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An Insight into Technical Analysis

Stock and commodity prices and price movements are the result of many factors. Price and price changes are dependent on these fundamental supply and demand factors, and the observed time frame within which they occur. Fundamental factors such as supply and demand, inflation, seasonal price tendencies and governmental programs are relatively long-term in nature. These price influencing elements are used in much of the analysis concerning the movement of prices and price trends. Appreciation and knowledge of these elements is prudent for both the speculator and the commodity hedger.

Unfortunately, there are several weaknesses in relying solely on fundamental analyses in trading commodities. Charles Keltner, one of the first and most famous of the grain fundamentalists, developed some fundamental commodity trading rules used yet today. His methods employed factors such as supply and demand figures, seasonal price tendencies and current price levels. These economic data are then used to estimate various models and formulas to establish price forecasts. A market position can be established based on whether current prices are significantly below or above the forecast.

Since fundamental forecasting is based on primarily supply and demand statistics over longer periods (usually years), or weekly and monthly price data, it is usually not meaningful to apply short-term technical commodity trading techniques to data which are more aggregate than daily. Although fundamental methods have proven successful in establishing the long-run nature of commodity price trends, Barnes concludes that there are five basic weaknesses in applying these techniques to short-run trading strategies:

- Many rules for the development and application of fundamental analysis are vague.
- It takes a long time to adjust supply-demand equations to reflect new facts.
- Price corrections in the market often cause large losses, resulting in trader disillusionment.
- As a result of wide price variations, a fundamental trader must be able to put up a sufficiently large amount of equity to stay in the market.
- There exist no timing strategies inherently built in these systems to signal entering or exiting a position.

Just and Rausser (1981) compared price forecasting of econometric models and futures prices for eight different commodities. They concluded that for more stable markets, such as the grains, the absolute accuracy of fundamental models diminishes dramatically for the forecast horizon. Thus, due to the greater relative availability of information in the futures trading of grains, actual futures prices may be an even better long-run price forecaster than certain fundamental methods.

In essence, fundamental analysis simply doesn't account for many of the erratic short-run price movements that occur during trend formation. Short-run influences such as speculation, near-term production requirements and public demand cause variations that appear as "noise" around a long-term price movement (Kaufman).

The study of these variations and the market itself is known as technical analysis. Technicians study past price behavior and patterns in order to forecast future price movements. Although both fundamental and technical analyses may assume the existence of trends, technicians place more emphasis on the timing of trades to more successfully buy near expected lows and sell near expected highs.

Charles Dow, the man who developed the famous market barometer, the Dow Jones Industrial Average in the early twentieth century, was also one of the first technical analysts. He believed that the market itself produces all knowledge of finance, both domestic and foreign. It was in the 1920's that Robert Rhea refined, confirmed and popularized Charles Dow's teachings of technical analysis in his book, *The Dow Theory*. This theory emphasizes that the market is self-contained and must therefore account for all price fluctuations, especially those occurring as short-run variations in long-term trend formation.

Despite the unpredictability of short-term price movements, pure technicians argue that prices have a property which allows for a mathematical interpretation of the movement. That is, each price occurs sequentially in time. Therefore, market prices comprise a time series. An important trait of a time series is sequential dependence, in which values of successive elements are somehow dependent on the values of prior elements. In mathematical terms, this can be expressed as follows:

(1) $P_t = f\ (P_{t-1},\ P_{t-2},\ \ldots\ P_{t-n})$

where,

P_t is a price at time i, and

n is the last element of the sequence.

Much of the early work in time series analysis was concerned with the decomposition of a series into a trend, seasonal and cyclic variations, as well as chance components. Usually the processes that generate these cycles also reveal interesting economic relationships, the parameters of which can be given economic interpretation (Larson). Time series analysis thus became an integral part of technical analysis, which concerns itself almost exclusively with the interpretation and dissemination of price trends, cycles and variations.

Research in Technical Analysis

Since the formulation of the Dow theory in the early part of this century, technical analysis has been the subject of varied tests and studies. The periodogram was one of the first methods used to test cycles of a fixed period against the counter-hypothesis of a purely random series. In the 1930's a systematic development of the theory of stationary stochastic processes began. This permitted the formulation of a large sample theory for the harmonic, autoregression and moving average processes. These theories and their application to time series data are the basis for much of the technical analysis done today.

Despite developments in the research relating to technical analysis, there has still been a remarkable differences between the concepts of price behavior held by professional market analysts and those held by academic statisticians and economists. An early study which challenged the tenets of technical analysis was conducted by Holbrook Working (1934). He concluded that time series possess the characteristics of a series of cumulated random numbers. Although the items in the series itself are not random, the changes between successive items are random in nature. These and similar studies became the foundation for the random walk hypothesis.

Most academicians today accept the random character or the purely random series of stock and commodity prices. The underlying economic foundation for this hypothesis is that an efficient market, characterized by numerous, well informed participants, should create prices which accurately reflect all current information (Fama, Stevenson, Bear). Price changes will reflect new information and be approximate to random variation, and thus will not exhibit discernable price trends or patterns.

Conversely, most professional market analysts believe that certain trend generating facts, knowable today, will earn speculative profit if interpreted correctly. These facts are believed to generate price trends rather than instantaneous or random jumps. This is based on the assumption that most traders in speculative markets have imperfect factual knowledge. The future trend in prices will thus result from a gradual spread to awareness of these facts throughout the market (Alexander).

Although the debate over the nature of stock and commodity prices continues, the last twenty years have seen an increased interest in technical analysis in academic circles. More research has been done on the application of technical factors to investment or hedging strategies, than determining the validity of technical analysis as a whole. The proliferation of computers and software use has simplified and increased the use of technical tools and indicators such as odd lot statistics, short interest ratios, advance-decline indexes, volume and open interest data, bar charts, point and figure charts and moving averages.[1]

Early Research

Most of the early research into combining technical factors with traditional investment strategies was done using stock market prices. Theil and Leenders, in a study done in 1964, employed information theory to examine the percentage of stocks increasing, decreasing or remaining unchanged. Their study of stock prices at the Amsterdam Stock Exchange led to the conclusion that there is considerable positive dependence in successive values of the proportions of securities advancing, declining and remaining unchanged. Thus, the study concluded that past market data do provide some information about future proportions of stocks that will advance, decline, or remain unchanged.

Charles Ying, in 1966, completed a study which employed daily data from Standard and Poor's 500 stock average and the volume of sales on the New York Stock Exchange. Using both analysis of variance and spectral analysis, Ying found significant relationships between volume and price. In brief, a fall in volume suggested falling prices, whereas large increases in volume signified increases in price.

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[1] Odd lot or job lot statistics refer to the quantities of commodities moved through commerce, which are smaller or larger than the standard futures contract size. Short interest ratios reveal the number of short positions relative to overall security positions held in the stock market at any given time. Advance-decline indexes compare the ratio of advancing to declining stock issues. Volume data refer to the number of commodity contracts or security issues traded during a given period of time. Open interest refers to the total number of futures contracts bought or sold which have not yet been offset by sale, purchase or delivery. Bar charts are horizontal bars on vertical columns comparing characteristics of two or more items, usually time and price. Point and figure charts map price movements and trends, but disregard time as a factor. A moving average is a trend following system in which the formula employed acts to smooth erratic price behavior.

Robert Levy conducted another well known study published in 1967. He used computer simulation models to show that certain technical trading rules could be profitably applied to investment strategies. Weekly closing prices of 200 stocks on the New York Stock Exchange were analyzed from 1960 to 1965. Distribution of these stocks by industry was the same as that of the Standard and Poor's Industry Stock Price Indexes. Evidence from this study suggests that technical trading rules had produced a greater than random profitability, at a less than random risk, during the five year period.

Studies by Alexander, Fama and Blume have also indicated that it is possible to devise technical trading schemes based on short-term price swings that will, on average, outperform traditional buy-and-hold investment strategies. These trading methods employed filter rules, in which a security is purchased if it moves up by a certain percentage. The stock is then held until the price moves down at least some prespecified percent from a subsequent high, at which time one simultaneously sells and goes short. The short position is then maintained until the daily closing price rises at least some prespecified percent above a subsequent low, at which time one reverses position and goes long. Filters of 0.5, 1.0 and 1.5 percent proved to be most profitable in these studies. [2]

Commodity Applications

Research into the application of technical trading systems to commodity prices began to receive more attention in the early 1960's. Studies such as Larson's analysis of corn prices (1960) concluded there was a tendency

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[2] A filter or band is a zone of commitment which surrounds a price or price trend line. A trade is initiated when the filter, which can be a percentage or nominal figure, is penetrated.

for shocks (large price movements) followed by reversals over a shorter period of time, and then a weak trend effect for a long period of time. Alexander (1961) found that commodity prices tend to exhibit more non-random behavior than stock prices. Nonrandomness prompted more research in commodity prices and the applicability of technical trading rules to investment and hedging strategies.

Stevenson and Bear (1970) studied daily corn and soybean prices from 1957 to 1968. The main thrust of their research was to test the random walk hypothesis through a series of statistical methods, such as serial correlations and runs analysis. Technical trading systems were also tested using filters of 1.5, 3.0 and 5.0 percent. Results were compared to the traditional buy and hold strategy. Evidence from statistical and technical trading tests suggested that the random walk hypothesis did not offer a satisfactory explanation for corn price movement. Furthermore, the application of filter rules to trading strategies provided higher and more consistent profits for certain filters employed.

A similar study conducted by Leuthold in 1972 examined daily cattle prices from 1965 to 1970. Serial correlation, runs analysis and technical trading systems were applied to the price data. The work showed that spectral analysis had created some doubt about the random walk hypothesis in at least seventeen of the thirty contracts studied. Evidence from the technical trading methods further supported these findings. Six filter rules were applied in the simulation trading strategies, and all provided gross profits. Leuthold concluded that if cattle prices do behave in the non-random fashion he observed, it is possible to apply technical trading systems that are more profitable than traditional buy and hold strategies.

Leuthold also claimed that the buy and hold strategy is not applicable to commodities for the following reasons:

- Commodity contracts generally endure for only a year as opposed to several years for securities, thus eliminating long term inflation effects.
- For every long position in the commodities market there is also a short position. This is not true for securities.
- There is no a priori reason in the commodities market to initially buy and hold instead of sell and hold.

Other notable studies include the research done by Bradford Cornell in the late 1970's. He examined the relationship between volume of trading and price variability for futures contracts. Eighteen different contracts were studied, fourteen of which exhibited significant, positive and contemporaneous correlation between changes in average daily volume and changes in standard deviation of daily log prices. This type of correlation data are frequently used by technical analysts in determining the direction of movement in commodity prices.

Tomek and Querin (1983) analyzed the coexistence of technical analysis and random walks, in which moving average systems were applied to several futures contracts. This study concludes that information which influences commodity prices may occur in such a way as to create a trend. In these cases, trend following technical trading systems could be profitable.

Neftci and Policano (1984) conducted studies into the predictive power of technical analysis on gold and Treasury Bill futures contracts. The slope method and moving average systems were used, in which F test mean square criteria were employed, to determine whether the technical processes were linear covariance stationary and non-deterministic. The authors concluded that at least one method, the moving average, did possess some predictive power in a mean squared error sense.

One of the most well known technical methods is Richard Donchians 5- and 20-day moving average system. This multiple average claims one of the longest recorded operational results, beginning in January of 1961. Donchian's idea is to use a volatility-penetration criterion relative to the 20-day average. The current penetration must not only cross the 20-day average but also exceed any previous 1-day penetration of a closing price by at least one volatility measure. The 5-day average serves as a liquidation criterion and also is modified by prior penetration and volatility. Donchian's use of combined volatility and moving averages is still unique in trading systems (Kaufman).

In 1972 Robert Taylor published a system called the Major Price Trend Directional Indicator (MPTDI). It is one of the few well-defined published systems and has served as the basis for much experimentation for current technicians and analysts. MPTDI is based on a step weighted moving average of varying lengths, with an effective band of designated widths relative to a commodity's inherent volatility. It is a unique system due to its complete dependence on incremental values for all aspects of the system: the moving average, entry and stop loss points.

Among the most comprehensive studies of multiple moving average systems and their application to commodity trading have been R.E. Davis and C.C. Thiels. These studies were done throughout the 1960's and early 1970's.

Davis and Thiel analyzed virtually all of the United States crops as well as eggs, cattle and the soybean complex. Their moving average systems used combinations of simple buy and sell signals, leading plots, and skips in the selection of sequential prices used (for example, a skip of two uses every other price). Their study tested a total of 100 combinations of these factors.

Kaufman, in his book *Commodity Trading Systems and Methods*, reviews several other comprehensive moving average systems. Over 300 different computed tested methods are mentioned. These systems all involve elaborate rules and consist of two and three day combinations.

Another pertinent and more recent study was performed by K. E. Johnson. Johnson developed moving average marketing tools for the Texas Northern High Plains wheat producers. Of the nine different marketing strategies compared over the 1974-80 period, Johnson found the 10- and 21-day and the (linearly weighted) 9- and 18-day double moving average combinations performed the best at increasing the net price received by producers.

In 1979, Merrill Lynch published results showing the 11- and 47-day moving average crossover model to be the most consistent indicator of all computerized techniques for both wheat and corn over the 1970-76 period. Models were evaluated in terms of cumulative net profit, smallest string of losses, and percentage of profitable trades.[3] Then, in 1982, Merrill Lynch completed an identical study covering the 1970-81 period and concluded the 11- and 47-day moving average combination was still the most consistent wheat trading indicator, whereas the 13- and 47-day was the most consistent barometer of corn trading.

After studying the 1960-78 trading period, Irwin and Uhrig concluded in 1983 that the most optimal parameters to include in a double moving

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[3] The term "crossover" is derived from the graphical interpretation of moving averages. The term "computerized" is used since computer routines have been developed to simulate technical futures trading techniques.

average combination were 10 and 54 days for corn and 10 and 44 days for wheat.

These studies, as well as others have provided numerous combinations of moving averages from which a hedger could choose as a guide for seasonal price risk management decisions (Frederick; Purcell and Richardson). They represented years of research, and therefore ample data regarding the use of specific moving average systems and their effectiveness with respect to many different commodities. Other academic studies as well as research sponsored by brokerage firms, agribusiness and related industries have also produced useful information on technical analysis. These studies have provided evidence which suggests that technical factors may be of value in designing risk management strategies.

TRENDING MODELS

The techniques most commonly used for evaluating the direction of commodity and security prices are classified as autoregressive forecasting. Unlike many models used in business applications and involving growth, this approach evaluates the current direction of prices.

In an autoregressive model, one or more of the previous day's prices are used to determine the next sequential price. It is a time series model which uses only past price data to predict future price trends. The model does not have to be linear. Specification could be curvilinear, exponential or logarithmic.

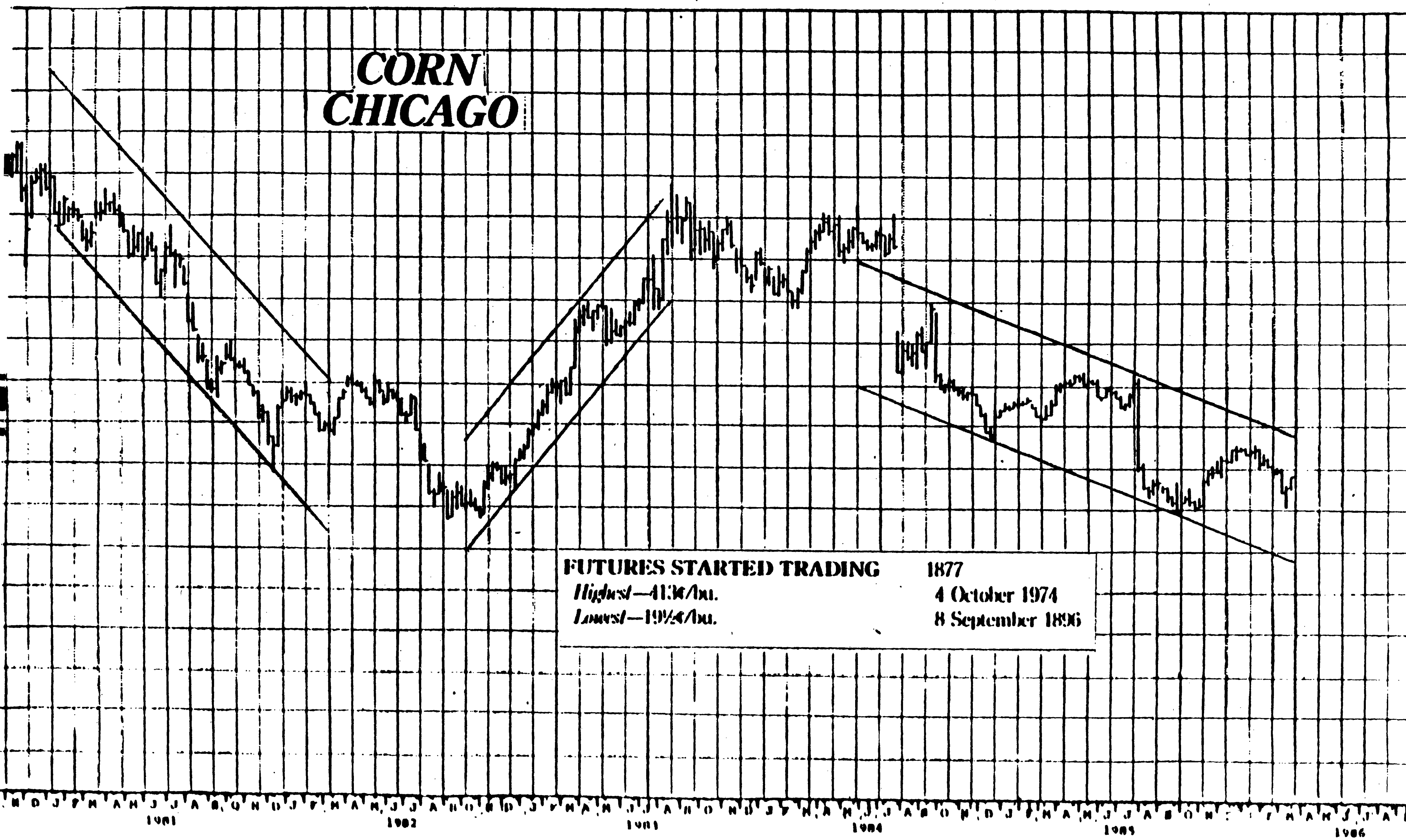
Moving Averages

One of the simplest and most widely used autoregressive techniques is the moving average method. This approach is popular among technical practitioners in both the stock and commodity markets. It is easy to formulate in quantitative terms and can be readily tested and manipulated on computers. Consequently, many serious analysts use the moving average method as an integral part of their speculative or investment strategies. Most individuals use these systems to indicate buy and sell signals. However, computer simulated track histories of a moving average strategy can also tell the analyst portfolio account values, growths, risks and general market influences on a daily basis.

The basic concept involved in the moving average method is to smooth the effects of erratic price behavior. Using daily settlement prices, a price trend can be approximated by a flexible growth line that adjusts to current price movements. The line is a price series and generally is plotted on the same graph as actual prices, using the same size and time scales. In theory, this moving average line of current prices represents the current growth line of the trend. If actual prices diverge significantly from this growth trend, such as below the line in a bull trend or above the line in a bear trend, the current trend itself is then suspect, and a change in actual prices to a new, oppositely directed trend has probably occurred (Barnes).

Many traders employ channel rules to define growth or price trends. A channel establishes a band of prices within which no trading activity takes place. If, however, prices break out of a channel, a trend is suspected and buy or sell signals are triggered. Moving average filters and bands are a more direct application of this concept to the moving average line itself. Basic trading price channels can thus be established with or without moving averages. Figure 1 is an example of how channels are used in conjunction with price data.

Figure 1: Application of Channels to Corn Prices



Source: Continental Commodities Futures Report.

Before traders calculate a moving average, they must first specify how many prices to include in the average. A large number of prices (e.g. 100) will generate a smoother, more conservative line which varies slowly and is small in scope. Conversely, if a few prices (e.g. 5) are used in the average, the growth line will be more volatile and respond greatly to daily price making events. The type of line used by a trader depends on the particular investment strategy and the type of commodity or security being traded. Generally, professional traders lean towards faster averages and portfolio managers towards slower ones.

The various methods used in calculating moving averages are presented here and closely follow those used by Kaufman in *Commodity Trading Systems and Methods*. The most basic of these methods is the simple moving average:

$$(2) \qquad MA_t = \frac{\sum_{i=1}^{n} P_{t-(i-1)}}{n}$$

where,

MA_t is a simple moving average,

P_1, P_2 ... $P_{t-(n-1)}$ is the set of time sequential prices, and

n is the number of prices used in the calculation.

A point on a simple moving average line is the average (arithmetic mean) of the prior n data points. The number of elements to be averaged remains the same, but new information on price is added while the oldest is deleted. When the next sequential price is added, and the oldest is dropped, the prior average is changed by a percentage of the difference between the old and new values. This percentage varies and is based on the number of days used in the calculation (Kaufman). For example, in a 5-day average the change from the prior average will be one-fifth of the difference between the old and new price. The more terms a moving average has (the larger n is) the less impact a new term will have on the average calculated.

Another moving average method is the weighted moving average. This method can be expressed in the general form as:

(3) $$WMA_t = \frac{\sum_{i=1}^{n} w_i P_{t-(i-1)}}{\sum_{i=1}^{n} w_i}$$

where,

WMA_t = the name of the weighted moving average formula,

$P_{t-(i-1)}$ is a price in the t-(i-1) previous period,

w_1P_1, w_2P_2 ... w_tP_t is the set of weighted time sequential elements ending at t-(n-1), and

w_i is the weight assigned to the i^{th} according to its position to t.

This system gives the point at time t as the average of previous prices. It also gives more weight to recent price data and reduces the significance of older elements.

There are two basic methods of assigning weights to elements in the average. One method employs regression analysis to determine w_i. The other approach, more common but not necessarily as well-founded, is called step-weighting. Here each successive w_i differs from the previous elements by the fixed increment C:

(4) $$C = w_i - w_{i-1}$$

This case assigns integer values for an n-day step weighted moving average:

$$(5)\qquad \begin{aligned} w_n &= n \\ w_{n-1} &= n-1 \\ &\vdots \\ w_1 &= 1 \end{aligned}$$

Thus, giving the weighting factors values of 5, 4, 3, 2, and 1 for a 5-day average.

Another approach to step weighting would be a percentage relationship between w_i elements:

$$(6)\qquad w_{i-1} = a \bullet w_i$$

where a is equal to a certain percentage. For example, if a =.80, $w_5 = 5$, $w_4 = 4$, $w_3 = 3.2$, $w_2 = 2.56$, and $w_1 = 2.048$ for a 5-day average.

A variation of the weighted moving average method is the exponentially smoothed moving average. This method uses a geometric progression:

$$(7)\qquad 1, \gamma, \gamma^2, \gamma^3 \;.\;.\;.\; \gamma^{n-1}.$$

This is applied to the basic weighted average formula and gives the values $w_1 = 1$, $w_2 = \gamma$, $w_3 = \gamma^2$ . . ., $w_n = \gamma^{n-1}$. A percentage value is then assigned to "a" to give the weighting sequence. For example if a = 1/4 (25% smoothed) the sequence would be

$$(8)\qquad 1,\ 1/4,\ 1/8,\ 1/16 \ldots (1/4)^{n-1}.$$

The exponentially smoother moving average equation is obtained by substituting the geometric progression into the weighted average formula. This can be written as:

$$(9)\qquad ESMA_t = \frac{P_t + \gamma P_{t-1} + \gamma^2 P_{t-2} + \ldots + \gamma^{n-1} P_{t-(n-1)}}{1 + \gamma + \gamma^2 + \ldots \gamma^{n-1}}$$

where

$ESMA_t$ is the name of the exponentially smoothed moving average formula, and

"γ" represents a member of a geometric progression.

An important aspect of this weighted average is that the immediate past is used to project the immediate future. Current data are the most heavily weighted and the significance of older data diminishes rapidly, even more so than in the basic weighted moving average. Despite this, all previous information is still included in the calculation of each new data point. Since all prior information is always included, exponentially smoothed averages are slower than their standard moving average counterparts. For example, a 20% smoothed average is slower than a corresponding 5-day standard moving average, and so forth.

Another way to calculate moving averages is through the use of geometric,rather than arithmetic, averaging. This variation can be applied to all of the previous moving average methods. Thus, a geometrically averaged simple moving average can be expressed as:

$$(10) \qquad GMA_t = \frac{1}{n(\sum_{i=1}^{n} \ln P_{t-(n-1)})}$$

where,

GMA_t is the name of the geometrically averaged simple moving average formula, and

ln is the natural logarithm of price.

A geometrically weighted moving average would have the form:

$$(11) \qquad GWMA_t = \frac{\sum_{i=1}^{n} w_i \ln P_{t-(i-1)}}{\sum_{i=1}^{n} w_i}$$

where,

$GWMA_t$ is the name of the geometrically weighted moving average formula, and

ln is the natural logarithm of price.

Moving Average Systems

A moving average system is an applicatian of moving average methods to specific rules and guidelines. These rules and guidelines define the timing of buy and sell signals as well as the length and type of average(s) to be employed.

Basically, signals are indicated when price crosses the moving average line. When this occurs, the trading signals would be:

- Buy when the rising price crosses the moving average.
- Sell when the declining price crosses the moving average.

This is the fundamental rule for all moving average systems. The reasoning behind this procedure is that the price line (or the fast moving average line) determines the immediate direction of prices. For example, if price (or the fast moving average) is rising, it indicates a bullish trend formation when and only if the slower moving average line is crossed. According to technical analysis, prices move in trends and are not random in nature. If prices move in a certain direction, they are expected to continue this movement and thus form a trend. Only significant deviations from price activity will trigger buy or sell signals within a moving average system. This deviation is defined by the size of "n" in a moving average system. The greater "n" is, the more significant the trend formation must be in order to initiate buy or sell signals. It is straight forward and well defined. Since it is quite simplistic, most systems employ additional qualifiers to determine the timing of buy and sell signals.

A common method of qualifying or confirming a signal is through the use of bands. A band is simply an area surrounding a trend line, which acts as a zone of committment for the trader (Kaufman). Bands are generally applied to the price trend. In this case, the trading rules are:

- Buy when the price penetrates the upper moving average band.
- Sell when the price penetrates the lower moving average band.

Bands are created in several ways. Commonly they are a percentage of the current price or current trend line value. Another popular type of band is the absolute point value, in which the band width is based on a specific monetary unit. For example corn may have a 5 cent band or cattle a 25 point band. The band method is also known as the penetration rule method. Under this name the penetration points correspond to the band width.

More complex moving average systems which employ two or three averages are also frequently used. These multiple systems generally use a slow average to define the long term trend and a faster average as a timing mechanism. Since the price line is omitted as an indicator, the following rules are applied to multiple moving average systems:

- Buy when the faster moving average crosses the slower moving average going up.
- Sell when the faster moving average crosses the slower moving average going down.

A third average also can be employed. In this case it is the fastest average and is considered a confirming average. This average confirms a buy or sell signal only when it moves in the same direction as and crosses the faster moving average using the same rules as above. Bands or penetration rules can also be used in conjunction with two and three day moving average systems. In this case buy and sell signals are initiated only if the confirming average penetrates the band using the basic multiple moving average system rules.

The moving average systems described previously are the foundation for most of the trading strategies used today. Hundreds of moving average systems have been devised. Their information and application to various strategies can be the basis of numerous studies.

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