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A Guide to
FRACTAL FINANCE
“Patterns from Pieces”
(MotiveWave Edition)
Risk Disclosure Statement

The risk of loss in trading commodity futures contracts can be substantial. You should therefore carefully consider whether such trading is suitable for you in light of your financial condition. You may sustain a total loss of the initial margin funds and any additional funds that you deposit with your broker to establish or maintain a position in the commodity futures market. Past performance is not indicative of future results. We recommend that you learn more from the Commodity Futures Trading Commission (CFTC) or the National Futures Association.

Trading Securities:

In considering whether to trade in securities or enter into any such transaction, you should be aware that trading in securities can be extremely risky. You should be prepared to lose all of the funds used for trading in securities. You should not fund your security trading activities with retirement savings, emergency funds or funds set aside for purposes such as education or home ownership. Trading in securities can also lead to large and immediate financial losses. Trading in securities requires knowledge of the securities markets. Trading in securities require in-depth knowledge of the securities markets and trading techniques and strategies. In attempting to profit through trading in securities, you must compete with professional, licensed traders employed by securities companies. You should have the appropriate experience before engaging in the trading of securities. All losses are your responsibility.

Hypothetical Risk Disclosure Statement:

"Hypothetical performance results have many inherent limitations, some of which are described below. No representation is being made that any account will or is likely to achieve profits or losses similar to those shown. In fact, there are frequently sharp differences between hypothetical performance results and the actual results subsequently achieved by any particular trading program.

One of the limitations of hypothetical performance results is that they are generally prepared with the benefit of hindsight. In addition, hypothetical trading does not involve financial risk, and no hypothetical trading record can completely account for the impact of financial risk in actual trading. For example, the ability to withstand losses or to adhere to a particular trading program in spite of trading losses are material points which can also adversely affect actual trading results. There are numerous other factors related to the markets in general or to the implementation of any specific trading program which cannot be fully accounted for in the preparation of hypothetical performance results and all of which can adversely affect actual trading results."
What is Fractal Finance?

A Fractal View

- Fractal Finance is a completely new way of looking at the markets.
- With the help of Chaos theory, it is possible to find hidden order in price data.
- Fractal attractors define price attraction ranges.
- Fractal Finance can identify these attractors and use them to trade.
- Fractal Finance makes very accurate predictions.
- Fractal Finance Toolkit contains the functions and indicators to do this.
Order and Randomness

- Chaos Theory is a way to describe or quantify nonlinear, apparently random events or systems.
- Analyze events or systems that are influenced by their own outcomes, taking on a life of their own.
- Order and randomness can coexist allowing predictability.
Market Applications of Chaos Theory and Fractal Analysis

- Market prices tend to seek natural levels or ranges of balance.
- These levels or ranges can be described as “attractors.”
- These ranges (attractors) are determinant.
- However, data within these ranges remains random (local randomness & global determinism.)
Fractal Attractor in IBM
Fractal Attractor (a different resolution)
Why Use Chaos Theory and Fractals in Trading?

- Markets are nonlinear
- Traditional technical analysis is linear and Euclidean
- Linear analysis techniques cannot quantify nonlinear noise
- Market reversals are also nonlinear events
- Technical Analysis is a poor indicator for the trend vs range trading decision
- Fractals quantify what Euclidian geometry cannot
Fractal Rulers – Measuring Chaos

- Markets are not random and are nonlinear.
- Chaos theory is the study of apparently random nonlinear systems. *This is exactly what we need for financial markets!*
- Fractals are the modern measuring tools of Chaos theory.
- Markets are man-made nonlinear dynamic systems.
- Would you measure an ocean wave with a ruler? You should if it is a “Fractal Ruler.”
Measuring Chaos

- Benoit Mandelbrot is considered the founder of fractal analysis
- Mandelbrot measured England’s irregular, chaotic coastline more accurately by using a fractal ruler
- The Koch Snowflake demonstrates how using infinitely finer fractals increases measurement accuracy
- Mandelbrot applied these same nonlinear measuring techniques to the cotton market
What is the Goal?

Given a time series \( \{x_t\} \), predict its future course, that is, \( x_{t+1}, x_{t+2}, \ldots \)
Traditional Forecasting Methods

- ARIMA ➔ but linearity assumption
- Neural Networks ➔ but large number of parameters and long training times
- Hidden Markov Models ➔ O(N^2) in number of nodes N; also fixing N is a problem
- Lag Plots
The Fractal Finance Method

- Based on the “Takens’ Theorem” [Takens/1981]
- which says that delay vectors can be used for predictive purposes
By Discovering the Fractal Attractor
Given a time series \( \{x_t\} \), predict its future course, that is, \( x_{t+1}, x_{t+2}, \ldots \)
To That!
To This! (Prediction is Blue Line)
How do we do it?
Start with Lag Plots

Q0: Interpolation Method
Q1: Lag = ?
Q2: K = ?

Interpolate these...

To get the final prediction

Fractal Finance 1/31/2019
Find the Fractal Dimensions

FD = intrinsic dimensionality
[Belussi/1995]

Points to note:
• FD can be a non-integer
• There are fast methods to compute it

"Embedding" dimensionality = 3
Intrinsic dimensionality = 1

log(# pairs)

log(r)

Sierpinski Triangle
Self-Same fractal

Fractal Finance 1/31/2019
Q1: Finding L(opt)

- Use Fractal Dimensions to find the optimal lag length L(opt)
Q2: Finding $k(\text{opt})$

- To find $k(\text{opt})$ also known as the optimum number of lag points
  
  - Conjecture: $k(\text{opt}) \sim O(f)$

We choose $k(\text{opt}) = 2f + 1$

- $f = \text{the Fractal Dimension (FD)}$
Interpolate Prediction

Our Prediction from here

Value

Timesteps
Summary of Method

- Create a lag-plot of time series data
- Use the fractal dimension to find the optimal lag number
- Identify the nearest neighbors (NN)
- Use Kopt to determine optimal number of nearest neighbors for prediction
- Interpolate new point using statistical methods to arrive at new prediction
Installation

Fractal Finance is designed for all styles and time frames of trading. Fractal Finance may be used with stocks, futures, and forex markets. The Fractal Finance tools may even be used for options trading.

The Fractal Finance Toolkit is what is commonly referred to as a, “gray box.” All of the module’s inputs are open to manipulation by the user.

In order for Fractal Finance to function properly, it must be imported into MotiveWave. There is one file that you must import. Once it is imported, you will have access to the Fractal Finance indicators.

Please use the following steps to import Fractal Finance:

1) From the Study dropdown menu → select Add Study
2) From the Add Study menu → select Import
3) From the Import Studies/Strategies → select Add
4) Browse to where you have saved Fractal Finance → Import the FractalFinance_S.jar file
5) From the Import Studies/Strategies → select the FractalFinance_S.jar file and click Import
6) Close the Add Study menu → Click Cancel
7) Restart MotiveWave. Installation is complete and you are ready to use Fractal Finance.
8) From the Study menu → Scroll down to Fractal Finance
9) Select one of the four indicators
Installation – Study Dropdown Menu
Installation – Add Study Menu

The following table contains all available studies. Select the desired study below and choose OK to configure the settings.

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<th>Name</th>
<th>Overlay</th>
<th>Signal</th>
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<tr>
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<td>false</td>
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<tr>
<td>ATR Trailing Stops</td>
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<tr>
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<tr>
<td>Average Directional Index (ADX)</td>
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</tr>
</tbody>
</table>
Installation – Import Studies/Strategy

This dialog allows you to import third party studies and/or strategies which will be packaged in one or more files with a .jar extension (Java Archive File). Press the Add button to add a jar file from your local file system.

**Jar Files**

C:\Users\Erik\Desktop\Fractal Finance\MotiveWave\FractalFinance_S.jar

**Import**

**Cancel**
The Fractal Finance Indicators

- Indicators are found in the Fractal Finance Study. There are four primary studies.
- All inputs and indicators can be controlled from the Format Study Menu.
- The format study window lists the necessary variables and on/off switches under the General and Options tabs.
- Style, Properties, Scaling, and Alerts allows you to customize visual and other features.
- Further information on the Study Menu can be found in the MotiveWave guide.
Study 1 – Fractal Basics
Study 1 – Fractal Basics (Inputs)
Study 1 - Indicator Inputs Explained

Fractal Basics is a collection of the components that produce the prediction as described earlier in this guide. This study is used for education and testing the components of the predictor to make sure it is working correctly. It is unlikely that you will use these indicators for trading. The exception is the fractal dimension (FD) indicator. An explanation for using the FD to detect a trend or range is given below.

1) Input Price – Price input used for the calculation of the prediction. Selections: Open, Close, Midpoint, High, Low, Typical Price, Weighted Price.

2) Lag – Represents the maximum number of the lag used for calculating the prediction. This number should not change results dramatically after 20. This is due to the dynamic nature of the program. It automatically searches for the ideal lag length under this input value. Experience dictates that a lag no greater than 15 will work in most cases.

3) FracLength – Number of bars used to calculate the fractal dimension of the lag plot used in determining the prediction. A larger number uses more data, time, and may not improve results. It is recommended to use less than 100 unless you have found a specific application.

4) FDavg – An average of the fractal dimension used to determine the flattening period of the maximum lag. Set to 1 for none.

5) Display Lag – Plots the dynamic lag length used for the prediction. This changes dynamically as the fractal dimension of the lag plot changes.

6) Display Lopt – Displays the changing optimum lag length. Will never be greater than the Lag input.

7) Display Kopt – Optimum number of nearest neighbors used in the prediction.

8) Display FD – Plots the fractal dimension of the underlying lag plot. Used to determine the optimum lag for predictor performance. This indicator may also be used as a trend//range indicator. By measuring the fractal dimension of the lag plot and hence the predictor it may be possible to forecast a trend or a range market. For values below 1.5, a trend is forecasted. For values above 1.5, a range is forecasted. In the unlikely event a 1.5 is the fractal dimension, the market is acting randomly and cannot be forecasted. The closer the number is to the extremes (2 or 1) the stronger the signal.
Study 2 – Fractal Forward
The Fractal Forward Indicator

Plot_FForward – This indicator uses the predictor to gauge the strength and direction of the market. Technically, the indicator is meant to determine if the predictions (High, Low, Close) are predicting in the same direction (up, down) or some variation in-between. In practice, three predictions are made for each type of price (High, Low, Close) over the last three bars. Three bars are used, because that is the minimum number of points necessary to plot a trend. Every time a prediction is higher than a previous prediction, a value of positive one (+1) is assigned. Every time a prediction is lower than a previous prediction, a value of negative one (-1) is assigned. When all of these numbers are totaled for each price type (High, Low, Close), a total of positive nine to negative nine (+9 to -9) is possible on the indicator. For example, if the indicator is positive nine (+9), all three predictions over three bars over all price types (High, Low, Close) are going sequentially higher. The opposite is true for a negative nine (-9).

In summary, the Fractal Forward is meant to do the following:

1. Act as a bullish, bearish, or neutral sentiment of the three most recent high, low, and close predictions.
2. The indicator is comparing the three most recent predictions to establish a prediction trend.
3. Used as a proxy for trend strength, trend direction, or trend purity.
4. Indicate a potential change in trend direction. Example: When reversing direction from an extreme (9 or -9) the price will often follow.
Study 2 – Fractal Forward (Inputs)
Study 2 - Indicator Inputs Explained

Fractal Forward only uses the same inputs that influence the Predictor. In theory, you should use the same inputs for Fractal Forward that you are using for the Fractal Predictor. The Fractal Predictor will be explained in more detail next. It is suggested that you read about the Fractal Predictor before using this indicator.

1) Input Price – Price input used for the calculation of the prediction. Selections: Open, Close, Midpoint, High, Low, Typical Price, Weighted Price.

2) Lag – Represents the maximum number of the lag used for calculating the prediction. This number should not change results dramatically after 15. This is due to the dynamic nature of the program. It automatically searches for the ideal lag length under this input value. Experience dictates that a lag input no greater than 15 will work in most cases.

3) FracLength – Number of bars used to calculate the fractal dimension of the lag plot used in determining the prediction. A larger number uses more data, time, and may not improve results. It is recommended to use less than 100 unless you have found a specific application.

4) FDavg – An average of the fractal dimension used to determine the flattening period of the maximum lag. Set to 1 for none.

5) Steps – The number of steps (bars) to predict ahead.

6) Display Forward – Displays the Fractal Forward indicator parameters on the chart.
Study 3 – Fractal Predictor
The Fractal Predictor

Plot_Predict – This is the heart of the toolkit and it plots the predictor on the chart. The Predictor uses all of the functions in Fractal Finance to generate a forecast. The forecast will always be based on the Price input. For example, if Close is the Price input, the close price will be forecasted. The same holds true for Open, High, Low, Close. In addition to these inputs, you can also use this indicator on any type of indicator data. For example, you may want to forecast the volume rather than price. This flexibility makes Fractal Finance a powerful trading tool.

The predictor is already designed to function as a moving average of the predicted price. By changing the Smoothing input parameter, you can turn the predictor into a moving average of the predictor. For example, when Smoothing is set to the default of 1, no average is calculated and the prediction functions normally. However, if a 10 is the input, a 10 bar average of the predictor will be plotted on the chart. This may be used for a number of different strategies and indicators.

The Fractal Finance Predictor is capable of forecasting an unlimited number of steps ahead. Unfortunately, because of the physical laws associated with chaotic systems, prediction accuracy breaks down rapidly with further steps. This is logical, because every minor prediction error is magnified exponentially for each step. For this reason, it is recommended that you do not forecast more than four steps ahead.

More than one Predictor can be used on the same chart. The limit is really your imagination. You may plot a one step prediction with a three step or plot the predicted High, Low, and Close on the same chart. Maybe you would rather combine moving averages of the predictor. All of this is possible by inserting more than one Fractal Finance indicator on the same chart.
Study 3 – Fractal Predictor (Inputs)
Study 3 - Indicator Inputs Explained

The Fractal Predictor uses the following input parameters to generate a forecast of price or other indicator values. These are the same input values that are mentioned in the explanation of the fractal predictor listed in the explanation section above. The Fractal Predictor may be used to predict any indicator value available from the drop down menu.

1) Input Price – Price input used for the calculation of the prediction. Selections: Open, Close, Midpoint, High, Low, Typical Price, Weighted Price.

2) Lag – Represents the maximum number of the lag used for calculating the prediction. This number should not change results dramatically after 15. This is due to the dynamic nature of the program. It automatically searches for the ideal lag length under this input value. Experience dictates that a lag input no greater than 15 will work in most cases.

3) FracLength – Number of bars used to calculate the fractal dimension of the lag plot used in determining the prediction. A larger number uses more data, time, and may not improve results. It is recommended to use less than 100 unless you have found a specific application.

4) FDavg – An average of the fractal dimension used to determine the flattening period of the maximum lag. Set to 1 for none.

5) Steps – The number of steps (bars) to predict ahead.

6) Smoothing – Acts to average the predictor. As the number increases after the value of one, it smoothes the predictor in a similar fashion to a moving average of the predictor.

7) Shift Plot – Simply shifts the plot of the predictor to the right of the chart. This is useful if the Steps are greater than 1 and you would like to see where that input number falls on the chart.
Study 4 – Fractal Wave Oscillator
Study 4 – Fractal Wave Oscillator
Study 4 - Indicator Inputs Explained

This indicator is based on two smoothed predictor values that are normalized to generate a trade signal using the Fractal predictor. The two smoothed predictor values were discovered by the Fractal Finance team to correspond with short term and medium term trend signals. When the shorter length oscillator value is greater than the longer length oscillator value, the Fractal Wave Oscillator signal is a bullish. When the opposite is true, the signal is bearish.

1) Input Price – Price input used for the calculation of the prediction. Selections: Open, Close, Midpoint, High, Low, Typical Price, Weighted Price.

2) Lag – Represents the maximum number of the lag used for calculating the prediction. This number should not change results dramatically after 15. This is due to the dynamic nature of the program. It automatically searches for the ideal lag length under this input value. Experience dictates that a lag input no greater than 15 will work in most cases.

3) FracLength – Number of bars used to calculate the fractal dimension of the lag plot used in determining the prediction. A larger number uses more data, time, and may not improve results. It is recommended to use less than 100 unless you have found a specific application.

4) FDavg – An average of the fractal dimension used to determine the flattening period of the maximum lag. Set to 1 for none.

5) Steps – The number of steps (bars) to predict ahead.

6) OscLen – Corresponds to the shorter length oscillator value.

7) Smooth – Corresponds to the longer length oscillator value.
The **FRACTAL FINANCE** Toolkit

Includes:

- Fractal Basics
- Fractal Forward indicator
- Fractal Predictor
- Fractal Wave Oscillator

Available at: www.fractalfinance.com

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