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Chapter 1

WHY CYCLES EXIST IN THE MARKET

Technical analysis of the market is successful because the market is not always efficient. Discernible events that occur in chart patterns, such as double tops and Elliott waves, enable trading to be guided by technical analysis. Cycles are one of these discernible events that occur and are identifiable by direct measurement. Identification of cycles does not take a lifetime of experience or an expert system. Cycles can be measured directly, either by a simple system such as measuring the distance between successive lows or by a sophisticated computer software program such as MESA.

The fact that cycles exist does not imply that they exist all the time. Cycles come and go. External events sometimes dominate and obscure existing cycles. Experience shows that cycles useful for trading are present only about 15 to 30 percent of the time. This corresponds remarkably with J. M. Hurst's statement that "23% of all price motion is oscillatory in nature and semi-predictable." It is analogous to the problems of the trend-follower, who finds that the markets trend only a small percentage of the time.

Historical Perspective

Cyclic recurring processes observed in natural phenomena by humans since the earliest times have embedded the basic concepts used in modern spectral estimation. Ancient civilizations were able to design calendars and time measures from their observations of the periodicities in the length of day, the length of the year, the seasonal changes, the phases of the moon, and the motion of the planets and stars. Pythagoras developed a relationship between the periodicity of musical notes produced by a fixed-tension string and a number representing the length of the string in the sixth century B.C. He believed that the essence of harmony was inherent in the numbers. Pythagoras extended the relationship to describe the harmonic motion of heavenly bodies, describing the motion as the "music of the spheres."

Sir Isaac Newton provided the mathematical basis for modern spectral analysis. In the seventeenth century, he discovered that sunlight passing through a glass prism expanded into a band of many colors. He determined that each color represented a particular wavelength of light and that the white light of the sun contained all wavelengths. He invented the word *spectrum* as a scientific term to describe the band of light colors.

Daniel Bernoulli developed the solution to the wave equation for the vibrating musical string in 1738. Later, in 1822, the French Engineer Jean-Baptiste-Joseph Fourier extended the wave equation results by asserting that any function could be represented as an infinite summation of sine and cosine terms. The mathematics of such representation has become known as harmonic analysis due to the harmonic relationship between the sine and cosine terms. *Fourier transforms,* the frequency description of time domain events (and vice versa), have been named in his honor.

Norbert Wiener provided the major turning point for the theory of spectral analysis in 1930, when he published his classic paper "Generalized Harmonic Analysis." Among his contributions were precise statistical definitions of *autocorrelation* and *power spectral density* for stationary random processes. The use of Fourier transforms, rather than the *Fourier series* of traditional harmonic analysis, enabled Wiener to define spectra in terms of a continuum of frequencies rather than as discrete harmonic frequencies.

John Tukey is the pioneer of modern empirical spectral analysis. In 1949 he provided the foundation for spectral estimation using correlation estimates produced from finite time sequences. Many of the terms of modern spectral estimation (such as *aliasing, windowing, prewhitening, tapering, smoothing,* and *decimation*) are attributed to Tukey. In 1965 he collaborated with Jim Cooley to describe an efficient algorithm for digital computation of the Fourier transform. This *fast Fourier transform* (FFT) unfortunately is not suitable for analysis of market data, as we will develop in later chapters.

The work of John Burg was the prime impetus for the current interest in high-resolution spectral estimation from limited time sequences. He described his high-resolution spectral estimate in terms of a *maximum entropy* formalism in his 1975 doctoral thesis and has been instrumental in the development of modeling approaches to high-resolution spectral estimation. Burg's approach was initially applied to the geophysical exploration for oil and gas through the analysis of seismic waves. The approach is also applicable for technical market analysis because it produces high-resolution spectral estimates using minimal data. This is important because the short-term market cycles are always shifting. Another benefit of the approach is that is maximally responsive to the selected data length and is not subject to distortions due to end effects at the ends of the data. The trading program, MESA, is an acronym for *maximum entropy spectral analysis.*

What Is a Cycle?

The dictionary definition of a cycle is that it is "an interval or space of time in which is completed one round of events or phenomena that recur regularly and in the same sequence." In the market, we consider a classic cycle exists when the price starts low, rises smoothly to a high over a length of time, and then smoothly falls back to the original price over the same length of time. The time required to complete the cycle is called the *period* of the cycle, or the cycle length.

Cycles certainly exist in the market. Many times they are justified on the basis of fundamental considerations. The clearest is the seasonal change for agricultural prices (lowest at harvest), or the decline in real estate prices in the winter. Television analysts are always talking about the rate of inflation being "seasonally adjusted" by the government. But the seasonal is a specific case of the cycle, always being 12 months. Other fundamentals-related cycles can originate from the 18-month cattle-breeding cycle or the monthly cold-storage report on pork bellies.

Business cycles are not as clear, but they exist. Business cycles vary with interest rates. The government sets objectives for economic growth based on its ability to hold inflation to reasonable levels. This growth is increased or decreased by adding or withdrawing funds from the economy and by changing the rate at which government lends money to banks. Easing of rates encourages business; tightening of rates inhibits it. Inevitably this process alternates, causing what we see as a business cycle. Although in practice this cycle may repeat in the same number of years, the exact repetition of the period is not necessary. The business cycle is limited on the upside by the amount of growth the government will allow (usually 3 percent) and on the downside by moderate negative growth (about –1 percent), which indicates a recession. The range of the cycle from +3 to –1 percent is called its *amplitude.*

Components of the Market

Statisticians and economists have identified four important characteristics of price movement. All price forecasts and analyses deal with each of these elements:

1. A *trend,* or a tendency to move in one direction for a specified time period.
2. A *seasonal* factor, a pattern related to the calendar.
3. A *cycle* (other than seasonal) that may exist due to government action, the lag in starting up and winding down of business, or crop estimate announcements.
4. Other unaccountable price movement, often called *noise.*

Since points 2 and 3 are both cycles, it is clear that cycles are a significant and accepted part of all price movement.

When trading using cycles, one key question is the desired time span of the trade. At one extreme, the 54-year Kondratieff economic cycle (not without its critics) could be considered. A cattle rancher might prefer the 18-month breeding cycle, while a grain farmer probably hedges on the basis of the annual harvest. Speculators often work over a short (sometimes very short) time span.

Behavioral cycles in prices have been most popular in Elliott's wave theory and more recently in the works of

Gann. But these methods have a large element of interpretation and subjectivity.

Short-term cycles can exist even within the definition of point 4, "noise." A casual glance at almost any bar chart shows, in retrospect, that short-term cycles ebb and flow. The ability to isolate and use market phenomena, such as cycles, is related to the awareness of its existence and the tools available. Many forecasting methods were not practical until the computer became popular. Now these methods can be used by nearly everyone. The philosophical foundation for these short-term cycles is derived from the random walk theory and is developed so you will feel more comfortable dealing with cycles within the constraints of point 4.

Random Walk

Randomness in the market results from a large number of traders exercising their prerogatives with different motivations of profit, loss, greed, fear, and entertainment; it is complicated by different perspectives of time. Market movement can therefore be analyzed in terms of random variables. One such analysis is the *random walk*. Imagine an atom of oxygen in a plastic box containing nothing but air. The path of this atom is erratic as it bounces from one molecule to another. Brownian motion is used to describe the way the atom moves. Its path is described as a three-dimensional random walk. Following such a random walk, the position of that atom is just as likely to be at any one location in that box as at any other.

Another form of the random walk is more appropriate for describing the motion of the market. This form is a two-dimensional random walk, called the "Drunkard's Walk." The two-dimensional structure is appropriate for the market because the prices can only go up or down in one dimension.

The other dimension, time, can only move forward. These are similar to the way a drunkard's walk is described.

Diffusion Equation

The Drunkard's Walk is formulated by allowing the drunkard to step to either the right or left randomly with each step forward. To ensure randomness, the decision to step right or left is made on the outcome of a coin toss from a fair coin. If the coin turns up heads, the drunk steps to the right. If the coin turns up tails, the drunk steps to the left. Viewed from above, we see the random path the drunk has followed. Figure 1.1 shows a computer-generated path using the Drunkard's Walk

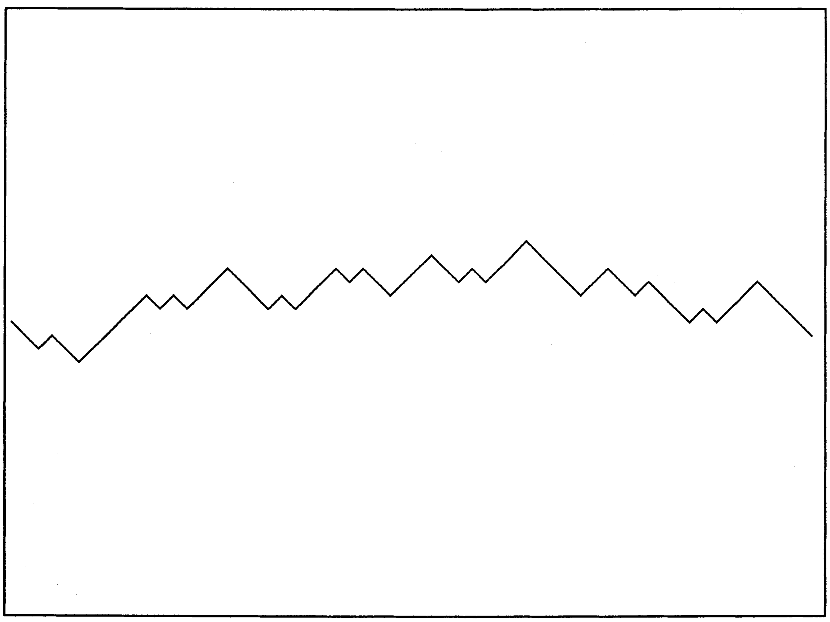

Figure 1.1 Random walk path. Direction is the random variable.

rules. We can write a differential equation for this path because the rate change of time is related to the rate change of position in two dimensions.

Differential equations are used to describe relationships due to variations. For example, *velocity* is the change of distance with respect to time, such as miles per hour. Written as a differential equation, velocity is expressed as

$$V = dx/dt$$

so that the equation shows that velocity is the change of distance with respect to time. Think of the *d* in the equation as meaning the difference. Similarly, *acceleration* is the change of velocity with respect to time. The equation for acceleration becomes

$$a = dV/dt$$

Since velocity is the change of distance with respect to time, we can think of acceleration as being the second rate change of distance with respect to time. Now the equation for acceleration can be written as

$$a = dV/dt = d^2x/dt^2$$

Mathematicians use these formats when writing differential equations.

Writing out the Drunkard's Walk problem, the differential equation is

$$dP/dt = D * d^2P/dx^2$$

where P = the position in time and space
D = the diffusion constant

This relatively famous differential equation (among mathematicians, at least) is known as the *diffusion equation.* In words, this equation states that the change of position with respect to time is proportional to the second rate change of position with respect to space. It describes many natural phenomena (e.g., the way heat travels up a silver spoon when it's placed in a hot cup of coffee). A better analogy to the way the market works is that the diffusion equation can describe the plume of smoke coming from a smokestack. Figure 1.2 shows 100 overlaid computer-generated Drunkard's Walk paths.

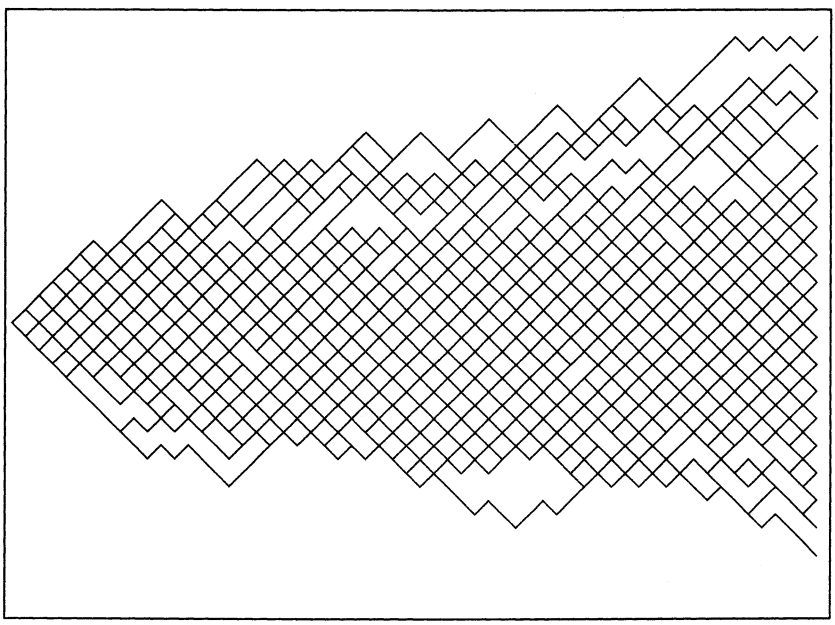

Figure 1.2 100 random walk paths overlayed. Direction is the random variable.

Using some imagination, you can picture Figure 1.2 as a plume of smoke.

Picture this plume of smoke in a gentle breeze. The plume is roughly conical, widening with greater distance from the smokestack. The plume is bent in the direction of the breeze. The diffusion equation describes the position of a single smoke particle, and you see the random position of all the particles in macrospect. Due to the random nature of the variable, the best estimate of the position you can make for any particle is the average position of the plume. There clearly are no cycles involved. Relating the smoke plume to the market, the general direction can be determined by averaging the random price. This, of course, is the moving average. It identifies the trend as surely as you can see the bending of the smoke plume in the breeze. Several centuries ago Gauss proved that such an average is the best estimator for a truly random variable. Note that the estimation, or prediction, degrades with distance from the origin just as the smoke plume widens as it leaves the smokestack. For this reason, moving average predictors for the market trend to degrade rapidly, as do most forecasts.

Telegrapher's Equation

Let's revisit the mathematical formulation of the Drunkard's Walk problem. This time, the result of the coin flip will determine whether the drunk takes the next step in the same direction as the previous one or whether he reverses his direction. This makes the random variable his momentum rather than direction. Figure 1.3 shows a computer-generated Drunkard's Walk path formed using momentum as the random variable. Mathematicians call this the *Continuous-Time Random Walk,* or CTRW. In this case, the random variable is his momentum

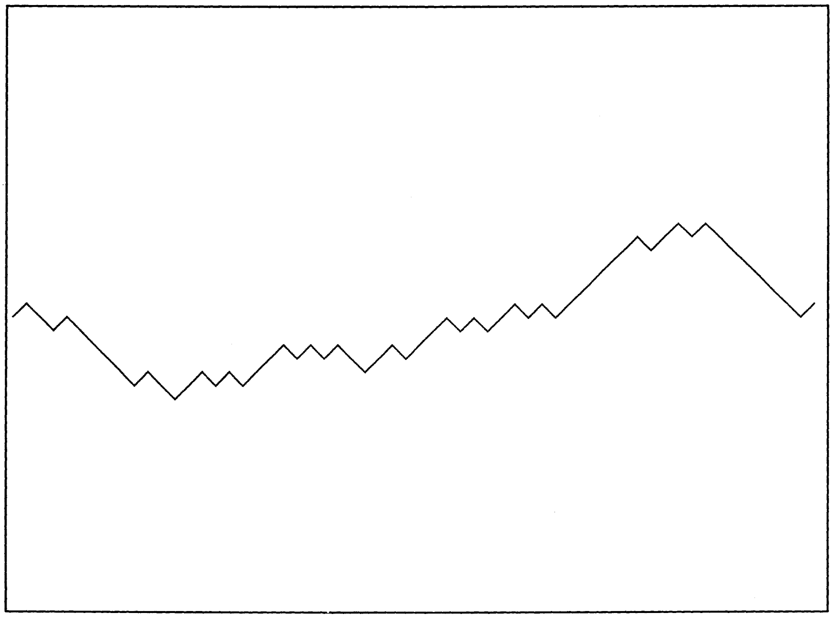

Figure 1.3 Random walk path. Random variable is momentum.

rather than his direction. We have altered the way his position changes as a function of time. When we now express his position as a differential equation, we obtain

$$d^2P/dt^2 + (1/T) * dP/dt = C * d^2P/dx^2$$

where T and C are constants.

This is also a famous equation. It is called the *Telegrapher's Equation* because, among other things, it describes the way the electronic waves travel along a telegraph wire. Note the structure of the Telegrapher's Equation is identical to the structure of the diffusion equation, except it contains the extra term for the second rate change of position with respect to time. The Telegrapher's Equation also describes the meandering of a river, a physical phenomenon we can relate to the market. Viewed as an aerial photograph, every river in the world meanders. This meandering is due not to a lack of homogeneity in the soil, but to the conservation of energy. You can appreciate that soil homogeneity is not a factor because other streams, such as ocean currents, also meander in a homogeneous medium. Ocean currents are not nearly as familiar to most of us as rivers.

Every meander in a river is independent of other meanders, satisfying the random requirement. If we looked at all the meanders as an ensemble, overlaying one on top of another like a multiple-exposure photograph, the meander randomness would also become apparent. The composite envelope of the river paths would be about the same as the cross section of the smoke plume. Figure 1.4 illustrates this point by showing the overlay of 100 Drunkard's Walk paths where the random variable is momentum. On the other hand, if we are in a given meander, we are virtually certain of the general path of the river. The result is that the river has a short-term coherency but is random over the longer span.

By analogy, the river meanders are the kind of cycles we have in the market. We can measure and use these short-term cycles to our advantage if we realize they can come and go in the longer term.

We can extend our analogy to understand when short-term cycles occur. The physical reason a river meanders is that it attempts to maintain a constant slope on its way to the ocean. The constant water slope is a variation on the principle of the conservation of energy. If the water speeds up, the width of the river decreases to yield a constant flow volume. The faster flow contains more kinetic energy, and the river attempts to slow it down by changing direction. However, the river direction cannot change abruptly because

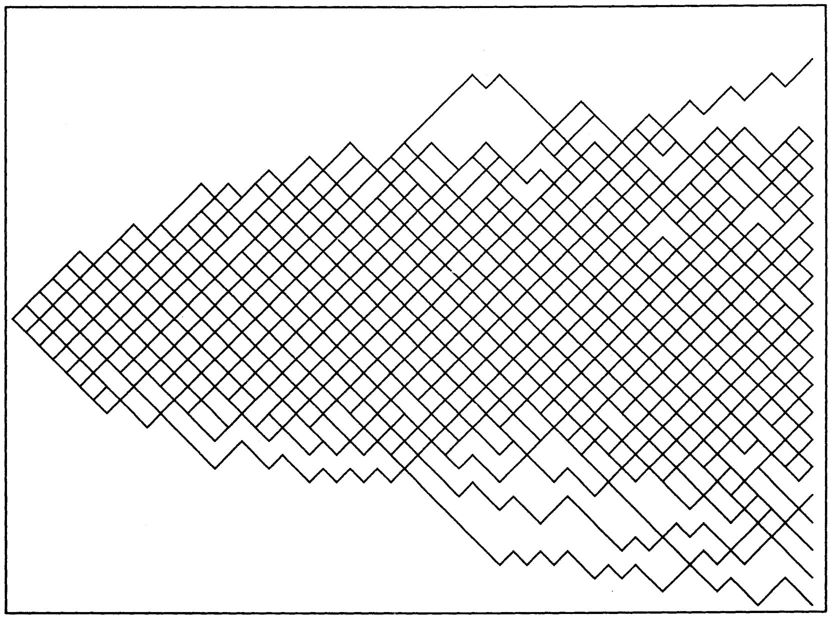

Figure 1.4 100 random walk paths overlayed. Random variable is the Momentum.

of the momentum of the flow. Meandering results. Thus, the meanders cause the river to take the path of least resistance in the energy sense. We should think of markets in just the same way. Time must progress as surely as the river must flow to the ocean. The overbought and oversold conditions result from an attempt to conserve the "energy" of the market. This energy arises from all the fear and greed emotions of the traders.

You can test the principle of conservation of energy for yourself. Tear a strip about 1 inch wide along the side of a standard sheet of paper about 11 inches long. Grasp each end of this strip between your thumb and forefinger of each hand. Now move your hands together. Your compression is putting energy into this strip, and its natural response can have several forms. These forms are determined by the boundary conditions that you forced. If both hands are pointing up, the response is a single upward arc, approximately one alternation of a sinewave. If both hands are pointing down, the response is a downward arc. If one hand is pointing down and the other is pointing up, the strip response to the energy input is approximately a full sinewave. The four lowest modes are the natural response following the principle of conservation of energy. You can introduce additional bends in the strip, but a minor jiggling will cause the paper to snap to one of the four lowest modes, the exact mode depending on the boundary conditions that you impose.

Tying all this theory together, we can judge that the market will be random if the majority of traders ask themselves, "Will the market go up or down?" In this case, the random variable is direction. If the majority of traders ask, "Will the trend continue?" the random variable is market momentum and a short-term cycle will follow. A trend does not necessarily produce cycles, because the trend can exist and the traders could still be asking themselves if the market is going to be up or down. There is no reliable measure of mass trader psychology leading to cycles. Therefore, we must be content with identifying these short-term cycles as they arise.

Conclusions

Arguments that cycles exist in the market arise not only from fundamental considerations or direct measurement but also on philosophical grounds related to physical phenomena. The natural response to any physical disturbance is a corrective motion. If you pluck a guitar string, the string vibrates with cycles you can hear. By analogy, we have every right to expect that the market will respond to disturbances with a cyclic motion. This expectation is reinforced with random walk theory that suggests there are times the market prices can be described by the diffusion equation and other times when the market prices can be described by the Telegrapher's Equation.

The challenge for technical traders is to recognize when the short-term cycles are present and to trade them in a logical and consistent manner so these cycles can contribute profitably to the bottom line.

In the chapters that follow I will define the basics of cycles and how to manipulate them to tune the momentum and moving average functions—components of every technical trading indicator. Cycle primitives will even be related to traditional charting patterns, perhaps giving these patterns a whole new meaning to you. Perhaps most important, I will discuss when to use cycles for trading and when to avoid their use.