

Measuring market choppiness with chaos

Making profitable use of chaos theory in the markets has been an enticing but elusive goal for many traders. E.W. Dreiss has developed the Choppiness Index using chaos principles to measure market trendiness.

By Gibbons Burke

The science of chaos has piqued the imaginations of traders looking for an edge in the markets. Since Benoit Mandelbrot, a pioneer in chaos theory, did some of his early analysis of the cotton markets, traders have tried to find an application in the markets, but few have succeeded.

E.W. "Bill" Dreiss, a commodity trading advisor based in Australia, has used concepts from chaos theory to construct a simple measure of the "choppiness" or directionality of the market, that is, whether prices are trending or are in a period of trendless consolidation.

Several indicators already exist that perform a similar function. Welles Wilder's Directional Movement Indicator (ADX) is one of the oldest and most widely known. More recent new indicators of this type are the Random Walk Index, created by Michael Poulos of Trader's Insight and Adam White's Vertical Horizontal Filter.

With the "Choppiness In-

dex" (CI) Dreiss measures something akin to the "fractal dimension" of the market. Conventional Euclidean geometry describes geometric figures in terms of dimensions. Two points in space define a line, and a line has one dimension — length. Three points not on the same line define a plane which has two dimensions — length and width. Four points not on the same plane define a space which has three dimensions — length, width and depth.

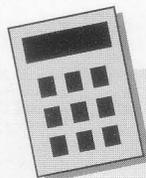
New paradigm

Chaos theory says the real world is not so neatly Euclidean. While standard geometry has proven useful for measuring and quantifying the world around us, it falls short in critical areas and leads to paradoxes. Chaos theory provides a new "paradigm" for viewing the world that may be more useful. It says, among other things, that objects don't necessarily have an integral dimension, i.e. whole numbers like one, two, three or four. Rather, real world objects are more likely to have fractional or fractal dimension

which may be 1.37 or 2.89.

Market prices provide a good example of fractal dimension. When prices are plotted over time on a chart, the resulting figure is by no means a one-dimensional straight line. Nor is the figure fully two-dimensional because it does not cover an area as such. However, the market exhibits times when its movement is more linear (when trends appear), and other times when its movement is more plane-filling (choppy consolidating periods). The dimension of the market price through time falls on a fractional number somewhere between one and two dimensions.

Dreiss employed this concept when he created the CI to measure the trending characteristic of the market. Higher index readings indicate the market is more choppy with fewer identifiable trends (which correspond to a fractal dimension closer to two); lower numbers indicate market prices are moving in a more linear or trendy way (and have fractal dimensions closer to one). The index can be used as a measure of market risk or volatility in a way



How to calculate CI

One advantage of the Choppiness Index over other "trendiness" indicators is its simplicity and ease of calculation. Here are the steps needed to calculate a 14-day CI. It may help to refer to the software calculations included for the exact formulas.

One Calculate the true range for each day. True range is different from a daily range (high minus

the low) because it includes yesterday's close to account for days when the market moves strongly from one day to the next, creating a gap or a hole between yesterday's prices and today's prices. (Wilder introduced this concept in the seminal *New Concepts in Technical Trading Systems* where the ADX indicator also is described.) A day's true high is the greater of today's high

or yesterday's close; the true low is the lower of today's low or yesterday's close. The true range for a given day is then the difference between the true high and true low.

Two For each day, sum up the last 14 (or other time frame) days' true ranges to get the total amount of "ink" for that period.

Three Find the highest true high (top of the box) and the lowest true low (bottom of the box) in the 14-day period and take

the difference between them to get the height of the 14-day box.

Four Divide the sum of the true ranges (from step 2) by the 14-day range (from step 3) and take the logarithm (base 10) of the result. Divide this number by the logarithm of 14 and multiply the result by 100 to get the Choppiness Index.

For users who cannot calculate the log function, Dreiss suggests it can be dropped from the calcula-

that is easy to calculate, simple to understand, and well-behaved (well bounded) on the numerical scale.

The CI measures the relationship between the sum of daily trading ranges during a given period of time against the total range for that period. To illustrate the concept, look at the bar chart of IMM Deutsche mark futures prices titled "Choppiness Index in action," (page 52). We can draw a rectangle around a number of market days (say, 14, although other time frames can be used). The top of the box lies at the highest high during those 14 days and the bottom of the box lies at the lowest price low during the period. For example, the box drawn on the chart labeled "Choppy" highlights a period of consolidation corresponding to a high reading on the CI. The box labeled "Trendy" illustrates a very different 14-day period, with a corresponding lower reading on the CI.

Ink blots

To understand the CI, think of the ratio of printed ink within the box to the total area of the box. In a market like "Trendy," there will be less ink in relationship to the white space (a lower CI reading). During choppy, trendless market phases, there will be more ink relative to the boxed area (higher CI). The CI is simply a mathematical measure of this relationship. "How to calculate CI" explains the mathematics of the indicator; the examples of software code show how to program it.

There are several potential uses for the CI. Because it doesn't indicate price direction

CompuTrac/SNAP or TeleTrac TradePlan Definition

Name	Definition	Type / Format	Comments
item	"German Mark 15B	DATA	IMM D-mark, Sept. 1993
date	DATA(date,first,last,item)	DATA	
open	DATA(open,item)	DATA / 2	
high	DATA(high,item)	DATA / 2	
low	DATA(low,item)	DATA / 2	
close	DATA(close,item)	DATA / 2	
all_vol	DATA(general,item)	DATA / 0	
all_oi	DATA(oi,item)	DATA / 0	
n	14	COEF / 0	allows easy adjustment of CI period
true_high	Maximum(high,close[1])	FUNC / 2	highest of today's high or previous close
true_low	Minimum(low,close[1])	FUNC / 2	lowest of today's low or previous close
tr_rang	true_high - true_low	USER / 2	daily true range
sum	Sum(tr_rang,n)	FUNC / 2	sum total of last n-day's true ranges
n_high	Highest(true_high,n)	FUNC / 2	highest true high for the n-day period
n_low	Lowest(true_low,n)	FUNC / 2	lowest true low for the n-day period
n_range	n_high - n_low	USER / 2	true range for the n-day period
ratio	sum / n_range	USER / 2	ratio of sum of true ranges to n-day range
log_ratio	Log(ratio)	FUNC / 2	log (base 10) of the above ratio
log_n	Log(n)	FUNC / 2	log of n
ci	100 * log_ratio / log_n	USER / 2	CI, expressed as a percentage

Excel Spreadsheet Formulas

Column Name	Formula	Belongs in:	Comments
Date	data	A2:A25	Date Format: "YYMMDD"
High	data	B2:B25	
Low	data	C2:C25	
Close	data	D2:D25	
TrueHigh	=MAX(B3,D2)	E3 *	highest of today's high or previous close
TrueLow	=MIN(C3,D2)	F3 *	lowest of today's low or previous close
TrueRange	=E3-F3	G3 *	daily true range
Sum14	=SUM(G3:G16)	H16 *	sum total of last 14 day's true ranges
High14	=MAX(E3:E16)	I16 *	highest true high for the 14-day period
Low14	=MIN(F3:F16)	J16 *	lowest true low for the 14-day period
Range14	=I16-J16	K16 *	true range for the 14-day period
CI14	=100*LOG(H16/K16)/LOG(14)	L16 *	14-day Choppiness Index

* Enter formula into this cell and copy it down to all cells in the column for the length of the data.

	A	B	C	D	E	F	G	H	I	J	K	L
	Date	High	Low	Close	TrueHigh	TrueLow	TrueRange	Sum14	High14	Low14	Range14	CI14
1	930709	57.76	57.54	57.67								
2	930712	57.48	57.27	57.39	57.67	57.27	0.40					
3	930713	57.87	57.53	57.77	57.87	57.39	0.48					
4	930714	57.96	57.44	57.85	57.96	57.44	0.52					
5	930715	57.98	57.52	57.70	57.98	57.52	0.46					
6	930716	57.94	57.33	57.90	57.94	57.33	0.61					
7	930719	58.35	58.06	58.25	58.35	57.90	0.45					
8	930720	58.55	58.05	58.51	58.55	58.05	0.50					
9	930721	58.73	58.42	58.57	58.73	58.42	0.31					
10	930722	58.36	58.08	58.33	58.57	58.08	0.49					
11	930723	58.00	57.76	57.87	58.33	57.76	0.57					
12	930726	57.73	57.60	57.68	57.87	57.60	0.27					
13	930727	57.83	57.58	57.60	57.83	57.58	0.25					
14	930728	57.97	57.70	57.93	57.97	57.60	0.37					
15	930729	57.98	57.09	57.14	57.98	57.09	0.89	6.57	58.73	57.09	1.64	52.59
16	930730	57.31	57.03	57.20	57.31	57.03	0.28	6.45	58.73	57.03	1.70	50.53
17	930802	58.42	57.48	58.34	58.42	57.20	1.22	7.19	58.73	57.03	1.70	54.64
18	930803	58.61	58.12	58.35	58.61	58.12	0.49	7.16	58.73	57.03	1.70	54.48
19	930804	58.31	58.13	58.26	58.35	58.13	0.22	6.92	58.73	57.03	1.70	53.19
20	930805	58.25	57.94	58.21	58.26	57.94	0.32	6.63	58.73	57.03	1.70	51.57
21	930806	58.89	58.12	58.79	58.89	58.12	0.77	6.95	58.89	57.03	1.86	49.95
22	930809	58.90	58.56	58.73	58.90	58.56	0.34	6.79	58.90	57.03	1.87	48.86
23	930810	58.60	58.01	58.05	58.73	58.01	0.72	7.20	58.90	57.03	1.87	51.08
24	930811	58.24	57.80	57.88	58.24	57.80	0.44	7.15	58.90	57.03	1.87	50.82

Data: IMM D-mark Sept. 1993 futures Source: Technical Tools

tion. He calls this modification the "linear choppiness index" (LCI), and it correlates perfectly with the CI.

To provide a benchmark for normal and extreme readings in the CI, Dreiss calculates the average CI level for all commodities. This is used as a center reference line. Extreme bands are located two standard deviations above and below the center line. Dreiss also suggests the CI can be smoothed with a three-day simple moving average.

Trading Techniques

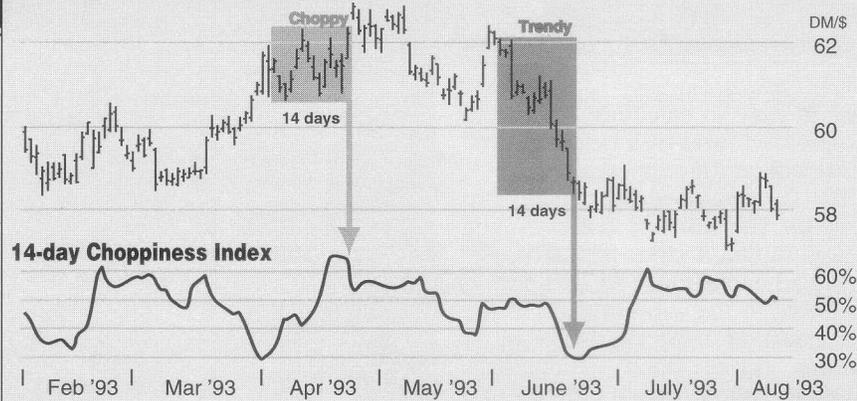
per se, the CI is not suitable as a stand-alone tool in a trading method; it is better as an adjunct to other methods. The CI can be employed in conjunction with a trend-following method to indicate periods when trades are less likely to be successful because there are no trends in the market. When these conditions are present, trades are filtered.

In the November 1991 issue of *Technical Trader's Bulletin*, Dreiss explains how he interprets the CI:

"Low readings in the CI correspond closely with the end of strong impulsive movements either up or down, while high readings occur after significant consolidations in the price. Extended periods of trendless price movement are reflected in extended periods of above-average readings of the CI. One might assume that markets with high CI should be avoided and only markets with low CI should be traded. However, it is more likely that one would want to avoid markets with constant above-average CI and trade markets where the CI swings from one extreme to the other."

Choppiness Index in action

IMM D-mark futures (back-adjusted continuous)



Source: Technical Tools/Chart:CompuTrac/SNAP

The Choppiness Index is a measure of the trendiness of the market during a given timeframe. If a box is drawn around the timeframe with the top of the box at the highest high and the bottom at the lowest low, the CI is a measure of the amount of area used by the market's movements in relation to the total area of the box. "Choppy" periods correspond to higher readings on the CI scale, "trendy" periods have lower CI readings.

As with many technical indicators that look at past data, the CI describes what has happened in the past, but isn't a crystal ball into the future. It may provide, however, useful information about impending changes in the current condition of the market. Dreiss says "high CI readings can be used to indicate that a consolidation is about to end and a position should be entered or a breakout anticipated. (Since the CI reading has nothing to do with market direction, it does not indicate in which direction to expect the breakout, but that the

breakout will probably be followed by a significant move.)

"Low CI readings can be used as a signal to take profits or tighten stops in anticipation of a market reversal or consolidation, or in some cases could be used to pick tops or bottoms." **FM**

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