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# Cybernetic Analysis for Stocks and Futures

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*Cutting-Edge DSP Technology  
to Improve Your Trading*

**JOHN F. EHLERS**



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*To Elizabeth—my friend,  
my companion, my wife*



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J. F. E.



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# Introduction

*“This is a synopsis of my book,” Tom said abstractly.*

**A**s Sir Arthur C. Clarke has noted, any significantly advanced technology is indistinguishable from magic. The advances made in computer technology in the past two decades have been dramatic and can qualify as nearly magical. The computer on my desk today is far more powerful than that which was available to the entire national defense system just 30 years ago. Software for traders, however, has not kept pace. Most of the trading tools available today are neither different from nor more complex than the simple pencil-and-paper calculations that can be achieved through the use of mechanical adding machines. True, these calculations are now made with blinding speed and presented in colorful and eye-grabbing displays, but the power and usefulness of the underlying procedures have not changed. If anything, the relative power of the calculations has diminished because the increased speed of information exchange and increased market capitalization have caused fundamental shifts in the technical character of the market. These shifts include increased volatility and shorter periods for the market swings.

*Cybernetic Analysis for Stocks and Futures* promises to bring magic to the art of trading by introducing wholly new digital signal-processing techniques. The application of digital signal processing offers the advantage of viewing old problems from a new perspective. The new perspective gained by digital signal processing has led me to develop some profoundly effective new trading tools. The advances in trading tools, along with the continuing advancements in hardware capabilities, virtually ensure the continued application of digital signal processing in the future. Traders who master the new concepts, therefore, will find themselves at a great advantage when

approaching the volatile market of the twenty-first century. If you like code, you will love this book. Every new technique, indicator, and automatic trading system is defined in exquisite detail in both EasyLanguage code for use in TradeStation and in eSignal Formula Script (EFS) code. They are also available as compiled DLLs to be run in NeuroShell trader.

Chapter 1 starts the wizardry off with a bang by challenging the conventional wisdom that market prices have a Gaussian probability density function (PDF). Just think about it. Do prices really have several events separated by a standard deviation from the mean across the screen as you would expect with a Gaussian PDF? Absolutely not! If the PDF is not Gaussian, then attaching significance to the one-sigma points in trading systems is, at best, just plain wrong. I show you how to establish an approximate Gaussian PDF through the application of the Fisher transform.

I derive a new zero-lag Instantaneous Trendline in Chapter 2. By dividing the market into a trend component and a cycle component, I create a zero-lag cycle oscillator from the derivation. These results are put to work by designing an automatic trend-following trading strategy in Chapter 3 and an automatic cycle-trading strategy in Chapter 4.

Several new oscillators are then derived. These include the CG Oscillator in Chapter 5 and the Relative Vigor Index (RVI) in Chapter 6. The performance of the Cyber Cycle Oscillator, the CG Oscillator, and the RVI are compared in Chapter 7. Noting that a favorite technical analysis tool is the Stochastic Relative Strength Index (RSI), where the RSI curve is sharpened by taking the Stochastic of it, I then show you in Chapter 8 how to enhance the oscillators by taking the Stochastic of them and also applying the Fisher transform.

In Chapter 9 I give an all-new exciting method of measuring market cycles. Using the Hilbert transform, a fast-reacting method of measuring cycles is derived. The validity and accuracy of these measurements are then demonstrated using several stressing theoretical waveforms. In Chapter 10 I then show you how to use the measured Dominant Cycle length to make standard indicators automatically adaptive to the measured Dominant Cycle. This adaptation makes good indicators stand out and sparkle as outstanding indicators. In Chapter 11, the cycle component of the Dominant Cycle is synthesized from the cycle measurement and displayed as the Sinewave Indicator. The advantages of the Sinewave Indicator are that it can anticipate cyclic turning points and that it is not subject to whipsaw trades when the market is in a trend. I continue the theme of adapting to the measured Dominant Cycle in Chapter 12 by showing you how to use the measurement to design an automatic trend-following trading strategy. The performance of the strategies I disclose is on par with or exceeds that of commercially available strategies.

Chapter 13 provides you with several types of filters that give vastly superior smoothing with a minimum penalty in lag. Computer code is provided for these filters, as well as tables of coefficient values. Another way to obtain superior smoothing is through the use of Laguerre polynomials. Laguerre polynomials enable smoothing to be done using a very short amount of data, as I explain in Chapter 14.

One of the problems with using backtests of automatic trading strategies is that they don't necessarily predict future performance. I describe a technique in Chapter 15 that will enable you to use the theory of probability to visualize how your trading strategy could perform. It also illustrates what historical parameters are important to make this assessment. In Chapter 16 I show you how to generate leading indicators, along with the penalty in increased noise that you must accept when these indicators are used. I conclude in Chapter 17 by showing you how to simplify the coding of simple moving averages (SMAs).

Many of the digital signal-processing techniques described in this book have been known and used in the physical sciences for many years. For example, Maximum Entropy Spectral Analysis (MESA) algorithm was originally developed by geophysicists in their exploration for oil. The small amount of data obtainable from seismic exploration demanded a solution using a short amount of data. I successfully adapted this approach and popularized it for the measurement of market cycles. More recently, the use of digital signal processing has exploded in consumer electronics, making devices such as CDs and DVDs possible. Today, complete radio receivers are constructed without the use of analog components. As we expand DSP use by introducing it to the field of trading, we will see that digital signal processing is an exciting new field, perfect for technically oriented traders. It allows us to generalize and expand the use of many traditionally used indicators as well as achieve more precise computations.

I begin each chapter with a Tom Swifty. Perhaps this is a testament to my adolescent sense of humor, but the idea is to anchor the concept of the chapter in your mind. A Tom Swifty is a play on words that follows an unvarying pattern and relies for its humor on a punning relationship between the way an adverb describes the speaker and at the same time refers significantly to the import of the speaker's statement, as in, "*I like fuzzy bunnies,*" said Tom acutely. The combinations are endless. Since this book contains magic, perhaps I should have selected Harry Potter as a hero rather than Tom Swift.

Throughout this book my objective is to not only describe new techniques and tools but also to provide you the means to make your trading more profitable and therefore more pleasurable.



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# **Cybernetic Analysis for Stocks and Futures**



# The Fisher Transform

*“I don’t see any chance of a market recovery,”  
said Tom improbably.*

**T**he focus of my research for more than two decades has been directed toward applying my background in engineering and signal processing to the art of trading. The goal of this book is to share the results of this research with you. Throughout the book I will demonstrate new methods for technical analysis of stocks and commodities and ways to code them for maximum efficiency and effectiveness. I will discuss methods for modeling the market to help categorize market activity. In addition to new indicators and automatic trading systems, I will explain how to turn good-performing traditional indicators into outstanding adaptive indicators. The trading systems that subsequently evolve from this analysis will seriously challenge, and often exceed, the consistent performance and profit-making capabilities of most commercially available trading systems. While much of what is covered in this book breaks new ground, it is not simply innovation for innovation’s sake. Rather, it is intended to challenge conventional wisdom and illuminate the shortcomings of many prevailing approaches to systems development.

In this chapter we plunge right into an excellent example of challenging conventional wisdom. I know at least a dozen statistically based indicators that reference “the one-sigma point,” “the three-sigma point,” and so on. Sigma is the standard deviation from the mean. In order to have a standard deviation from the mean, one must know the probability density function (PDF). A Gaussian, or Normal, PDF is almost universally assumed. A Gaussian PDF is the familiar bell-shaped curve used to describe IQ distribution in the population and a host of other statistical descriptions. The Gaussian PDF has long “tails” that describe events that have a wide deviation

from the mean with relatively low probability. With a Gaussian PDF, 68.26 percent of all occurrences fall within plus or minus one standard deviation from the mean, 95.44 percent of occurrences fall within plus or minus two standard deviations, and 99.73 percent of all occurrences fall within plus or minus three deviations. In other words, the majority of all cases fall within the one-sigma “boundary” with a Gaussian PDF. If an event falls outside the one-sigma level, then certain inferences have been drawn about what can happen in the future.

The real question here is whether the Gaussian PDF can be used to reliably describe market activity. You can easily answer that question yourself. Just think about the way prices look on a bar chart. Do you see only 68 percent of the prices clustered near the mean price? That is, do you see 32 percent of the prices separated by more than one deviation from the mean? And, do you see prices spike away from the mean nearly 5 percent of the time by two standard deviations? How often do you even see price spikes at all? If you don’t see these deviations, a Gaussian PDF is not a good assumption.

The Fisher transform is a simple mathematical process used to convert any data set to a modified data set whose PDF is approximately Gaussian. Once the Fisher transform is computed, we can then analyze the transformed data set in terms of its deviation from the mean.

The Commodity Channel Index (CCI), developed by Donald Lambert, is an example of reliance on the Gaussian PDF assumption. The equation to compute the CCI is

$$\text{CCI} = \frac{\text{Price} - \text{Moving Average}}{0.015 * \text{Deviation}} \quad (1.1)$$

Deviation is computed from the difference of prices and moving average values over a period. The period of the moving average over which the computation is done is selectable by the user. The CCI can be viewed as the current deviation normalized to the standard deviation. But what gives with the 0.015 term? Well, conveniently enough, the reciprocal of 0.015 is 66.7, which is close enough to one standard deviation of a Gaussian PDF for most technical analysis work. The premise is that if prices exceed a standard deviation, they will revert to the mean. Therefore, the common rules are to sell if the CCI exceeds +100 and buy if the CCI is less than -100. Needless to say, the CCI can be improved substantially through the use of the Fisher transform.

Suppose prices behave as a square wave. If you tried to use the price crossing a moving average as a trading system, you would be destined for failure because the price has already switched to the opposite value by the time the movement is detected. There are only two price values. Therefore,