Adapting Moving Averages For Changing Markets

The problem of selecting an optimal trend speed, defined as an N-day simple moving average, with which to analyze a market is one that continues to intrigue the best technical.

The interest in this problem is far more than academic: most traders sense intuitively that the trading methods used in a trending market should differ from those used in a sideways market.

Most selection processes rely solely on the closing price series for a commodity, ignoring the information contained in the daily price range. The method described below places both interday price change and intraday price range into an economic context and produces the following conclusions:

1. A sideways market is characterized by a fast moving average around which the price oscillates frequently.

This is shown in Figure 1, a bar chart for the June 1993 Canadian Dollar overlaid with a 13-day moving average. The sharp downtrend for the C-Dollar slowed by mid-February 1994, with the contract unable to move to new lows. The contract began oscillating about its moving average.

2. A trending market is characterized by a slow moving average which is seldom crossed by the price series.

This is shown in Figure 2, a standard high-low-close chart for June 1994 Treasury Bond overlaid with a 29-day moving average. The early February 1994 breakout for bonds into a strong downtrend produces a slow moving average that is substantially higher than the actual price series itself.

The N-day moving averages produced by the method described below are for the most recent data available for the price series; the value produced, therefore, is only the most recent data point in a time series of N-day selections for the underlying series.

There are three premises regarding market behavior that serve as the bases for this method of market identification. These premises are intended to serve as the link between technical market analysis, wherein price is the only information of value, and fundamental market analysis, which seeks to place price information within an industry context.

The first is that price patterns represent a search for underlying economic value; restated, markets dynamically seek equilibrium between supply (sellers) and demand (buyers). Price is always known exactly, but value can never be known exactly. A trend begins as value moves away from price, and a trend ends when price moves away from value. A trading range or sideways market, wherein value is stable, exists otherwise.

The second premise flows from the first: in the early stages of a trend, interday price change dominates intraday price range. On a standard high-low-close bar chart, this can be seen as a tightly-channeled directional move, perhaps with some gapping in its early phases. The rapid movement of price towards value is characterized by either dominant buying or selling and by little countertrending or profit taking. As a result, the volatility of the market -- discussed in detail later -- declines *even if the interday price changes are large*.

The third premise is the converse of the second: in the latter stages of a trend and in all but the very end of a sideways market, intraday price range dominates interday price change as the search for value becomes less precise. On a high-low-close chart, this can be seen as a meandering move with little directional price change and with numerous reversals and retracements. Volatility rises under such conditions *even if the interday price changes are small.*

Finally, a postulate is offered:

An optimal moving average or trend line is the locus of points derived from an underlying price series whose volatility-adjusted sum of differences between itself and the underlying series is minimized, and whose volatility-adjusted sum of first differences also is minimized.

The volatility measure used in this construct is not the widely-recognized close-to-close volatility, but Parkinson's high-low-close volatility. This measure accommodates both interday price range and intraday price range, and unlike a standard volatility measure, will actually decline in a tightly-channeled, strongly-trending market. Also unlike a standard volatility measure, it will increase in a choppy, sideways market. Finally, the high-low-close volatility measure will explode at the end of end of a strong trend.

The two-step formula for calculating this volatility measure is shown below. In step one, a time series is constructed by taking the minimum of .000001 and.50 times the square of the logarithm of the high/low ratio and subtracting from it .39 times the squared logarithm of the interday price ratio. The second step converts this time series into an annualized measure for any N-day period by taking its average over the past N days, multiplying it by 260, and taking its square root. The resultant number is a percentage of the market's annual range that can be expected during the following N-day period. The example below shows the creation of a 21-day high-low-close volatility:

1. $V' = \max(.5 * \ln(high_t/low_t)^2 - .39 * \ln(close_t/close_{t-1})^2, .000001)$

2. $Vol_t = (Sum(i = t-20 \text{ to } 0): V'_t/21 * 260)^{.5}$

The function to be solved to select the N-day moving average over the arbitrarily-bounded range of trend speeds from four to twenty-nine days is the volatility-adjusted absolute value of the difference between the price and the N-day moving average divided by the volatility-adjusted absolute value of the first difference of the N-day moving average:

3. (|PRMA|/Vol)/(Vol * |DMA|), which reduces to

$(Vol^2 * |DMA|)/(|PRMA|)$,

where PRMA is the difference between the price and the N-day moving average, and DMA is the first difference of the N-day moving average. This function is minimized by solving for its values over the four to twenty-nine day range.

How does this formula help identify trending and sideways markets? Let us restate Function 3 in a partial form and look at how its components behave under the market conditions discussed above as the N-day selection changes:

3a. $(DMA)/(PRMA_t)$

First, the difference between the close and the moving average will increase as N increases. This is readily clear at the extremes: a one-day moving average will be the series itself, and PRMA will be zero, while MA will approach the mean of the series as the number of days in the moving average gets large and PRMA asymptotically approaches a constant.

Second, the first difference of the moving average will decrease as N increases. Here again, this is most clear at the extremes, with the first difference of the moving average approaching zero as the moving average itself approaches the mean of the series.

If the series is strongly trending, PRMA will increase faster than the first difference of the moving average as price changes outstrip the ability of a moving average to remain in pace. At ever-higher values of N, the first difference of the moving average decreases while the difference between price and moving average increases. This will produce the characteristically slow moving average of a strongly trending series.

If the series is non-trending, the delta of the moving average will increase faster than the difference between price and moving average. Thus the numerator of the fraction is minimized and the denominator maximized at a lower value of N. This will produce the fast moving average characteristic of a sideways market.

In function 3a above, no allowance was made for the effects of volatility. As a market becomes more volatile, the probability that a given price movement does not represent convergence toward economic value increases, and therefore the difference between price and any N-day moving average should be penalized accordingly. By the same logic, the first difference of the moving average should be rewarded as it would tend unnaturally to a smaller value as volatility increases.

In function 3b below, the effects of volatility are added back in. Please note that a low volatility value will skew the function toward the first difference of the moving average in the minimization process. This is consistent with the overall function being minimized in a trending, low-volatility market with a slow moving average.

3b. (PRMA/Vol)/(DMA * Vol)

The optimal moving average produced by this method does not serve as the sole basis for any trading decision. It does, however, serve as an input variable into a larger trading rule matrix.