks at half (green curve normalized by the total Extension signal count).

ExtremeHurst Extension “Excitation-Relaxation” Behavior

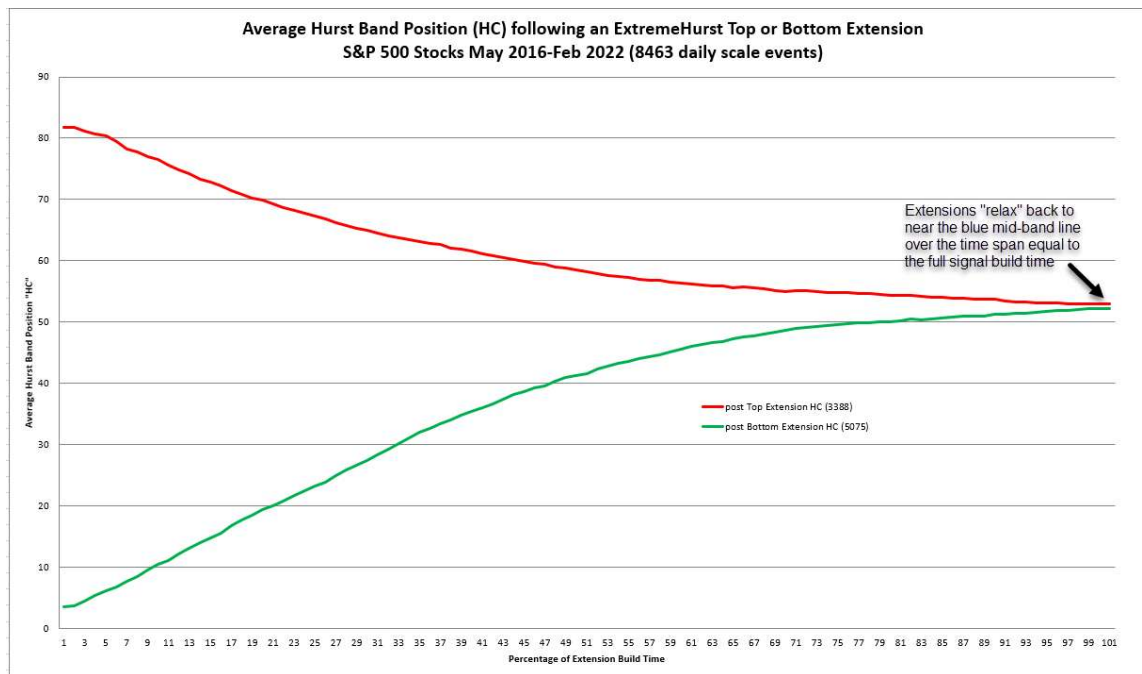
ExtremeHurst extension events occur because of **extreme positive feedback** on multiple scales with an associated converging log-periodic cycle. **The associated investor excitement leads to what is called self-organized criticality (SOC)**, as the rapid price movement inadvertently leaves the security in a critical state where everyone who wanted to participate has already done so. **It’s primed for a sudden reversal.**

In psychology, there is a limit to how long humans can remain in an excited state before they need to relax. If we similarly identify extensions as excited states, then where does price have to go for us to say that the group is now “relaxed”?

The Hurst Bands provide an answer. The inner blue band region is the center of stability, where equilibrium is re-established. Using our Hurst Band coordinate system, where the magenta bands span 0 to 100, the mid-band blue line is at 50, the first green line at ~67, and the first red line at ~33, we found that following an extension, price tends to consistently move back to the mid-band over the build full time.



Signal Name	HC	Max Edge%	Initial Edge%	Duration	Peak%	Decay%
Upper Magenta Band	100	-6.84%	-1.84%	43 bars	40%	50%
Lower Magenta Band	0	4.41%	1.70%	37 bars	24%	50%

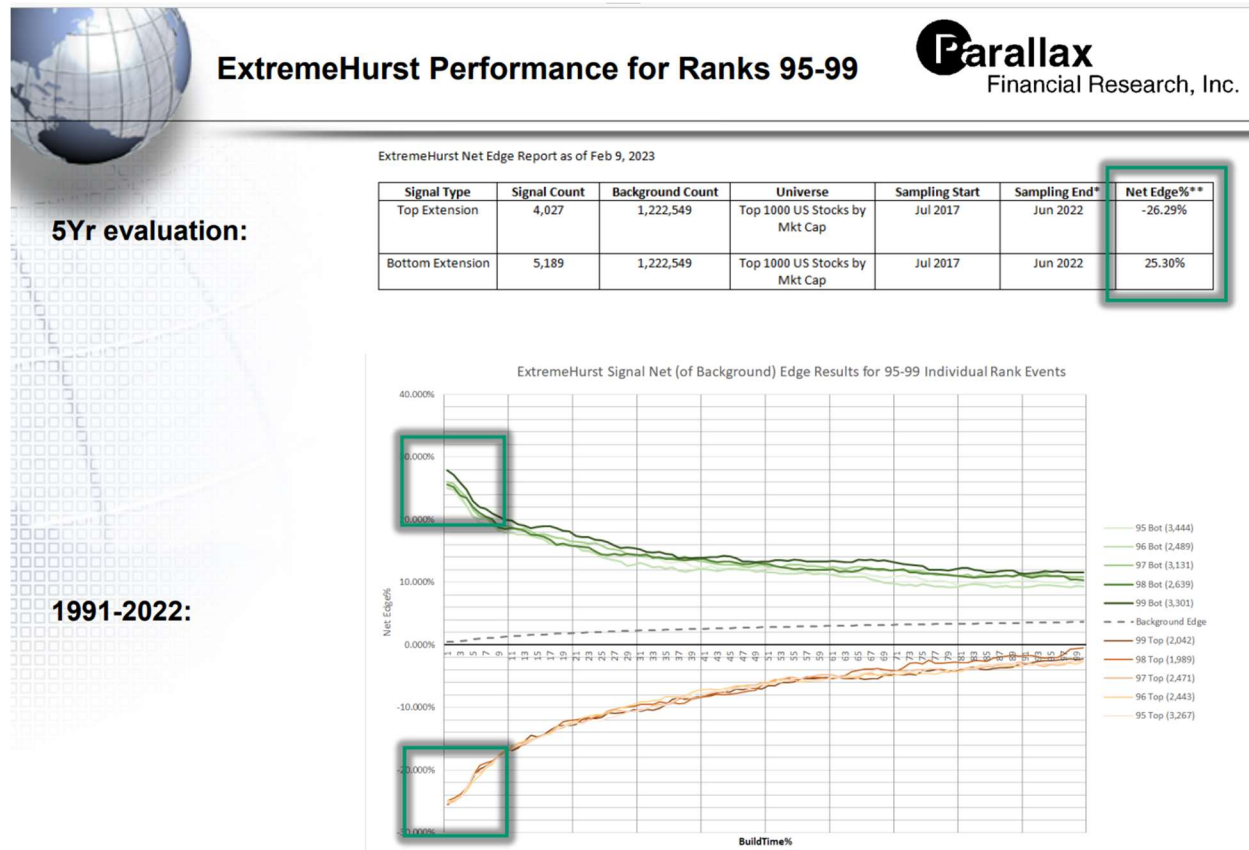


This is very important because **the Hurst band lines may now be used for profit take targeting.** In addition, we have also discovered that the mid-band's rate of change is a determining factor in selecting which extensions will be the most profitable

ExtremeHurst - Predictive Edge & Duration

There are three types of ExtremeHurst signals, top and bottom Extensions, and Compressions. Extensions mark the end of trends, while Compressions mark the end of sideways, mean-reverting periods. We measure the performance of our predictors by tracking whether the subsequent market prices were above or below the event by more than a random background drawn from the same time range and scale. We call that difference the **“Edge%”**.

Our time scale is often proportional to the time over which the signal is formed (**“build-time”**). That is the case with ExtremeHurst. The X-Axis below varies from 5% to 100% of the build-time. The edge usually diminishes as we move away from the event, where **a timely signal has a maximum edge at or near the beginning**. The Y-Axis is the edge, and to make it easier to read, sell signals will be shown with negative edges.



Glossary of Terms

Artificial Intelligence (AI)

Artificial intelligence refers to the simulation of human intelligence by software-coded heuristics. Specifically, software programs that emulate human neural networks are presented large datasets containing both the predictive factors and their associated target solutions during a learning phase. Training can be a lengthy process and often requires supervision. The resulting trained network is said to be intelligent if it can generalize what it learned to successfully operate on unseen data. Bias and memorization are the telltale signs of a poorly trained network. See Neural Net

Backtest

A statistical test performed on historical market data for the purpose of finding successful signals or strategies. The best testing practice should include multiple dissimilar securities over many time scales and over enough years to include many economic environments.

Buildtime

The amount of historical data required to define a market signal type. (See Signal)

Channel

A channel is a type of emergent self-referential price geometry, where a significant ($p < 0.001$) number of parallel and/or co-linear line segments can be identified by connecting historical price extrema. Recognition of these channels helps to define the current trend, useful stops or targets, and when broken can indicate the start of a new trend. These channels also tend to nest inside of bigger scale channels, like [fractals](#). See also, Complexity Theory and our [Smart Channel tool description](#) for more information.

Chaos Theory

Chaos theory is the study of non-linear systems with known mathematical formulas (deterministic), which through both negative and positive feedback effects, become highly sensitive to initial conditions resulting in very limited future predictability. Weather forecasting is the most commonly used example. ([Wikipedia](#)) See also [Complexity Theory](#), [Scale-Invariance](#), and [Fractals](#).

Complexity Theory

Complexity is the study of multi-agent networked system dynamics, where each agent follows a simple set of rules. In markets, the investment agents are constantly pursuing price. Through positive and negative feedback effects, emergent price geometry and self-organized criticality are the resulting global manifestations that are not dictated by any one of the individual agents. ([Wikipedia](#))

Complex Number

“In [mathematics](#), a complex number is an element of a [number system](#) that extends the [real](#)

[numbers](#) with a specific element denoted i , called the [imaginary unit](#) and satisfying the [equation](#) $i^2=-1$; every complex number can be expressed in the form $z=a + ib$, where a and b are real numbers. Because no real number satisfies the above equation, i was called an [imaginary number](#) by [René Descartes](#).” ([Wikipedia](#)). They can also be represented in a trigonometric form as $z=r (\cos(\theta) + i \sin(\theta))$, where r = square root ($a^2 + b^2$) and $\tan \theta = (b/a)$. The solutions of many physics problems are complex numbers, including the complex numbered Hurst exponent at the heart of our ExtremeHurst product.

Compression

Compressions are a signal type produced by our ExtremeHurst product. They correspond to extreme levels of [mean-reversion](#), or investor competition, on multiple time scales. These signals mark the end of trendless periods and the beginning of new trends by finding when the vigorous competition between supply and demand has reached a critical point. Price is expected to move very rapidly away from its current price following a compression. (Opposite of [Extension](#))



Competition between supply and demand reaches a crescendo at compression signals

Critical Points

Critical points in the context of markets are moments when a sudden change in direction occurs that is the result of investment agents having self-organized through extreme periods of positive or negative feedback, to a common outlook on multiple time scales. At these moments, even a slight change in news or outlook can cause an unusually large change in trend. In thermodynamics, critical points occur at the freezing or boiling point temperatures. See Also [self-organized criticality](#).

Cycles

Cycles in the context of markets are repeating patterns of high and low prices that exhibit a consistent predictable time interval or wavelength. In mathematics, a sine wave is the best example. To measure price cycles, the most frequently used method is the Fourier Transform. After such a transform, dominant cycles in the price series show up as high amplitude spikes. Another less-commonly used method is to average prices over a number of historical lengths and identify which

length results in a minimum number. This is analogous to averaging the full length of a sine wave, where the positive and negative excursions exactly cancel each other.

Decay

Predictive edge decays over time until full Duration is reached at which point the edge is zero. The decay number stands for the percentage of edge remaining at the halfway point. For example, a decay rate of 0.5 means that only half of the initial edge remains at half Duration. (See Edge, [Duration](#)).

Discrete Scale Invariance (DSI)

Discrete scale invariance is special type of [scale invariance](#) that happens only occasionally. This is due to the presence of a complex fractal dimension. (See Fractal, Scale Invariance)

Duration

The elapsed time between a signal with a non-zero-edge, and the time when that edge decays back to zero. (See Edge, Decay)

Edge

The excess probability of winning a game of chance (also referred to in this document as “Excess %Winners”). We all know that the flip of a coin has a 50% probability of coming up heads. For that case we call the outcome random and so the edge is zero. If one were to place a dollar bet each time the coin was tossed, after many tosses, the expected gain would be zero dollars. If instead one was playing a game where he had, say, a 5% edge above random, then after playing 1000 times and betting a dollar each time, he would be expected to walk away with \$100 in profit. Given that edge, he would have won about 550 times and lost about 450 times, for a difference of 100. In math we call this effect the law of large numbers. In other words, the more times you wager with a given edge and constant bet, the closer you will realize that edge. Playing many times with a similar risk and a positive edge is the way to make consistent profits in the markets.

To find those consistent profits, you need an entry signal exhibiting a significant and stable edge. Figuring out what constitutes a significant signal is the hardest part, but once a candidate is found, we need to know how much edge it has. In markets we have a couple of additional hurdles. Edges decay over time. For example, the moving average crossover that signaled an upward period with an edge of say 3%, is unlikely to have any effect many bars later. The initial edge decays over time until it reaches an edge of zero. We call this time interval “[Duration](#)”.

Markets are often biased during certain periods of time, and for reasons that may be unstable. Sometimes just picking randomly gives you an edge that is non-zero. To find the edge and duration due only to a signal, you must subtract the random **background edge**. The random background is found by

picking dates & symbols at random from the same time period as the sample was drawn and finding the edge for that group.

Emergent Price Geometry

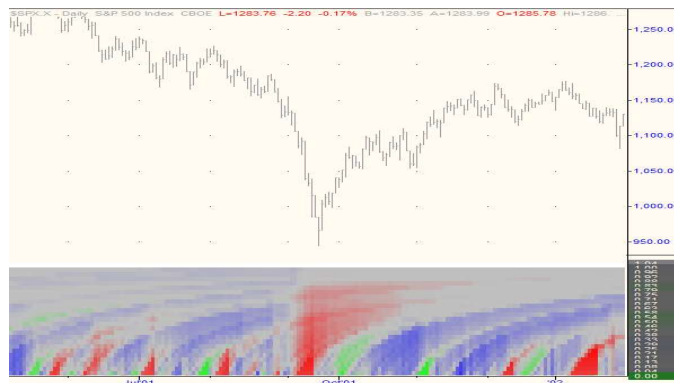
Complex systems exhibit emergent geometric patterns due to [feedback](#) effects. We have all seen the intricate flocking patterns in birds, and the [fractal](#) structure of snowflakes. In markets, the action of each investment agent, pursuing price and setting buy or sell levels, creates emergent price geometry that manifests as trend lines and channels.

Equilibrium (related to Price)

The price is in equilibrium when [negative feedback](#) is the primary driver of price, causing it to swing back and forth within a range. Our Hurst Bands show a blue central line which represents an area of high negative feedback. We take that as an equilibrium level and assigned it a Hurst Coordinate system reading of 50. (See Hurst Bands)

Extension

Extensions are a signal type produced by our ExtremeHurst product. **Extensions** correspond to extreme levels of [trend persistency](#) on multiple time scales, and mark the end of trend persistent periods, either at market tops or bottoms (Opposite of [Compression](#)). The picture below shows multiple [Hurst exponent](#) measurements for a particular security at different scales. The shortest scales are on the bottom. **Red** represents persistent down trends. **Green** represents persistent up trends. **Gray** shows random price movement, and **blue** represents mean-reverting exponents. Note the column of red at almost the exact price low. As impressive as this is, a true extension must always be preceded by a convergent log-periodic price cycle.



Color-coded Hurst exponents at multiple scales

Fat-Tail Errors

“Fat tails are a statistical phenomenon exhibiting large [leptokurtosis](#). This represents a greater likelihood of extreme events occurring similar to the financial crisis. Since the magnitude of fat tails are

so difficult to predict, left tail events can have devastating effects on portfolio returns. As a result, sufficiently protecting a portfolio requires tail risk hedging from unexpected market events.”
(Nasdaq.com)

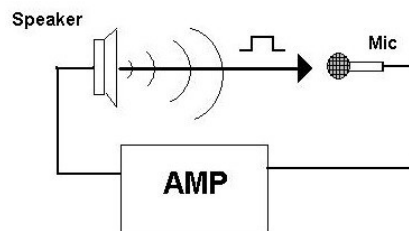
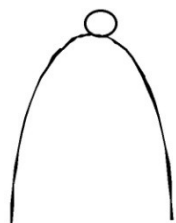
At Parallax, fat-tail errors are one of the things our software is designed to account for, helped along by the [stochastics pursuit model](#) we use, developed by Dr. Kellan Toman. His dissertation on the topic is [here](#). See our ZBand product that incorporates the correction.

Feedback

Feedback occurs when outputs of a system are repeatedly fed back into the system as new inputs, producing more outputs. This cycle continues until the loop is broken. Within the context of our tools, this primarily relates to how the decisions of investors can influence other investors. This can be seen, for instance, when price goes on a runaway upward trend in a period defined by positive crowd feedback. Other investors believing that a stock is good buy can lead others to believe the same and buy in as well.

Positive Feedback

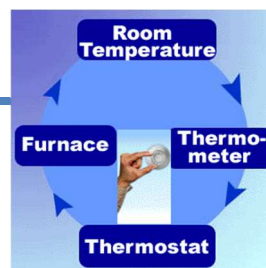
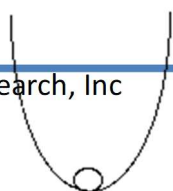
Place a microphone a bit too close to a speaker, and then make a small sound. **Positive feedback** continues to amplify that sound into a terrible screech. In the moment before positive feedback begins, the system is unstable, as illustrated by the ball sitting on top of the curved hill. Instabilities like this precede many positive feedback phenomena such as earthquakes, avalanches, and strong financial price movements. The end of a positive feedback event can be spectacular. The avalanche runs out of unstable snow as it sweeps down the mountain. An earthquake stops as all the accumulated stress is released. Financial panics or manias end when



nobody is left that has not bought or sold.

Negative Feedback

Negative feedback examples are even more common and far less dramatic. The thermostat in your house controls the temperature through negative feedback. As the room temperature rises, the thermostat switches the furnace off, which in turn results in a lower





room temperature, causing the thermostat to switch the furnace on again.

Fractal

“A fractal is a never-ending pattern. Fractals are infinitely complex patterns that are self-similar across different scales. They are created by repeating a simple process over and over in an ongoing feedback loop. Driven by recursion, fractals are images of dynamic systems – the pictures of Chaos. Geometrically, they exist in between our familiar dimensions. Fractal patterns are extremely familiar, since nature is full of fractals. For instance: trees, rivers, coastlines, mountains, clouds, seashells, hurricanes, etc. Abstract fractals – such as the Mandelbrot Set – can be generated by a computer calculating a simple equation over and over.” (Fractalfoundation.org) Fractals are characterized by their dimension. Our classic dimensions of 1, 2, or 3 are said to be whole number dimensions, while traditional fractals have real numbered dimensions such as 1.2 or 2.5. The third kind of dimension, which we use, is a complex numbered dimension, such as $1.4 + i 0.5$. (See Complex Numbers)

Fusion

“Fusion” is the term used for combining fundamental and quantitative methods together.

Growth vs Value Stocks

“Growth stocks are those of companies that are considered to have the potential to outperform the overall market over time because of their future potential.” (Investopedia)

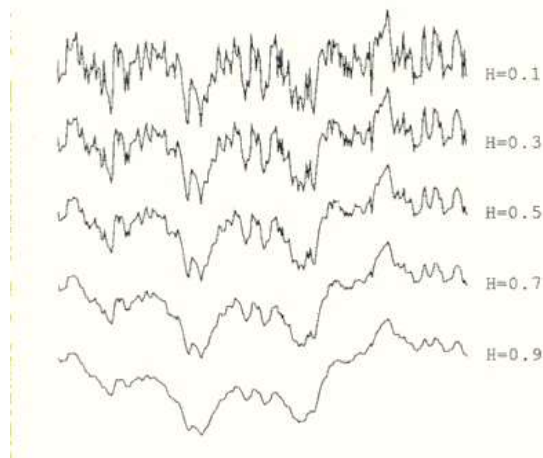
This contrasts with [value stocks](http://Investopedia), which “...are classified as companies that are currently trading below what they are really worth and will thus provide a superior return.” (Investopedia)

Half-Life Duration

The time it takes for the predictive edge to decay by half. (See [Duration](http://Investopedia), Edge, Decay)

Hurst Exponent

The **Hurst exponent**, as applied to a financial series, represents the degree of randomness which is present. Deviations from random take the form of [mean-reversion](http://Investopedia) or [trend persistency](http://Investopedia). The picture below shows five time series with different Hurst exponents. The topmost example is the most mean-reverting, while the bottom example shows the most trend persistency. The middle one is random.



Time series generated with different Hurst exponent values

Traditionally Hurst equals 2-Fractal dimension (See Fractal). Parallax uses a complex numbered Hurst exponent that varies with scale, exhibiting discrete scale invariance.

Information Coefficient (IC)

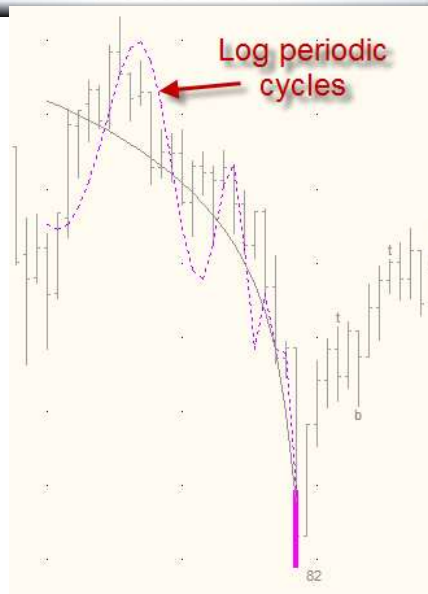
An accepted measure of skill for ranking stocks. IC is calculated as follows:

1. Rank the stocks from best long ideas (forecasted highest return) to best short ideas (forecasted lowest return).
2. Rank the subsequent period actual returns (e.g. one or 6 month from highest return to lowest return).
3. Calculate the correlation between those 2 series of numbers.

Stock picking skill is measured using IC. A good IC is typically in the .05-.06 range, and above .07 is generally considered excellent.

Log-Periodic Cycle

Log-periodic cycles are simply price cycles that are periodic with respect to the logarithm of time instead of time. The peaks and troughs appear to converge or diverge when plotted on a standard price vs time graph. Log-periodic cycles in markets are present preceding critical points due to the critical point solution being a complex number with a non-zero imaginary part. (See Complex Number, Cycles, Critical Point)



Mean Reversion (Negative Feedback)

“Mean reversion, or reversion to the mean, is a theory used in finance that suggests that asset price volatility and historical returns eventually will revert to the long-run mean or average level of the entire dataset. Mean reversion is an example of negative feedback. (See Feedback)

This mean level can appear in several contexts such as economic growth, the volatility of a stock, a stock's price-to-earnings ratio (P/E ratio), or the average return of an industry.” ([Investopedia](#))

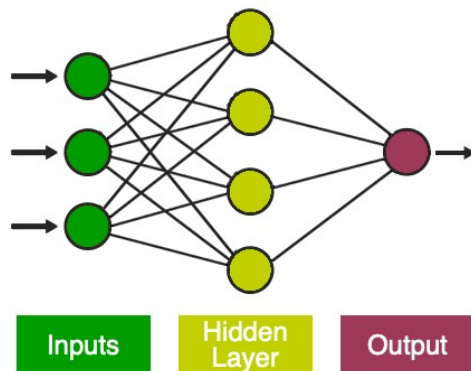
In the context of investments, buying a stock that is undervalued and selling it when it becomes overvalued, much like a thermostat-controlled system, is a good example of negative feedback, and is often termed “value investing”.

Moving Average

“In finance, a moving average (MA) is a stock indicator commonly used in technical analysis. The reason for calculating the moving average of a stock is to help smooth out the price data by creating a constantly updated average price.

By calculating the moving average, the impacts of random, short-term fluctuations on the price of a stock over a specified time frame are mitigated. Simple moving averages (SMAs) use a simple arithmetic average of prices over some timespan, while exponential moving averages (EMAs) place greater weight on more recent prices than older ones over the time period.” ([Investopedia](#))

Neural Net



A **neural network** is a mathematical modeling tool that has the capacity to learn by example. This is an extraordinarily useful ability, especially in financial modeling, where the predictive inputs are usually known and there are countless example forecasts. Networks are “trained” by entering thousands of facts. Each fact consists of inputs and corresponding outputs. Through a unique feedback process, the network learns how those inputs are related to the outputs and develops an internal model that describes the relationship.

Neural networks differ from standard regression methods and are better suited to real world problems. Mathematical models are normally built by making *a priori* assumptions about the functional form of the solution. These are called **parametric models** and are solved by regression methods to determine a number of coefficients. This is sufficient if the solution is known to be a simple, well-known function. But in the real world, functional relationships are not necessarily simple. Inputs and outputs often have a non-linear relationship. Neural networks offer a distinct advantage because the functional form of the answer is not required. They are what we call **non-parametric models**.

For more information on Neural Networks, [check out this informative video from Simplilearn](#).

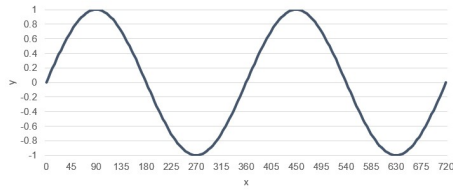
Peak%

The percentage of the full duration at which point the highest signal edge occurs. This is often at signal onset (See Edge, Duration, and Decay).

Phase

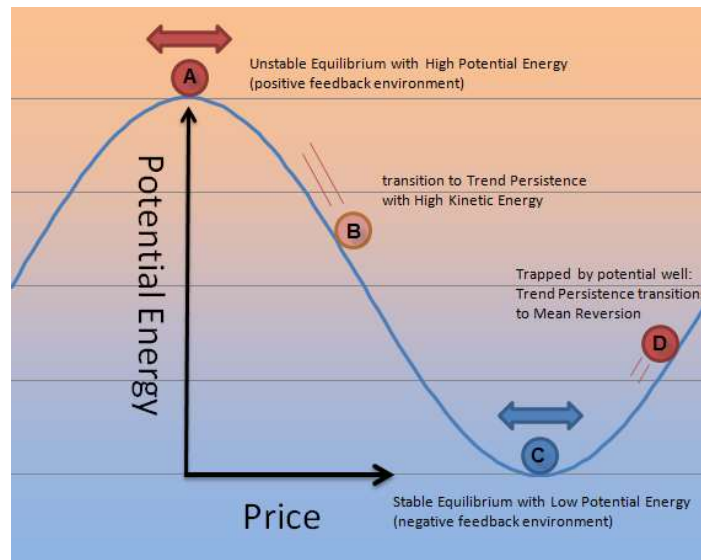
When discussing cycles, the phase of the cycle describes where in the cycle you are referring. For a sine wave for instance, the high is at a phase of 90 degrees, where the low is at 270 degrees.

Graph of $y = \sin(x)$



Potential Energy (as it relates to Price Movement)

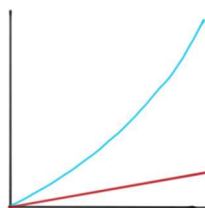
Stocks that have stable [equilibrium](#) have low potential energy, while those with unstable equilibrium have high potential energy. High energy translates to fast movement in a [positive feedback](#)



phase, while low energy is governed by [negative feedback](#) and periods of [mean reversion](#).

Power Law Move

When price is accelerating it is said to be moving according to a power law. A parabola is a great example of a simple power law geometric shape. The parabola function is $y = x^2$, where x is raised to the power of 2. Here is a graph showing linear growth in red vs power law growth in blue:



Quasiperiodicity

“Quasiperiodicity is the property of a system that displays irregular periodicity. Periodic behavior is defined as recurring at regular intervals, such as "every 24 hours". Quasiperiodic behavior is a pattern of recurrence with a component of unpredictability that does not lend itself to precise measurement. It is different from the mathematical concept of an almost periodic function, which has increasing regularity over multiple periods.” ([Wikipedia](#))

Our Precision Turn cycle indicator has been engineered to work in a quasiperiodic environment. Quasiperiodicity affects price cycle forecasting by introducing unstable phase behavior. As a result, it's possible to predict the timing of a cycle, but not whether it will be a "high" or "low" until the cycle date arrives. (See Phase)

Rank

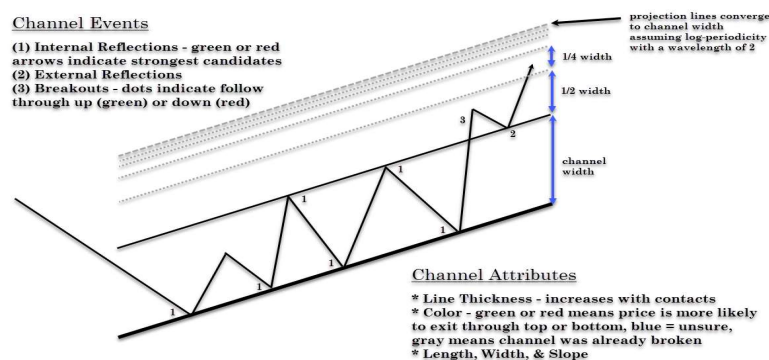
Throughout our product line we use the term rank as a means of gauging signal quality. A high rank is normally indicative of a great signal, while a low rank is not. Ranks usually fall between 0 and 100.

Ratio Spread

A ratio spread is a combination of two securities in a fractional A/B format. The idea here is that if a top signal occurs for example, the numerator A should be sold and the denominator B bought, because the ratio on a whole is expected to drop, even if both A and B move in the same direction.

Reflection

When a trend channel line is tested and price rebounds from that line, we call that event a reflection. An **internal reflection** is defined as: tests of a pre-existing channel line from the inside. An **external reflection** is defined as a retest of a channel that has been broken, and where price has come back to test the broken channel line from the outside. **Top/bottom reflections** refer to whether the reflection is along the top or bottom channel line.



Relative Strength Index (RSI)

"The relative strength index (RSI) is a technical indicator used in the analysis of financial markets. It is intended to chart the current and historical strength or weakness of a stock or market based on the closing prices of a recent trading period." ([Wikipedia](#))

Our version of RSI is called RSIz. It counts the number of up and down bars within a given period and performs a statistical test on the result. It assumes that up and down bars have equal probabilities of occurrence. A reading above or below the lines drawn on the chart indicates a statistically significant

deviation from random has occurred.

Resistance

See [Support and Resistance](#).

Retracement

“A retracement is a minor pullback or change in the direction of a financial instrument, such as a stock or index.” ([Investopedia](#))

Scale Invariance

Scale invariance (also known as self-similarity) is defined as a feature of objects or laws that does not change if length scales are multiplied by a common factor. Basically, this means you can see the same features whether you zoom in or out. For investments, this means that if you see a strong trend on say a 5 minute scale, then as you zoom out, the same strong trend (smoothly trending) would be present on every higher scale. As one could imagine, this does not happen very often, and so perfect scale invariance becomes an occasional “discrete scale invariance” or DSI.

Benoit Mandelbrot called objects that exhibit perfect scale invariance [fractals](#) because they are partially characterized by a real-numbered (decimal number) fractional dimension. The presence of scale invariance means that the object has been produced by feedback process and is governed by the science of feedback systems known as [Chaos theory](#) (which in turn is a subset of Complexity theory).

Self-Organized Criticality (SOC)

When [positive feedback](#) is the engine driving prices to extremes, non-linear cycle analysis, statistical mechanics, and renormalization group science may be applied to predict likely endpoints. The term used to describe this field of study is **self-organized criticality, or SOC**. The critical points described in this field are reflected in the tendency of markets to organize themselves into unstable positions far from [equilibrium](#). Once a critical point occurs in a security, the market for it becomes unstable and can exhibit very sudden trend changes.

Self-Referential Geometry

The byproduct of price pursuit is the emergence of self-referential geometry – aka geometric price patterns made from [feedback](#) effects. This is a similar process to moguls forming on a ski slope. Repeated liquidity events happening on a line connecting prior price extrema, encourage more agents to plant orders on that same line, which reinforces its existence.

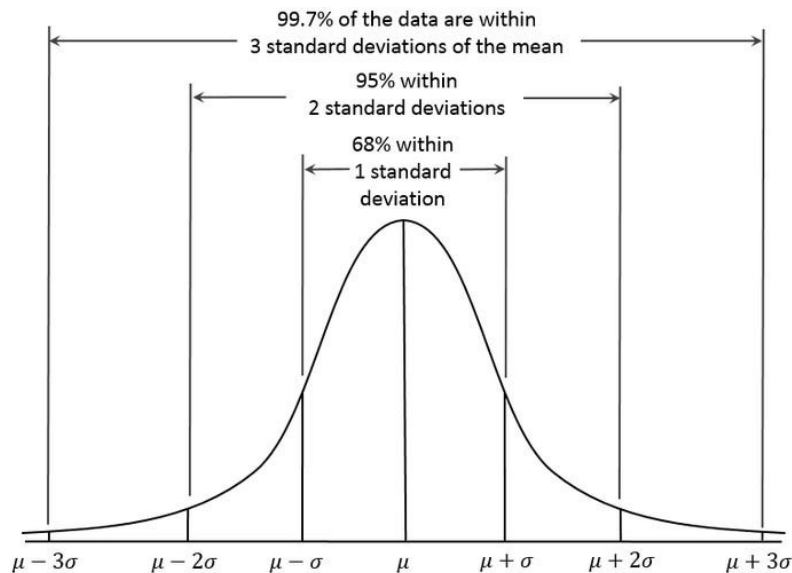
Signal

We define a signal as the product of some algorithm that is responsible for an investment agent deciding to enter or exit a position. Signals are NOT strategies and need to be evaluated as to their predictive edge and duration individually. Strategies on the other hand describe complete trades, with

entry, money management, and exit being present.

Standard Deviation

In statistics, the standard deviation is a measure of the amount of variation or dispersion of a set of independent trials. A low standard deviation indicates that the values tend to be close to the mean (also called the expected value) of the set, while a high standard deviation indicates that the values are spread out over a wider range. ([Wikipedia](#)) When independence is not fully present, as in markets,



(picture from [Business Insider](#)) – μ is the mean, whereas σ is the standard deviation.

standard deviations don't exactly follow the Normal distribution as shown above. (See Fat-Tail Errors)

Stochastics Pursuit Model

First of all, a stochastics model can be defined as: "A form of financial model that is used to help make investment decisions. This type of modeling forecasts the probability of various outcomes under different conditions, using random variables.

Stochastic modeling presents data and predicts outcomes that account for certain levels of unpredictability or randomness. Companies in many industries can employ stochastic modeling to improve their business practices and increase profitability. In the financial services sector, planners, analysts, and portfolio managers use stochastic modeling to manage their assets and liabilities and optimize their portfolios." ([Investopedia](#))

A stochastics pursuit model specifically can describe the following phenomenon: When investors

chase prices that are moving, their behavior creates a [positive feedback loop](#), which tends to increase prices much faster than random (Gaussian or Normal). Price movement then ceases to be independent from the near history. This means prices are observed way more often at highly positive or negative [Z scores](#) than you would expect from a random walk.

The stochastics pursuit model we use was developed by Kellan Toman. His dissertation on the topic is [here](#). It also addresses [fat-tail errors](#) well.

Strategy

We use the word strategy to describe a full trade, which necessarily includes a signal for entry, money management rules, and an exit signal. (See Signal)

Support and Resistance

“‘Support’ and ‘resistance’ are terms for two respective levels on a price chart that appear to limit the market’s range of movement. The support level is where the price regularly stops falling and bounces back up, while the resistance level is where the price normally stops rising and dips back down. The levels exist as a product of supply and demand – if there are more buyers than sellers, the price could rise, and if there are more sellers than buyers, the price tends to fall.” ([ig.com](#))

Price support and resistance are emergent geometric phenomena largely due to [negative feedback](#). Often the boundaries of support and resistance are defined using [trend channel lines](#).

Trend Persistence

High levels of the Hurst exponent correspond to a positive feedback or trend persistent dynamic. “Price persistence is the tendency of a security's price to continue moving in its present direction. A stock that has been in a strong upward or downward trend for weeks is displaying price persistence. Conversely, a stock that has been trading in a choppy manner for an extended period of time will display a low degree of price persistence.” ([Investopedia](#))

Trend persistence is synonymous with Momentum. “Momentum investing is a strategy that aims to capitalize on the continuance of an existing market trend (See Trend Persistence). It is a trading strategy in which investors buy securities that are already rising and look to sell them when they look to have peaked.

Momentum, in markets, refers to the capacity for a price trend to sustain itself going forward.” ([Investopedia](#))

Turn Measurement Index

TMI is a scale independent measure of price curvature. We take the absolute value of this measure, so when the trend is consistent, TMI is low, while it is a large positive number when the

market shows a large trend change.

Value

Intrinsic/True Value

“Intrinsic value refers to some fundamental, objective value contained in an object, asset, or financial contract. If the market price is below that value it may be a good buy—if above, a good sale.” ([Investopedia](#))

The [fundamental price](#) generated by our Price Wizard tool estimates intrinsic value.

Fair Value

“Fair value is the estimated price at which an asset is bought or sold when both the buyer and seller freely agree on a price.

To determine the fair value of a product or financial investment, an individual or business may look at actual market transactions for similar assets, estimate the expected earnings of the asset, and determine the cost to replace the asset.” ([Investopedia](#))

When fair value deviates by a large amount from intrinsic value, this is often due to periods of [positive feedback](#) movement in the markets.

Value Company

“A value stock refers to shares of a company that appears to trade at a lower price relative to its fundamentals, such as dividends, earnings, or sales, making it appealing to value investors.

A value stock can generally be contrasted with a [growth stock](#).” ([Investopedia](#))

Our Price Wizard tool can help to identify value companies by finding its [fundamental price](#).

Undervalued vs Overvalued

Simply put, an undervalued stock has an intrinsic value above its traded price, whereas an overvalued stock is trading above its intrinsic value. An undervalued stock is set up for a future rise in price, while the overvalued stock is set up for future decline.

Our Price Wizard tool can help identify undervalued vs overvalued stocks.

Valuation Growth Rate

We use a 3 year window to measure the trend in value for each equity using linear regression. It is presented as an annual average growth rate.

Valuation Acceleration Rate

We use a 3 year window of equity value to fit a 2nd order polynomial and derive the most recent acceleration rate. It is expressed as a quarterly rate of change of growth.



Z Score

The number of [standard deviations](#) a data point is away from the average in a normal