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Codifying the Fractal Nature of Market Data

Impact on Technical Indicators

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OUTLINE

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- Theoretical Basis of Market Data Structure
- Measured Market Data Structure
- Measuring Market Data Spectrums
- The Need to Think in Terms of Frequency
  - Frequency is the Dual of Conventional Time Waveforms
- Filter Basics
- Indicator Dynamics
  - The Impact of Spectral Dilation and What to Do About it
- An Introduction to www.StockSpotter.com

Drunkards Walk

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- Described in “MESA and Trading Market Cycles”
  - Drunk steps right or left with each step forward
    - Random Variable is position
    - Results in the famous Diffusion Equation
    - Describes the shape of a plume of smoke (or a trend)
  - Drunk steps in the same or opposite direction as the last step with each step forward
    - Random Variable is momentum
    - Results in the famous Wave Equation
    - Describes a meandering river (or a cycle)
- The 2nd Order Partial Differential Equations are nearly identical
- Results are that cycles and trends can coexist in a complex mixture

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Swerling Model

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- Peter Swerling statistically described radar echoes
  - Pulses were noisy over time – due to complex airplane shapes and changes in aspect from the fixed radar site.
  - Model described as pure noise with memory
- I have synthesized market data as noise with an EMA
  - Not bad for a simple model

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Hurst Exponent

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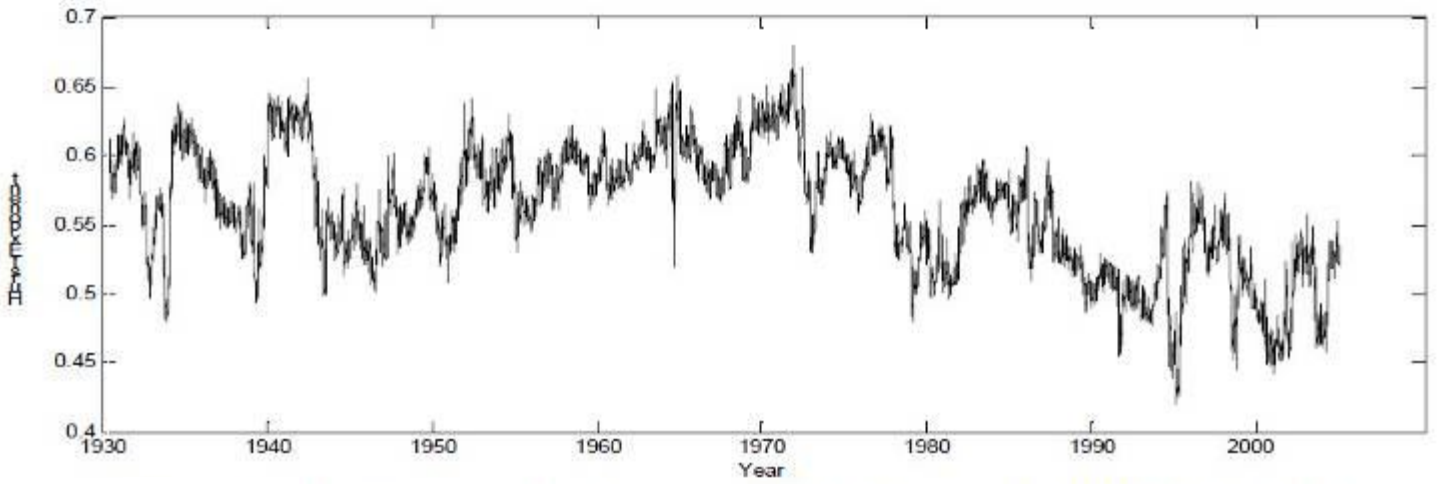
- The Hurst Exponent describes the randomness of a data series



Hurst exponent for Dow-Jones daily return from 1/2/1930 to 5/14/2004

"Hurst Exponent and Financial Market Predictability"
By Bo Qian and Khaled Rasheed
University of Georgia

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Measured & Modeled Market Spectrum

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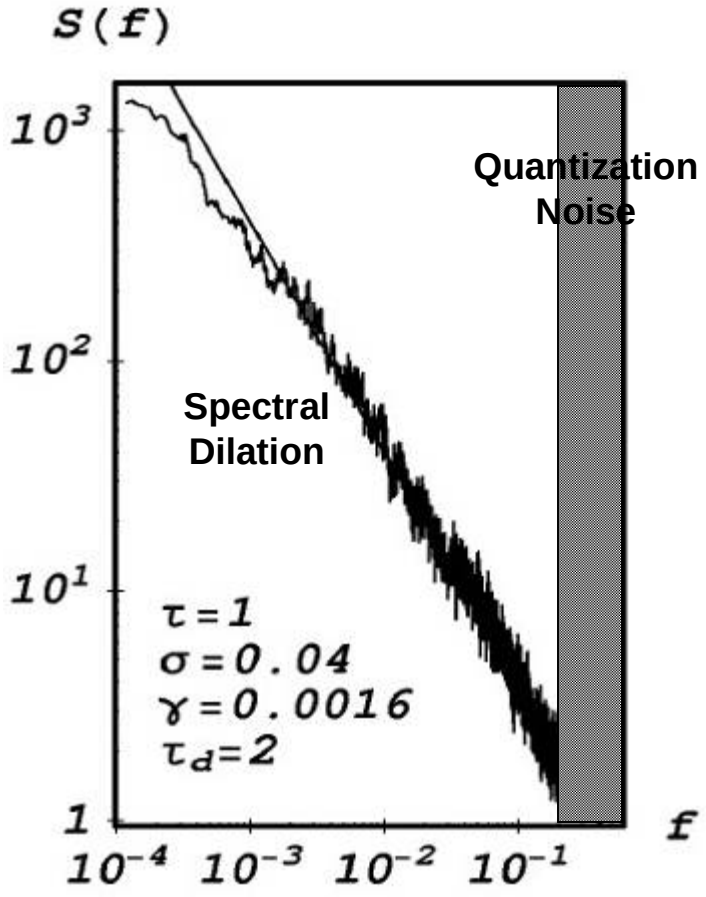
- Market spectrum amplitude models as $1/F^{\alpha}$
- $2*(1 - \text{Hurst Exponent}) = \alpha$
- Spectral Dilation increases approximately 6 dB/Octave
- 1/F Noise is apparently universal
- Model shows two mandates for Technical Analysis
  1) We must stay several octaves away from the Nyquist Frequency due to Quantization Noise
  2) Indicators must compensate for spectral dilation to get an accurate frequency response



"Modelling Share Volume Traded in Financial Markets"
By V. Gontis
Lithuanian Journal of Physics, 2001, 41, No. 4-6, 551-555

Quantization Noise

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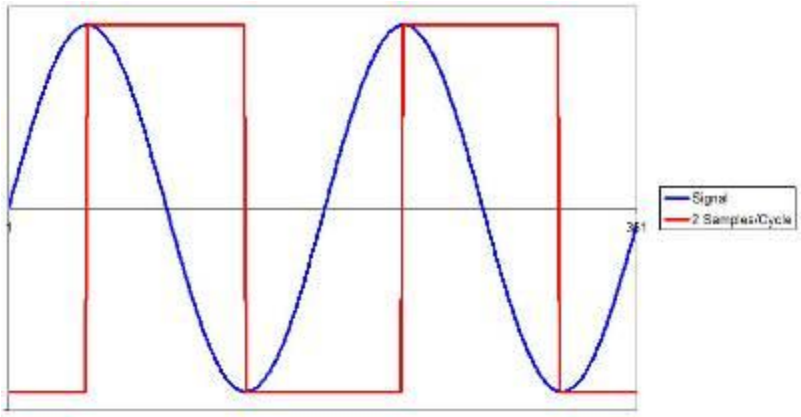
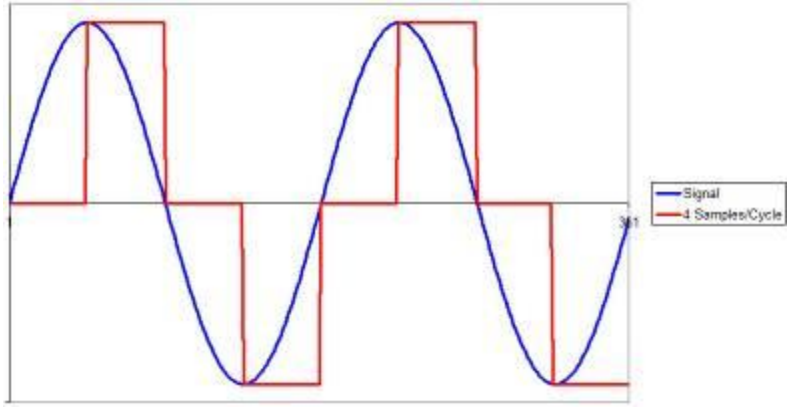
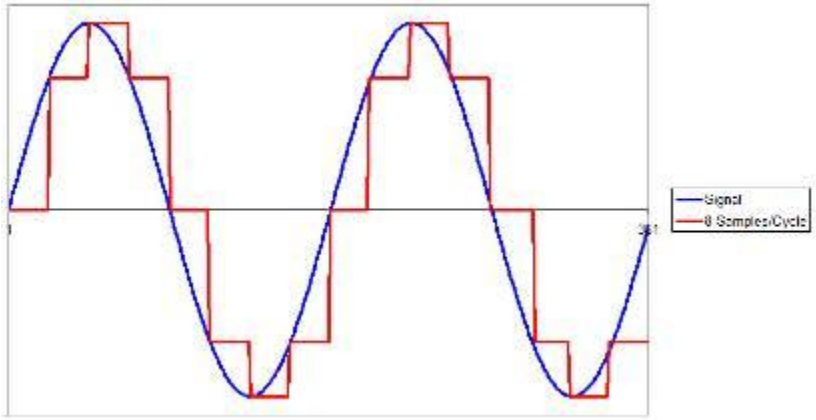
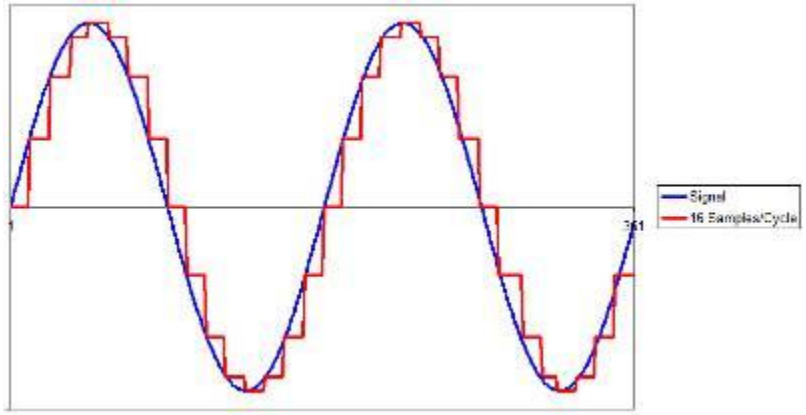
- Highest possible frequency has two samples per cycle (Nyquist Frequency)
  - 2 day period on daily bars









OverSampling

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- Why not reduce quantization noise by sampling more often?
  - For example – hourly data to trade daily bars
- What is a day? 6 hours? 24 hours?
- Gap openings are a data issue
- Spectral dilation becomes an even larger issue because several more octaves range is included in the data

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Autocorrelation

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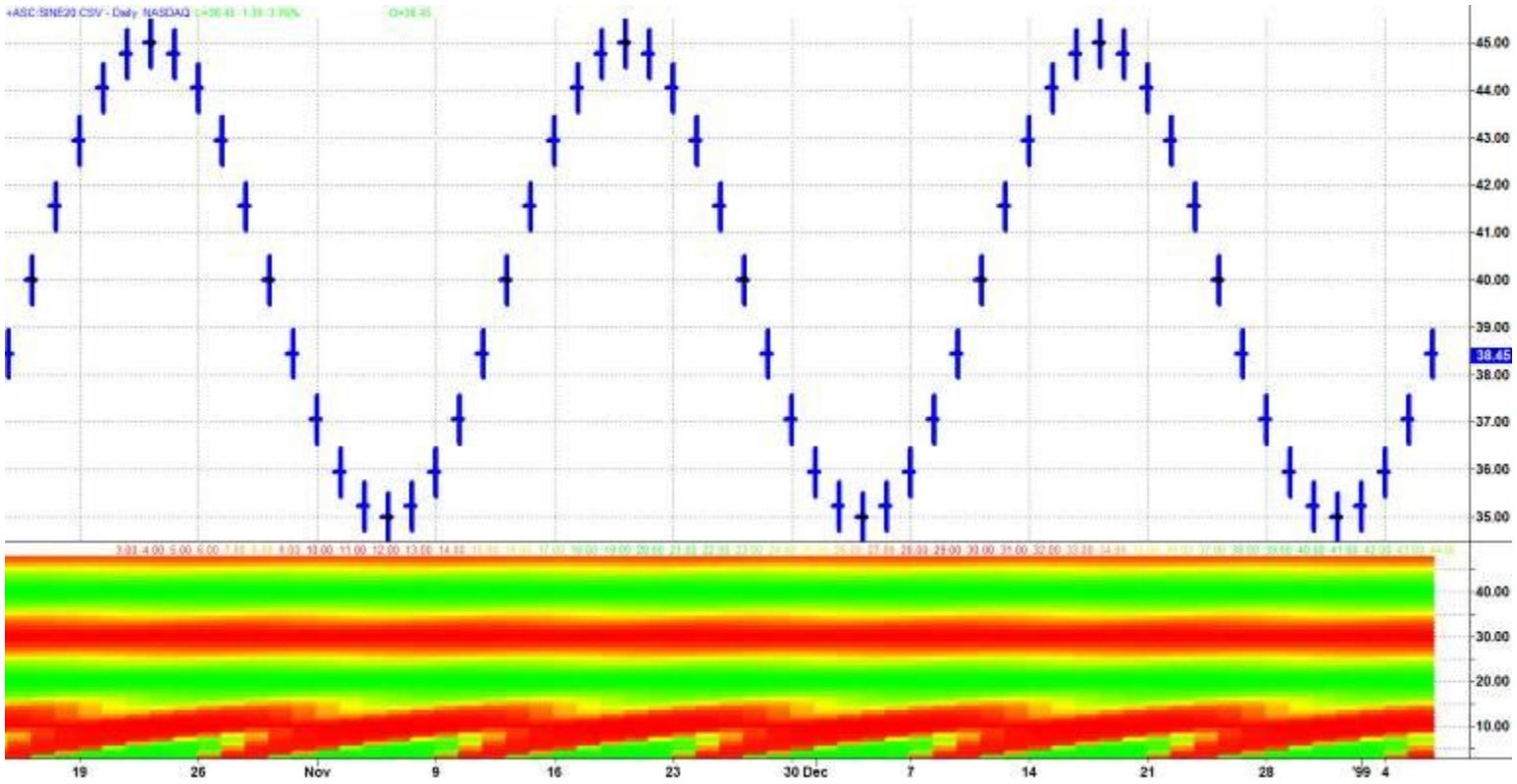
- Correlates a waveform with itself lagged in time
- SwamiCharts Autocorrelation of a theoretical 20 Bar Sine Wave
- Vertical Scale also shows periodicity



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Autocorrelation Periodogram

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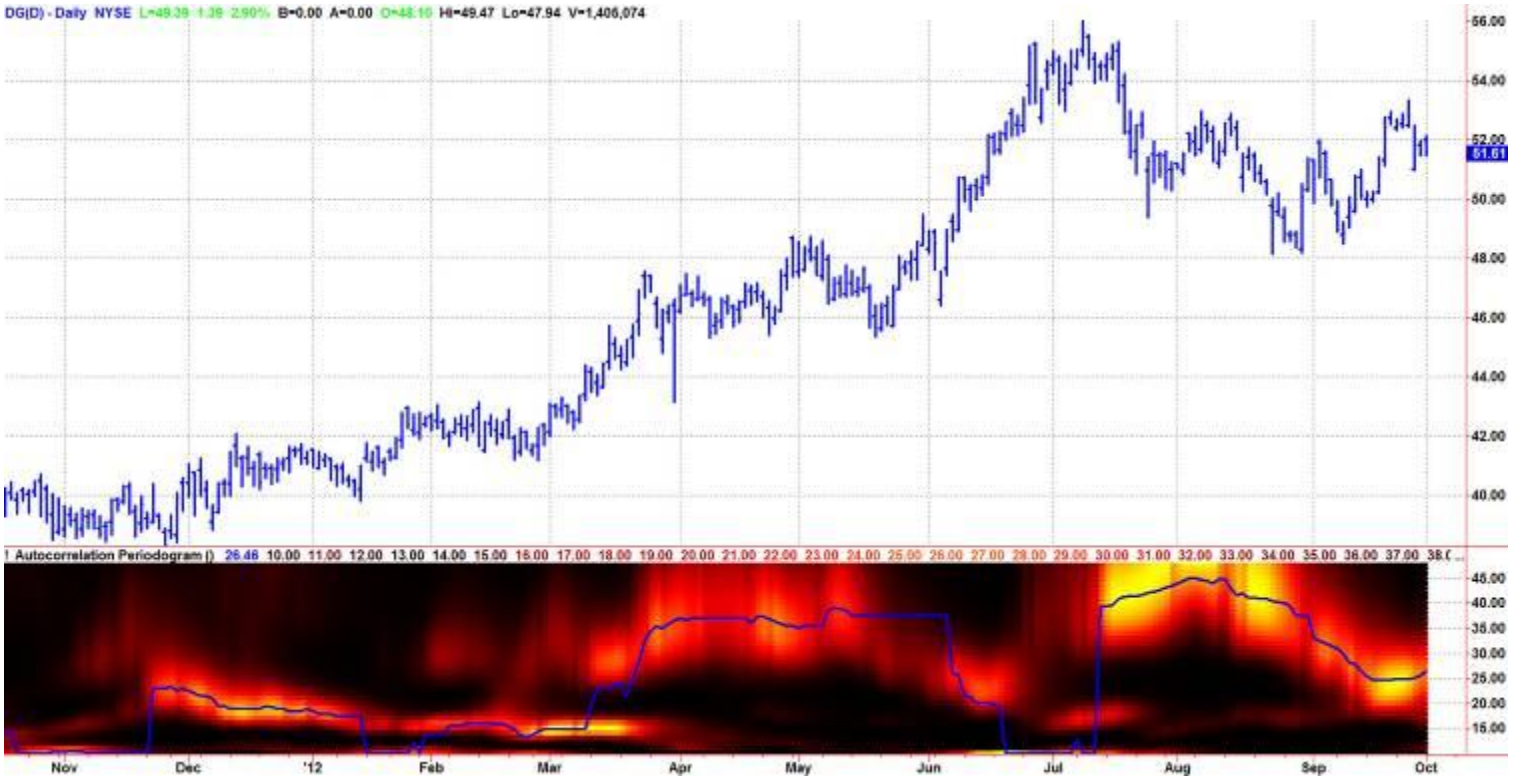
- Autocorrelation Periodogram produces spectrum amplitudes that are range bound by the correlation coefficient
- All other spectrum measurements must compensate for Spectral Dilation for a true picture of the Measured Spectrum
- This is really how I “discovered” spectral dilation



Filter Basics

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I'm sorry! I just have to do this

Let Z^{-1} represent one bar of delay

4 Bar Simple Moving Average: Output = $(1/4 + Z^{-1}/4 + Z^{-2}/4 + Z^{-3}/4)$*(Input Data)

Transfer Response = H(z) = Output / (Input Data)

More Generally: $H(z) = b0 + b1*Z^{-1} + b2*Z^{-2} + b3*Z^{-3} + b4*Z^{-4} + \ldots\ldots\ldots + bN*Z^{-N}$

An EMA uses a previously calculated value, so with still more generality:

$$H(z) = \frac{b_0 + b_1 * Z^{-1} + b_2 * Z^{-2} + b_3 * Z^{-3} + b_4 * Z^{-4} + \ldots\ldots\ldots + b_N * Z^{-N}}{a_0 + a_1 * Z^{-1} + a_2 * Z^{-2} + a_3 * Z^{-3} + a_4 * Z^{-4} + \ldots\ldots\ldots + a_N * Z^{-N}}$$

Therefore, filter transfer response is just a ratio of polynomials

The polynomials can be factored into their zeros

Zeros in the denominator are called poles

The rate of filter rolloff is 6 dB / Octave per Pole

Since we must use simple filters in trading we have only a few poles in the transfer response - BUT – the data are increasing at the rate of 6 dB / Octave. The result is there is no real filtering.

SMOOTHING FILTERS

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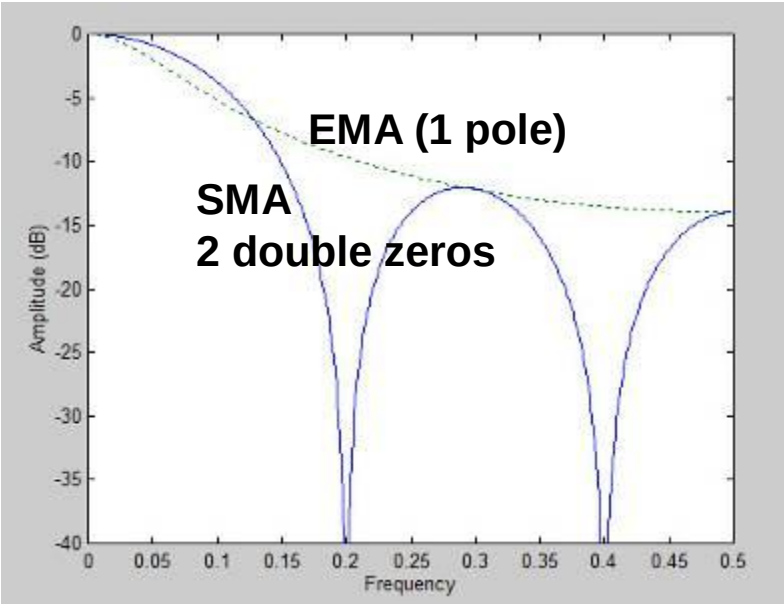
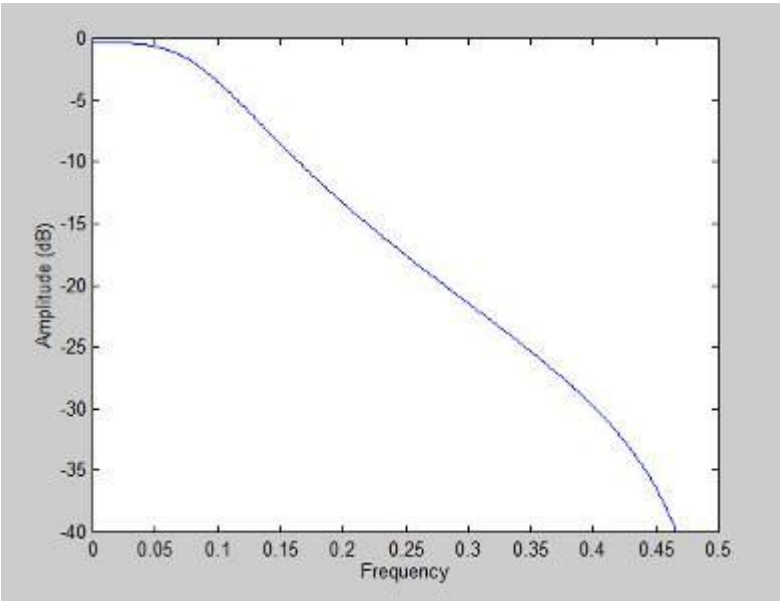
- The real reason to use averages or smoothing filters is to remove quantization noise

Take Your Pick

10 Bar SMA and EMA



10 Bar SuperSmoother



SuperSmoother Filter Code

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SuperSmoother Filter


```
a1 = expvalue(-1.414*3.14159 / 10);
b1 = 2*a1*Cosine(1.414*180 / 10);
c2 = b1;
c3 = -a1*a1;
c1 = 1 - c2 - c3;
Filt = c1*(Close + Close[1]) / 2 + c2*Filt[1] + c3*Filt[2];
```

Code Conversion Notes:

1) Filter is tuned to a 10 Bar Cycle (attenuates shorter cycle periods)
2) Arguments of Trig functions are in degrees
3) [N] means value of the variable “N” bars ago

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HighPass Filter

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- HighPass Filters are “detrenders” because they attenuate low frequency components

One pole HighPass and SuperSmoother does not produce a zero mean

Because low frequency spectral dilation components are “leaking” through The one pole HighPass Filter response

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Roofing Filter

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- Comprised of a two pole HighPass Filter and a SuperSmoother

The Roofing Filter guarantees only the desired frequency components will be passed for analysis

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Roofing Filter Code

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Roofing Filter


```
//Two Pole Highpass filter passes cyclic components whose periods are shorter than 48 bars
alpha1 = (Cosine(.707*360 / HPPeriod) + Sine (.707*360 / 48) - 1) / Cosine(.707*360 / 48);
HP = (1 - alpha1 / 2)*(1 - alpha1 / 2)*(Close - 2*Close[1] + Close[2]) + 2*(1 - alpha1)*HP[1] - (1 - alpha1)*(1 - alpha1)*HP[2];
//Smooth with a Super Smoother Filter
a1 = expvalue(-1.414*3.14159 / 10);
b1 = 2*a1*Cosine(1.414*180 / 10);
c2 = b1;
c3 = -a1*a1;
c1 = 1 - c2 - c3;
Filt = c1*(HP + HP[1]) / 2 + c2*Filt[1] + c3*Filt[2];
```

Code Modification Notes:

1) HP Filter is tuned to a 48 Bar Cycle (attenuates longer cycle periods)
2) SuperSmoother is tuned to a 10 Bar Cycle (attenuates shorter cycle periods)
3) Arguments of Trig functions are in degrees
4) [N] means value of the variable “N” bars ago

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Impact of Spectral Dilation On Traditional Indicators

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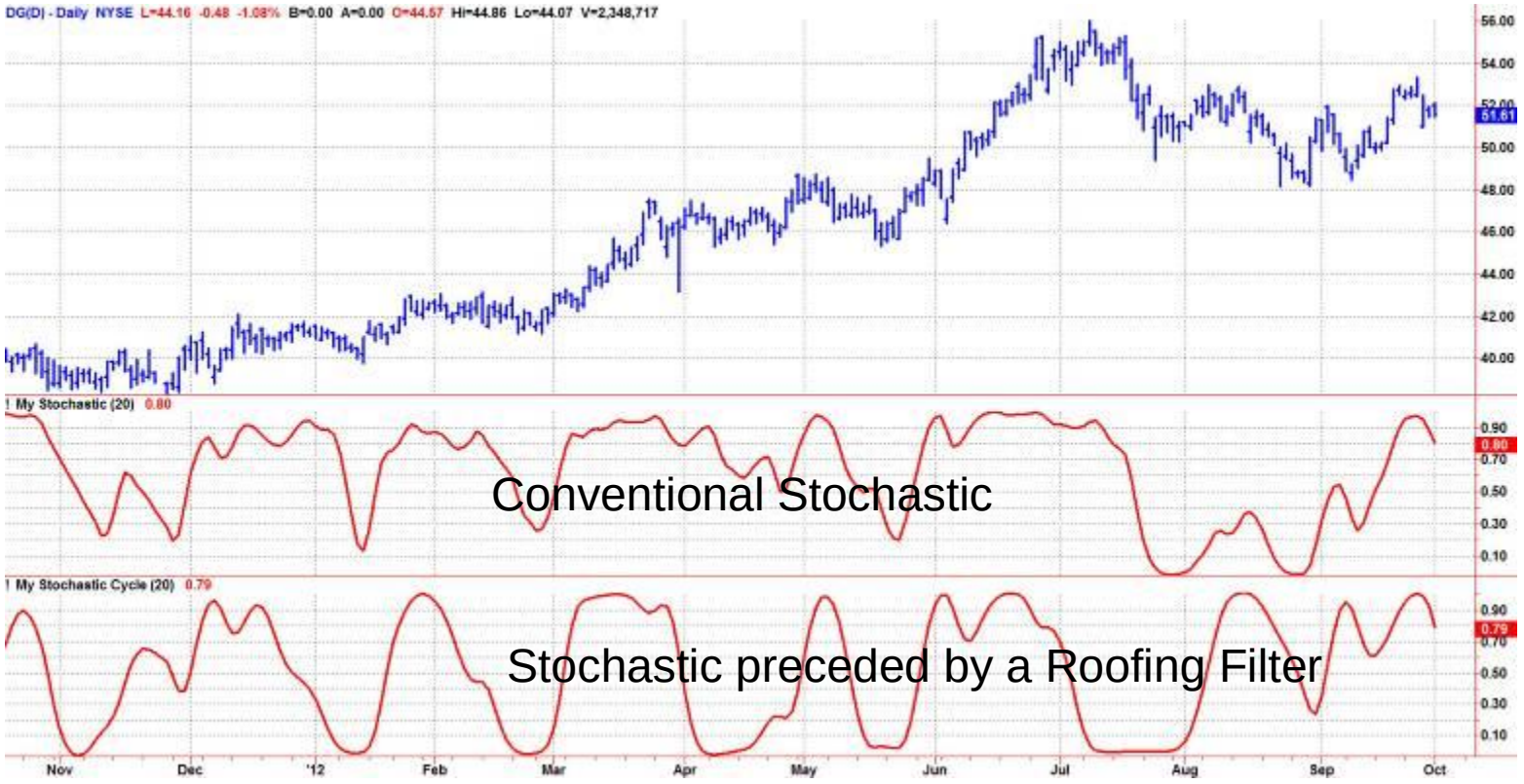
- Spectral Dilation has impacted (distorted?) the interpretation of virtually all indicators



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Roofing Filter Can Be An Indicator Itself

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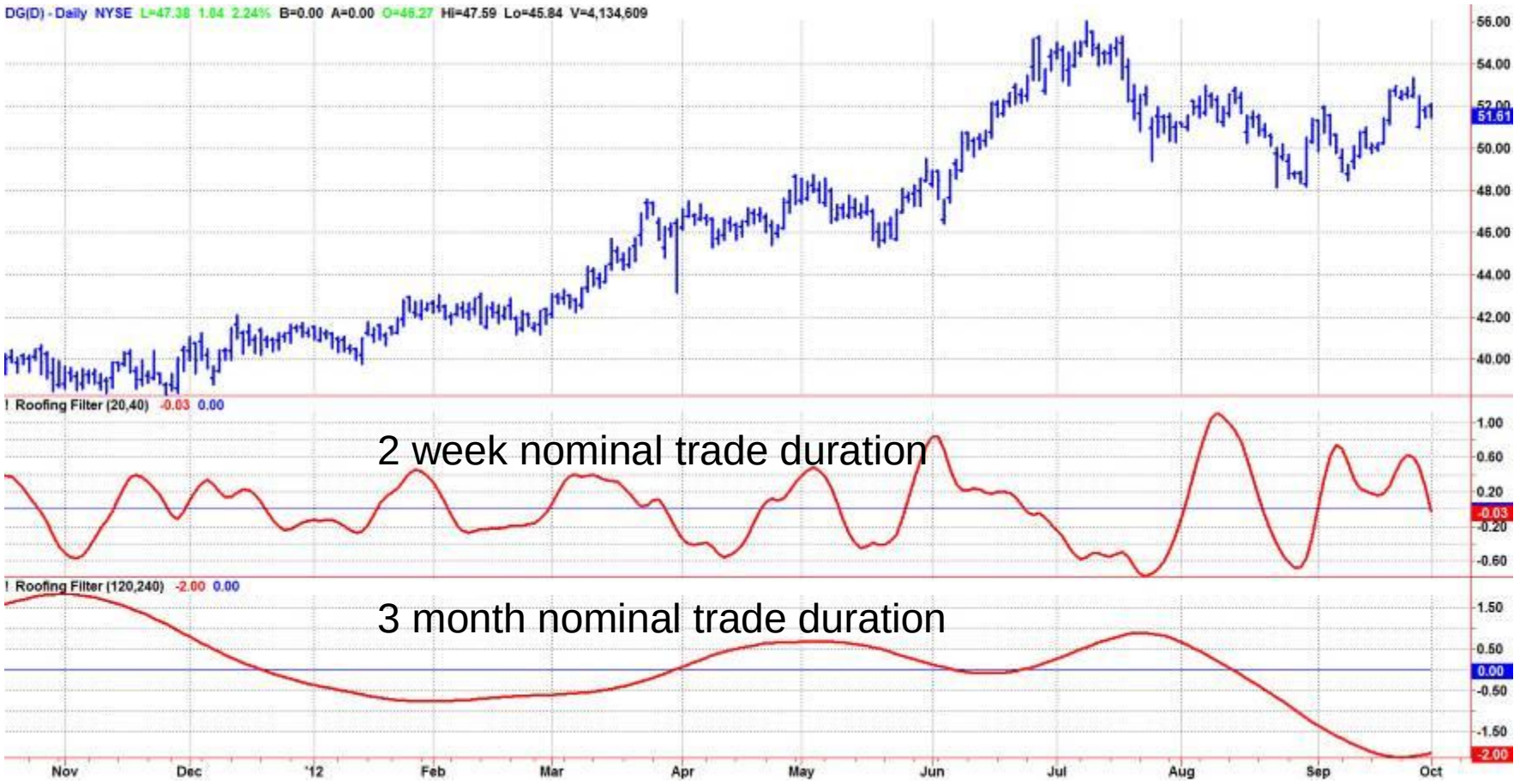
- Cycle Period is about twice the desired trade duration



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Even better DSP indicators DO exist

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  - Includes Advanced SwamiCharts
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- Watchlists
- Swing Trading signals called – IN ADVANCE
  - Performance is transparently tracked
- Monte Carlo Analysis of Performance
- Technical Presentations (this webinar is there)

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