WORKSHOP SESSION 1: THE SCIENCE

- PARALLAX EMPLOYS THE SCIENTIFIC PROCESS
  - OBSERVATION -> HYPOTHESIS -> THEORY -> PREDICTION (AND REPEAT)
  - GOAL 1 IS TO EXPLAIN MARKET DYNAMICS
  - GOAL 2 IS TO BUILD PREDICTIVE INDICATORS THAT ARE IN "SYNC" WITH THEORY
  - GOAL 3 BRING THESE INDICATORS TO THE PROFESSIONAL COMMUNITY & TRAIN
- MARKET DYNAMICS
  - FUNDAMENTAL DYNAMICS MODELING
    - VALUATION FACTOR MODELING USING NEURAL NETWORKS
    - DYNAMIC FACTORS SUCH AS VALUATION RATE OF CHANGE, PERSISTENCY, AND ACCELERATION
  - BEHAVIORAL DYNAMICS MODELING BASED ON COMPLEXITY THEORY:
    - MULTI-AGENT SYSTEMS (INVESTMENT AGENTS)
    - FEEDBACK (INVESTORS PURSUING PRICE)
    - EMERGENCE (GEOMETRIC PRICE PATTERN)
    - SELF-ORGANIZED CRITICALITY (MAJOR TREND CHANGE JUNCTIONS)

Market Dynamics

Market participants form a broad system of investment agents - the "Crowd".
Dynamics refers to the forces which stimulate growth, development, or change

Value effect is explained by

Crowd effect is explained by

Fundamental Value

is determined by factors

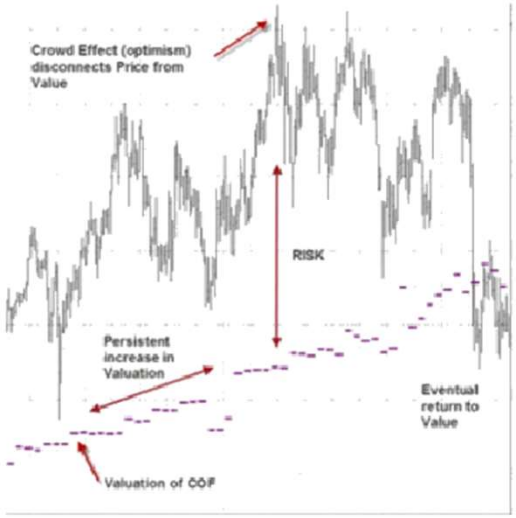
Factors

Sales	Debt
Earnings	Margins
Cash Flow	Interest Rates
Book Value	Inflation
Dividends	Industry

Price Wizard neural net modeling

Value

* Difference between market price and valuation
* Used to find aggregate value of indices and ETFs

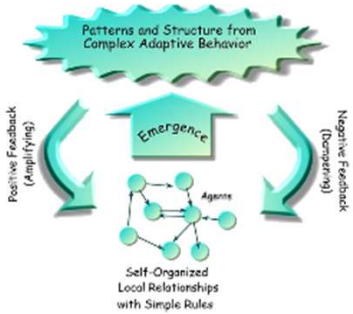


Value Dynamics

* Growth Rate
* Growth Persistence
* Acceleration Rate

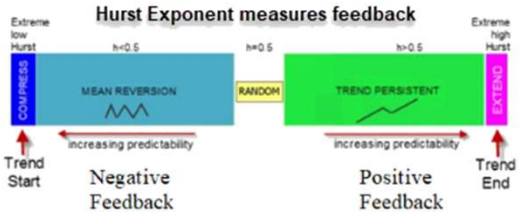
Complexity Theory

governs multi-agent systems obeying a simple set of rules



Rule 1: Investors Pursue Price

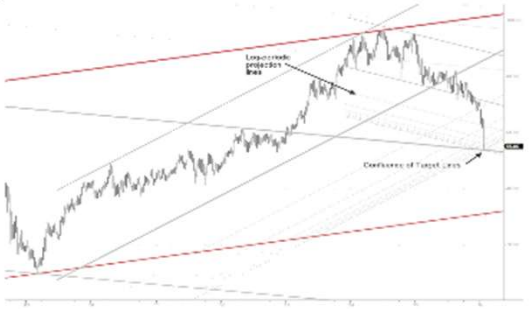
* Feedback Effects
  - Trend Persistence
  - Mean Reversion
  - Self-Organized Criticality
  - Fat Tails
* Quasi-periodic Cycles



Rule 2: Investors are attracted and repulsed from key prices

* Emergent Geometric Patterns
  - Trendlines and Channels
  - Support & Resistence
  - Pivot-based Patterns

or



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Complexity

The Theory of Multi-Agent Systems

What is Complexity Theory ?

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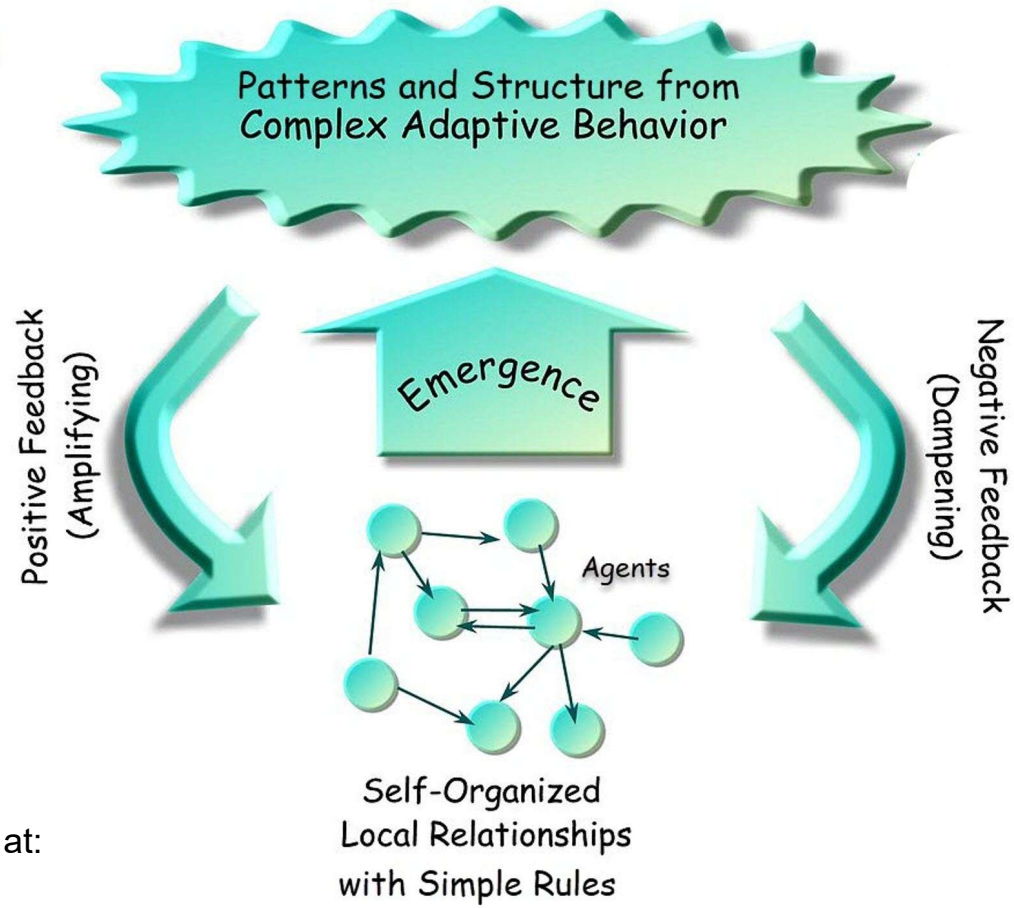
Crowd effect is explained by

Complexity Theory

governs multi-agent systems obeying a simple set of rules

Rule 1: Investors Pursue Price

Rule 2: Investors are attracted and repulsed from key prices



Note: In the US, This research is being pursued at:

- Santa Fe Institute, NM
- New England Complex Systems Institute at MIT

The Full Scope of Complexity Theory

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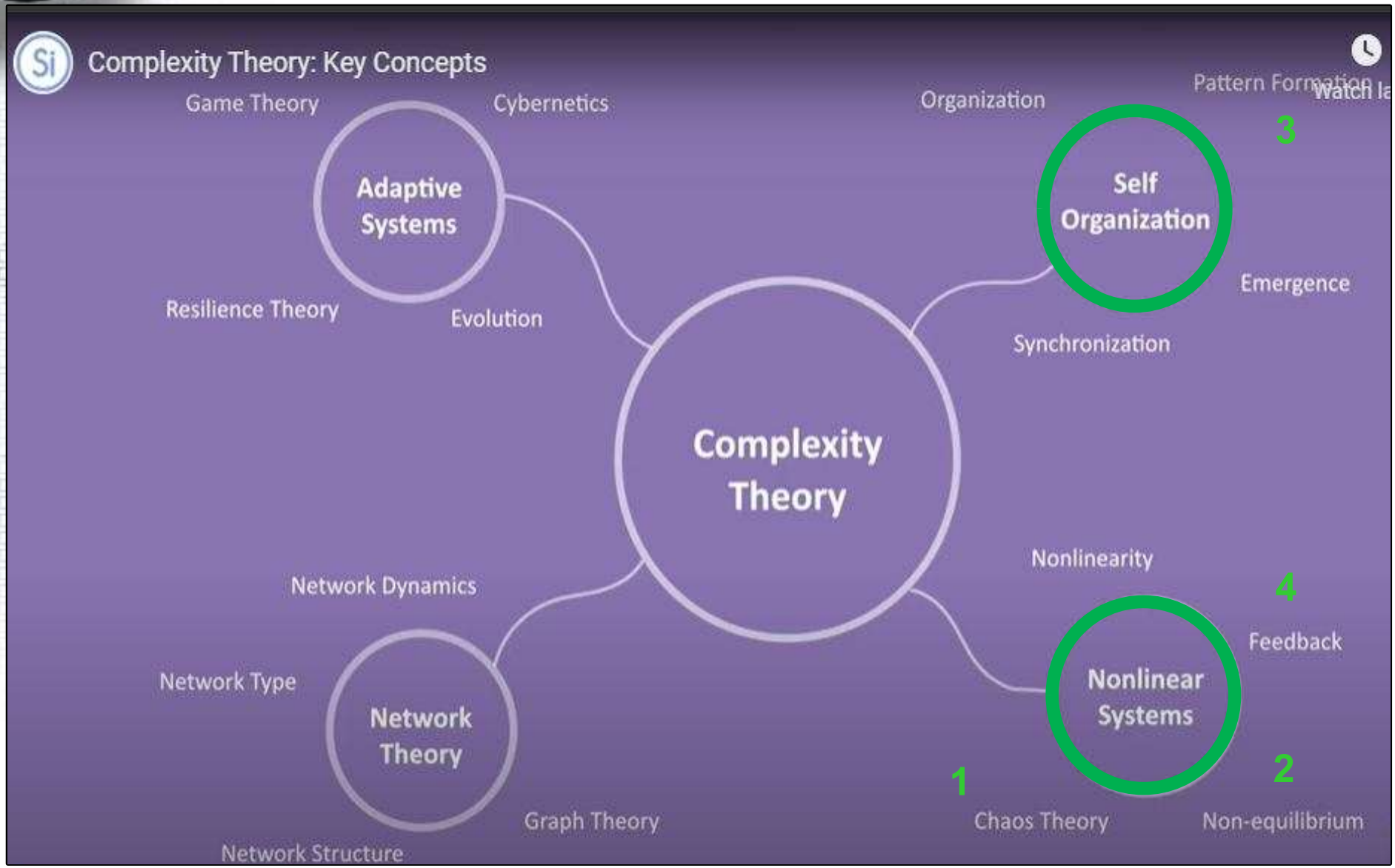

"Technical Analysis" is an Application of Complexity Theory

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Feedback in Multi-Agent Systems Produces the Observations that we call "Technical Analysis"

Scientific Name	1 Quasiperiodicity	Critical Phase Transition 2	Self-Organization & Emergence 3	Stochastic Pursuit 4
Technical Analysis Name	Price Cycles	Trend Change Exhaustion Bubble, Bust, Mania Top or Bottom Tension-on-the-Tape Compression	Trendlines Trend Channels Flags, Pennants, Head-and-Shoulders Zig-Zags Elliot Wave Support/Resistance	Trending Accumulation Distribution Fat Tails Z Score Moving Averages MACD
Parallax Tool	Precision Turn	ExtremeHurst	SmartChannel PriceMemory Forecasters	VolumeTrend Technical Rank Price-Volume Cross Hurst Bands

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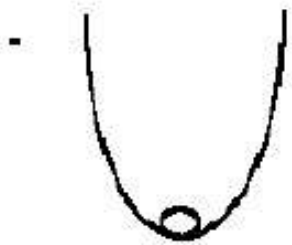
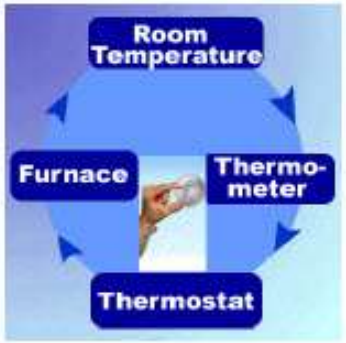
Feedback

Why it's the key to market dynamics and how to measure it

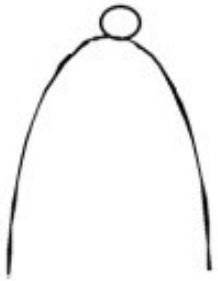
What is Feedback?

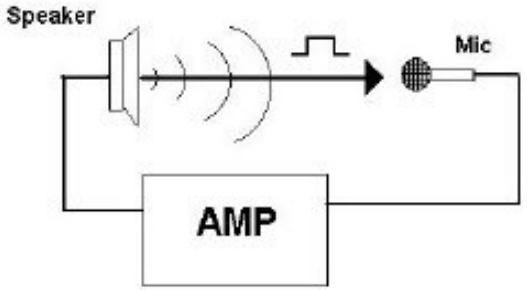
Negative feedback: *Process which causes a system to return to its initial state upon perturbation:*



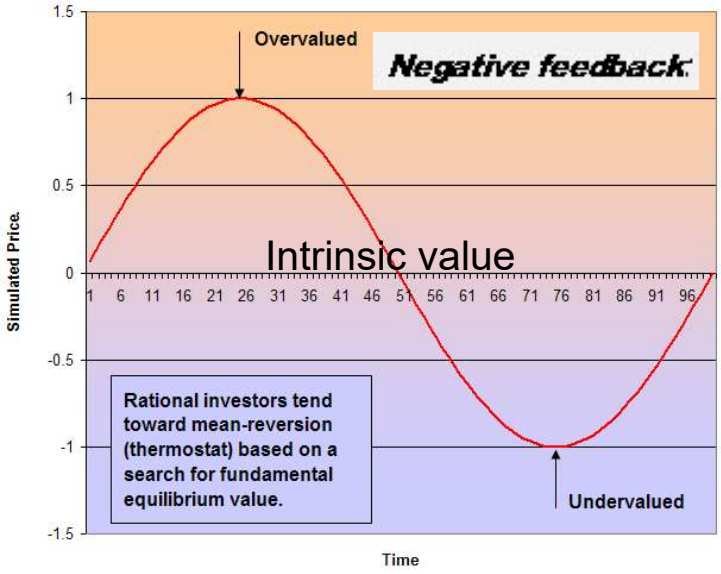


Positive feedback: *Process in which perturbation causes system to travel further away from initial state:*

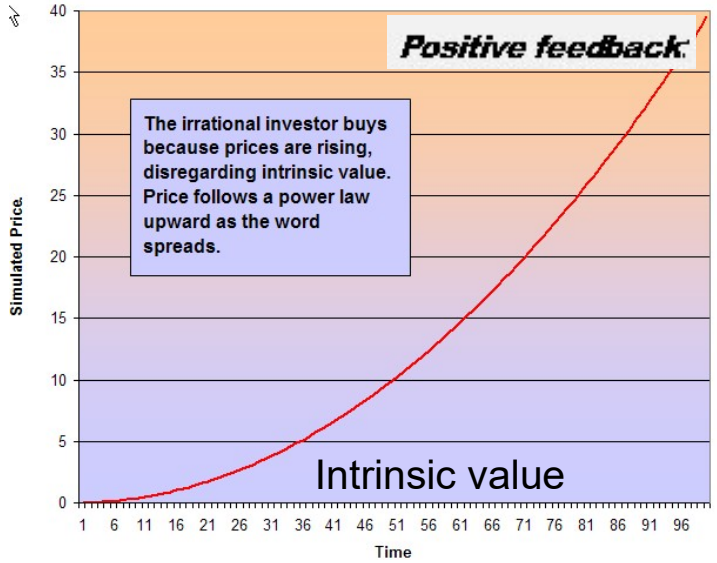




- Value Oriented Behavior
  - Buy undervalued and sell overvalued
  - Classic fundamental models
  - Searching for equilibrium
  - Example of Negative feedback or “mean reversion” (e.g. thermostat)



- Trend Following Behavior
  - Imitate the crowd
  - Buy because it’s “going up”
  - Ignore fundamentals or adopt untested models to explain price
  - Example of Positive feedback or “trend persistence” (e.g. avalanche)



Feedback & Simple Investor Behavior Model

- The Value Investor is driven to buy when price is less than value, which forces price down:

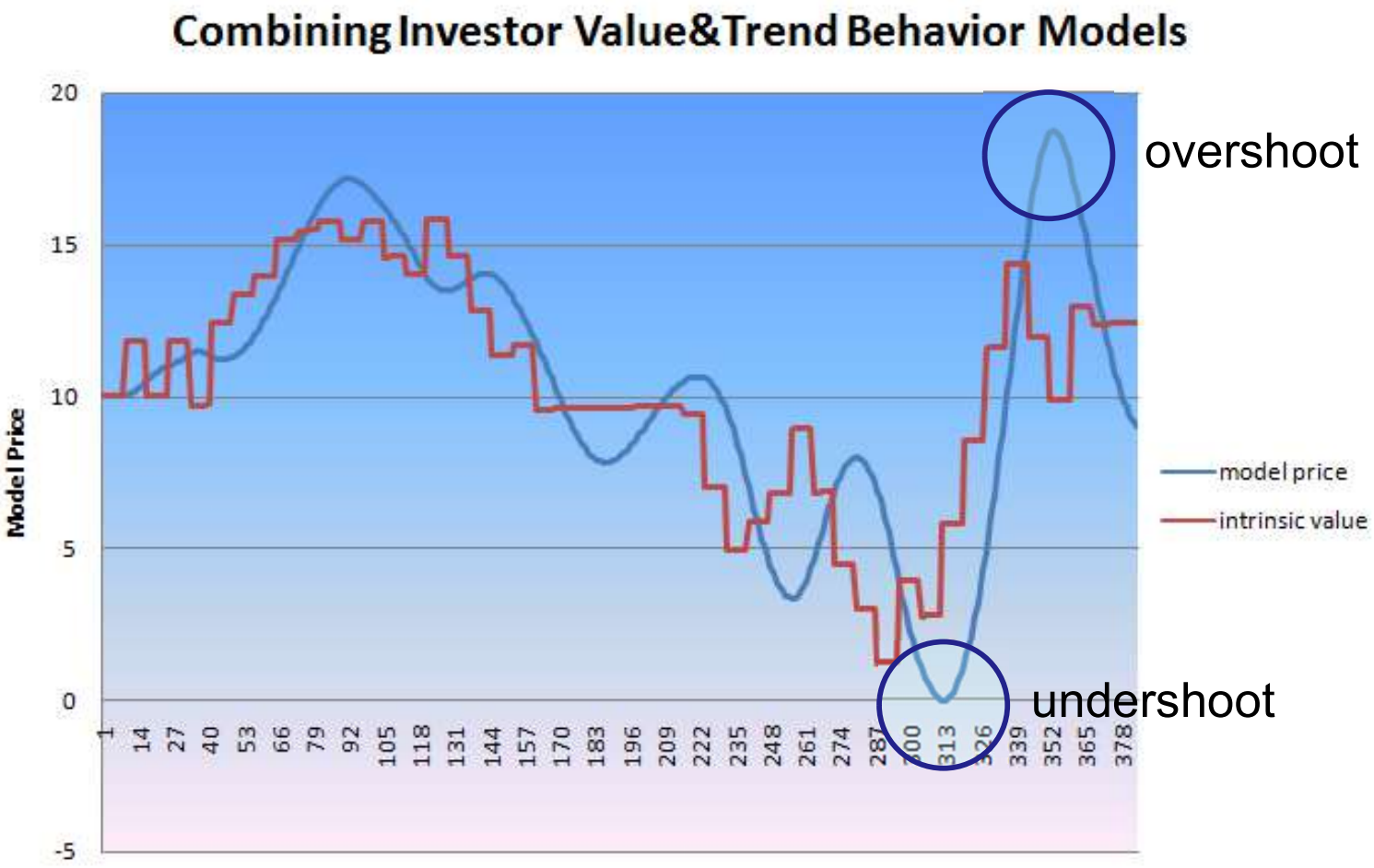
  dPv = -k1*(P-V)

- The Trend Following investor is driven to buy when price is going up, which forces price up more:

  dPt = k2*dP/dt

- Combining trend following and value behaviors yields complex results

New Price = Old Price +dPv +dPt



The Hurst Exponent Measures Feedback

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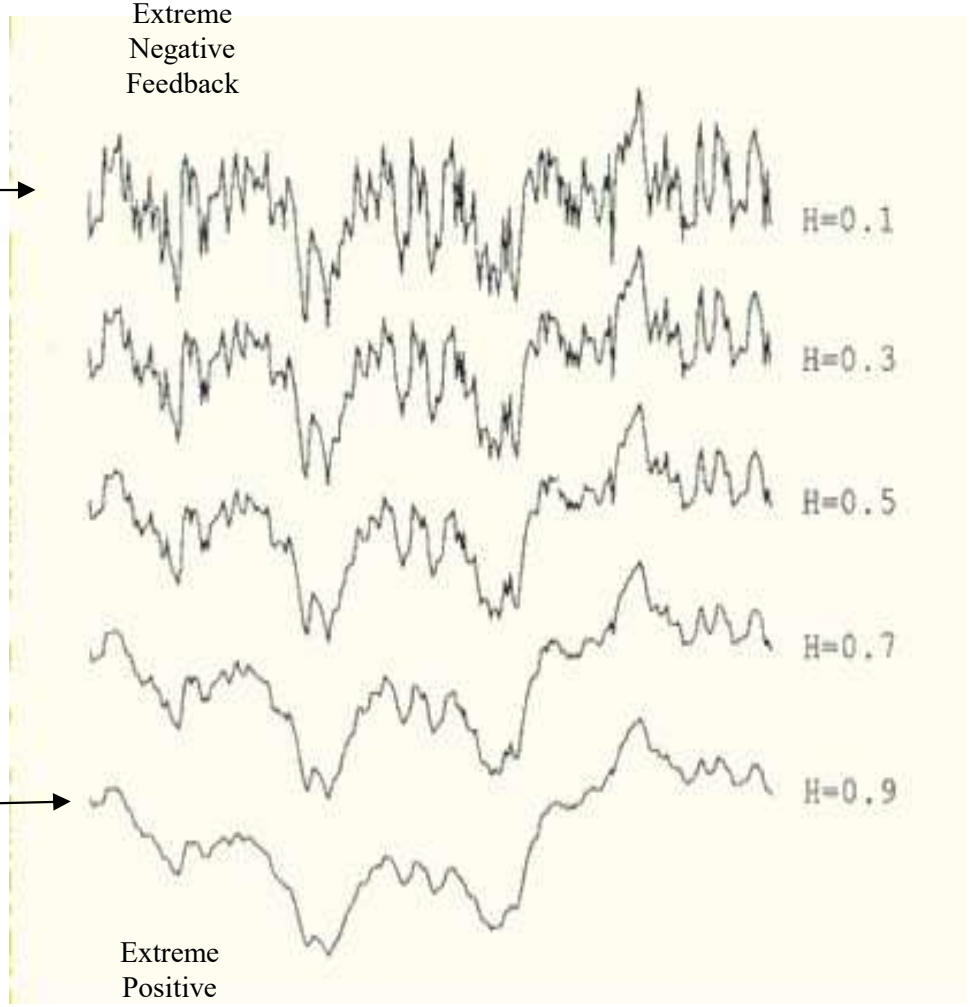
Extreme
Negative
Feedback



Extreme
Positive
Feedback

- The Hurst exponent is used to measure the presence of feedback
- Low Hurst numbers indicate mean-reversion is present
- Hurst of ½ indicates a random time series
- High Hurst numbers mean trend persistence is present (low fractal dimension)
- The farther away from random, the more predictability exists

Measuring Feedback Inversely

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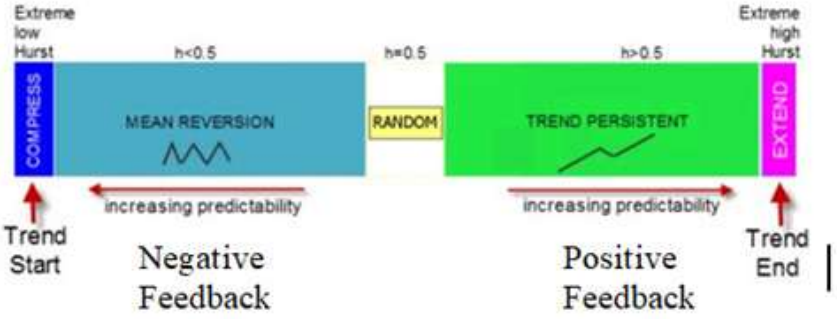
"Hurst Exponent" Tool Measures Feedback

The Hurst Exponent is a tool from Chaos Theory and is equal to 2 minus the fractal dimension



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Stochastic Pursuit

Are Technical Analysts Just "Noise Traders" ?

- Noise traders – "the dumb guys"
  - Follow price trends, charts, hunches
  - Usually, they are "momentum" players
  - Sometimes just random buyers and sellers (but that might mean they are irrelevant if they are truly "random" players

Economics 437 slideshow excerpt by Ellen Morris

The Tunnel Thru the Air

W.D. Gann: Divination By Mathematics: Harmonic Analysis

"MAGIC T Theory"

Sacred Geometry of The Market..."The Secrets of Trade Structure"

Financial Astrology Almanac

Cycles: The Mysterious Forces that Trigger Events

Magic is Real: The Runes, Twelve Ancient Contraries, Project the World

The Profit Magic of Stock Transaction Timing

- Price Pursuit should show up in price and Volume sequencing
- Quick way to visualize large sequences uses CGR
- Analyze relative changes in Price and Volume
- Change between observations fall into 4 categories:

A. Price increases & Volume increases (P+V+)

B. Price increases & Volume decreases (P+V-)

C. Price decreases & Volume increases (P-V+)

D. Price decreases & Volume decreases (P-V-)

Chaos Game Representation Unit Square

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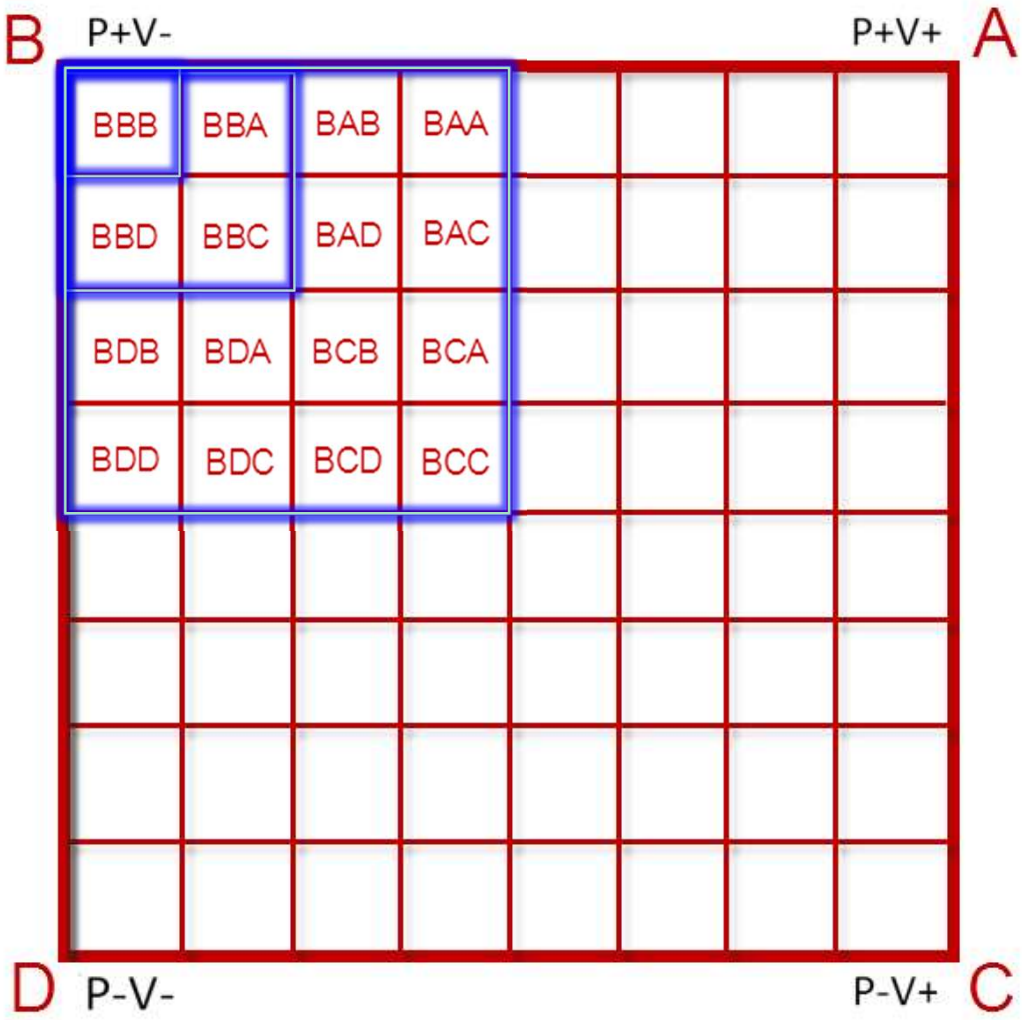

- Each point in PV sequence maps to a point in the square
- **Random** sequences fill square without a pattern
- **Non-Random** sequences show a fractal pattern

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Business: (425) 868-2486 URL: www.pfr.com

CGR Example Using DNA Sequence

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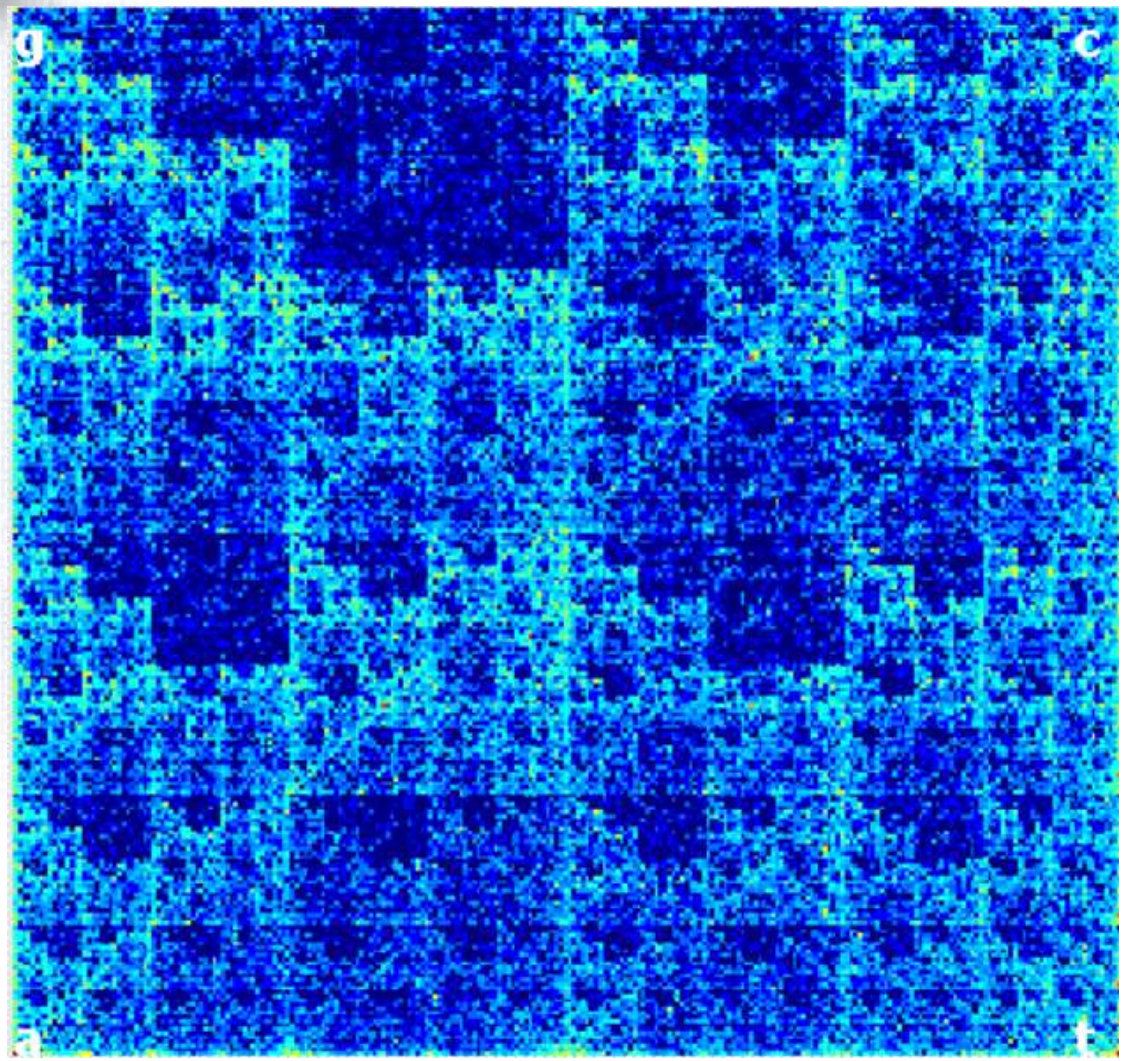

- CGR Visualization of a Genetic Sequence
- A Discernable fractal Pattern indicates that the sequence ***is NOT Random***

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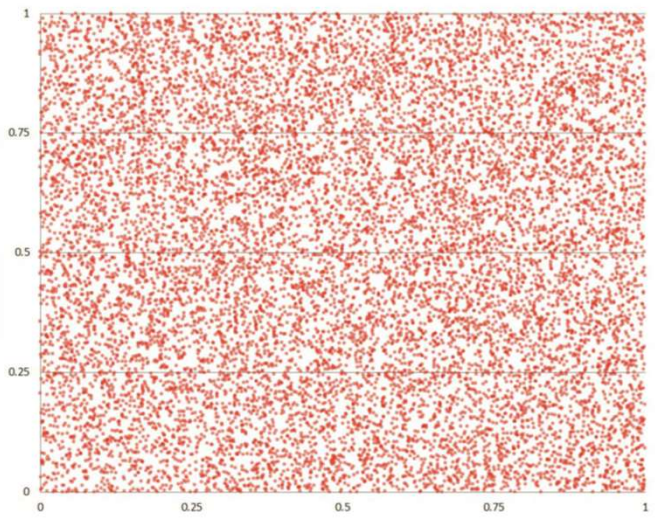
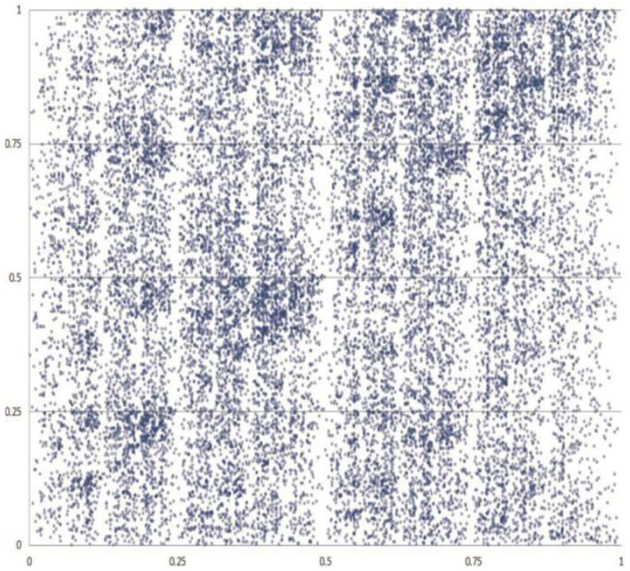
Random Example



DJIA Price-Volume sequences are NON-Random



- Analyzed sequences of price and volume changes

  P+V+, P-V+,P+V-, and P-V-

- Used “Chaos Game Representation to check if price-volume change sequences were random
- Random outcome has no discernable pattern
- Non-Random outcome has fractal structure
- The stock market is non-random and has a memory

Price Pursuit suggests a VolumeTrend Indicator

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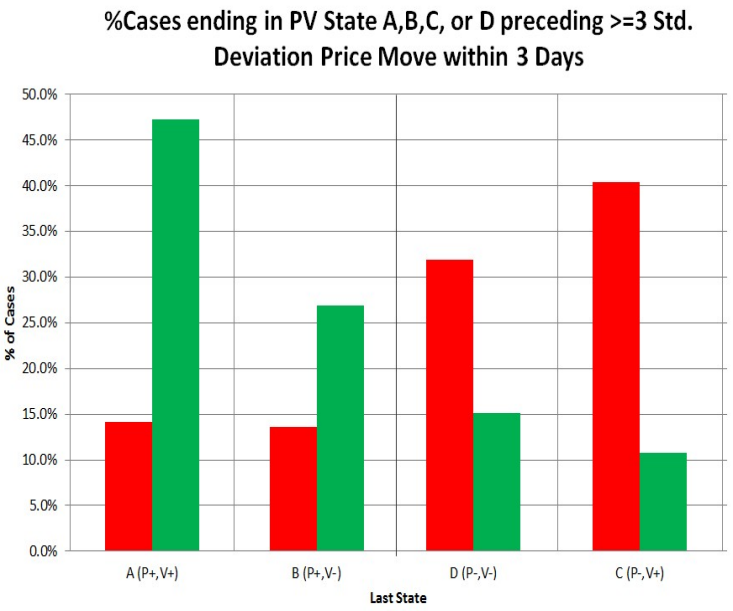
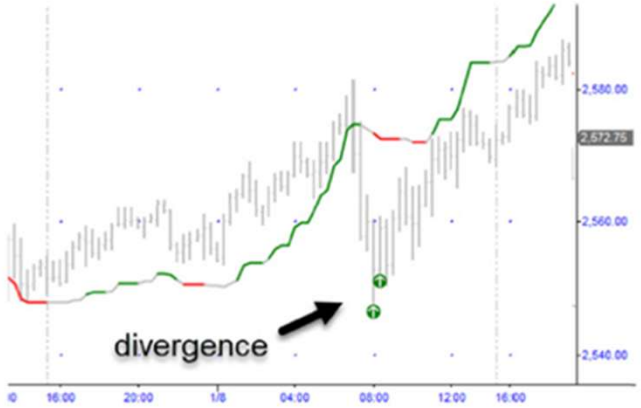
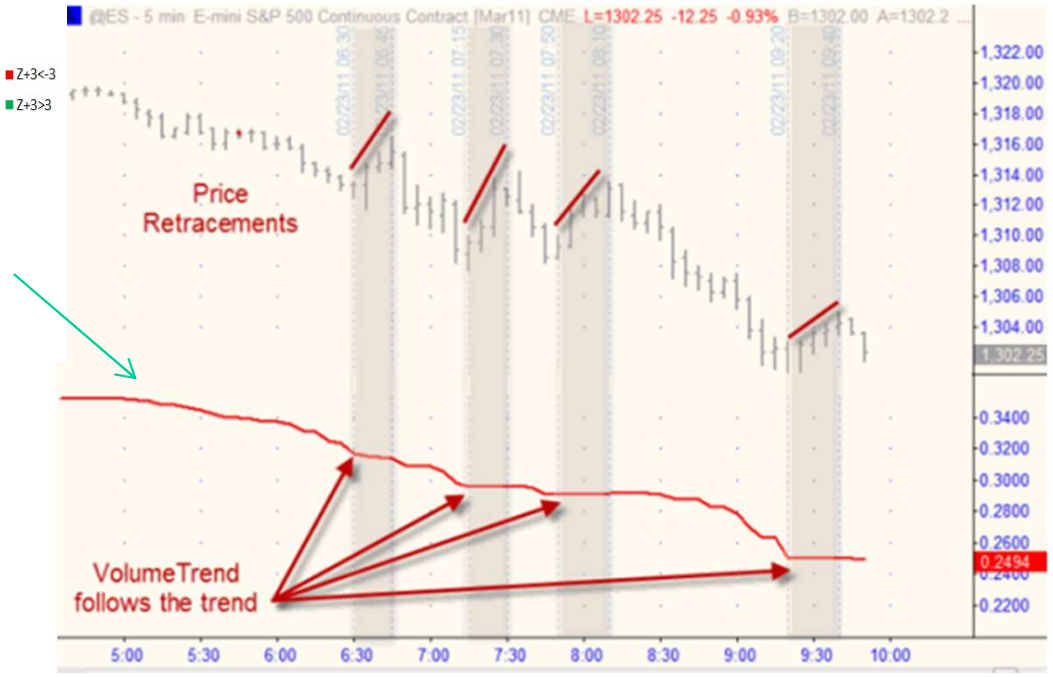
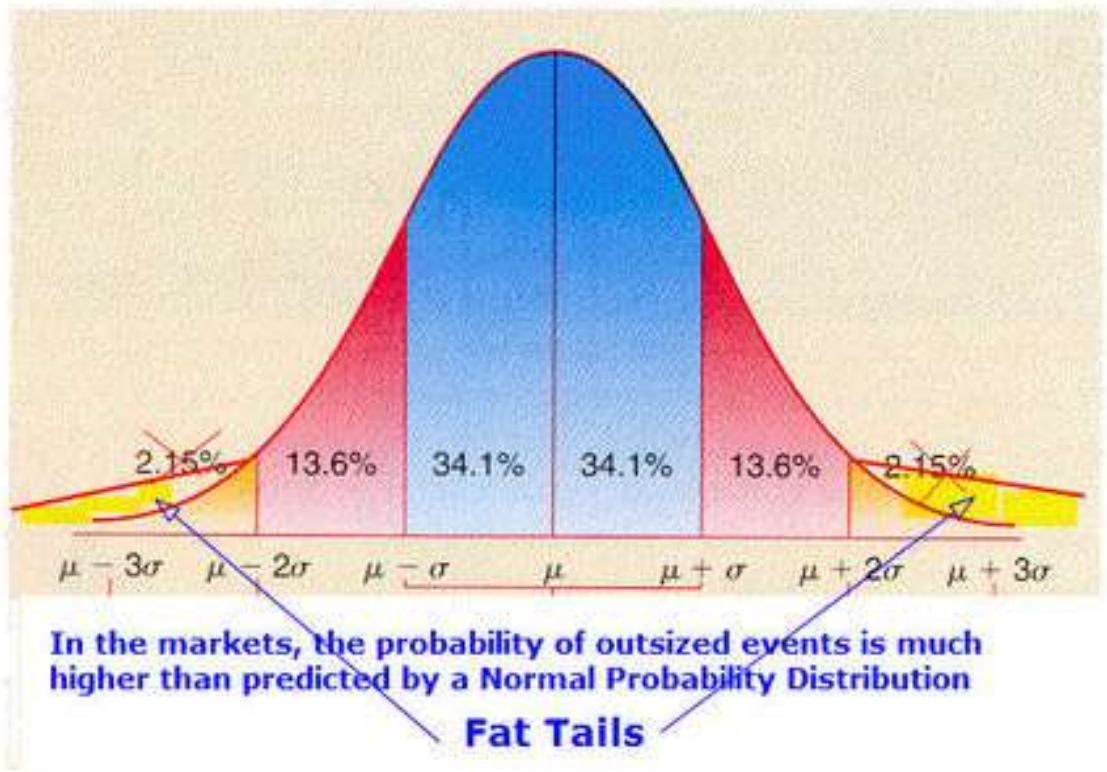




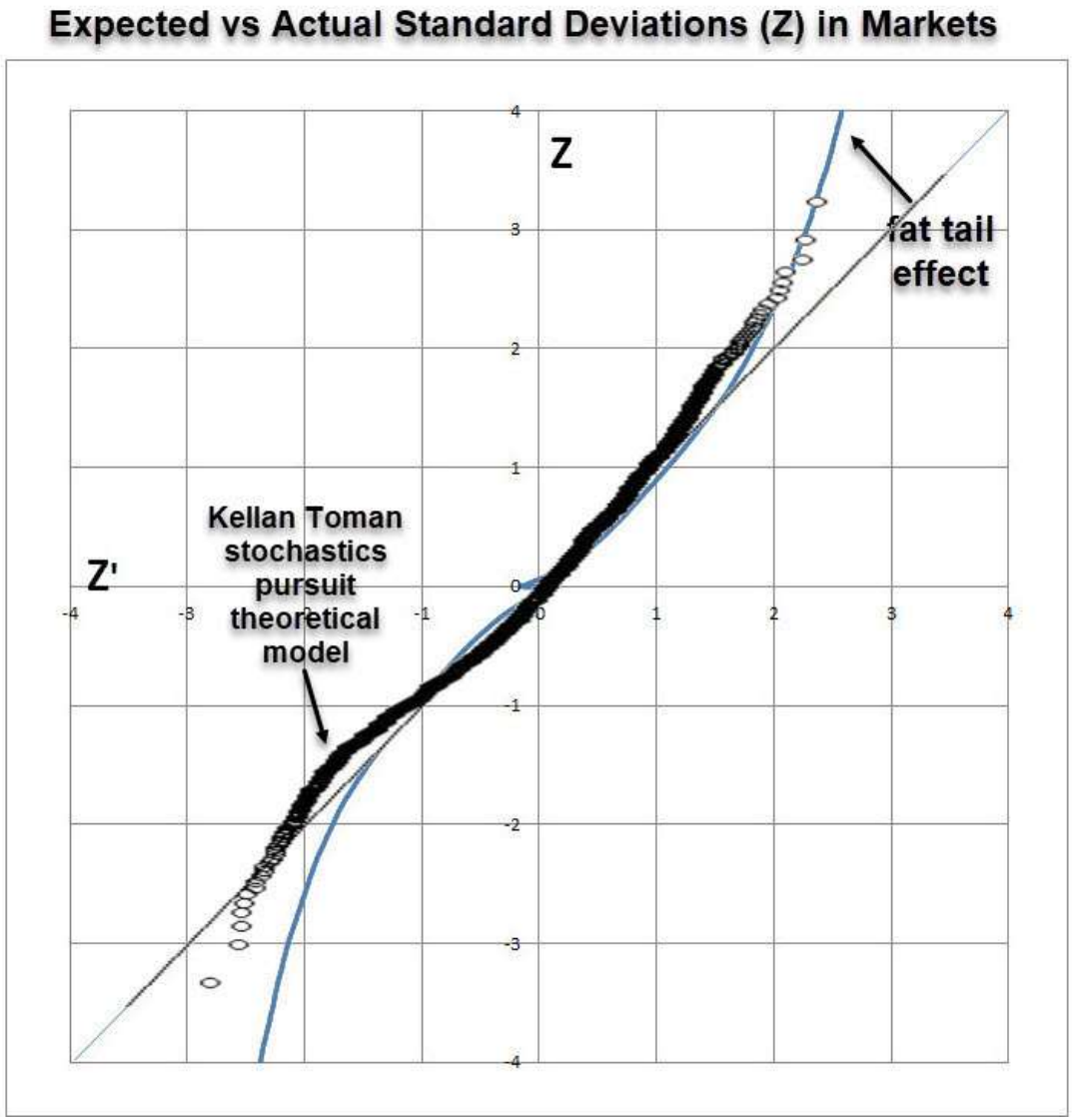


Increasing volume in states A and C significantly precedes large price change 3 days forward



The Markets are not quite Gaussian

- Our stop and target management system assumed a random (Gaussian) distribution…which is not quite correct
- When we ask for a 10% chance of being stopped out, we may get a slightly different result
- We built a converter to correct for these differences



Fat-Tail Conversion

- Desired occurrence rate must be converted to the equivalent Gaussian rate
- Stochastics pursuit theoretical result (Toman) predicts observed fat tail occurrence rate
- Up and Down move statistics are a bit different due to excess fear in down moves
- For example, if the desired probability is a 4% chance of hitting a long target, then the equivalent Gaussian rate is 1.5%,

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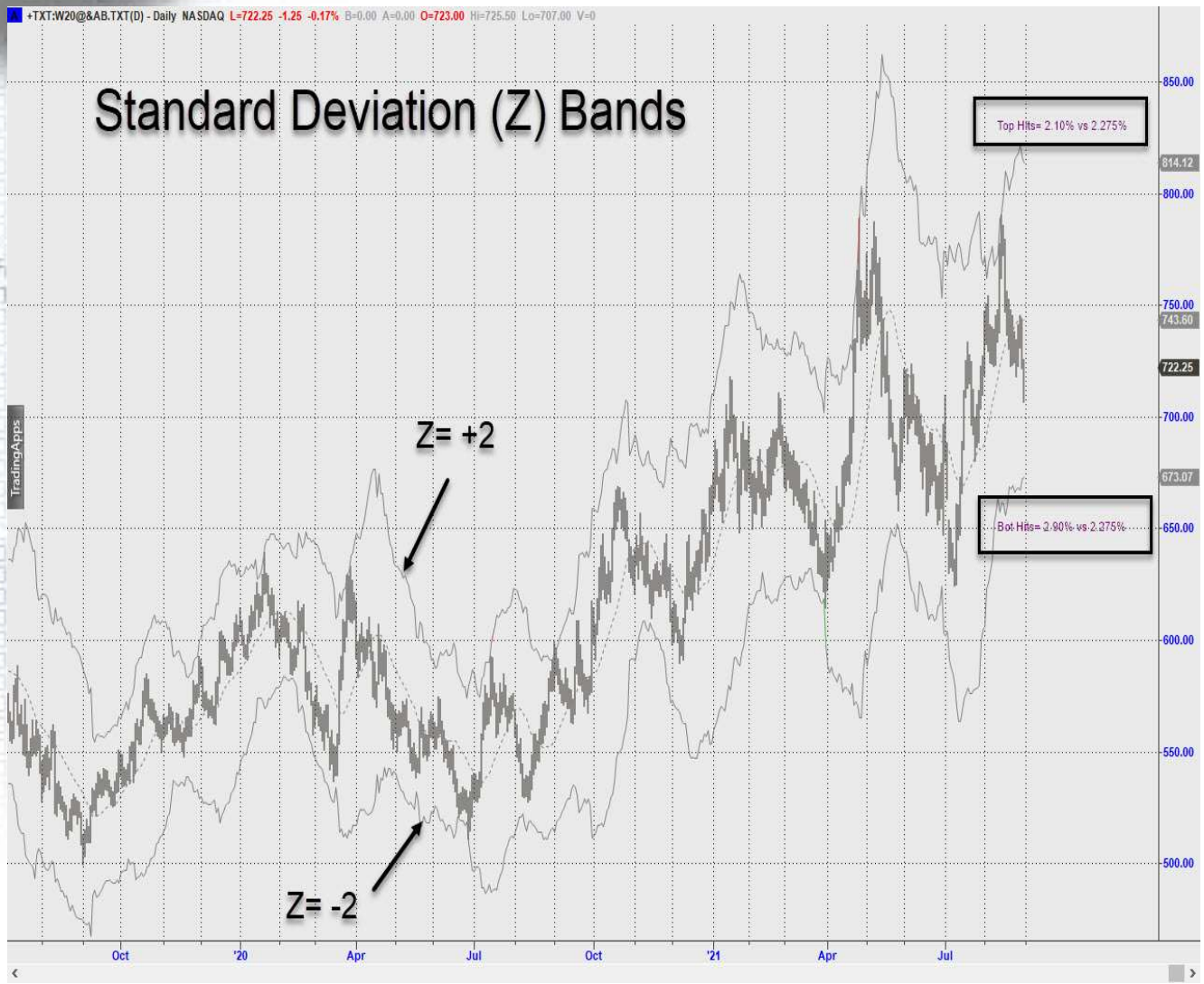

Applying the Fat-Tail Correction

- The graph shows the fat-tail corrected Gaussian bands at 2 standard deviations
- Because of the fat-tail problem, price would usually hit the standard bands 10% or more of the time when it should be 2.275%
- After applying the fat-tail correction due to stochastics pursuit, the hit rates more closely match the target at 2.1% and 2.9% for this example

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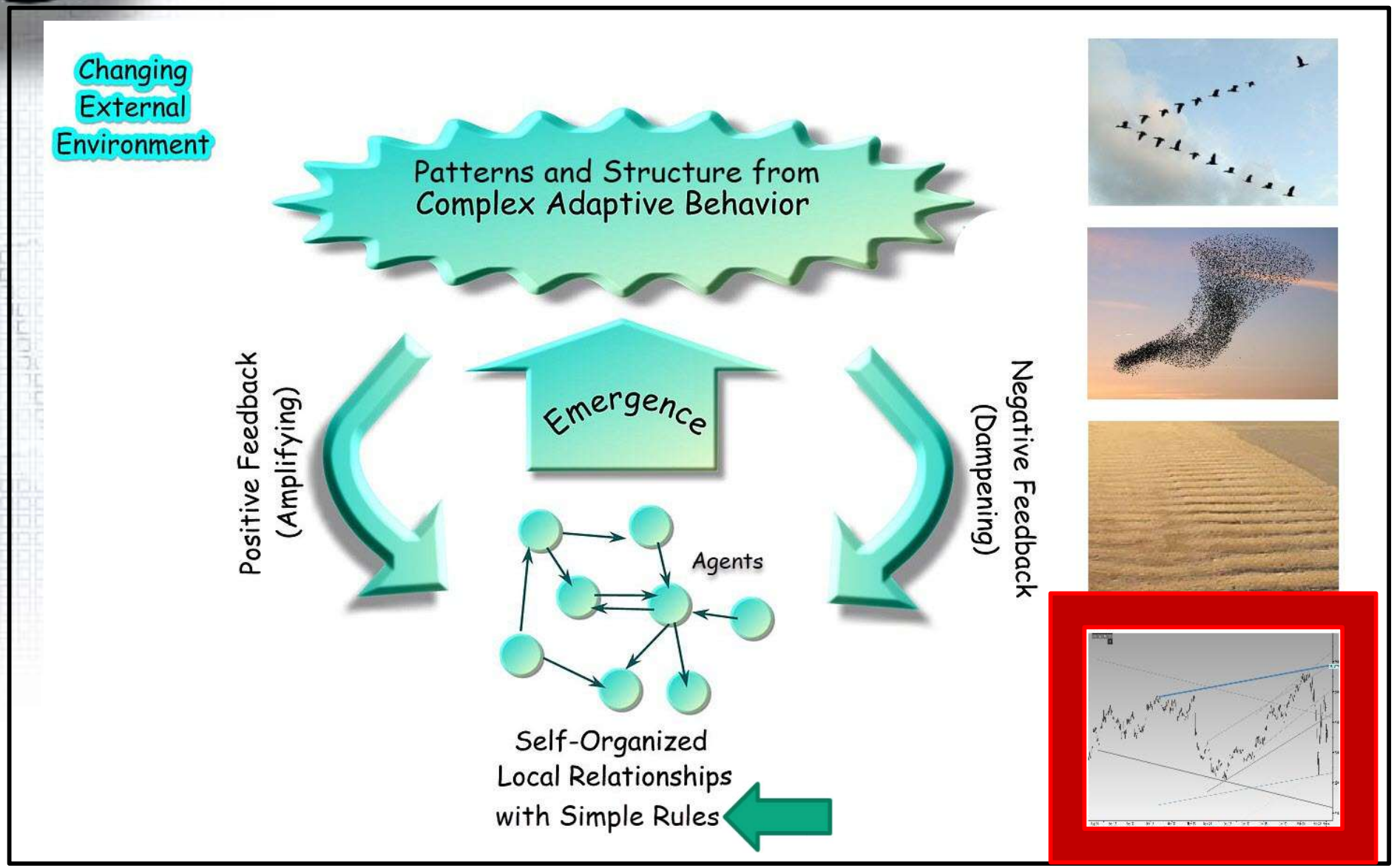
Emergent Geometry

Multi-Agent Systems Generate Geometric Patterns & Structure through Self-Organization



WHAT "SIMPLE RULES" DOES OUR MULTI-AGENT SYSTEM USE?

- PURSUIT OF PRICE
  - CHARACTERIZED BY VOLUME RISING IN THE DIRECTION OF THE TREND
  - CHARACTERIZED BY "FAT TAILS"
  - CHARACTERIZED BY TREND PERSISTENT , MEAN-REVERTING, AND EXTREME HURST MEASUREMENTS
- ATTRACT TO OR REPEL FROM PRIOR MARKET PRICE EXTREMES OR TRENDLINES
  - CHARACTERIZED BY NON-RANDOM GENERATION OF PRICE STRUCTURES SUCH AS TRENDLINES, CHANNELS, TRIANGLES, ETC.
  - CHARACTERIZED BY MEASURABLE MARKET REACTIONS TO OTHERWISE MEANINGLESS PRICE POINTS

Simple Rules Leads to Patterns

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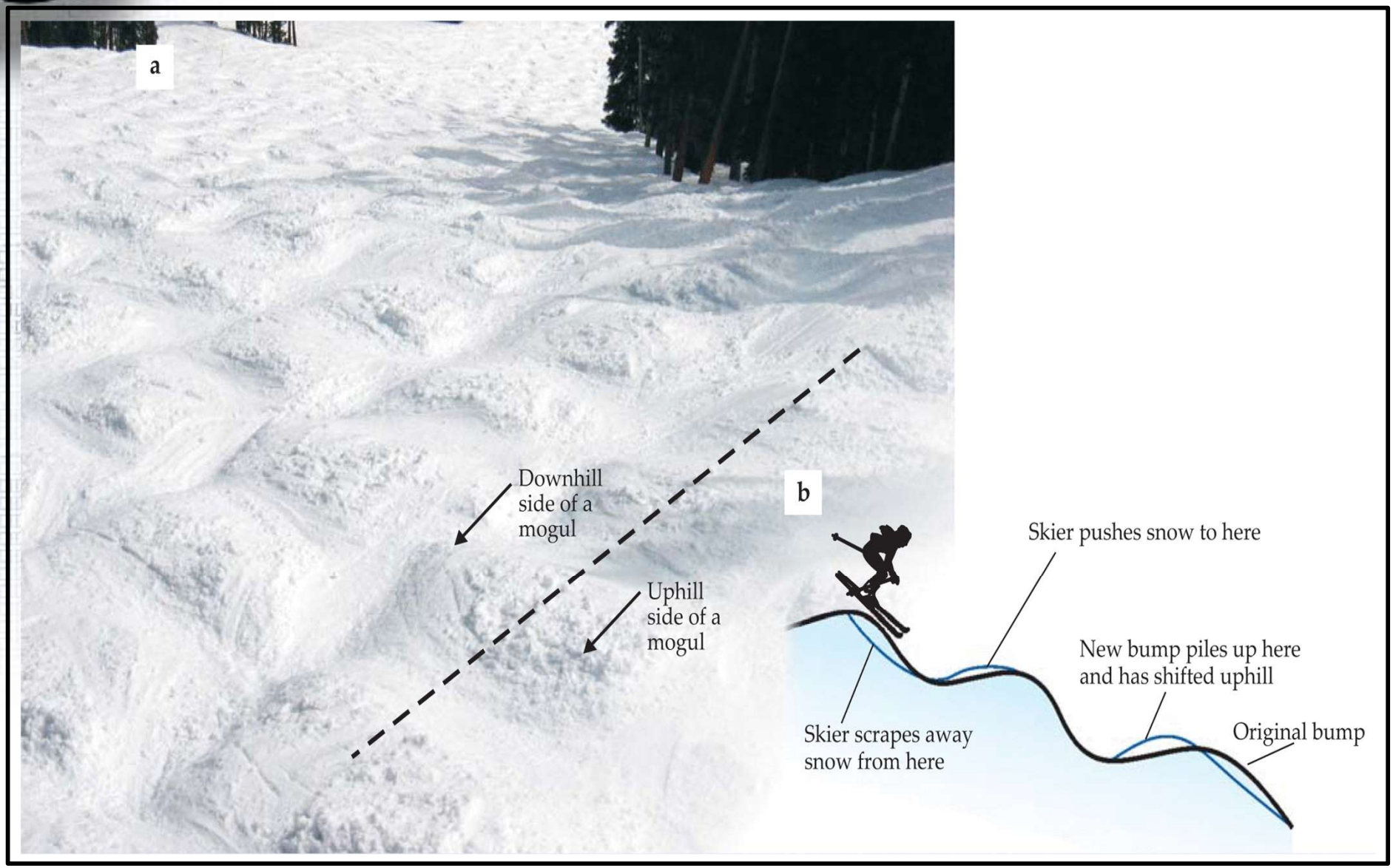

Attraction & Repulsion Rules yields Price Geometries

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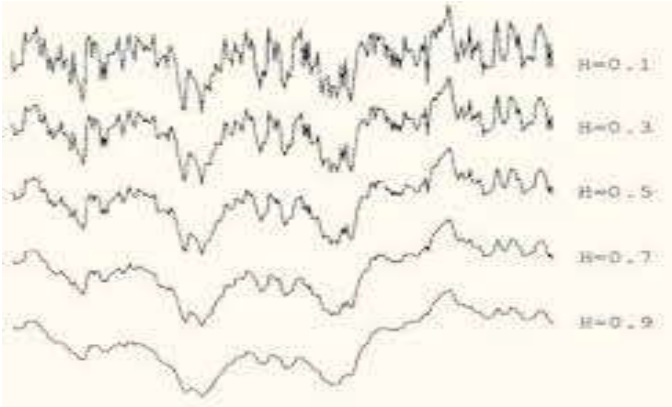
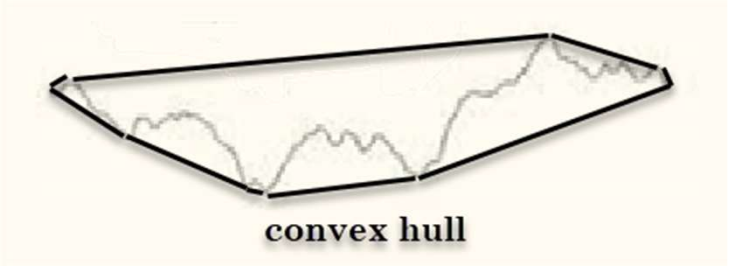
Channel Technology

- Simulate market series using fractional Brownian walks with millions of lengths and Hurst exponents
- Find Convex Hulls for each simulated market series
- Find Parallel and Collinear segments
- Build a statistic (p-value) to identify how common it is to find price channels with Parallel and/or Collinear segments
- Once identified, find event significance for internal & external reflections, and breakouts

Fractional Brownian Walks



Convex Hull – is the smallest convex polygon surrounding a set of points, where each point is either inside or on the boundary.



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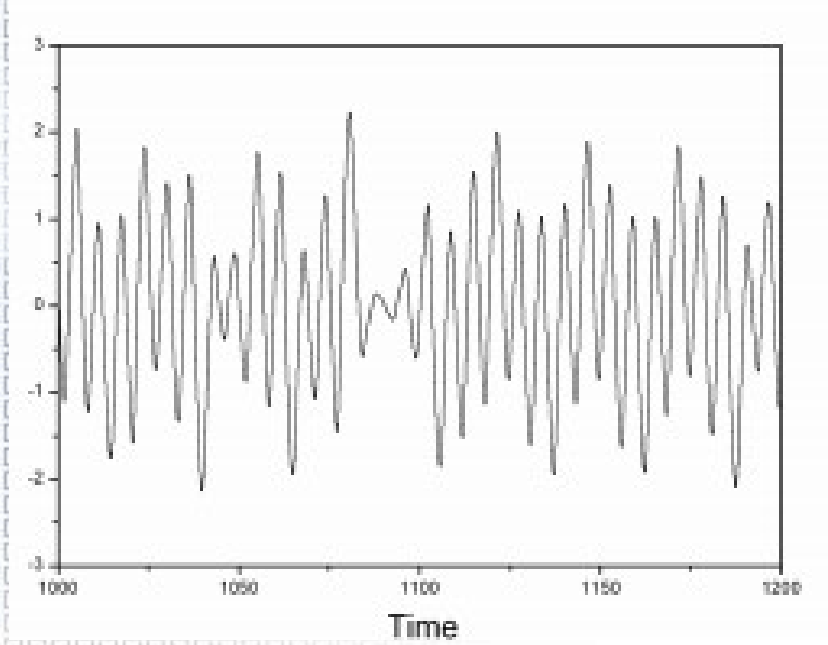
Quasiperiodic Cycles

Price cycles can and do invert and why

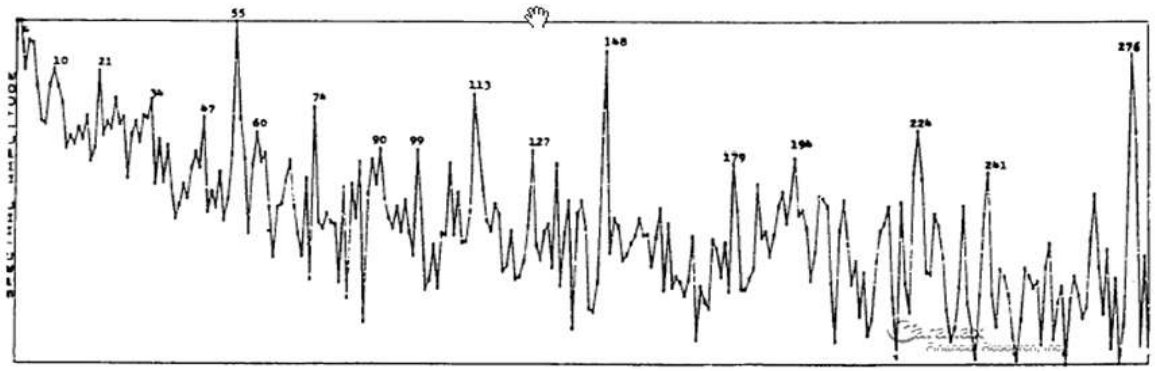


Precision Turn™

Evidence for Cycles

Any discussion of cyclic behavior usually begins with a display of unexplained peaks in the frequency spectrum of the time series in question. The Fourier transform is used to build the amplitude versus frequency picture of the target time series. If all frequencies were equally represented then the graph would be flat and featureless. If however some frequencies were very strong, a large amplitude spike would appear in the graph. This would have to be explained by some phenomenon that occurs regularly and is stationary over time.

The Dow Jones daily financial series was analyzed from 1885 to 1998 in this manner and a number of unexplained spectral peaks emerged as shown



Quasiperiodic Cycles from Chaos Theory suggests the Precision Turn Indicator

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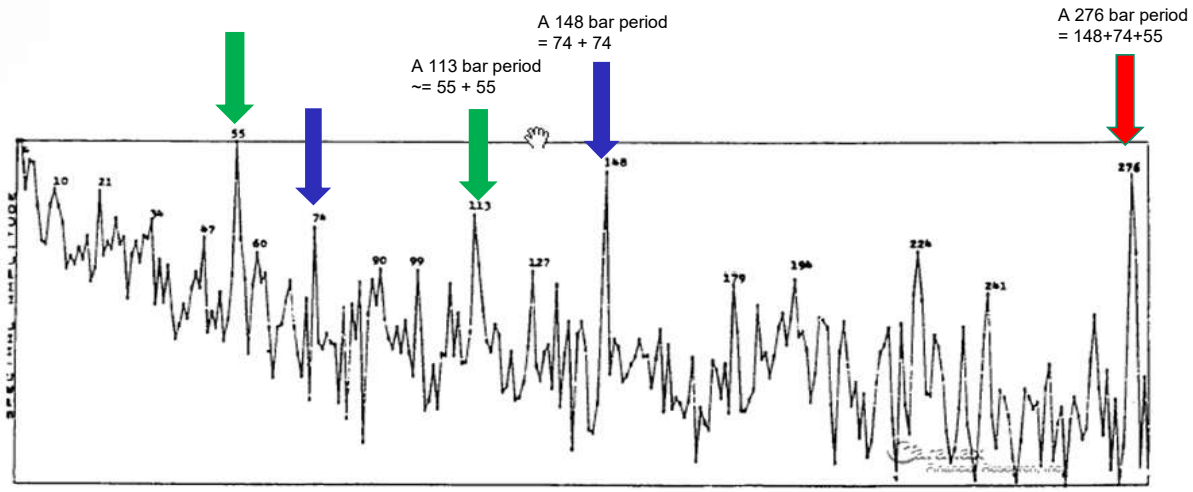
Normally peaks in the spectrum mean that dominant cycles are present and with them the ability to forecast future cycle highs and lows. Quasiperiodicity however, is characterized by cycle peaks that are linear combinations of other cycle periods, and as a consequence, the future phase is unstable (butterfly wings) and may unpredictably invert. The timing of a trend change remains stable though. Precision Turn is a trend change predictor. The sense of high or low must be determined at the time of the trend change.



Quasiperiodic Cycles imply Predictability of Absolute Value of Price Curvature

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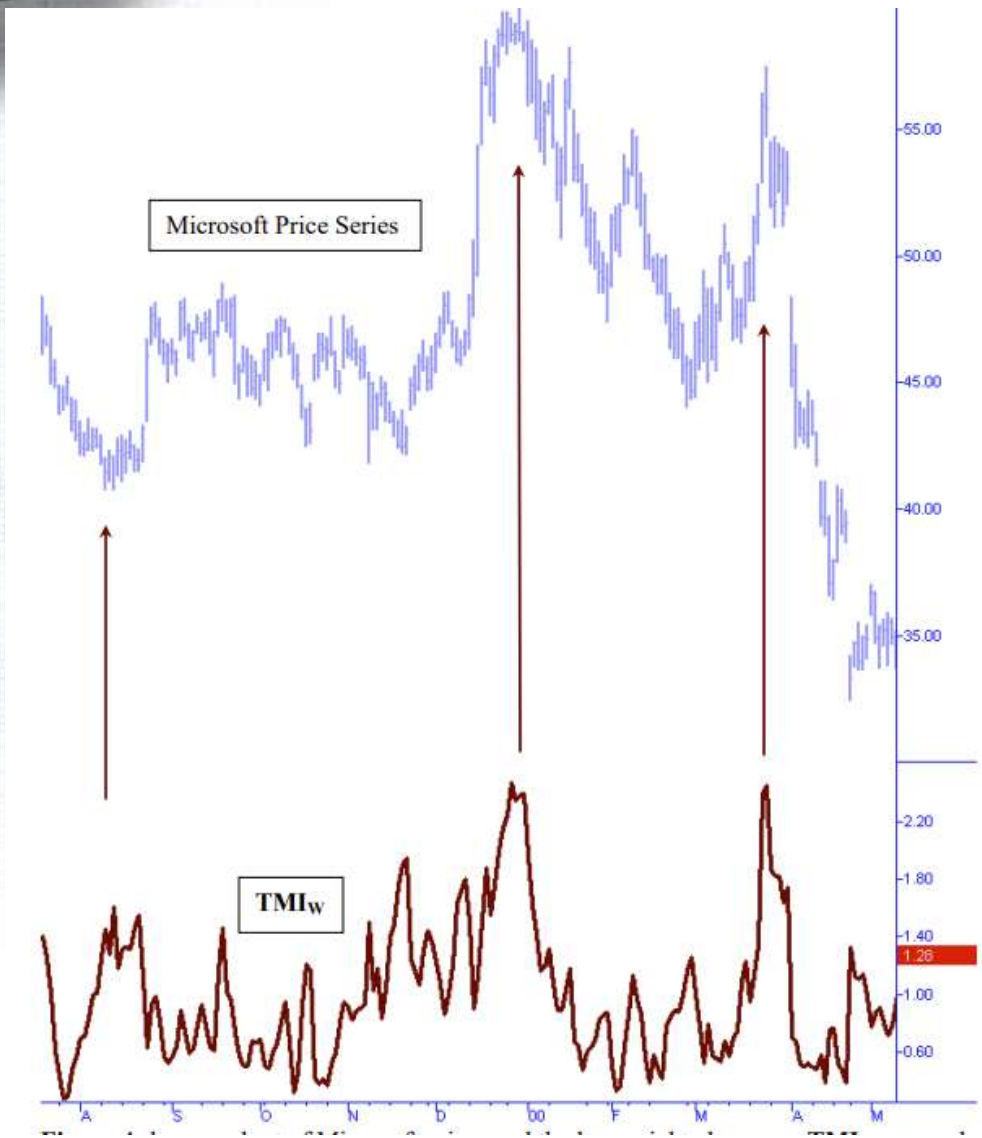
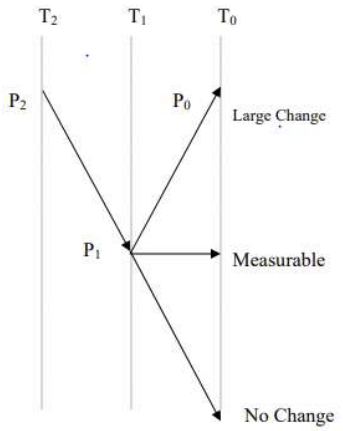


- Cycle Highs and Lows are not predictable because quasiperiodic phase is unstable
- Remove H/L by using absolute value
- Predict price “Trend Change” (also called “Curvature”
- Invented Turn Measurement Index (“TMI”) as an alternate target
- Produces trend change forecast dates without knowing H/L



Measure of Trend Change T Bars Ago=

$$\frac{\left|P_0 - 2P_1 + P_2\right|}{\sqrt{T}\langle R_T \rangle}$$

Where,
P0 = price today
P1 = price T bars ago
P2 = price 2T bars ago
T = number of bars since turn
$\langle R_T \rangle$ = average true range over T bars
| | = Absolute value

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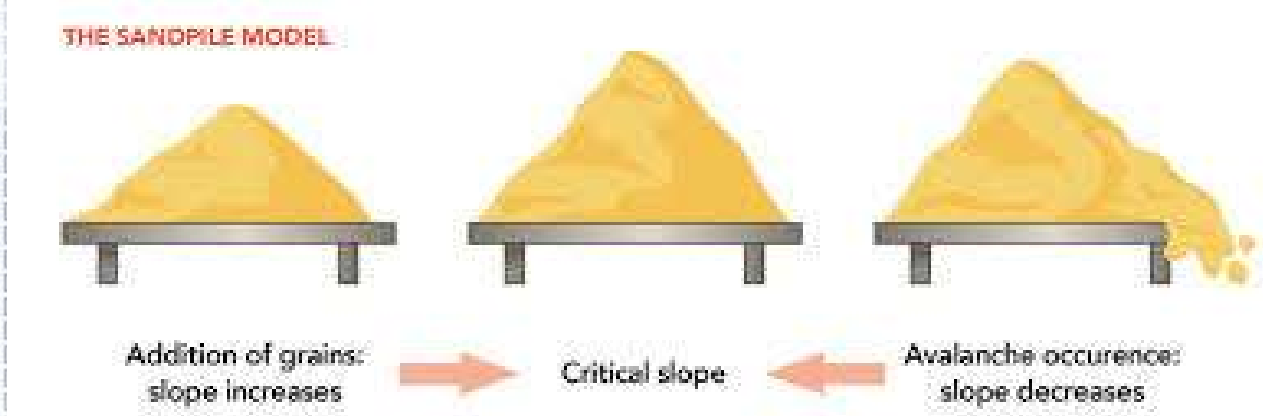
Self-Organized Criticality (SOC)

Multi-Agent Systems Self-Organize To Critical Points when far from Equilibrium



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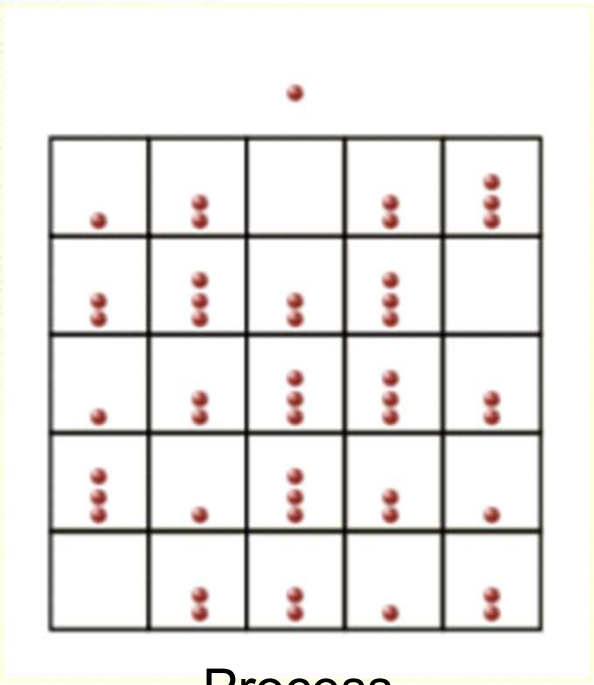
Extreme Positive Feedback:

Small changes in a system near the critical point lead to big effects as in
Avalanches, Earthquakes, and
Financial market bubbles and busts

Markets tend to self-organize to critical states



Process

Result

Potential Energy Price Model

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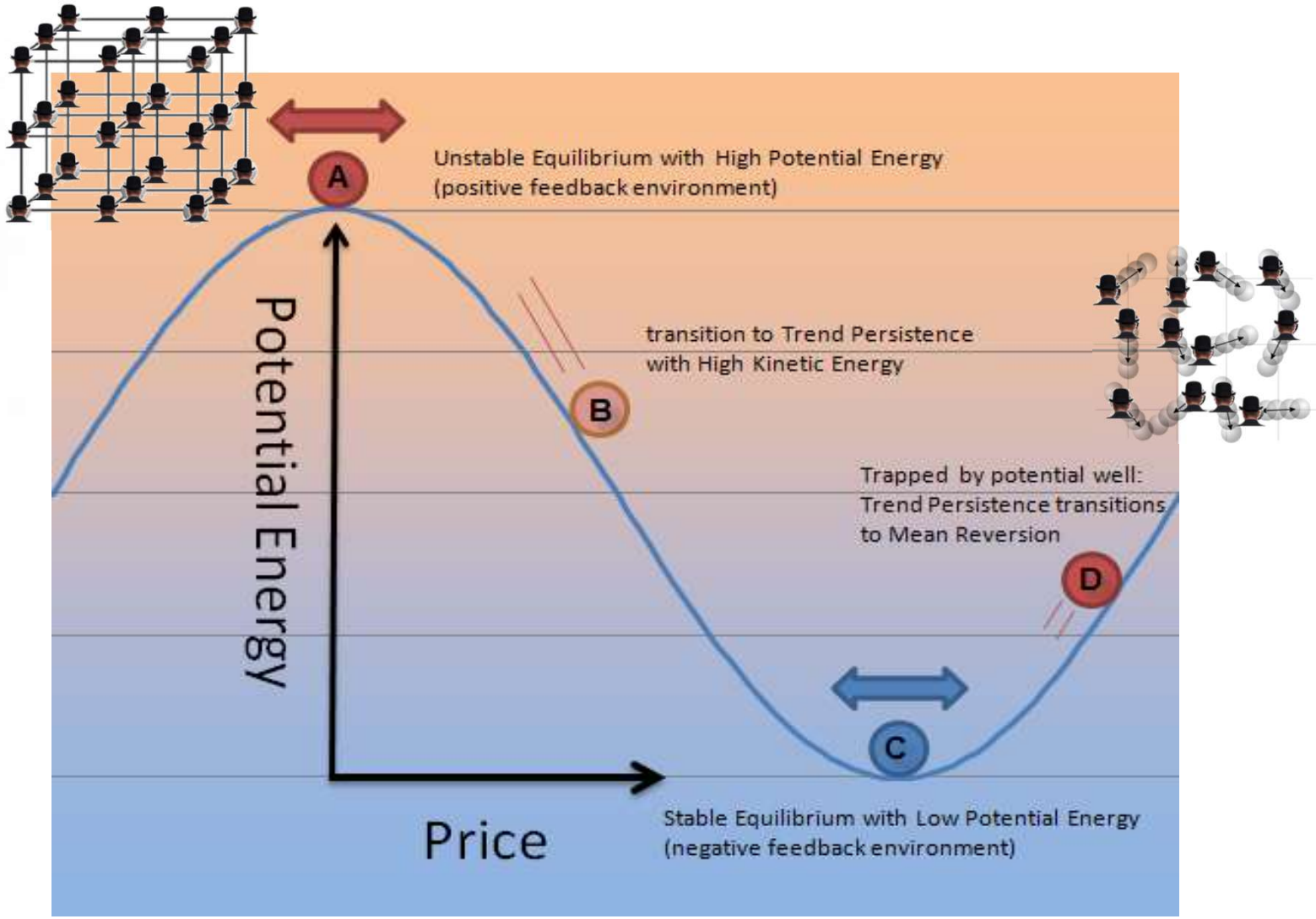
- Ball **A** is unstable far from equilibrium and will run toward higher or lower prices very fast if nudged.
- Ball **B** is trend persistent with high kinetic energy. It overshoots equilibrium moving past **C** up to position **D** and stalls
- Ball **D** is trapped by the potential well and marks the end-of-trend
- Ball **C** is at equilibrium and moves back and forth randomly




What Happens Next?
Ball C can move either way freely & symmetrically
C
Symmetry is breaking as stress builds
Ball C has become Ball A and is at an unstable equilibrium again
A
<- Down
Up ->
price
Investor Stress Accumulates

Excitation-Relaxation: Moving from D to C

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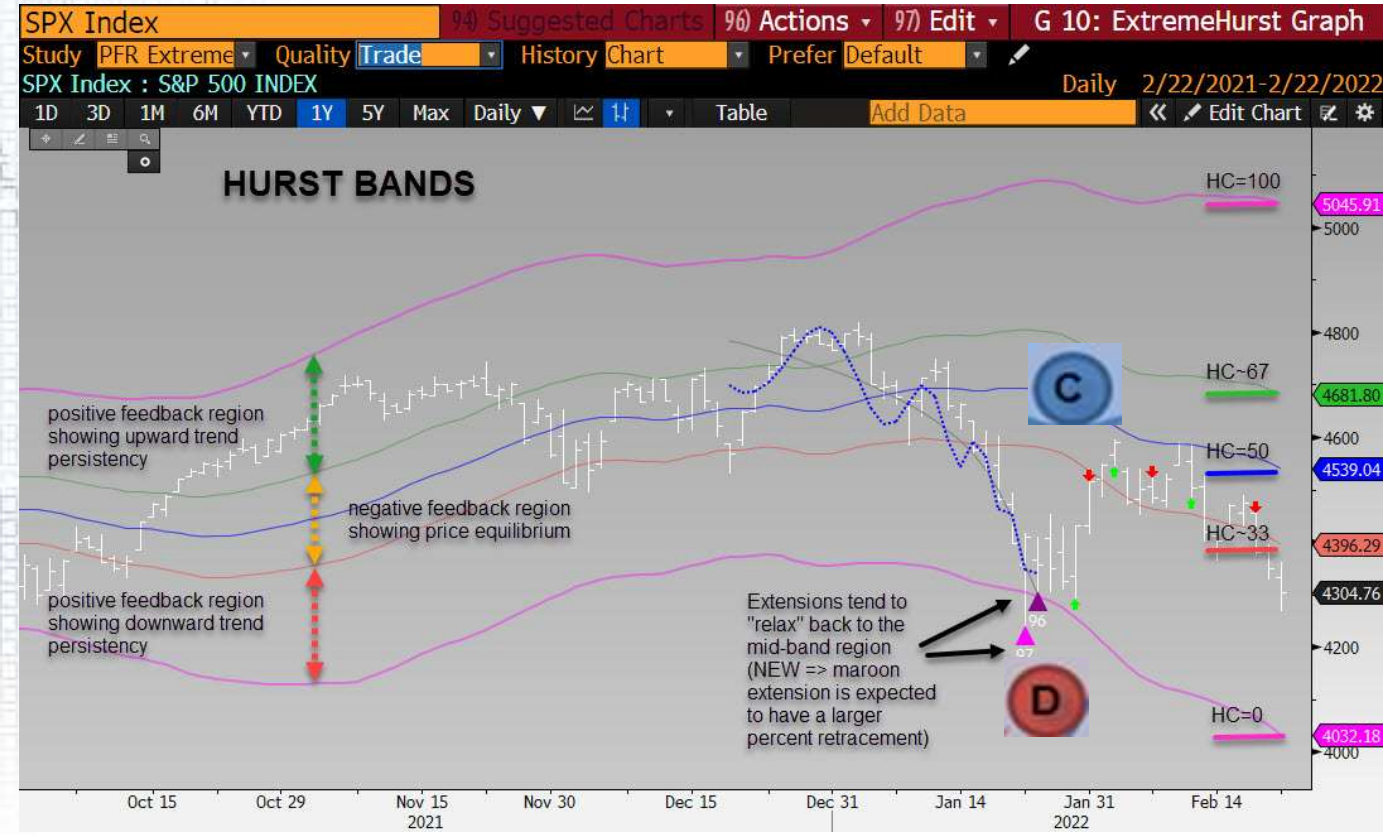
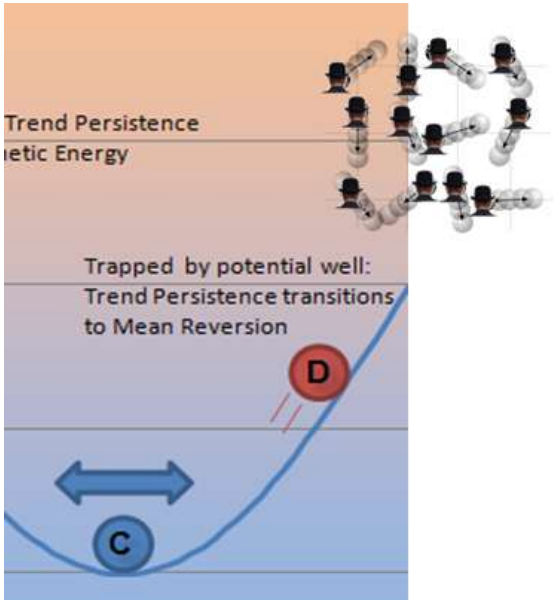
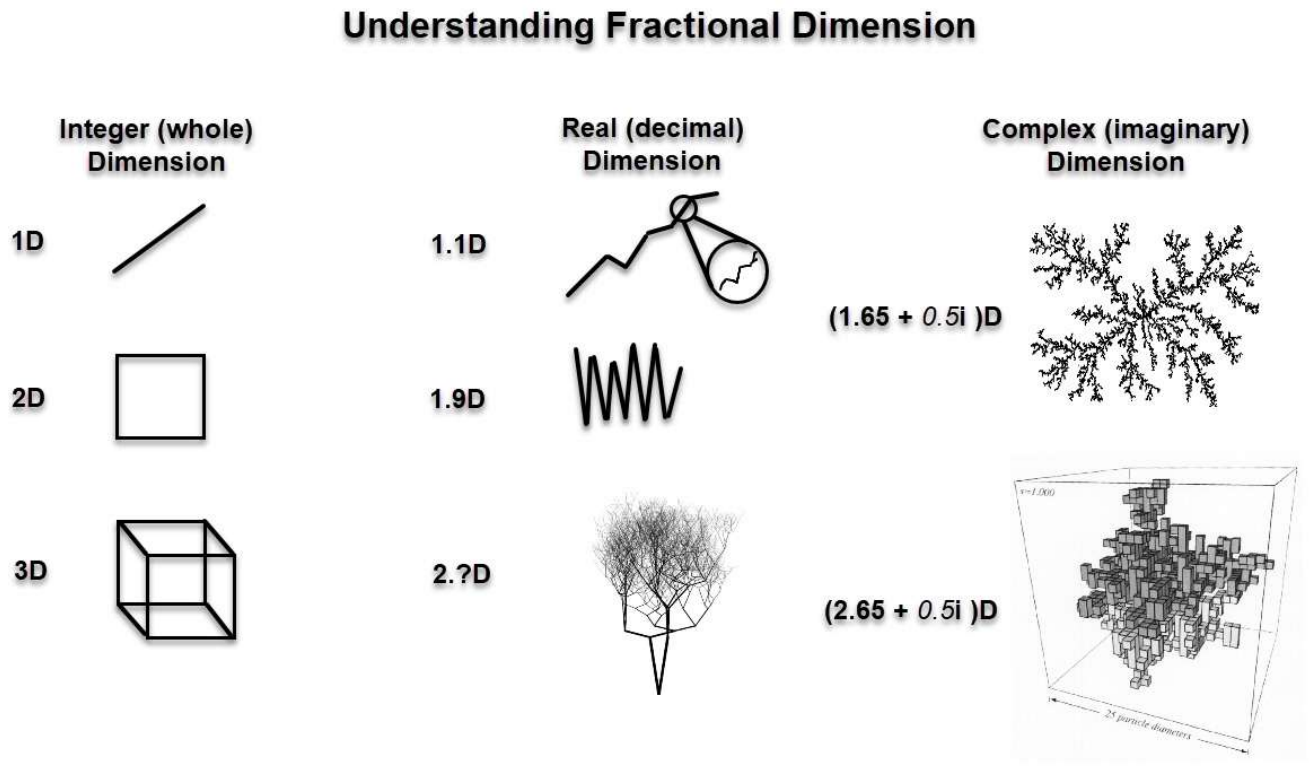




Critical failure systems that exhibit symmetry breaking are characterized by **complex fractals, discrete scale invariance, and log-periodicity**



Feedback & Investor Behavior : Home Depot Chart

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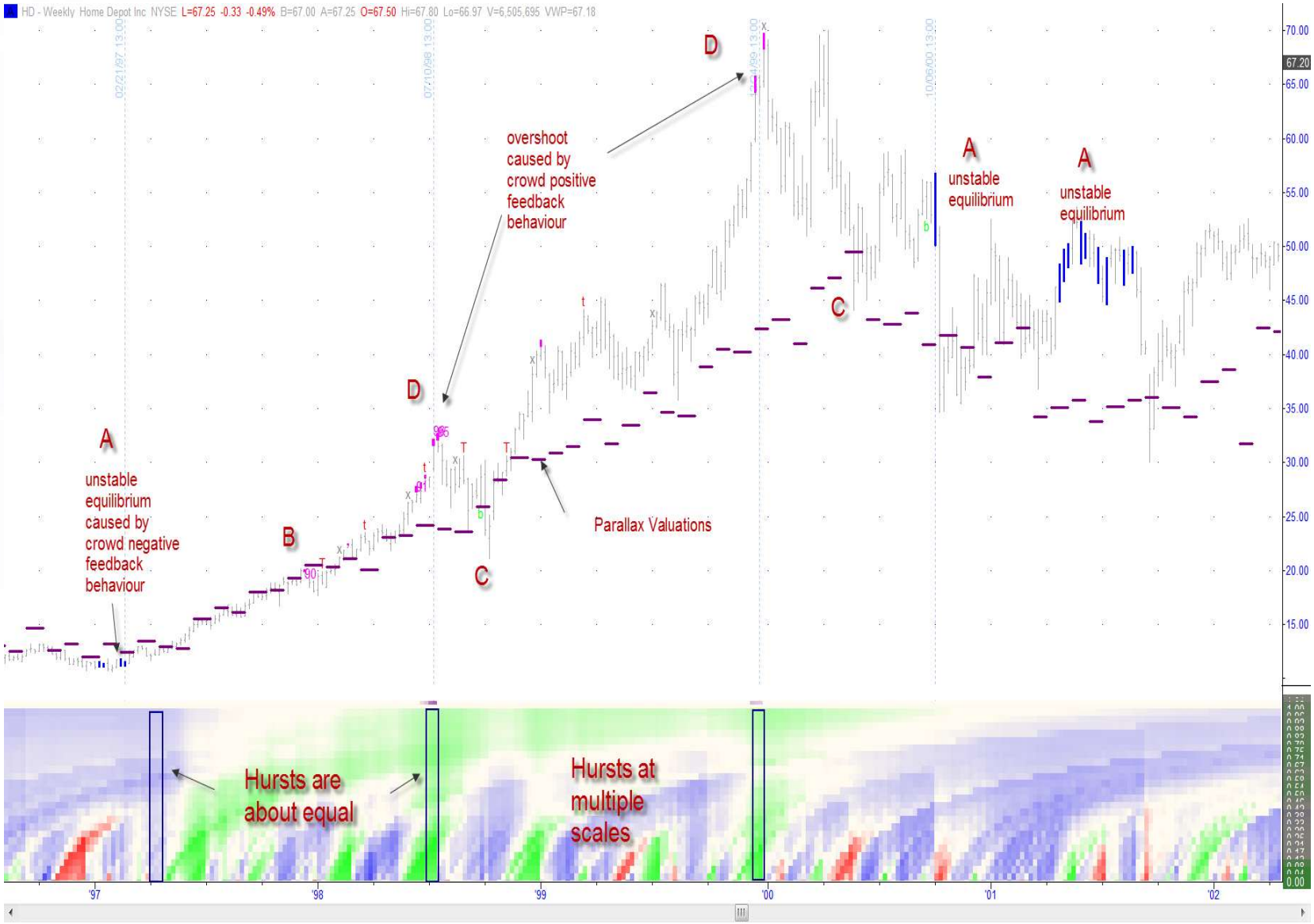
- The Value Investor watches the stock valuation for opportunities
- The Trend Following investor is driven to buy when price is going up and sell when going down which causes a “crowd effect”
- Combining trend following and value behaviors yields overshoots and undershoots



Extreme Hurst with Discrete Scale Invariance

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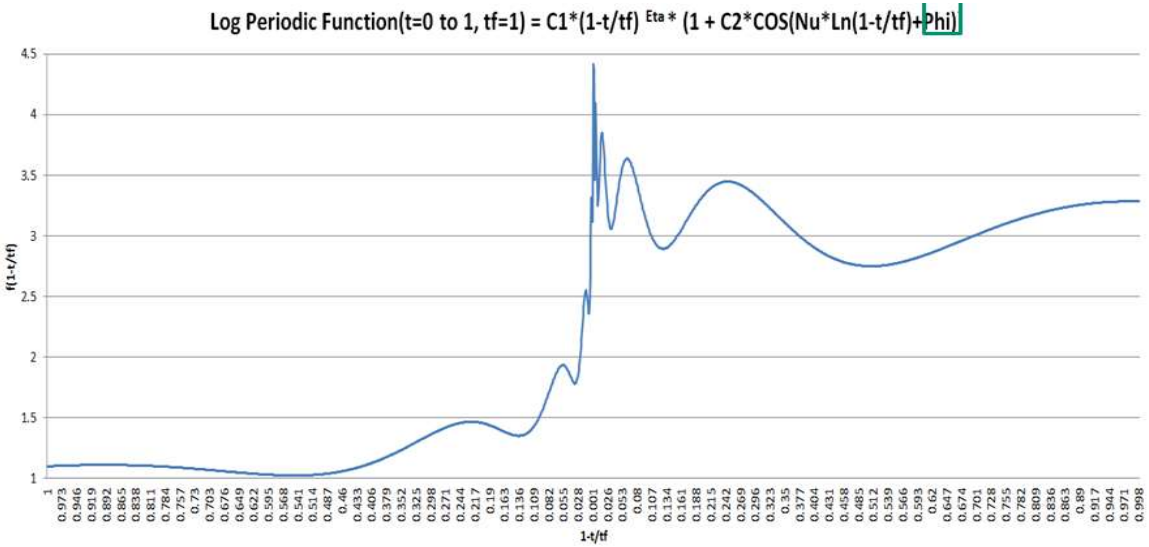
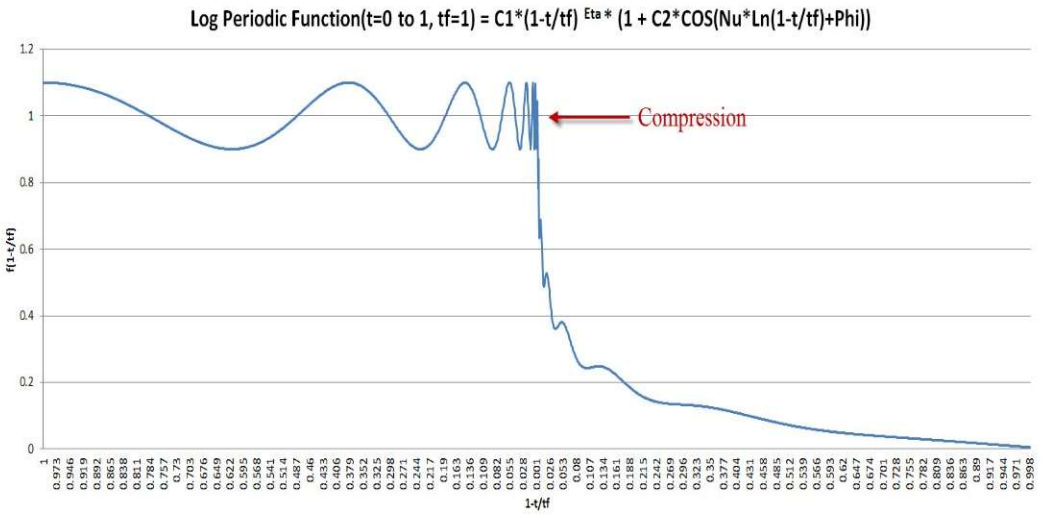
- Signal when:
  - Hurst at extreme levels
  - Hurst nearly equal across multiple time scales
  - Log periodic ripples are present due to discrete scale invariance
- Same science as critical phase transitions in materials
- Discrete Scale Invariance theory requires log-periodicity
- Log periodic ripples lead into and out of these critical points

Extreme High Hurst: Extension



Extreme Low Hurst: Compression



Log Periodicity and the Fibonacci Series

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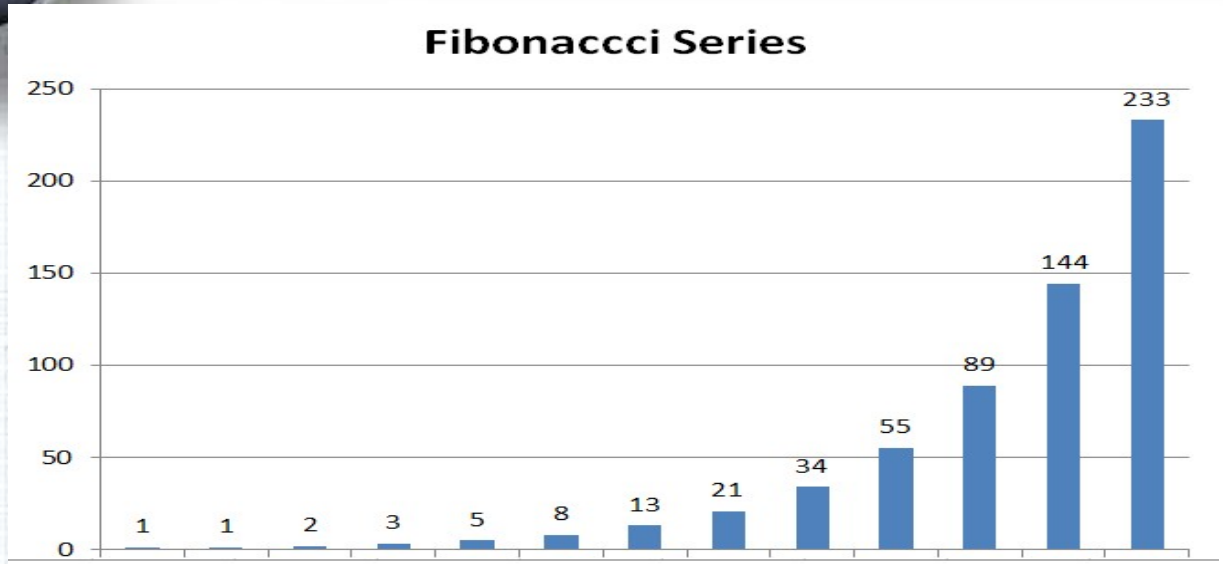

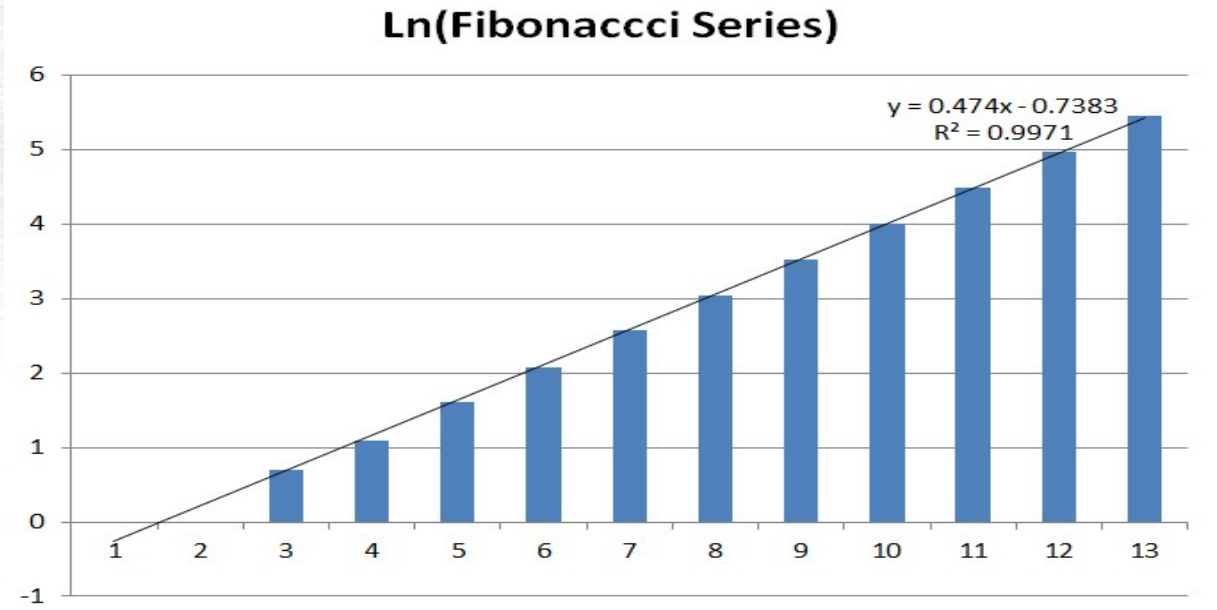

- Certain number series are log periodic
- Adjacent Fibonacci Series terms are progressively farther apart
- But if you take the logarithm of each Fibonacci term, then adjacent terms are approx. equidistant
- The Fibonacci series is Log Periodic


… ARE MIRRORED FOLLOWING THE EXTENSION
compression
Log-periodic aftershock cycle times are predicted AT the time of the bottom extension
CONVERGING LP CYCLES ….
bottom extension
135
130
129.6300049
127.4515457
125
120
115
Oct 15
Oct 31
Nov 15
2019
Nov 29
Dec 16
Dec 31
Jan 15
Jan 31
Feb 14
Feb 28
Mar 16
Mar 31
Apr 15
04/20/20
Apr 30
May 15
2020
May 29
Jun 15
Jun 30
Jul 15
Jul 31
Aug 14
Aug 31
Sep 15

ExtremeHurst may be the key to forecasting earthquakes

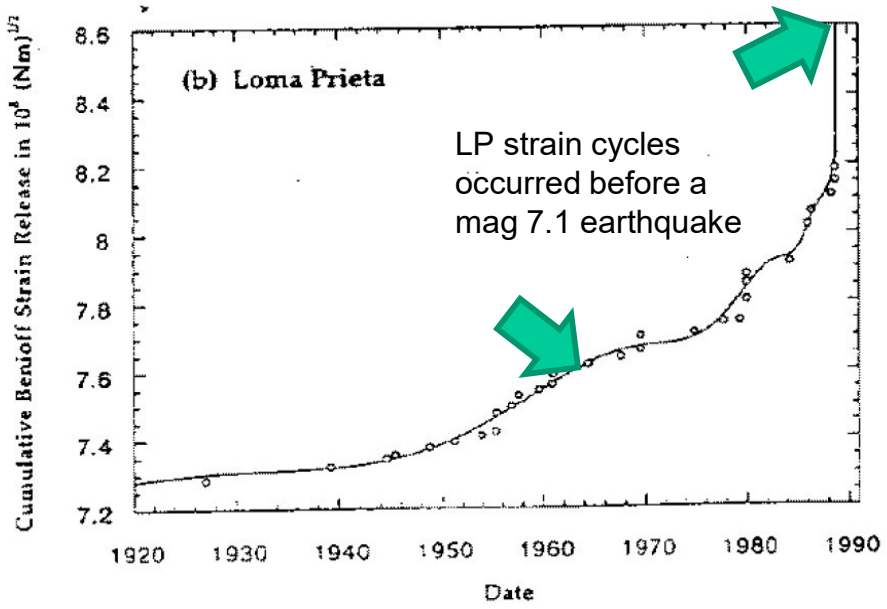

Figure 1: Cumulative Benioff strain released by magnitude 5 and greater earthquake in the San Francisco Bay area prior to the 1989 Loma Prieta earthquake. In (a), the data have been fit to the power law Eq.(2). In (b), the data have been fit to Eq.(14) which includes the first order correction to scaling.

Feedback in Multi-Agent Systems Produces the Observations that we call "Technical Analysis"

Scientific Name	Quasiperiodicity	Critical Phase Transition	Self-Organization & Emergence	Stochastic Pursuit
Technical Analysis Name	Price Cycles	Trend Change Exhaustion Bubble, Bust, Mania Top or Bottom Tension-on-the-Tape Compression	Trendlines Trend Channels Flags, Pennants, Head-and-Shoulders Zig-Zags Elliot Wave Support/Resistance	Trending Accumulation Distribution Fat Tails Z Score Moving Averages MACD
Parallax Tool	Precision Turn	ExtremeHurst	SmartChannel PriceMemory Forecasters	VolumeTrend Technical Rank Price-Volume Cross Hurst Bands

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Building a Fundamental Valuation Model using Artificial Intelligence

Fundamental Value Factors:

- Earnings
- Cash Flow
- Debt
- Sector & Industry
- Book Value
- Sales

↓

Value-Oriented Behavior

What is Artificial Intelligence?

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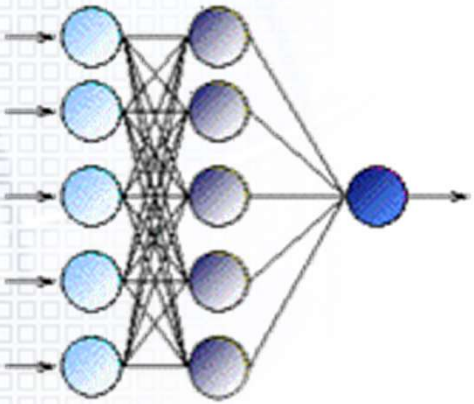
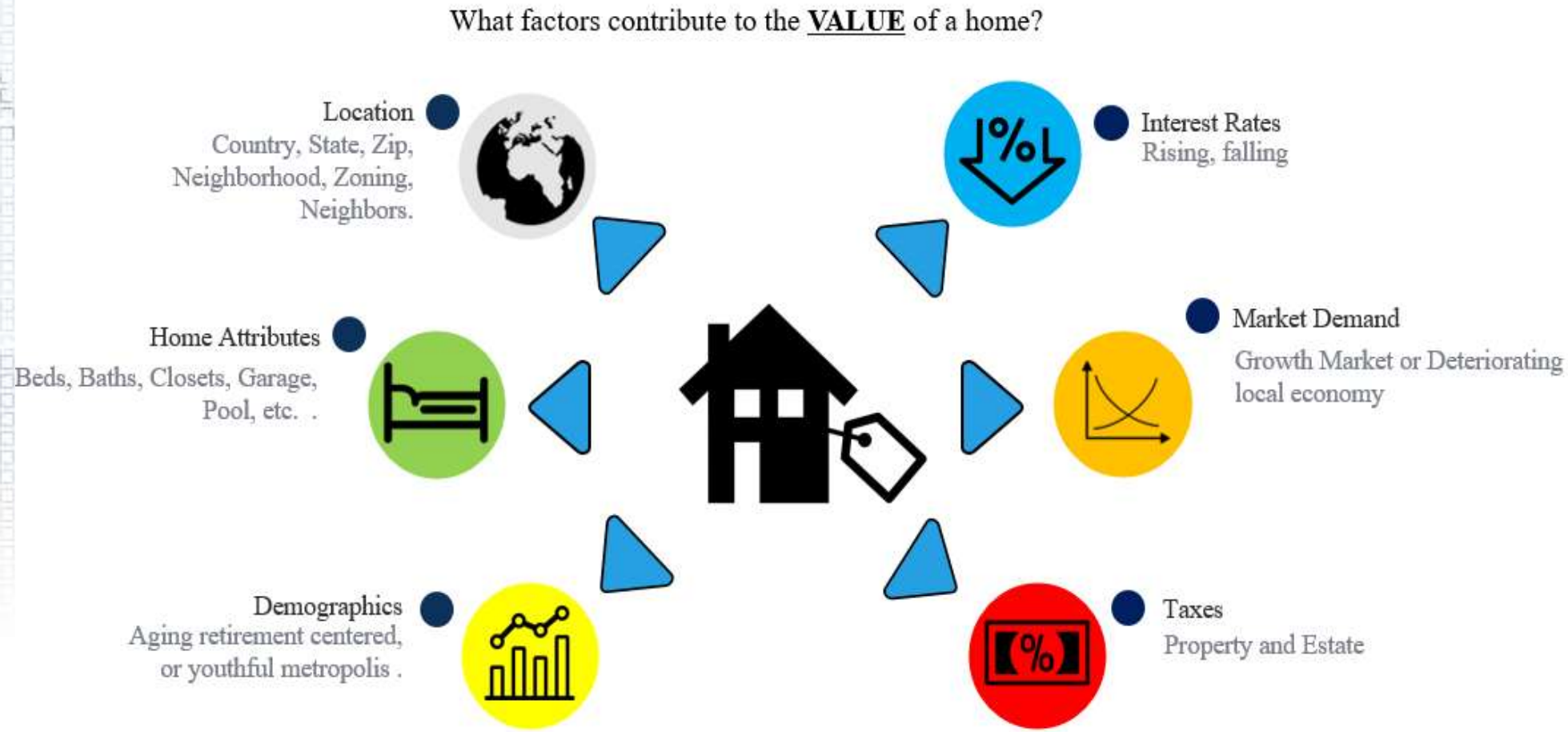


- Artificial Intelligence refers to mathematical modeling methods that employ learning
- Mimics how humans learn
- Commonly use “neural nets”
- The models have no pre-determined form
- Have they acquired general knowledge or just memorized what they were fed
- We use them to build multi-factor models to capture the interrelation of factors and any non-linearities

How Do We Determine Real Estate Value?



How Do We Determine Stock Value?

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- Just like Zillow and FICO, we can build a value model for stock prices
- We use neural networks to make models with multiple factors (also known as artificial intelligence or "**AI**")
- **AI** models learn from example, so we "**train**" them to understand how fundamental factors combine to make a market price
- Once they are trained, we can value any stock
- Stock prices tend to converge to our valuation over time

Price Wizard™: Fundamental Valuation in Bloomberg

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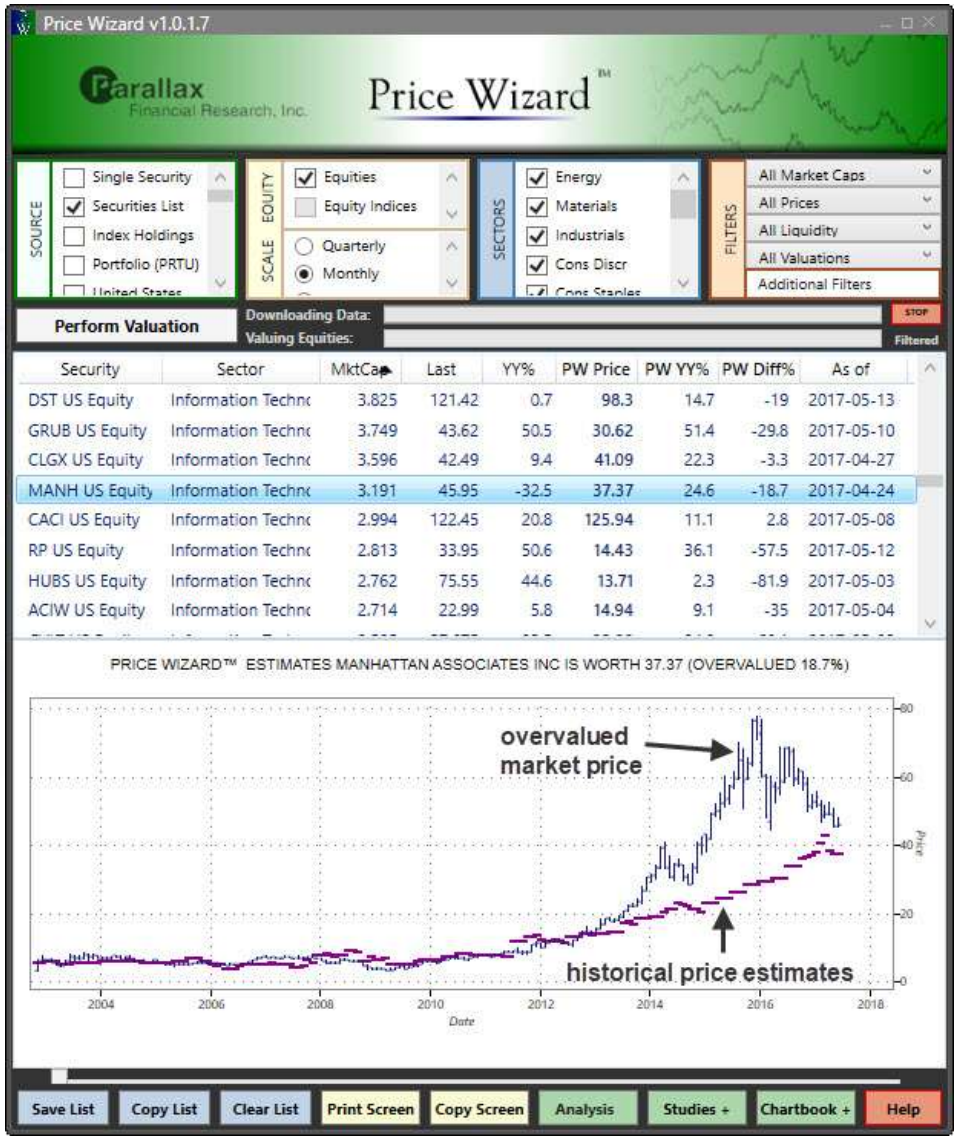

- Sector neural nets trained to estimate a current market price
- Uses common fundamental factors
- Out-of-sample since early 2000
- No analyst estimates
- Price tends to converge to valuation over time
- Works Internationally

Price Wizard™: Fundamental Valuation in TradeStation

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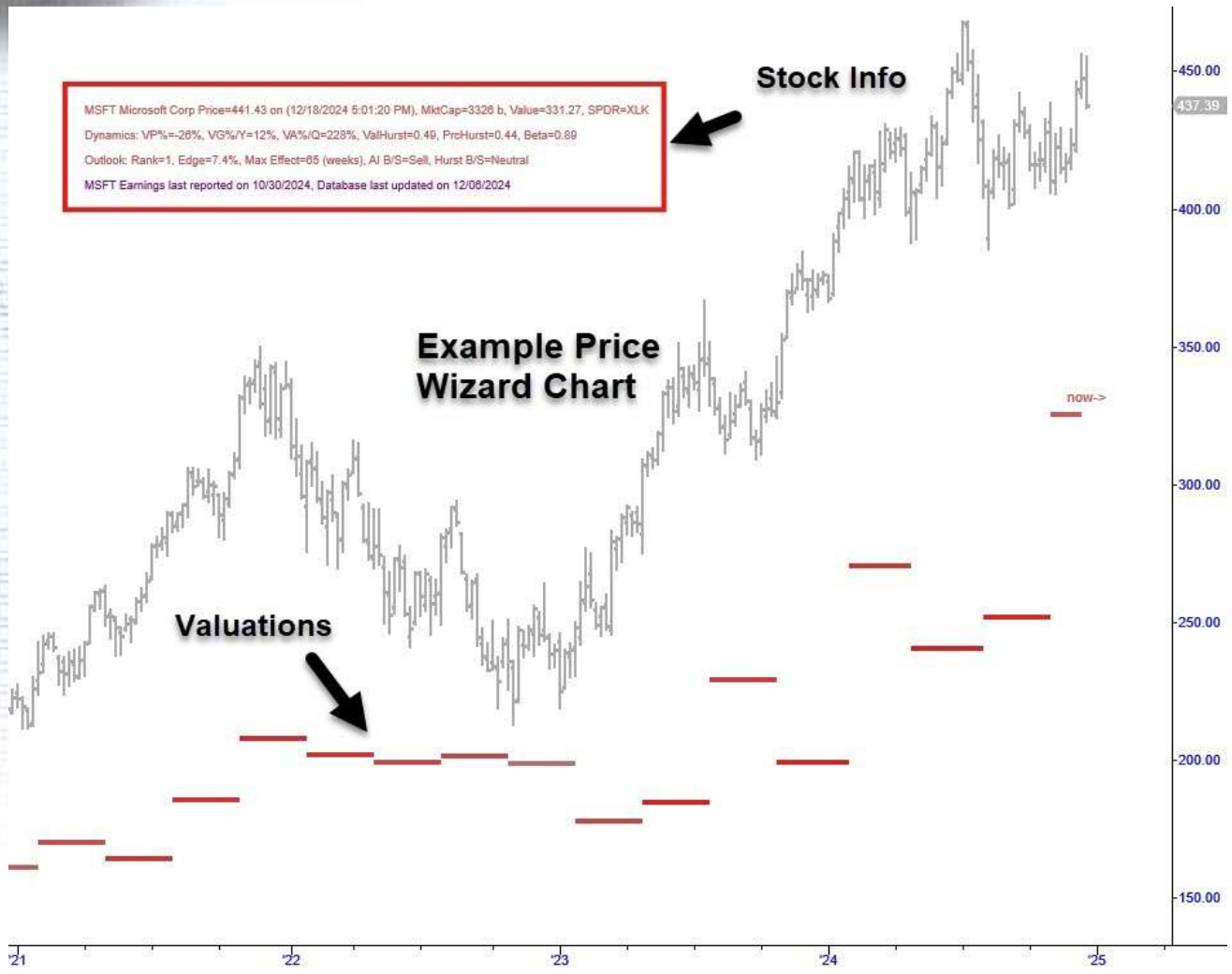

- TradeStation uses Reuters fundamental data
- Updates one day after earnings reports
- US Data Only
- EXCEL output
- Works in Charts and RadarScreen

Which Fundamental Factors are Important?

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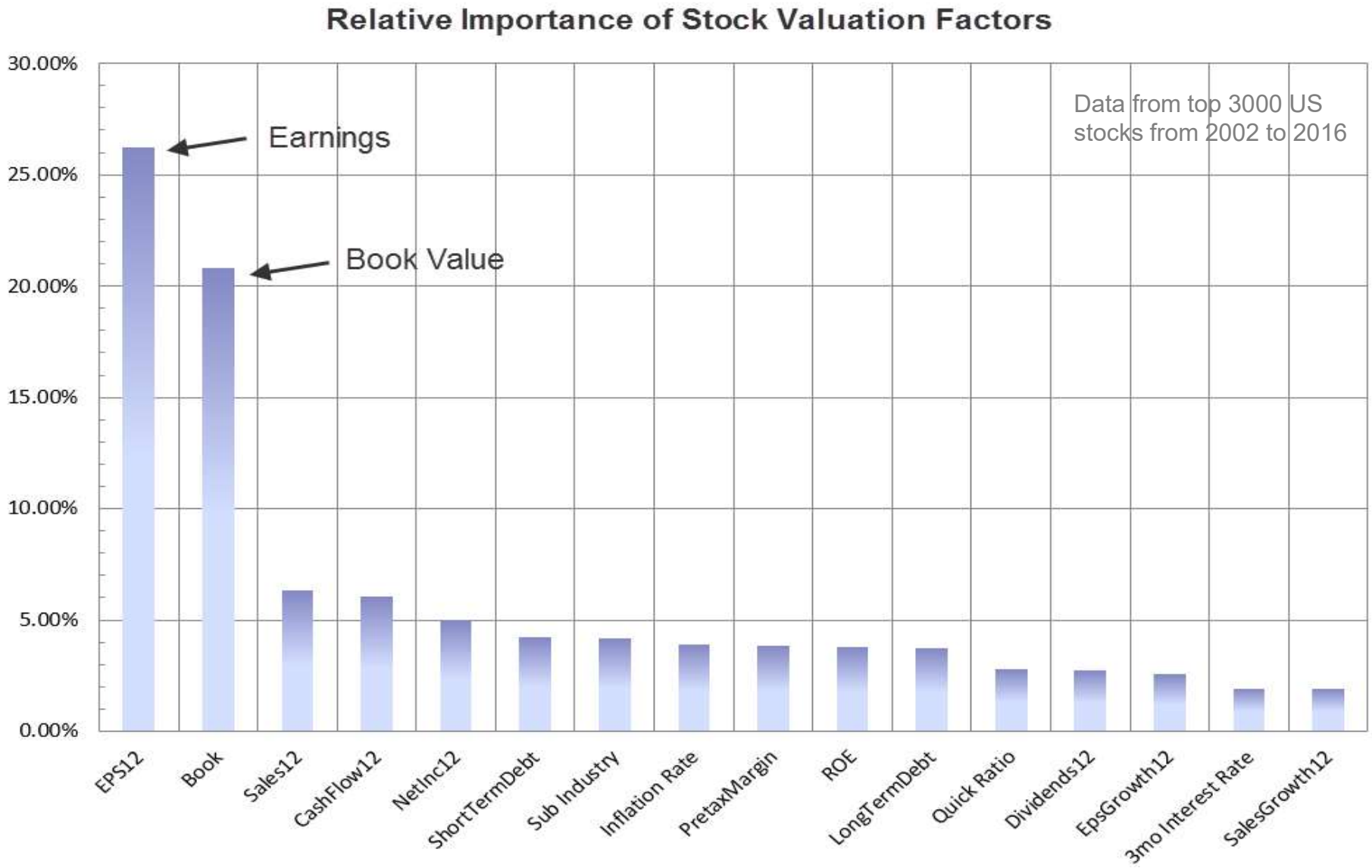

Comparison to Ford Equity Valuation Model

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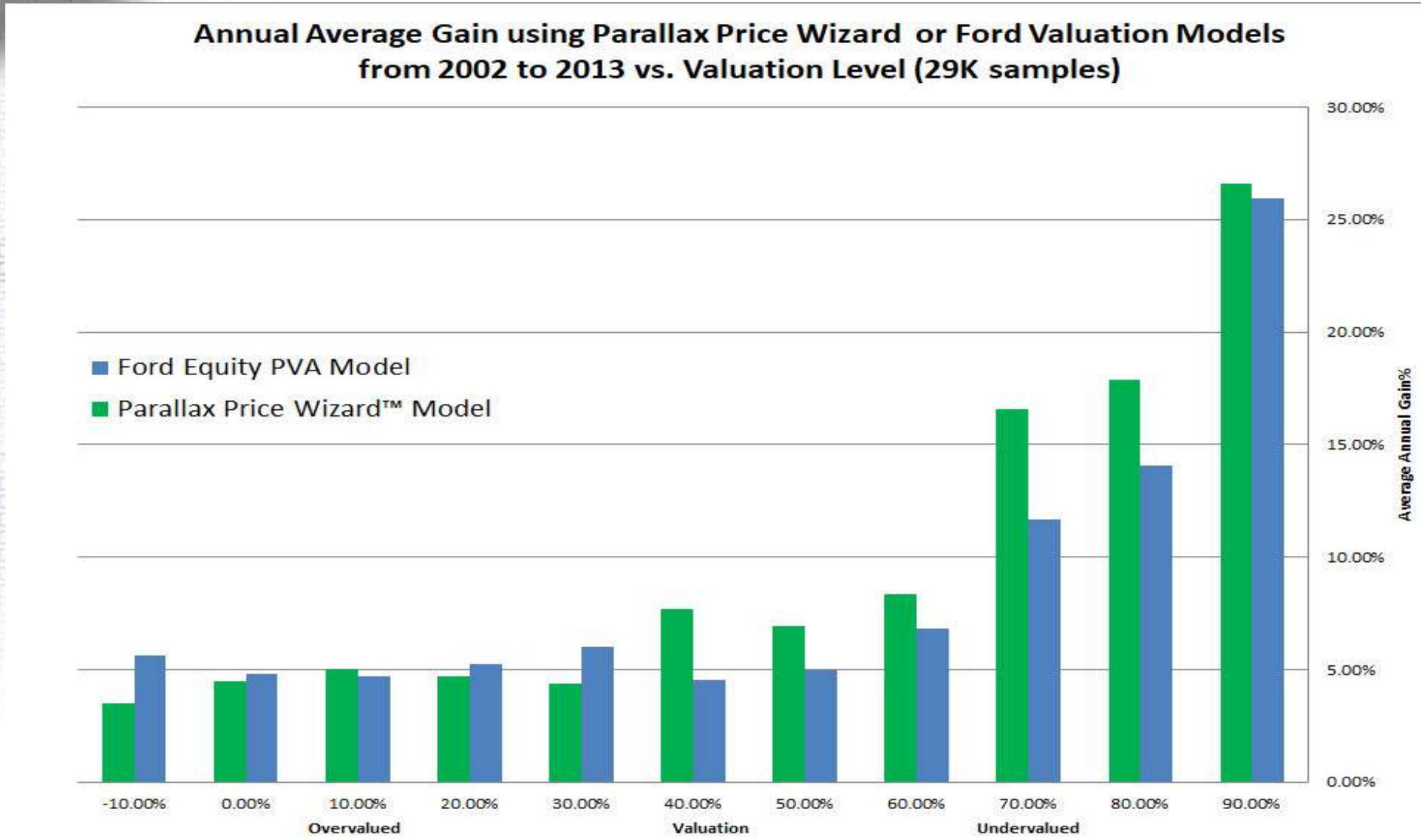

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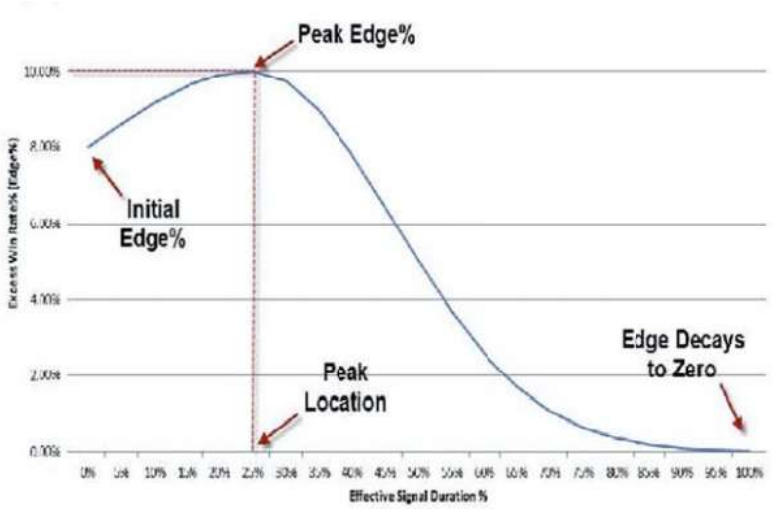
Measuring Signal Performance

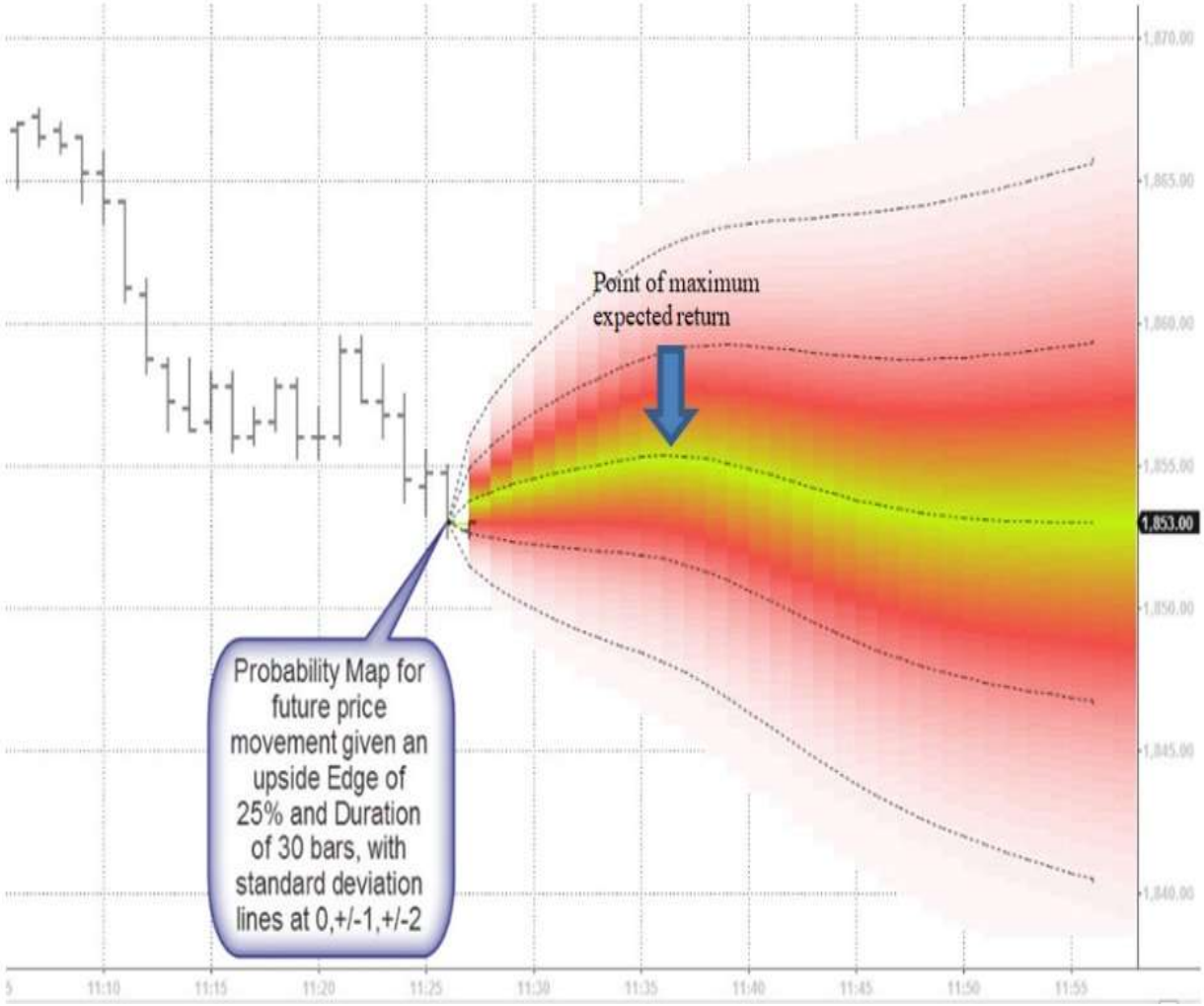
A Predictive Edge is the Key to Investment Success

- **Signal** definition:
  - Any combination of measurements, rules, intuition, observations, etc. that leads to the entry or exit from a Trade
  - Performance is measured by Edge and Duration
- **Strategy** definition:
  - Any combination of Signals that leads to a full Trade, always including entry and exit
  - Performance is typically measured by Profit Factor
- **Trade** definition:
  - A trade occurs when money is put at risk by purchasing or shorting a security
- **Profit Factor** definition:
  - Total gain divided by total cost of a trade
- **Edge** definition:
  - The probability of winning a game of chance minus the random chance of winning
  - We consider a “Signal” as a “flip of a coin” with a long vs short result
- **Duration** definition:
  - The time it takes for Edge to return to zero



- Directional Edge Bias
  - The probability of finding price at a certain level in the future is expressed as a cone of probability
  - If there is a directional "edge", then the cone is tilted up or down

- Volatility Bias
  - Market volatility can change, and this changes the width of the cone



Edge & Duration

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$$edge(i) = \frac{1}{2N}\sum_{j=1}^{N}(\delta_{i,j}) - \{Random\ backgound\ edge\}, \text{ where}$$

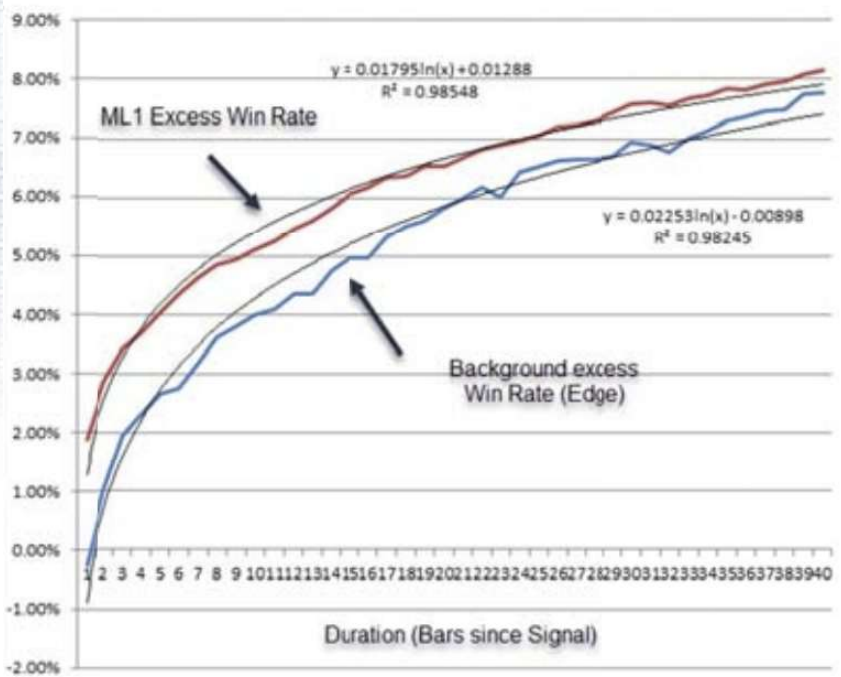
i = the bar number,

j = the signal number,

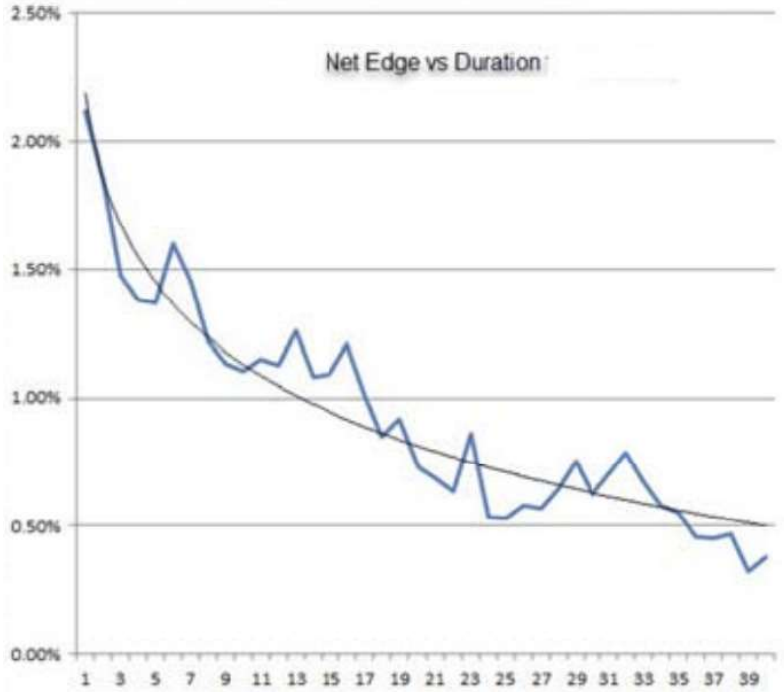
δ=+1 if market is above signal price, or -1 if it is below

N = number of signals. This should be hundreds to thousands

$$duration = i : edge(i) \approx 0$$



subtract background



Summary of Basic Ideas

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Technical Analysis is derived from Complexity Theory

- Investors Pursue Price
- Negative Feedback behavior as Value Investing
- Positive Feedback behavior as Booms & Busts
- Geometry is an Emergent Property of multi-agent systems under Complexity Theory

Extreme Feedback is Predictive

- Critical Events present on all scales “Earthquakes”
- With Log Periodic “Aftershock” Cycles
- Evidence of Self-Organized Criticality

Implications for Equilibrium Economics

- Self-Organized Criticality implies Markets tend to organize far from Equilibrium
- Booms and Busts are present on all scales