The Coherent Market Hypothesis

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Source: *Financial Analysts Journal*, Nov. - Dec., 1990, Vol. 46, No. 6 (Nov. - Dec., 1990), pp. 36-49

Published by: Taylor & Francis, Ltd.

Stable URL: https://www.jstor.org/stable/4479378

by Tonis Vaga

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Chaos theory has received considerable attention in the aftermath of the Crash of 1987. However, an alternative non-linear statistical model is far more useful for understanding both the coherent bull market prior to the crash and the subsequent chaotic market fluctuations in October 1987. Unlike chaos theory, which seeks to forecast the path of stock prices in a deterministic sense, the non-linear statistical model, based on "A Theory of Social Imitation," can forecast transitions from trendless (random-walk) markets to periods of coherent, or orderly, price trends and periods of chaotic fluctuations (the panics and crashes associated with abrupt trend reversals).

A coherent bull market is characterized by an "inversion" in the historical risk-reward ratio. Over the past 60 years, the stock market has provided an average 10 per cent total yearly return, with a standard deviation of 20 per cent. During coherent bull markets, the return from the stock market averages over 25 per cent, while the standard deviation drops to the neighborhood of 10 per cent. Missing these low-risk opportunities can lead to underperformance, because the rest of the time the market presents more risk than reward, in the form of chaotic markets and periods of true random walk.

This article describes the theoretical basis and practical indicators of coherent markets. The results suggest that both technical and fundamental analysis can add real value to the investment decision-making process.

THE MAGNETIZATION of a bar of iron, electromagnetic fields in a laser, the phase of cells contracting in live heart tissue and the polarization of political opinion in social groups—all undergo transitions between states of macroscopic disorder and more orderly, or coherent, states.[1] This article reviews non-linear models of such state transitions and examines the conditions under which we might expect, in the capital markets, transitions from disorderly, random-walk (efficient-market) states to more ordered states (chaotic and coherent markets).

More specifically, I describe stock market fluctuations in terms of "A Theory of Social Imitation."[2] Unlike chaos theory, which is based on deterministic models, the Theory of Social Imitation is a non-linear statistical model. It may be regarded as a statistical version of chaos theory. Furthermore, it includes random walk as a special case. Table I summarizes this model and its controlling parameters.

Transitions from random-walk markets to periods of crowd behavior are characterized by instability.[3] As Figure A illustrates, the normal distribution flattens out into a wide, uniform distribution, and the impact of random news on stock prices is no longer discounted (damped) quickly. Large, long-lasting (undamped) price fluctuations are likely, posing abnormally high risk to investors.

In Figure A, the major market states predicted by the Theory of Social Imitation are illustrated in terms of "potential wells" and probability distributions. Annualized return may be thought of as a ball in the well, which is buffeted by random forces. Prevailing investor sentiment and economic fundamentals determine the shape of the well, while random news buffets the ball (return from a market index). When "normal" sentiment gives way to collective "group-think," we have to look at non-linear forces to understand market fluctuations.

1. Footnotes appear at end of article.

Table I Non-Linear Theory of Social Imitation

$$f(q) = c\,Q^{-1}(q)\exp\{2\int_{-1/2}^{q}[K(y)/Q(y)]dy\}$$

where:

$f(q)$ = probability of annualized return, q
$K(q) = \sinh(kq + h) - 2q\cosh(kq + h)$
$Q(q) = 1/n[\cosh(kq + h) - 2q\sinh(kq + h)]$

and:

n = number of degrees of freedom
k = degree of crowd behavior
h = fundamental bias

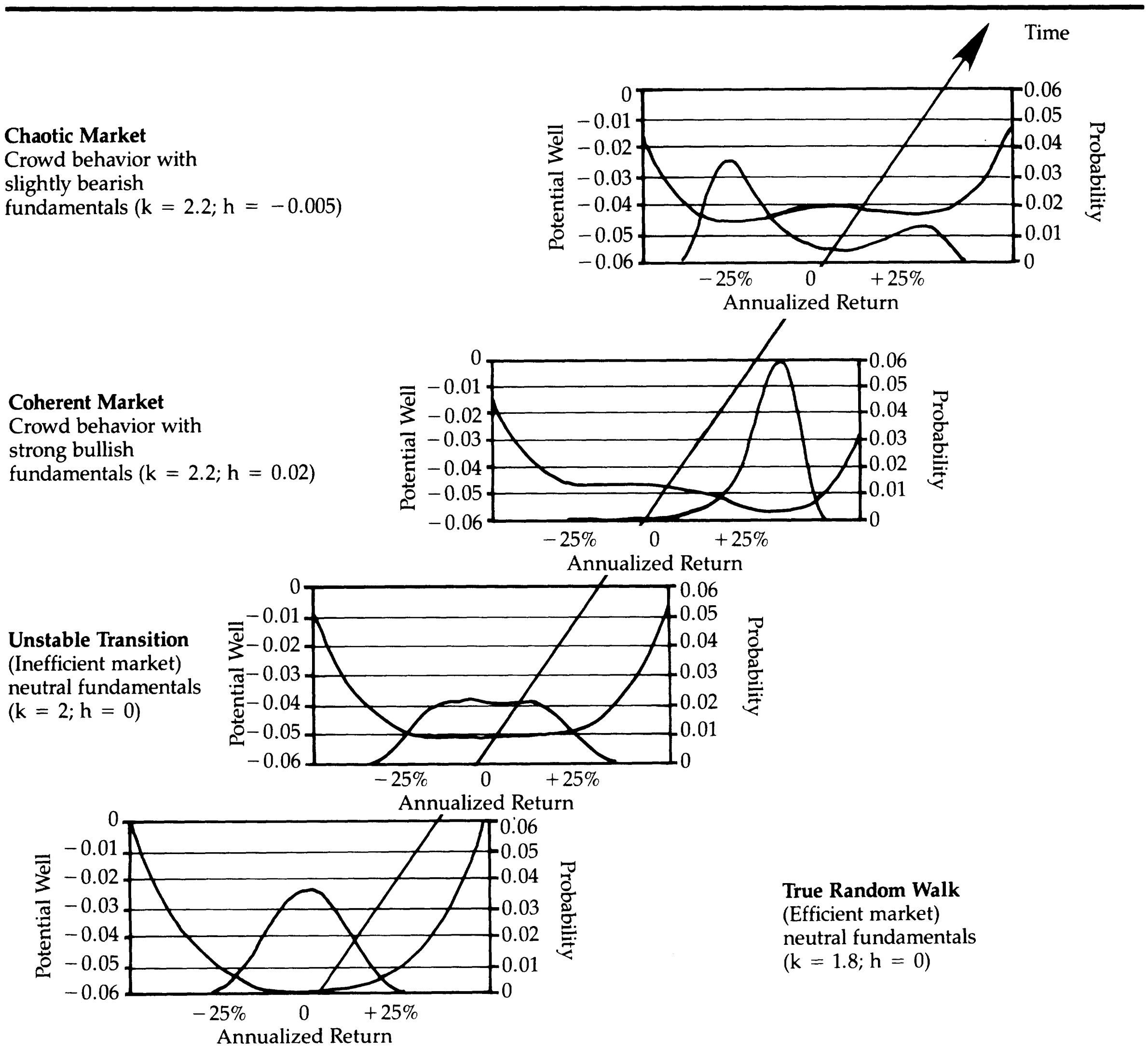
$$c^{-1} = \int_{-1/2}^{+1/2} Q^{-1}(q)\exp\{2\int_{-1/2}^{q}[K(y)/Q(y)]\,dy\}\,dq$$

Crowd behavior can lead to a "chaotic" market, as occurred in October 1978 and October 1987, *or* to the safest, most rewarding investment opportunities—January 1975 and August 1982, for example. The latter are examples of "coherent" markets. They should be of special interest to investors and are the focus of this article.

Market States

Investor sentiment and the prevailing bias in economic fundamentals control the state of the market. When investor sentiment is not conducive to "group think" or crowd behavior, the market is likely to be in a **random-walk** state (efficient market). In such relatively quiet peri-

Figure A Transition from Random Walk to Crowd Behavior



Glossary

Coherent Behavior: A state of (macroscopic) order in a complex physical or social system made up of a large number of component parts where each part is free to act independently. For example, order may arise in the orientation of molecules in a magnet, the synchronization of light waves in a laser or the polarization of opinions in a social group. Periods of coherent behavior in the stock market occur when the annualized return from a market index is greater than the annualized volatility of the index, reflecting a strong bias or orderly trend in price fluctuations.

Chaos Theory: Also known as catastrophy theory (made popular by the mathematician Rene Thom), a branch of mathematics concerned with the deterministic solution of abrupt or discontinuous (i.e., chaotic) changes in the state of a system, such as the buckling of a beam or turbulent (as opposed to laminar) flow of a fluid. In the stock market, chaos theory seeks to forecast in a deterministic sense the future path of stock prices, including large, abrupt price changes that occur during panics and crashes.

Non-Linear Statistical Model: A mathematical model that forecasts the conditions under which one may expect transitions from a state of macroscopic disorder (random walk) to more orderly states (coherent behavior with stable price trends), as well as abrupt (chaotic) trend reversals (i.e., panics and crashes). Unlike deterministic chaos theory, a non-linear statistical model seeks to define the *probability distribution* governing stock market fluctuations, rather than the specific future path of stock prices.

Uniform Distribution: A specific type of probability distribution which best represents stock market behavior during the unstable transition from a true random-walk market to a coherent or chaotic market. Unlike the bell-shaped normal distribution governing price fluctuations in a true random-walk market, the uniform probability distribution is much wider and flatter, implying that large, long-lasting price fluctuations are more likely during the period of instability. In a chaotic market, a "bimodal" probability distribution may occur, where extremes are more likely than the center of the distribution function.

Theory of Social Imitation: One particular non-linear statistical model, which can be applied to the stock market to describe transitions from periods of true random walk to coherent price trends and the chaotic fluctuations associated with panics and crashes. This theory includes random walk as a special case and may be thought of as a statistical form of chaos theory.

ods, the stock market is least likely to outperform fixed dollar and fixed income alternatives. The combination of strong positive fundamentals and investor sentiment conducive to crowd behavior leads to the safest, most rewarding state—a **coherent bull market**. In these market periods, a fully invested position is necessary to avoid the risk of underperforming the market averages. When the fundamental bias is neither strongly bullish nor bearish during a period of crowd behavior, the result is a **chaotic market**—a dangerous, "quasi-efficient" market in which random news is discounted quickly, but with a bias, and sentiment may switch abruptly from bullish to bearish (as during the Crash of '87).

In addition to these most prevalent market states, a coherent bear market (highly negative fundamentals with crowd behavior) is theoretically possible. This may be the best model of the 1973–74 bear market and the Crash of 1929, which unfolded over a period of several years. Fortunately, coherent bear markets are historically rare. Bearish fundamentals usually dampen investor enthusiasm, and prices tend to drift lower, in a random walk, over an extended bear market.

Figure A shows that when crowd behavior prevails, market fluctuations will tend to follow a bimodal distribution. Under these conditions, market action can best be described as a biased random walk or as "quasi-efficient." On a short-term basis, new developments will be discounted quickly, but investors will tend to respond to good news while ignoring bad news (or vice versa). Under these conditions, sentiment may also, by chance, switch abruptly from one state to its mirror image, producing anomalous short-term volatility.

During periods of crowd behavior, the market is highly sensitive to any underlying bias in economic fundamentals. Somewhat bearish fundamentals may increase the negative lobe of the bimodal distribution and decrease the positive. Under these conditions, if investor sentiment is bullish, even small random events may be enough to push the ball (market index return) across the potential barrier in the center of the well separating the bullish from the bearish state. Strong bullish fundamentals, however, can effectively suppress the negative lobe of the probability distribution, yielding a high expected return with a low standard deviation—i.e., a coherent market.

Edgar Peters has recently presented evidence of biased random walks.[4] Peters concludes that "pure random walk theory does not apply to the capital markets. The capital markets instead follow a biased random walk." The Theory of Social Imitation suggests that, at times, the market *is* in a true random-walk state. If these periods of true random walk are eliminated, the remaining periods of crowd behavior may be expected to exhibit even greater persistence (i.e., return trends) than Peters' data indicate. This conclusion would have important implications for market timing and asset allocation. Techniques such as tactical asset allocation may not be futile in periods of coherent markets. However, when true random-walk markets prevail, trend-following strategies and relative-strength approaches will not be effective.

A Theory of Social Imitation

More than 10 years ago, A. Woodcock observed that "certain events, such as stock market crashes and sudden structural failures, are totally unpredictable. But that could change if a revolutionary mathematical theory lives up to its promise."[5] The revolution referred to was the emerging field of catastrophe, or chaos, theory.

Chaos theory in general includes a wide variety of non-linear models, all of which are deterministic. This poses a problem in terms of the practical application of chaos theory to the stock market, inasmuch as the market is heavily influenced by random noise. On Wall Street, the element of chance must be an integral part of any new theory of stock price fluctuations.

The Theory of Social Imitation is a non-linear statistical model based on the Fokker Planck equation. (See the appendix for mathematical details.) As it includes both a statistical version of catastrophe theory and the random walk as special cases, it avoids the limitations of deterministic chaos theory models. It is therefore well equipped to deal with stock market fluctuations.

The Theory of Social Imitation, developed by Earl Callen and Don Shapero, extends the well known Ising model of ferromagnetism to the phenomenon of polarization of opinion in social groups.[6] Wolfgang Weidlich of the University of Stuttgart originally proposed this approach to describe intense polarization of opinions in social groups, such as arose in the French student revolution of the 1960s.[7]

The Ising Model

To appreciate the Ising model, consider a bar of iron in which individual molecular magnetic spins point either up or down. If the bar is hot, random bombardment by neighboring molecules will cause molecular orientation to become disordered. At times, just by chance, more molecules may point up than down, or vice versa. The macroscopic magnetic field will fluctuate randomly around zero, in a state of disorder.

When the temperature of the iron bar is lowered below a critical point, the magnetic interaction between adjacent molecules begins to become stronger than the random thermal forces. If, by chance, a small cluster of molecules begins to orient in one direction, neighboring molecules will tend to follow suite. Soon numerous large clusters may form. Each cluster will have molecules aligned, but some clusters will align in one direction and some in another. On a macroscopic level, there may be large, long-lasting magnetic field fluctuations. On average, however, the net field strength will still be zero, unless there is an external bias tending to align the clusters in one way rather than another.

When a bar of iron is susceptible to magnetization, an external magnetic force will tend to align most clusters in one direction. Random thermal forces will still cause some variations in the macroscopic magnetic field, but the fluctuations will be stable around some large net value. In this situation, the iron has a high degree of order. The orientation of the magnetic field, however, could "flip" as a result of external forces or even just as a matter of chance.

Polarization in Social Groups

Callen and Shapero suggested that the Ising model could be used to describe the behavior of a wide variety of social groups—fish aligned in schools, birds flying in flocks, fireflies flashing in unison and people conforming to the dictates of fads and fashions. Their Theory of Social Imitation is based on the assumption that, on a macroscopic level, individuals in a group behave in a manner similar to the molecules in a bar of iron. Under some conditions, the individuals will act independently of each other. Under the right conditions, however, the same individuals' thinking may become polarized—i.e., the individuals will act as a crowd and individual rational thinking will be replaced by a collective "group think."[8]

As Charles Mackay observed in the 19th century: "Men it has well been said, think in herds; it will be seen that they go mad in herds, while they recover their senses slowly, and one by one."[9] Likewise, a bar of iron susceptible to magnetization by an external impulse (magnetic field) will become strongly polarized for an extended period of time and slowly return to the unpolarized state, long after the external influence has passed.

In general, transitions from disorder to order tend to share the same macroscopic characteristics, whether the subsystems are from physics, chemistry, biology or sociology. Even though the magnet and social groups have vastly different subsystems, their macroscopic behavior shares the same properties of all transitions from disorder to order. These have been described by Haken and are summarized in the quantitative models in the appendix.[10]

Stock Market Fluctuations

Unlike a bar of iron, the stock market is an "open" system. It requires a continuous flow of money to maintain a transition from a disordered to a more ordered state, just as the laser requires an external pump to create the population inversion needed to maintain a fresh supply of electrons ready to emit light. If the flow of energy in a laser is insufficient, it will only emit normal, "random," light. One of the surprising features of the laser transition, however, is that it is remarkably similar to the magnet's state change, even though the underlying process is vastly different and the laser is far from thermal equilibrium.[11]

I assume that industry groups in the stock market are analogous to the molecules in a bar of iron, and that the return from the stock market is proportional to the difference between the number of industry groups trending higher and the number trending lower. Market returns may either fluctuate randomly around zero (as in the overheated bar of iron) or, under the right conditions, they may exhibit a high degree of polarization, leading to a large net difference between gainers and losers and corresponding large market moves.

The Ising model, as applied to the stock market, has three key inputs. The first is sentiment—k—a measure of whether the level of "group think" is above or below a critical transition threshold. The second, fundamental bias—h—is a measure of external preference toward bullish or bearish sentiment. The third—n—represents the number of degrees of freedom that exist. For the stock market, I interpret n as the number of industry groups. While k and h may vary widely, n remains relatively constant. (It is assumed to be 186 in sample calculations.)

Figure B Major Market States

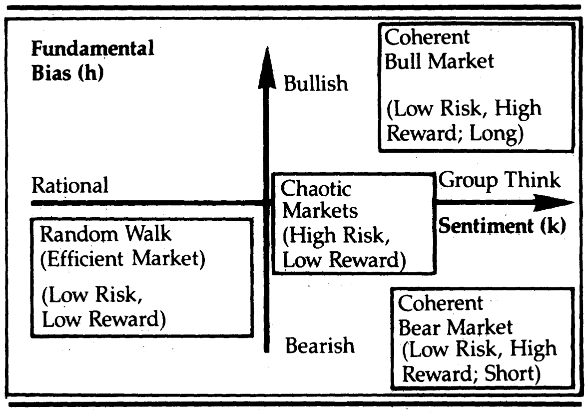


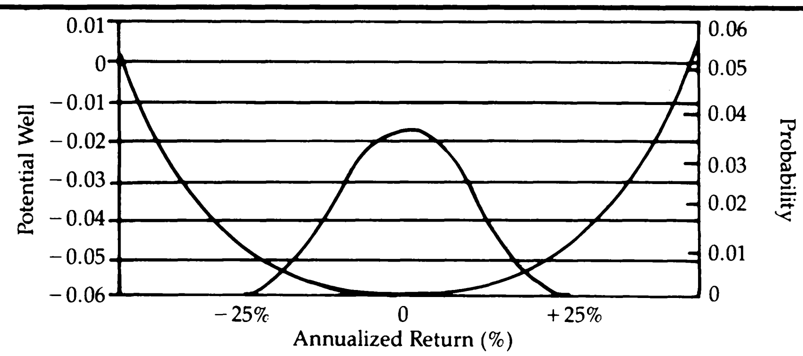
Figure B summarizes the market states expected as a function of prevailing investor sentiment and fundamentals. Below the critical transition threshold (k = 2), the random walk state prevails. Above the transition threshold, coherent bull markets occur if fundamentals are strongly positive, while chaotic markets are likely if fundamentals don't provide a clear direction for investors.

Table II presents theoretical expected returns and standard deviations for a range of combinations of sentiment and fundamentals. For equal changes in fundamentals, h, expected return increases in a non-linear fashion. In a random-

Table II Risk-Reward Forecasts

Market State	*Sentiment (k)*	*Fundamentals (h)*	*Expected Return*	*Standard Deviation*
Random	1.8	+0.02	+8%	10%
Walk	1.8	0	0	10
	1.8	−0.02	−8	10
Transition	2.0	+0.02	14	12
	2.0	0	0	16
	2.0	−0.02	−14	12
Coherent	2.2	+0.03	+27	8
Bull	2.2	+0.02	+25	11
Chaotic	2.2	+0.01	+16	18
	2.2	+0.005	+10	21
	2.2	0	0	23
	2.2	−0.005	−10	21
	2.2	−0.01	−16	18
Coherent	2.2	−0.02	−25	11
Bear	2.2	−0.03	−27	8

Figure C Random Walk (Efficient Market)*



*Sentiment (k) = 1.8; fundamentals (h) = 0; expected return = 0; standard deviation = 10%.

walk market, the impact of a change in fundamentals is considerably less than it is during period of crowd behavior. Furthermore, in coherent markets, the magnitude of the expected return is more than twice its standard deviation, suggesting a potential quantitative definition of coherent behavior in capital markets.

Random Walk is Just the First Step!

The non-linear model given in Table I can be considerably simplified for the special case when sentiment is not conducive to crowd behavior—i.e., $k < 2$.[12] If we further assume that fundamentals are neutral ($h = 0$), the probability distribution of returns, $f(q)$ can be expressed as follows:

$$f(q) = (1/g\sqrt{\pi})\exp(-q^2/g^2), \quad (1)$$

where the variance is:

$$g^2 = 1/(2-k)n. \quad (2)$$

This is the "normal" distribution corresponding to a snapshot in time of a random-walk process.

In general, the random walk involves time-dependent diffusion (widening) of the probability distribution. The non-linear model in Table I represents a stationary solution to the Fokker Planck equation (which is a generalized form of the Langevin equation of Brownian motion). Time-dependent, non-linear solutions are treated as random walks involving both the usual time-dependent diffusion and a coherent drift toward the most stable stationary state.[13]

When non-linear effects are significant, transition probabilities of steps up or down are no longer equal. In effect, steps in one direction may be larger and more likely than steps in the other direction. This amounts to a biased random walk, where the bias may behave either in coherent or chaotic fashion depending on prevailing sentiment and fundamentals. While the non-linear model reduces to the usual random walk as a special (linear) case, the general non-linear, time-dependent situation is quite complex.

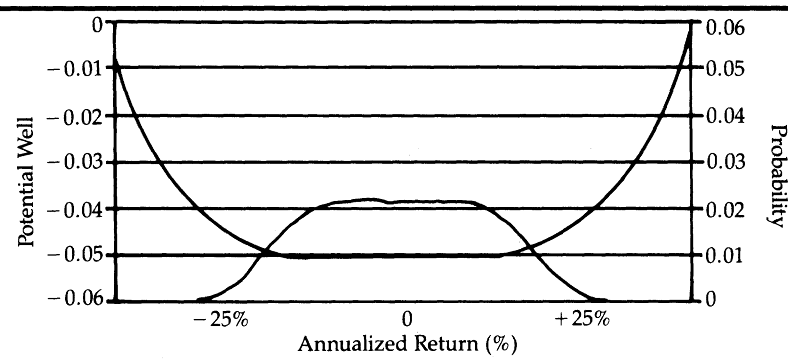
Figure C illustrates both a potential well and a probability distribution for the special case of a true random-walk market. The annualized return from a market index, q, can be thought of as a ball trapped in the potential well, buffeted by random forces. The probability distribution is determined in part by the shape of the well. In a true random-walk state, the well has a single bottom near zero, representing a disordered state. Theoretically, random-walk markets could provide either a small, stable bullish return or a small, stable bearish return, depending on fundamentals. Historically, however, random-walk markets have provided a stable negative return and are most frequently associated with bear markets.

Transition to Crowd Behavior

The variance in the normal probability distribution in Equation (1) becomes very large as k approaches two, the critical transition threshold. In this situation, the normal distribution no longer applies. The random-walk model is no longer valid during the transition to crowd behavior.

An instability occurs at transition. In a random-walk market, the motion of a ball in the potential well would be heavily damped; that is, the effects of each random push (piece of news) on the ball (return) would die out (be dis-

Figure D Unstable Transition*



*Sentiment (k) = 2.0; fundamentals (h) = 0; expected return = 0; standard deviation = 16%.

counted) quickly. At transition, however, the level of damping drops dramatically. The ball is free to swing from one extreme to another within the potential well. This implies a highly inefficient market in which large, long-lasting sentiment swings must be expected.

Figure D illustrates the potential well and probability distribution associated with the unstable transition from random walk to crowd behavior. The potential well for the transition to crowd behavior is nearly flat over a wide range of expected returns. Nearly anything can happen in a period of instability. The case shown is for neutral fundamentals; even a slight fundamental bias would tend to skew the distribution strongly in the direction of the bias.

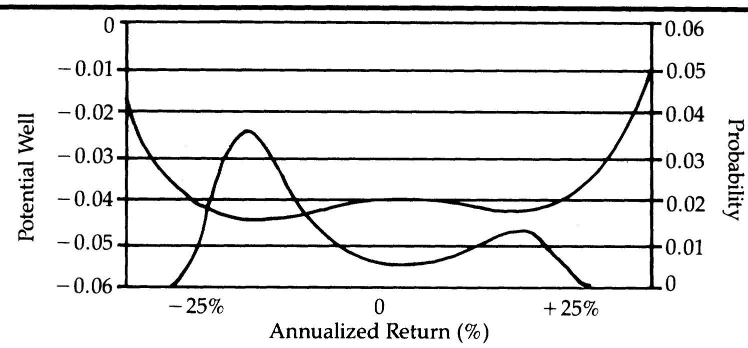
Chaotic Markets

As k increases above the critical threshold of two, the Ising model predicts a double-bottom potential well and bimodal probability distribution. That is, a high degree of polarization exists among investors, but without a strong fundamental bias, there is no clear indication as to whether the crowd will stabilize in a bullish or bearish state. Furthermore, there is a possibility of abrupt sentiment shifts (chaotic fluctuations) from bullish to bearish, or vice versa.

The probability of a large sentiment shift is greatest when prevailing investor sentiment runs counter to a small external bias in fundamentals. Figure E illustrates, for example, the potential well and probability distribution applicable to the period immediately prior to the Crash of '87.

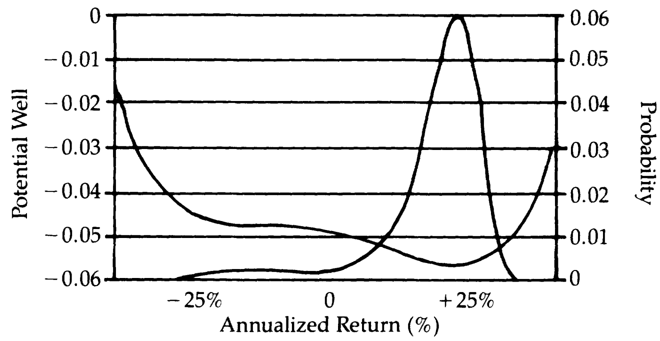
The climate prior to the crash was conducive to crowd behavior; this was indicated by the extremes in market volume and breadth. Fundamentals were somewhat bearish, as a result of rising interest rates throughout 1987 as well as unusually high valuations by historical norms. The hike in the discount rate on September 4, 1987 clearly signalled the Federal Reserve's intent to further tighten monetary conditions. At the same time, the market had risen more than 25 per cent during the prior 12 months, and

Figure E Chaotic Market*



*Sentiment (k) = 2.2; fundamentals (h) = −0.005; expected return = −10%; standard deviation = 21%.

Figure F Coherent Bull Market*



*Sentiment (k) = 2.2; fundamentals (h) = 0.02; expected return = 25%; standard deviation = 10%.

bullish sentiment prevailed. The market, viewed as a Brownian particle, was in the less probable state.

While a bullish state is quite possible when crowd behavior is combined with bearish fundamentals and may be interpreted as a period of market "mania," it is a potentially dangerous situation. Even small negative random impulses can push the ball (market return) over the shallow barrier in the center of the well toward the more probable state of net bearish sentiment and negative returns. The specific news prior to the Crash was less important a causal factor than the prevailing combination of sentiment and fundamentals—i.e., the shape of the potential well.

A chaotic market may be described as quasi-efficient. As long as sentiment remains stable on one side of the well or the other, new developments will be discounted quickly, but with a bias reflecting prevailing sentiment. This situation existed in the first eight months of 1989, when "good news" resulted in higher stock prices and "bad news" did the same (or at least did little damage on the downside). While the path of the ball in the well is unpredictable, the high standard deviation associated with the probability distribution in Figure E reflects the high degree of risk in a chaotic market.

Coherent Bull Markets

When fundamentals are strongly positive during a period of crowd behavior, a coherent bull market may emerge. January 1975 and August 1982 are classic examples of runaway bull markets dominated by crowd behavior (as measured by extremes in the ratios of NYSE upside volume to downside volume and advancing issues to declining issues) as well as bullish fundamentals (the Federal Reserve actively seeking to stimulate economic growth and historically low price-to-earnings ratios). A coherent bull market can be thought of as a chaotic market in which the bearish side of the potential well is high, and the associated lobe of the probability distribution becomes small.

Figure F illustrates a coherent bull market. The market's expected return and its standard deviation show the inversion of the historical risk-reward ratio. The peak of the distribution is even higher than the expected return. However, the distribution has a long tail that goes deep into negative territory. The non-linear model predicts that, even under extremely bullish conditions, there is a small but finite probability that the market will provide a negative return.

Coherent markets typically occur when cash reserves are unusually high. A supply of available funds is needed to maintain the coherent state or positive uptrend in stock prices, much as an external pump is needed in a laser to maintain the population of high-energy electrons ready to emit light.

Maintaining excessive cash reserves during a coherent bull market simply locks in underperformance. Most of the market's long-term gains can be attributed to coherent markets. After a coherent market ends, and a chaotic or random-walk state begins, it is too late to invest with the hope of making up forgone returns.

Coherent Bear Markets

Coherent bear markets are the mirror image of coherent bull markets. The conditions required to produce this state are crowd behavior with strong bearish fundamentals. This amounts to a chaotic market in which the bullish side of the potential well is high, and the associated lobe of the probability distribution begins to disappear. The standard deviation is the same as for a coherent bull market; however, expected return approaches the most probable return, deep in bearish territory.

The market of 1973–74 may be a good example of a coherent bear market. The Crash of 1929, which extended over a number of years, is another obvious example. Fortunately, there aren't many recent examples of coherent bear markets. As long as the Federal Reserve can maintain overall economic growth, and as long as recessions are reasonably short-lived, we should continue to enjoy coherent bull markets corrected by periods of random walk and perhaps occasional chaotic market periods. But the Ising model clearly does allow for a coherent bearish trend.

Table III Indicators of Coherent Markets

Signal	*Duration of Signal*	*Expected Return (%)*	*Standard Deviation (%)*
Double 9:1 NYSE up: down volume extremes within three months[a]	12 months	23.6	7.7
NYSE advance:decline ratio greater than 2:1 over a 10-day moving average and Fed indicator extremely bullish[b]	18 months	25.1	7.9[c]
S&P 500 price to five-year earnings ratio equal to 10 or less[d]	36 months[e]	22.2	8.5

a. From M. Zweig, "Go With the Flow," *Barron's*, August 13, 1984.
b. From M. Zweig, "The Fed and the Tape," *Barron's*, February 4, 1985.
c. Overlapping signals are treated as one period.
d. From S. Leuthold, "Testing the PE Histogram" (The Leuthold Group, Minneapolis, 1989).
e. Coherence time lasts for 10 years for P/E of 10.5 or less.

Indicators

In the Ising model, the probability distribution governing the stock market's risk-reward outlook is completely determined by the following three parameters.

- **Sentiment (k)** reflects the degree of coupling of opinion among investors in different market sectors (industry groups); it ranges from independent (k = 1.8) through unstable transition (k = 2.0) to "group think" or crowd behavior (k = 2.2).
- **Fundamentals (h)** reflect prevailing Federal Reserve policy, ranging typically from tightening (h = −0.02) to neutral (h = 0) to stimulating growth (h = 0.02).
- **Degrees of freedom (n)** is assumed here to be the number of industry groups making up the market (n = 186 for the illustrations).

The first two parameters determine the market state, given a fixed n. They may be rated subjectively or based on quantitative indicators. Some indicators of coherent markets are summarized in Table III and discussed further below.

Sentiment

Determining whether the climate is conducive to crowd behavior is the first step in assessing the risk-reward outlook. Crowd behavior is often perceived as undesirable, something to be avoided. When it comes to the market, at least, quite the opposite is usually true. As long as fundamentals aren't bearish, bullish crowd behavior can provide the best investment opportunities. In fact, investors who miss periods of bullish crowd behavior (coherent bull markets) will suffer underperformance over the long run.

One of the easiest ways to recognize crowd behavior is to look for extremes in various sentiment indicators. Zweig has published a series of articles in *Barron's* that can be reinterpreted to fit with the Theory of Social Imitation. Specifically, Zweig analyzed buy and sell signals based on strings of up-and-down volume ratios and advancing-to-declining issues ratios on the New York Stock Exchange.

Zweig defined a buy signal as two or more 1:9 downside extremes followed by a 9:1 upside reversal. He defined a sell signal as three or more uninterrupted downside extremes. Zweig noted that, for a period of six months after the buy signal, the market did extremely well (30.2 per cent annualized return). For a period of six months after a sell signal, the market produced a −21.8 per cent annualized return. When neither signal was in effect, the market tended to drift lower, at about a −9 per cent annualized return.[14]

Zweig's buy and sell signals can be interpreted as indicators of crowd behavior. Either the buy or the sell signal suggests that the climate will be conducive to crowd behavior for the next six months. When neither signal is in effect, a random-walk market is likely to prevail.

Crowd behavior can result in either coherent bull markets or dangerous chaotic markets, depending on fundamentals. During random-walk periods, prices tend to drift lower.

Zweig also evaluated market action after double 9:1 upside extremes.[15] He found that, over the 12-month period following two 9:1 NYSE up:down volume extremes within three months of each other, the market was up 27.8 per cent on average. This is a useful (12-month) indicator of crowd behavior and coherent bull markets as long as fundamentals remain bullish. Not only is the expected return high for this indicator, but the standard deviation, or risk, is 7.7 per cent—very low and consistent with the theoretical model of coherent bull markets.

Zweig also noted that, after these signals had expired (which I interpret as periods of true random-walk or chaotic markets) prices declined at a −5.7 per cent annualized rate. This suggests that long-term gains occur during coherent bull markets; the rest of the time the market offers risk without reward.

Fundamentals

During crowd behavior, economic fundamentals are critical. There's always good news and bad news regarding the economic outlook. However, the underlying bias can be reduced to whether monetary conditions are supporting or curtailing economic growth. The Federal Reserve's policy is widely followed by investors as the governing factor behind fundamentals.

Between 1984 and 1986, for example, the Fed cut the discount rate seven times, from 9 to 5-1/2 per cent—a nice example of a strong bullish bias in fundamentals. On September 4, 1987, it hiked the discount rate to 6 per cent. This slight change in policy from supporting growth to restraint occurred while the climate was conducive to crowd behavior and may have been one of the key factors triggering the Crash of '87. Changing fundamentals during crowd behavior can shift the risk-reward outlook from the safest to the most dangerous time to be in the stock market!

Highly bullish fundamentals coupled with strong market action (crowd behavior) accompany coherent bull markets. Zweig found that the combination of powerful tape action and aggressive stimulation by the Fed has accompanied all the biggest bull markets in history from 1926 to 1985.[16] Using a 10-day advance:decline ratio greater than 2:1 as an indicator of tape action (or crowd behavior) and Fed policy as a measure of fundamentals, Zweig found that the market advanced a powerful 40 per cent over the subsequent 18 months, a 25.1 per cent annualized rate for these "double-barrel buy signals." The standard deviation of returns during these periods was 7.7 per cent. This indicator therefore appears useful as an 18-month signal of crowd behavior and coherent markets as long as fundamentals remain positive.

Another fundamental indicator of coherent markets is the market's price-to-earnings (P/E) ratio. An analysis of the S&P 500's P/Es over the period from 1926 to 1989 was performed by The Leuthold Group.[17] Using a five-year moving average of quarterly earnings for this index, Leuthold's study showed that when stocks were cheap (i.e., the P/E ratio is 10 or less), the annualized return over the next three years averaged 22.2 per cent, while the standard deviation of returns was 8.5 per cent.

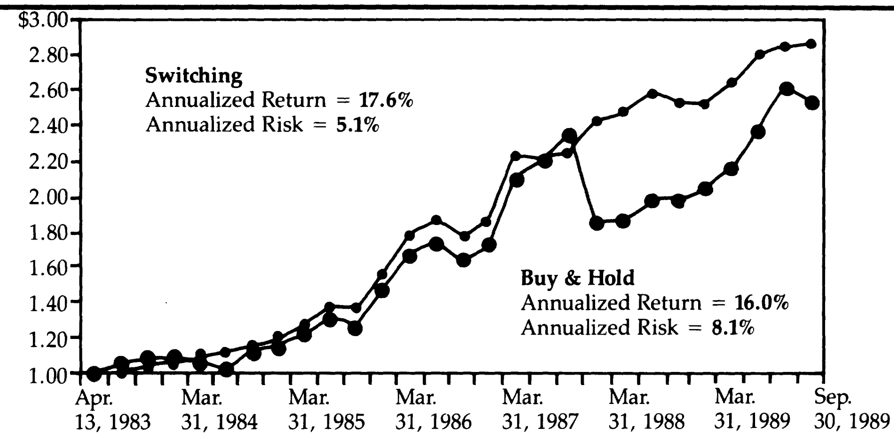
Similar coherent results followed P/E ratios of 12 or less, but the average returns were progressively lower. In contrast, after quarters that fell into the highest P/E category (21 or higher), annualized returns over the subsequent three years averaged 0, with a substantially larger 13 per cent standard deviation. Returns following P/Es greater than 17 averaged 2 per cent (annualized) over the next three years, with an 11.9 per cent standard deviation. Leuthold also showed that the bias toward above-average returns can persist even 10 years after a period of historically low valuations.

Implications

Under the various forms of the Efficient Market Hypothesis, technical analysis and fundamental analysis are generally construed as a waste of time and effort. The only real information that can be acted upon is the market's long-term uptrend—i.e., its historical 10 per cent average annual rate of return. Everything else is just noise, accounted for by the historical 20 per cent standard deviation of annual returns. This implies that a buy-and-hold strategy would be as effective as or more effective than the average investment timing strategy.

The Coherent Market Hypothesis outlined above suggests that the long-term uptrend in stock prices is really comprised of periods of above-average growth and below-average risk, mixed with other periods of net high risk and small or negative returns. This implies there is

Figure G Coherent Investment Results (4/13/83–10/31/89)



more information and less noise than Efficient Market Hypotheses would predict. Technical and fundamental analysis can be used to identify the likelihood of trends, or biased random walks. This makes tactical asset allocation meaningful and helps explain anomalies in the risk-reward principle.

Biased Random Walks

Random walk is just the first step down Wall Street! At times the sidewalk isn't perfectly level, so steps in one direction are larger and more likely than steps in the opposite direction. While random fluctuations always mask the trend in stock prices on a short-term basis, the effects of a coherent drift may be expected to become significant over the long term.

Unlike deterministic chaos, which, when applied to stock market behavior, seeks to replace the random walk hypothesis with formulas for computing the future path of market returns, the statistical chaos model underlying the Coherent Market Hypothesis retains random walk as a special case. In effect, this approach seeks to extend the random walk model into the nonlinear domain in the form of biased random walks. A coherent market can be viewed simply as a random walk with a strong drift toward the most probable stationary state. A chaotic market may be viewed as a biased random walk, where the bias may jump discontinuously between stable states that are widely separated in terms of annualized return.

Tactical Asset Allocation

Most hedging strategies are designed to trade upside potential off against reduced overall portfolio volatility. The Coherent Market Hypothesis suggests that it should be possible to beat the market *and* reduce risk. In April 1983, I began an experiment, the aim of which was to beat the market without taking above-average risk. I established two accounts—one allocated totally to either a market index fund (the Vanguard Index Trust) or a money market fund, depending on the risk-reward outlook, the other a passive indexing control or performance benchmark account.

The results over the first six years look promising. While I haven't beaten the market every year, the benefits have started to emerge over the long run. I've achieved a 17.6 per cent annualized return, compared with 16.0 per cent for the passive buy-and-hold strategy. Equally important, I've cut annualized risk from 16.2 to 10.2 per cent. Figure G shows the results through October 31, 1989.

The buy-and-hold index fund produced a total return of 154 per cent, while the strategy of switching between the stock index and cash produced a return of 188 per cent. These results may not be indicative of future performance. If coherent bull markets are less prevalent in the future, returns may not be as high. If the market declines, however, it may provide opportunities to increase the performance differential.

During the period prior to the Crash of '87, my performance was approximately the same as that of the buy-and-hold strategy. However, I had invested in stocks only 57 per cent of the time. In effect, by participating only in coherent market periods, I was able to capture fully the market's upside moves and actually hold a small lead as a result of switching to cash during the true random-walk periods.

Just prior to the Crash of '87 I briefly lost my lead to the buy-and-hold benchmark. At that time, both Zweig's double 9:1 NYSE up:down volume extreme signal and 2:1 extreme in the 10-day moving average of NYSE advance: decline issues signalled crowd behavior. But rising interest rates and the discount rate hike of September 4, 1987 suggested that this was a dangerous chaotic market, rather than a coherent bull market. (At the time I didn't have the benefits of Leuthold's work, which also showed historical valuation extremes.)

Much of my performance differential is attributable to avoiding the Crash of '87. However, I've lost some ground recently as a result of continued chaotic market action on the upside. Chaotic markets involve large moves in both directions. The switching strategy may still fall behind on a short-term basis if chaotic action continues in the future. Over the long run, however, the average of many separate chaotic market moves should produce a small net negative outcome. Hence a strategy of remaining in cash at these times should prove effective.

Risk-Reward Principle

The results of the switching experiment demonstrate a loophole in the risk-reward principle. As long as coherent markets occur, it is theoretically possible to beat the passive strategy of simply buying and holding. There is no assurance that coherent markets will continue to occur, or that the indicators outlined above will be adequate to identify such periods early enough to capitalize on them, or that the duration of coherent markets will be the same in the future as in the past.

The risk-reward principle theoretically does have exceptions, just as there are exceptions to the second law of thermodynamics in physics and chemistry. Open systems in these disciplines have shown remarkable ability to self-organize, in defiance of the entropy (disorder) maximization that occurs in closed systems in thermodynamic equilibrium.[18]

On Wall Street, exceptions to the Efficient Market Hypothesis have been observed. In addition to Peters' recent work, the long-term track records of *Value Line* and the *The Zweig Forecast*, which have been tracked by the *Hulbert Financial Digest*, are not necessarily just luck, as the Efficient Market Hypothesis would suggest. These services have evolved empirical strategies that are to varying degrees consistent with the Coherent Market Hypothesis. Other conventional technical and fundamental analysis techniques may be useful during coherent markets, though not as effective in periods of true random walk.

Non-Linear Macroeconomics

The Coherent Market Hypothesis is not necessarily limited to the stock market. Investors such as Warren Buffet and Benjamin Rosen may be successful in part because they recognize coherent growth potential in the markets for products and services in specific industries.

Callen and Shapero noted that imitation can be central to a variety of consumer purchase decisions, and that during periods of transition, it pays to advertise.[19] Clearly there have been fads in consumer goods such as CB radios, dolls and hula-hoops, where crowd behavior (without a strong fundamental need) has created chaotic fluctuations in the demand for specific products. In contrast, fluctuations in the demand for microcomputers, where there is a clear fundamental need, have centered around a stable, positive level of growth.

Macroeconomic models can, in principle, be constructed based on the non-linear statistical concepts presented here. Charles Kindleberger notes that modern macroeconomic theory is incomplete, because it leaves out "instabilities in expectations, speculation and credit."[20] The Coherent Market Hypothesis offers a theoretical framework within which future research can help to further our understanding of the instabilities—i.e., booms and busts—that have historically plagued financial markets, industry sectors and the economies of nations. The ultimate goal of non-linear analysis should be identification of the control parameters that can be used to regulate more effectively economic growth and avoid the disruptions of economic chaos. ■

Appendix

The macroscopic behavior of large, dynamic systems can be described by relatively simple models.[21] These systems typically have a large number of subsystems, or "degrees of freedom" in the jargon of physicists. In general, their macroscopic behavior is described in terms of variables known as "order parameters"—the magnetic field in a bar of iron, political opinion

Table AI Quantitative Models

	Linear	Non-Linear
Statistical	Random Walk (damped harmonic oscillator + random forces)	Statistical Chaos (A Theory of Social Imitation) (damped anharmonic oscillator + random forces)
Deterministic	Simple Pendulum (damped harmonic oscillator)	Deterministic Chaos (damped anharmonic oscillator)

polls in a social group, or the annualized returns of a market index comprising numerous industry groups.

Table A1 summarizes the classes of mathematical models that can be used to quantify the fluctuations of an order parameter. The simple pendulum (a damped harmonic oscillator) would adequately characterize a system in which there is little coupling or feedback among subsystems and no random forces. As feedback increases, however, non-linear effects become important, and the dynamics of the system (i.e., the order parameter) can exhibit chaotic behavior. As noise (random forces) increases, a statistical description becomes necessary.

Deterministic Chaos

A simple example of deterministic chaos is provided by the non-linear pendulum (heavily damped anharmonic oscillator). Its motion is governed by a potential function, V(q), given by:

$$V(q) = 1/2aq^2 + 1/4bq^4, \qquad \text{(A1)}$$

where q is the order parameter. This is the simple cusp potential in the language of catastrophe theory. It bifurcates from a single stable point (linear system as shown in Figure C) to a bistable configuration (non-linear system), depending on the values of a and b, the "control parameters."

The bistable configuration exhibits chaotic behavior. Even slight changes in initial conditions could lead to wide variations in the future state of the system. For this reason, deterministic chaos theory has long been treated as a model of the unpredictable.

Statistical Chaos

If random forces are significant, a statistical analysis is required. The probability distribution governing the fluctuations of the order parameter is then:

$$f(q,t) = \exp\{-(2/C)(1/2aq^2 + 1/4bq^4)\} \qquad \text{(A2)}$$

$$= \exp\{-2V(q)/C\}$$

In Equation (A2) the potential well becomes part of the solution for the probability distribution along with C, the correlation coefficient of random forces, which is analogous to temperature in physical systems. The control parameters (a,b) now determine the shape of the probability distribution. If non-linearities are small ($b = 0$), this reduces to the normal distribution. However, if non-linearities are important ($b > 0$ and $a < 0$), the normal distribution bifurcates, or splits into a symmetrical bimodal distribution. Therefore Equation (A2) may be regarded as a statistical version of chaos theory.

In general, chaos theory involves a wide variety of potential functions. The Theory of Social Imitation, summarized in Table I, is another example of statistical chaos. Here the potential function is more complex than the simple example in Equation (A1) and requires numerical solution by computer.

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