PINPOINTING THE CHANGES

FORMULA HELPS TO IDENTIFY TRENDS

by KESHAV P. VISHWAKARMA

A new, computer-based procedure enables analysts to identify trends and turning points in market price data.

These days technical analysis is mainly used to ascertain the current trend of market prices. In some computerised systems it also generates signals for buying and selling which depend upon the assessed trend. But technical analysis is no longer viewed as a forecasting scheme. It is perhaps well understood that the search for a forecasting method which will reliably predict market prices in the future is futile.

Instead, the operational approach is to adopt a strategy which specifies rules for actions in different contingencies. To consider an example, we refer to Loosigian (1980) who deals with interest rate futures. According to him, a good strategy is to trade with, never against, the market trend. That is one should not sell in a rising market and not buy in a falling one. This strategy, also advocated by others, is applicable to investment decisions as well as speculative trading. Its operation clearly depends on an assessment of the current trend.

Experience suggests that trends persist over longer periods than one might expect. Major market trends could last from several months to several years. Minor trends may persist over several weeks to a few months. Turning points mark the end of one trend and the beginning of another. It is the unpredictability of future turning points which introduces risk. Continual monitoring of market trends is therefore necessary. In practice, not only technical but also fundamental analysis, which includes examination of the economy and the international situation, are required.

When one or more approaches indicate that a reversal in trend has taken place, the need for buying or selling may arise. It is obviously desirable to detect a trend reversal at the earliest.

Even this is not easily accomplished in practice. To quote Pring (1981, p. 167): "The most realistic consistently obtained objective is the identification of a peak or trough area after the reversal has taken place." That is, some time needs to elapse before the latest turn is confirmed. During this time market price data accumulate. It then becomes possible to use a computerised statistical procedure to identify the turning points. Some of the existing technical procedures apparently achieve that.

Here we propose an alternative procedure. It is illustrated by means of three examples involving stock price, exchange rate and interest rate movements.

First, it is useful to recall one of the existing technical procedures for identifying turns, namely the moving average. Chart 1 shows the Standard and Poor's 500 stock daily price index from July to December, 1986 (as a curve of dashes), and the 16-day moving averages (as a solid curve). It is seen that peaks are indicated when the moving average crosses the observation data from below, and vice versa for the troughs. If com-

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puterised signalling is employed, then the 16-day moving average would generate the decisions shown in Table 1. It may be remarked that some of these decisions are unnecessary and need to be disregarded.

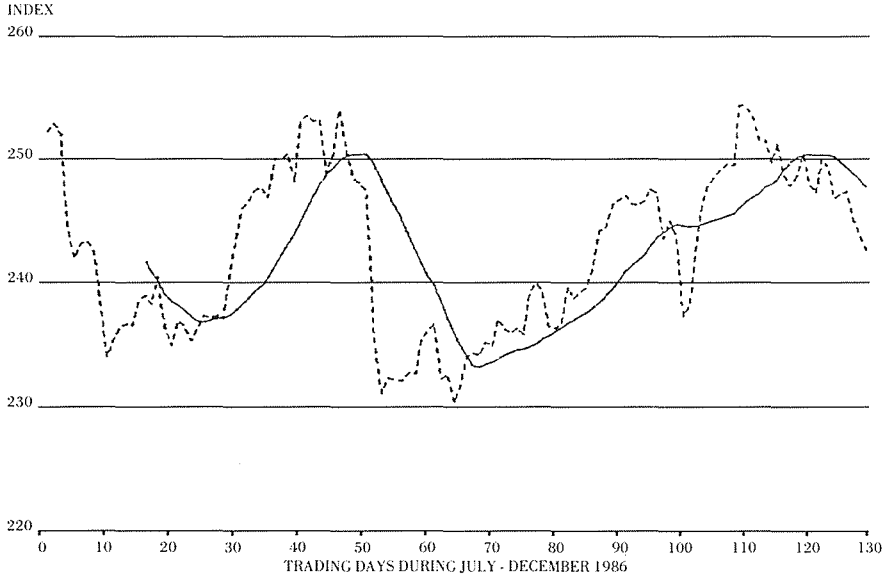
In Chart 2 we show the results obtained from using the new procedure. Again, the daily 500 stock price index is plotted as a curve of dashes. The changing trend, determined by the new method, is shown as solid straight line segments such that the end of one segment marks the beginning of the following one. The squares denote the turning points where changes in the direction of trend take place. Not all the turning points shown correspond to reversal of trend, although most of them do. The procedure allows for the possibility that the slope of trend line may change in the same direction. That is, the rate of change may display abrupt variation but not a complete reversal. Of course, buy and sell decisions need to be taken when a reversal in trend is identified. For the stock price index data under analysis the dates of the turning points are listed in Table 2.

To consider another example, in Chart 3 we show the daily US$/Yen exchange rate during May-October, 1986, and its 16-day moving average. In chart 4 the results from the new method are plotted.

These examples illustrate the ability of the new procedure to identify trend and its turning points in market price data.

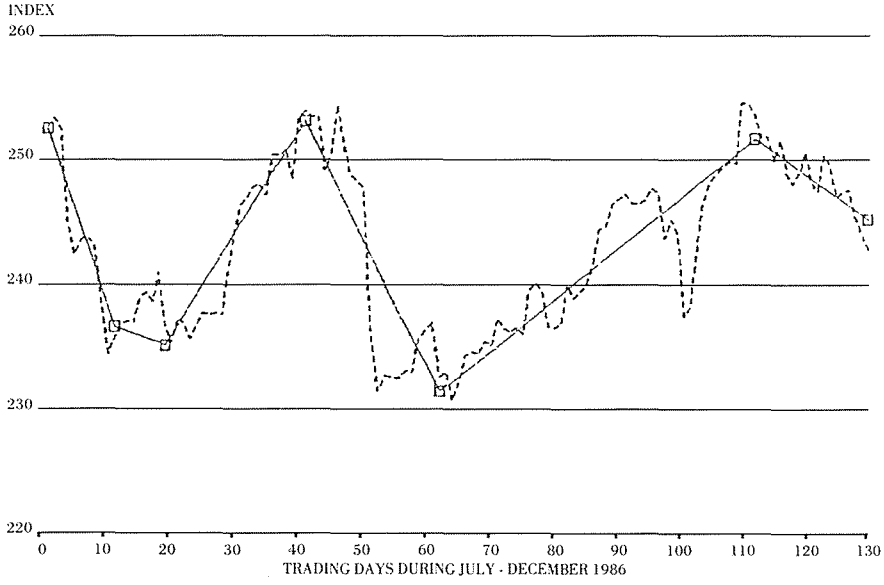
1. S & P 500 STOCK INDEX

ORIGINAL DATA AND 16-DAY MOVING AVERAGE



2. S & P 500 STOCK

DATA AND TREND



The piecewise straight line trend, with change of slope occurring at turning points, makes the past movement of prices easy to understand in a chart. It is also seen that these trends persist over fairly appreciable periods.

The new procedure makes use of an important concept in statistical theory, namely that of linear splines. Linear splines is the name given to a set of straight line segments such that the end of one piece is also the start of the following segment. The common point in which two contiguous splines meet is called a knot. Smith (1979) and Wegman and Wright (1983) have provided surveys of the relevant literature. Linear splines could also be considered a particular type of switching or piecewise regression. There is considerable literature on switching regressions as well. See, for example, Goldfeld and Quandt (1972), McGee and Carlton (1970) and Quandt (1972).

A set of linear splines can be described mathematically as follows. Suppose there are m pieces and that the time variable t runs from 1,2, . . . , to n. Also suppose that the knots are located at times $k_1, k_2 \ldots, k_{m-1}$, respectively. Then the equation for the straight line segments can be written as follows:

$$z(t) = a_1 + b_1 t, \quad 1 \leqslant t \leqslant k_1$$
$$= a_2 + b_2 t, \quad k_1 \leqslant t \leqslant k_2$$
$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$
$$= a_m + b_m t,, \quad k_{m-1} \leqslant t \leqslant n.$$

That is from time t = 1 to t = k_1 the equation $z(t) = a_1 + b_1 t$ holds, from time k_1 to k_2 the equation $z(t) = a_2 + b_2 t$ holds, and so on. The requirement that the successive pieces meet at knots is written as:

$$a_1 + b_1 k_1 = a_2 + b_2 k_1,$$
$$a_2 + b_2 k_2 = a_3 + b_3 k_2,$$
$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$
$$a_{m-1} + b_{m-1} k_{m-1} = a_m + b_m k_{m-1}$$

As illustrated in Charts 2 and 4, it is possible to determine an optimal set of splines for given market data. This is chosen so as to "best" approximate the statistical observations. It involves finding the number of splines m, the dates of the turning points $\{k_1, k_2, \ldots, k_{m-1}\}$ and the straight line parameters $\{(a_1, b_1), (a_2, b_2), \ldots, (a_m, b_m)\}$ for the splines. This is a fairly complicated exercise. However, several procedures for these calculations have been reported in the literature, in particularly by Guthery (1974) and Ertel and Fowlkes (1976).

The use of a computer is necessary for the calculations. The results, however, are easy to interpret, as can be seen from our illustrations. Once the piecewise

linear trend curve has been identified, the designation of peaks and troughs is straightforward. Peaks are the turning points where an upward sloping trend segment ends and a downward sloping segment begins, and vice versa for the troughs.

The new procedure is thus mathematical and computer-based. It effectively separates minor day-to-day swings from trends that persist over several weeks. Compared to the moving average, the use of the piecewise straight line trend makes even a visual inspection of charts somewhat easier. These trend line segments are now determined according to given rules, which is different from the manual, subjective approach of experts. As "Adam Smith" (1968) notes in his well-known volume, *The Money Game:*

"All Chartists, to extrapolate and visibly to determine motion, must draw some sort of a line between the prices at various times. It may be a mean line, it may be a line connecting the tops or the bottoms or both. Then the thesis is that the stock (or group) is *more likely than not* to continue along that line."

Our method is different. The trend lines it produces are neither the mean lines nor those connecting tops and bottoms. Instead it determines the optimal piecewise linear trend which changes direction at the turning points. More significantly, it identifies the turning points in a systematic fashion which is useful for making decisions.

To keep things in perspective, it is necessary to recall that technical analysis has been severely criticised in the literature. Highly readable and cogent accounts are given in *The Money Game* of "Adam Smith" (1968) and Malkiel's (1981) *A Random Walk Down Wall Street*. Malkiel also provides many references to the relevant literature.

The main point of such criticism seems to be the fact that past patterns are no guide to future price movements. We need to accept this. If past patterns could reliably forecast future happenings, then it would be possible to benefit from this knowledge. All sensible and informed investors would make use of it. In that case the market movements would be quite different from those actually observed.

We know that in practice buyers as well as sellers exist both at peaks and at troughs. They obviously have quite opposite assessments of the likely price trend. At the same price, sellers expect prices to decline while buyers think they will appreciate. This situation arises because of the sheer complexity and uncertainty of future price trends. Successful speculators, in fact, thrive on the inherent uncertainty of markets. It is this uncertainty that enables the functioning of purely speculative markets, such as stock price futures.

We have already stated that a strategy is needed when uncertainty is present. A sound strategy is needed when uncertainty is present. A sound strategy avoids the need to make accurate predictions of future events that are unpredictable in the first place. We have referred to the strategy which demands trading with the current market trends, not against them.

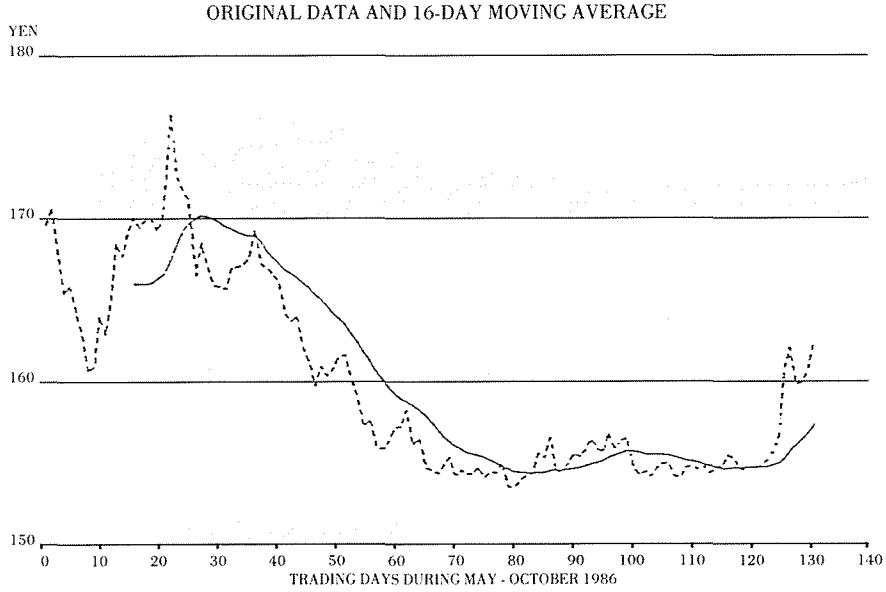
Loosigian (1980, p. 309) also states that one "should resist the temptation to anticipate reversals in the major trend". This is another way of saying that reliable forecasts of future turns in the trend are not available. Nor are they required in the operation of a strategy. The practice of trading with the current market trend requires monitoring of the latest turning point, not forecasts of the future turns.

It is in this context that moving averages and the procedure proposed here are worthwhile. They are relatively quick and inexpensive. If the objective of technical analysis is merely to ascertain the current trend, the criticism that it lacks predictive power is not entirely to the point. On the other hand, even an authoritative critic like "Adam Smith" admits:

"Does this mean that charts can be

3. US$ / YEN RATE

ORIGINAL DATA AND 16-DAY MOVING AVERAGE



4. US$ / YEN RATE

DATA AND TREND

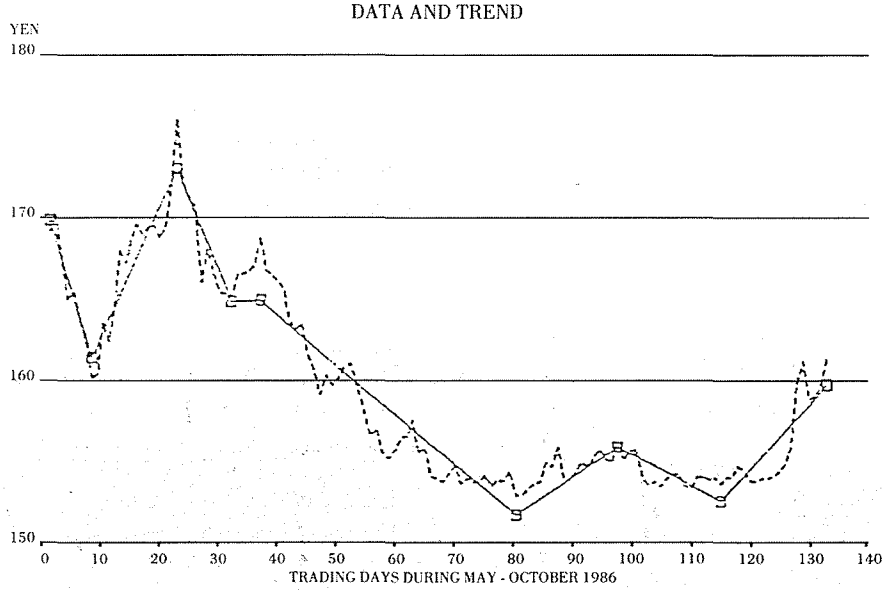
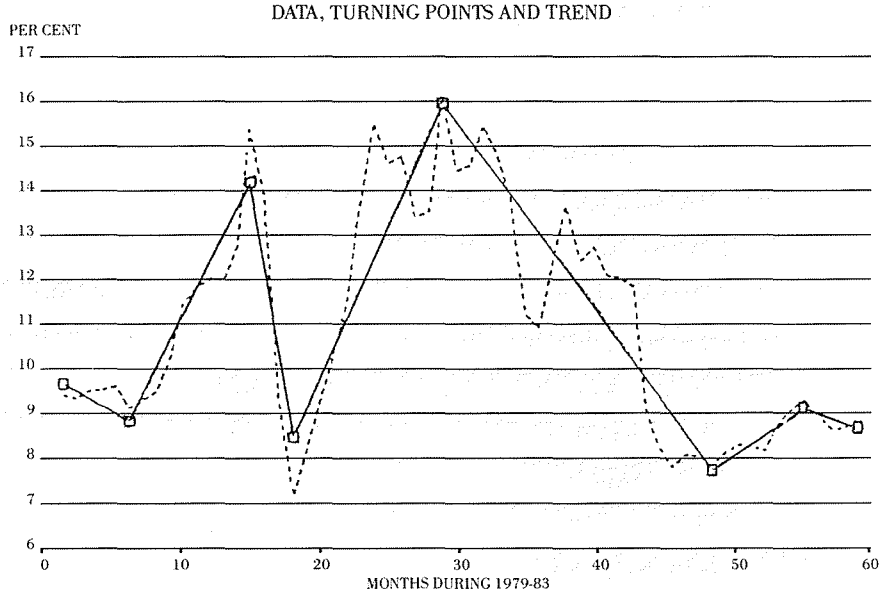


TABLE 1
STOCK PRICE INDEX: MOVING AVERAGE CROSSOVER POINTS DURING JULY-DECEMBER, 1986

S. No.	Date of Crossover	Type of Turn	Decision
18	Jul 25	Peak	Sell
23	Aug 5	Trough	Buy
48	Sep 8	Peak	Sell
66	Oct 2	Trough	Buy
96	Nov 13	Peak	Sell
97	Nov 15	Trough	Buy
98	Nov 17	Peak	Sell
102	Nov 21	Trough	Buy
115	Dec 11	Peak	Sell

5. YIELD OF T-BILLS
DATA, TURNING POINTS AND TREND



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ignored? Perhaps charts can be a useful tool even without inherent predictive qualities. A chart can give you an instant portrait of the character of a stock, whether it follows a minuet, a waltz, a twist, or the latest rock gyration. The chart can also sometimes tell you whether the character of the dancer seems to have changed."

Clearly charts can be of help in monitoring market movements. It is therefore not surprising that they are used a great deal in practice.

Our procedure is also applicable to statistical observations of different frequencies, such as weekly or monthly data. We illustrate this with monthly statistics of the yield of new 90-day US Treasury bills. In Chart 5 the observations and the linear splines trend are plotted. The period under examination extends over 60 months from 1979 to 1983. It is seen that the Treasury bill rate underwent wide swings then. More significantly, major fluctuations in this interest rate have close correspondence to the general business cycle. The turning points shown in Chart 5 mark cyclical turns in the Treasury bill rate.

The similarity of major fluctuations in interest rates with the business cycle swings has been discussed at length in the literature (see, e.g., Moore 1980). The general business cycle prevades all markets, including stock and interest rate markets.

Our illustration shows that the same procedure can be employed for monitoring cyclical movements in the economic environment. Other key indicators, such as industrial production, new housing starts, employment and new orders, can also be analysed in a similar fashion. Further details are given in other reports (Vishwakarma 1987 a, b). □

TABLE 2
STOCK PRICE INDEX: TURNING POINTS DURING JULY-DECEMBER, 1986 FOUND BY NEW METHOD

S. No.	Date	Type of turn
11	Jul 16	Inflexion
19	Jul 28	Trough
41	Aug 27	Peak
61	Sep 25	Trough
110	Dec 4	Peak