

actly the same logic can be applied to downward turning points, as was shown for gold in August 1993, and a similar improvement in timing will be obtained. The investor can use this information either to confirm that it is time to sell the existing holding in that security, and/or can decide to go short of that security, thereby taking advantage of down trends as well as up trends.

# CHAPTER 7

## Numerical Analysis—the Basics

So far we have shown how sine waves of various wavelengths and amplitudes can be combined together to produce more complex movements, and how we can build in random movement if necessary to arrive at approximations to the way in which stocks, currencies and commodities move over the course of time. We have also demonstrated how by simple graphical methods using channels, we can arrive at quite good estimations of the magnitudes and wavelengths of the various cycles.

By using artificial data, we were able to apply these methods to real data. We were able to make decisions about the turning points in trends and determine whether a trend would continue in the same direction.

Now we will adopt this same stepwise approach of developing a method, by applying it to artificial data to see how it works, and then apply it to real data. In this chapter we will show how we can analyze the numerical data to isolate the various components of the complex movements. The methods will fall into two categories— 1) those that can be carried out by simple calculations, mainly moving averages, and 2) those that require more intensive calculations, such as weighted moving averages and digital filters. The latter require a computer if they are to be carried quickly.

## MOVING AVERAGES

The calculation of a moving average is quite straightforward, and the process for a 5-point average, is shown in Table 7.1. A five point average is obtained by adding five successive values and then dividing by 5. These could be daily prices, in which case the average is described as a 5-day average, or weekly data, in which case the term 5-week average would apply. It is taken for granted that the sampling interval, be it days, weeks, hours or years, is constant. It would be incorrect to use the data from week 1, week 2, week 4, week 7 and week 10, for example, adding these together and calling the result the 5-week average. Only by taking the data for weeks 1, 2, 3, 4 and 5 will we achieve a result that has any meaning when applied to investment data. The 5 used in this case is known as the span of the average, and in the stock market a variety of spans are used for averages. We will see shortly that different spans have different effects on the data to which the average is being applied.

Date	Index	Subtract	5-week total	5-week average
02/06/98	8194.72	X		
02/13/98	8340.20	X		
02/20/98	8335.72	X		
02/27/98	8545.72	X		
03/06/98	8569.38	X	41985.74	8397.148
03/13/98	8602.52	X	42393.54	8478.708
03/20/98	8906.43	X	42959.77	8591.954
03/27/98	8826.47	X	43450.52	8690.104
04/03/98	8971.20	X	43876.00	8775.2
04/10/98	8994.86	X	44301.48	8860.296
04/17/98	9167.50	X	44866.46	8973.292
04/24/98	9064.62	X	45024.65	9004.93
05/01/98	9147.07	X	45345.25	9069.05
05/08/98	9055.15	X	45429.20	9085.84
05/15/98	9096.00	X	45530.34	9106.068
05/22/98	9114.44		45477.28	9095.456
05/29/98	8970.20		45382.86	9076.572
06/05/98	9037.71		45273.50	9054.7
06/12/98	8834.94		45053.29	9010.658
06/19/98	8712.87		44670.16	8934.032

Table 7.1. The calculation of a 5-week average for the Dow-Jones Index

The adjective 'moving' is applied because the calculation moves through the data, taking the sum of the first five points and dividing it by 5, then the sum of the five points that start with the second data point and dividing this by 5, and then taking the sum of the five points that start with the third point, and so on until we have used up all the data.

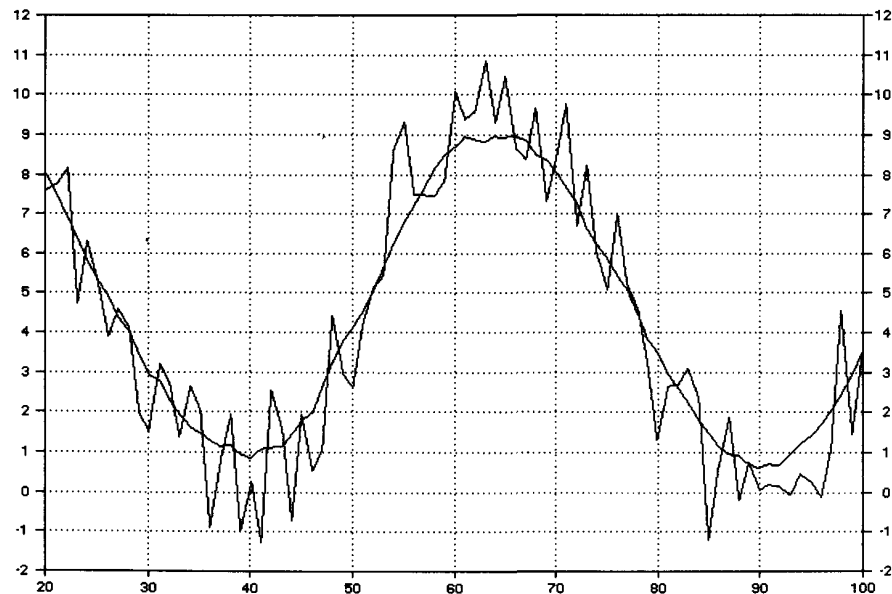
Rather than starting each time from a point and adding up the five points, there is a short cut which simplifies the calculation, coming into its own when larger span averages are required. We keep a running total, the first value is obtained by adding the first 5 points. Dividing this by 5 gives us the first value for the average. To compute the next value of the average, it is only necessary to add in the next value of the data and subtract the value the sixth point back (for 5-point averages). This is the new running total, and when it is divided by 5 it gives us the second average point. We proceed this way, updating the running total each time and dividing it by 5.

With say a 15 point average, we would first add up the first 15 points to give the running total, then divide it by 15 to get the average. Then add in point number 16 and subtract the sixteenth point back, *i.e.* point number 1 to give us a new running total that when divided by 15 gives us the second value of the average.

While it is obvious which point is to be added in to calculate the new running total, next one in the series, the point where the process could go wrong is if the wrong point is subtracted. In order to guard against this it is sensible to keep a note of the last point that has been subtracted by means of a tick or cross in a separate column, as shown in Table 7.1.

To the majority of readers who possess computers and software to carry out such calculations, this emphasis on the calculation of moving averages might seem misplaced. However, besides the fact that it is important not to treat computers as black boxes spitting out results, but to try to understand what is going on, there is another important point that is brought out by an examination of this method of computing an average.

The change in the running total, and hence the average, is brought about not only by the value of the next data point that is being added in, but by the data point, a whole span of the average in the past, that is being subtracted (the 'drop point'). This has an important implication when it comes to the turning points in averages and channels: whether an average changes direction will depend upon the relationship of these two data points. Besides the method of checking whether it is necessary to put a bend in a channel in order to allow peaks and troughs to settle comfortably at the boundaries, the investor can check the relative values of the next data point and the drop point as an additional aid in deciding if a channel has changed direction.



**Figure 7.1.** Upper panel: a 15 point average is plotted as unlagged. Lower panel: the same average plotted as a centered average, shifted 8 points back in time.

### Unlagged and Centered Averages

In the calculation of the 5 point average in Table 7.1, the calculated running total and the average derived from it by dividing by 5 were both

placed alongside the position of the latest data point that was used. When it comes to plotting such averages on a chart, we have a number of options.

An unlagged average is plotted in the same way in which the data is held in Table 7.1, *i.e.* the calculated average is plotted at the same point in time as the latest data point used in its calculation. On the other hand, a centered average is shifted back in time so that the latest calculated point is plotted at the position corresponding to the center of the set of points used in the calculation. Thus a 5-day average is plotted 3 days back in time. The amount by which it is shifted is given by the formula.

$$\text{shift} = \frac{(\text{span} - 1)}{2}$$

Note that with an even span, the average would be shifted back in time by an amount that caused it to be plotted in between the position of the data points. Thus, a six day average would be shifted back by 2.5 data points. Therefore in order to plot centered averages correctly, an odd span should be used. As far as the beginning of the plot is concerned, the first average point would be plotted at point 3.

The vital difference in presenting moving averages as unlagged or centered when these are plotted, is illustrated quite clearly in Figure 7.1. Here we have taken the set of data used in chapters 4 and 5, where a cycle of wavelength 52 weeks and magnitude \$10 was combined with a random movement that ranged from +\$2 to -\$2. A 15-point average has been calculated and in the upper panel it is plotted as an unlagged average, while in the lower panel it is plotted as a centered average. The obvious feature of both plots is that the minor fluctuations have now been greatly reduced, giving a plot that is much smoother than the original data. The smoothed data can now be seen to be cyclic in nature, allowing for the fact that it is not perfectly smooth and still contains traces of the minor fluctuations.

In the upper plot the peak in the smoothed data is not aligned with the peak in the data, while in the lower plot it is. We know from chapter 5 that when we drew a line through the center of this same data (Figure 5.2), it was similar to the original sine wave of wavelength 52 weeks, in position, magnitude and wavelength. The centered average also has each of these three properties, since it is also similar to the original in position, magnitude and wavelength, while the unlagged average, while similar in magnitude and wavelength, is not in the correct position. From this, we can deduce that a centered average, when the correct span is chosen, is a very good representation of the cyclic component present. It follows, therefore, in view of the relationship between cycles and trends, that a **centered average is also a good representation of a trend.**

This is an important point, and unfortunately is ignored by most technical analysts who insist on plotting averages on their charts as unlagged. To compound the sin, they typically use averages in only two ways. One way is to have a rule that a stock is not bought if its  $n$ -day moving average is falling, where the span  $n$  is usually of the order of 200. Another way is to have rules such as 'buy when the  $x$ -day average rises above the  $y$ -day average,' where the spans  $x$  and  $y$  can have a number of values such as 5 and 25. The fact that the average represents a trend, be it short term, medium term or long term, is lost because the average is not plotted as centered, where the relationship would be immediately obvious.

The consequence of plotting the average as centered is that we miss points at its beginning and end. Since the average is offset by  $(\text{span} - 1)/2$  places back from the latest point, this constitutes a gap of this much. There is also a similar gap at the beginning of the plot. Thus, for example in a 25-day average we lose 12 points at the beginning and 12 points at the end. This loss of points is the penalty we must pay for achieving a smoother plot than the original. The reason we lose points is because of the mathematics of calculating the average. For a 25-day average, we add up the first 25 points to get the first average point. We therefore have lost 24 points, and as mentioned above in the case of a centered average, these 24 points are split equally between the beginning and the end of the plot.

Since we now have come to the conclusion that a correctly chosen average will represent a trend, the fact that we are missing points at the end of the average draws attention to the fact that we do not know what the trend is doing between the last plotted point of the average and the latest data point. This question of the gap in the average will be addressed later once we have discussed the effect of using different spans for the average.

### The Effect of Different Averages on Cyclic Data

We saw in Figure 7.1. that the effect of a moving average was to smooth the data to provide a 'better' estimate of the underlying trend. Since we have defined trends previously as being part of a cycle, it is necessary to investigate the effect of applying averages of various spans to cyclic data. The main properties of a moving average are:

1. A moving average will totally remove cycles of the same wavelength as the span of the average.

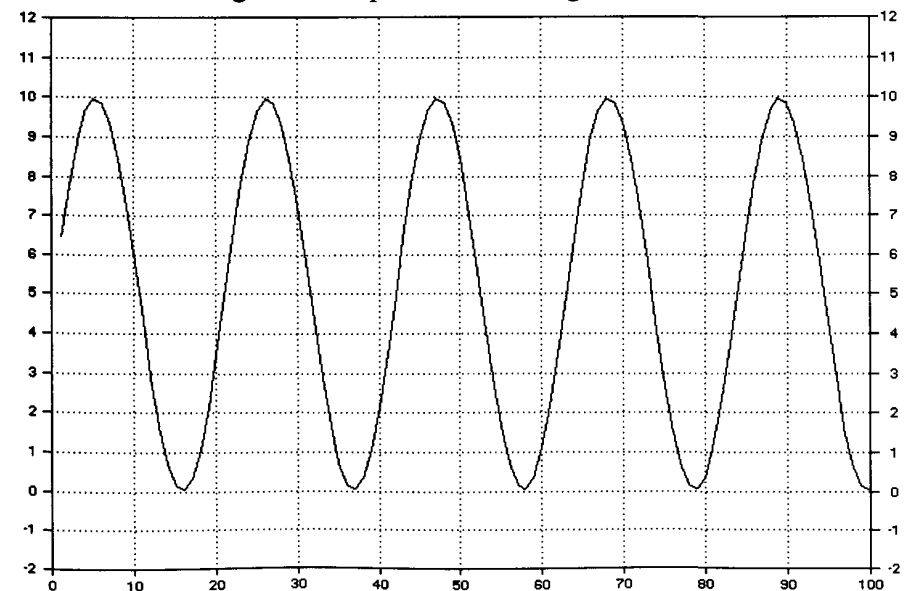


Figure 7.2. A sine wave of magnitude \$10 and wavelength 21 weeks.

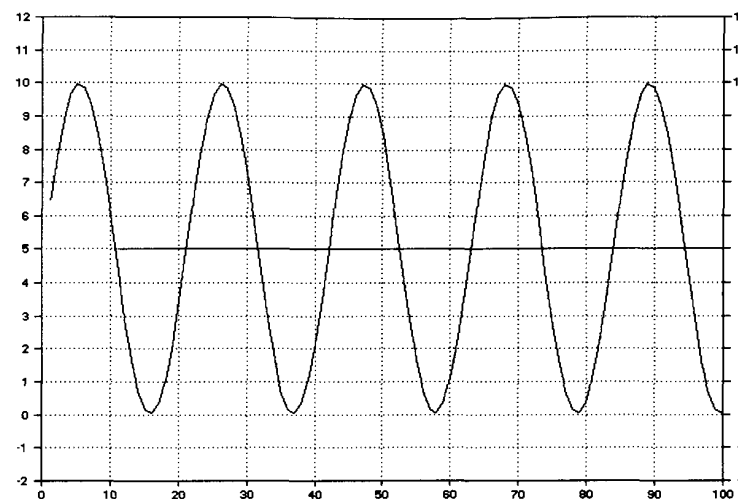
2. Cycles of longer wavelength than the span of the average will be reduced in amplitude. The smaller the span of the average relative to the cycle wavelength, the smaller the reduction in magnitude.
3. Cycles of shorter wavelength than the span of the average will be reduced in magnitude, and may sometimes be off set by half a wavelength from the original cycles, depending on the relationship between the span and the wave length. The greater the span of the average relative to the cycle wavelength, the greater the reduction in magnitude.

As an example, we will start off with a sine wave of wavelength 21 weeks and magnitude \$10. The first 100 points of this wave are shown in Figure 7.2. As expected, the peaks are 21 weeks apart and the troughs are also separated by the same amount. The wave swings from a value of zero up to \$10.

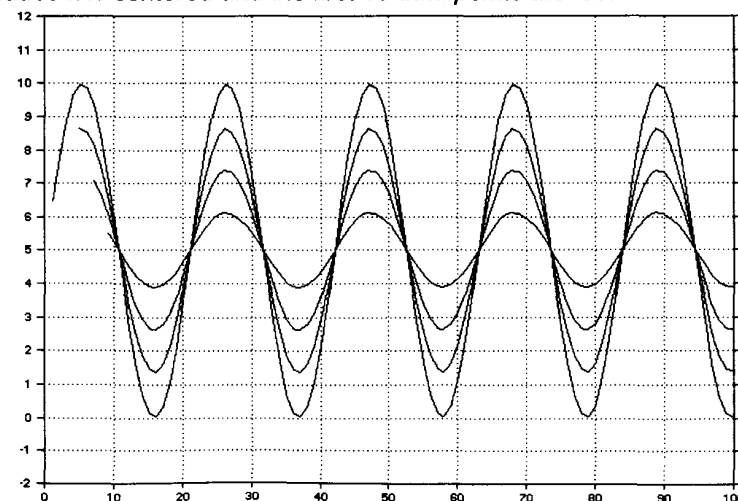
### Span equal to the cycle wavelength

The first rule pointed out that cycles of wavelength equal to the span of the average would be completely eliminated. This can be seen in Figure 7.3, where an average of span 21 weeks is applied to the cycle of wavelength 21 weeks. The original cycle is shown, while the result of applying the average is the horizontal line at the \$5 level. Thus the cycle has been totally removed from the data. Note the first point of the smoothed data appears at point 11. This is because we have a centered average and 10 points are missing at the beginning of the average calculation, as explained earlier.

The reason for the constant value of \$5 for the average is to be found in the running total calculation and the properties of sine waves. In a wave such as the present example, every point is repeated at exact distances of the wavelength apart in time. Since the span is equal to the wavelength, the drop point in the calculation has exactly the same value as the next



**Figure 7.3.** A moving average of span 21 is applied to the cyclic data from Figure 7.2. The average is the horizontal line at the \$5 level. Thus the sinusoidal movement has been totally removed. Note that the average starts at week 11 because it is centered and the first 10 data points are lost.



**Figure 7.4.** The result of applying moving averages with spans less than that of the wavelength. Averages of spans 9, 13 and 17 weeks have been applied to the sine wave of 21 weeks wavelength. The original sine wave is shown with magnitude \$10. As the span increases the magnitude of the smoothed data decreases. The most shallow wave is due to the application of the 17 week average.

data point to be added. Consequently the running total and so the average, remain constant.

This effect (when the span is equal to the wavelength) is simply a special case of the more general one that removes a cycle completely when the span is an exact multiple of the wavelength: **span = n x wavelength**

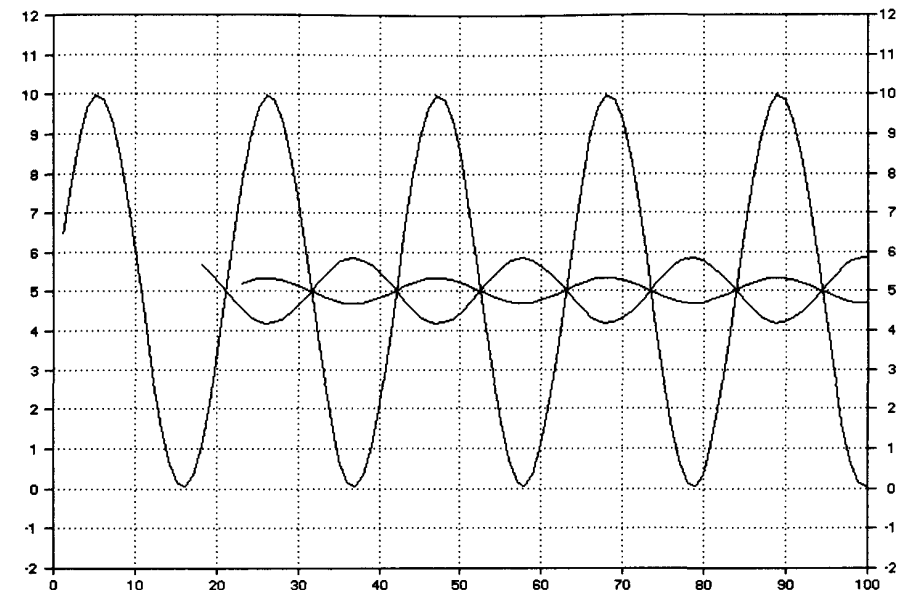
### Spans less than the cycle wavelength

In the second rule above we pointed out that using a span less than the wavelength of the cycle should lead to a reduction in the magnitude. In order to check this point, averages with spans of 9, 13 and 17 were applied to the cyclic data shown in Figure 7.2. The result is shown in Figure 7.4. The original sine wave is shown, and is the one with the greatest magnitude (10) in the Figure. The other three waves of decreasing magnitude are the results of applying each of these averages. The wave with the smallest magnitude is the result of applying the 17 week average, and, as predicted, the magnitudes increase as the span decreases through 14 and 9 weeks. So, as long as the span is less than the cycle wavelength, the smaller the span used, the less is the attenuation of the data. The smoothed data sets are also aligned perfectly in time with the original data. The first plotted points of the 9, 13 and 17 weeks averages are at weeks 5, 7 and 9 respectively because they have been plotted as centered averages.

### Spans greater than the cycle wavelength

In the third rule we pointed out that using a span greater than the wavelength of the cycle should lead to a reduction in the magnitude, but could also lead to an offset of the result so the original alignment was lost. In order to check this point, averages with spans of 35 and 45 were applied to the cyclic data shown in Figure 7.2. The result is shown in Figure 7.5.

The 35-week average starts at week 18 and the 45 week average at week 23 due to the fact they are plotted as centered averages. The interesting point is that while the 45 week average is aligned with the original data as



**Figure 7.5.** Averages of spans 35 and 45 weeks have been applied to the cyclic data from Figure 7.2. The 45 week average is the cycle whose peaks and troughs are still aligned with the original data. On the other hand, the 35 week average is shifted by half of a wavelength to the right.

far as peaks and troughs are concerned, the 35 week average is shifted one half of a wavelength to the right.

The effect of averages (with spans greater than the wavelength of the original data) suffers from the effect of the shifting of some averages. It also suffers from the fact that the magnitudes do not change in a straightforward manner, as was the case with averages, that have spans less than the wavelength of the data.

The shifting of some averages while others remain aligned with the original data is not a random effect, but does have a mathematical basis.

In the equation: **span = n x wavelength**  
the averaged data remains shifted by one wavelength from the original data for spans which lie between an odd value of **n** and the next even value of **n** in the above equation. The first range of these spans would be

from 22 to 41.

The averaged data remains aligned with the original data for spans that lie between an even value of  $n$  and the next odd value of  $n$  in the above equation. Thus the first range of these spans that are greater than the wavelength would be from 43 to 62.

In both of these cases, the magnitudes of the averaged data rise to a maximum and then falls back again. Therefore the least attenuation of the data occurs with a span of around 31 (shifted from original data) and 51 (aligned with original data.)

This shifting of the averaged data is something that the investor must guard against when it comes to the application of moving averages to real market data. We will see that averages will be used to highlight particular cycles, but that one has to be careful that a cycle is actually rising or falling, and not giving the impression simply because it has been shifted by half a wavelength because of the relationship between the span of the average and a cycle in the data. In such cases, the cycle will be moving in the opposite direction of that indicated on the plot. As long as the investor is aware of the possibility, it will be easy to check the exact status of the cycle by applying an average with a different (and very carefully chosen) span and viewing the result for consistency.

From these examples of the effect of different spans of average, the conclusion is we should use a moving average span less than the wavelength of the cycles we wish to observe. We will see later that we also have to take into account the presence of other cycles when deciding on the span most suited to our needs. Sometimes we may wish to remove a particular cycle totally, in which case we can choose a span equal to the wavelength of this cycle.

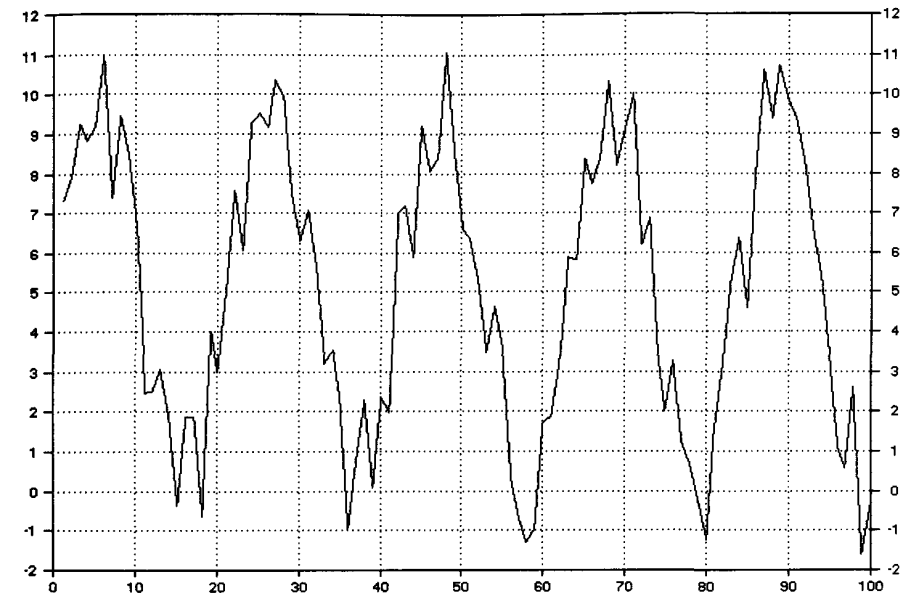
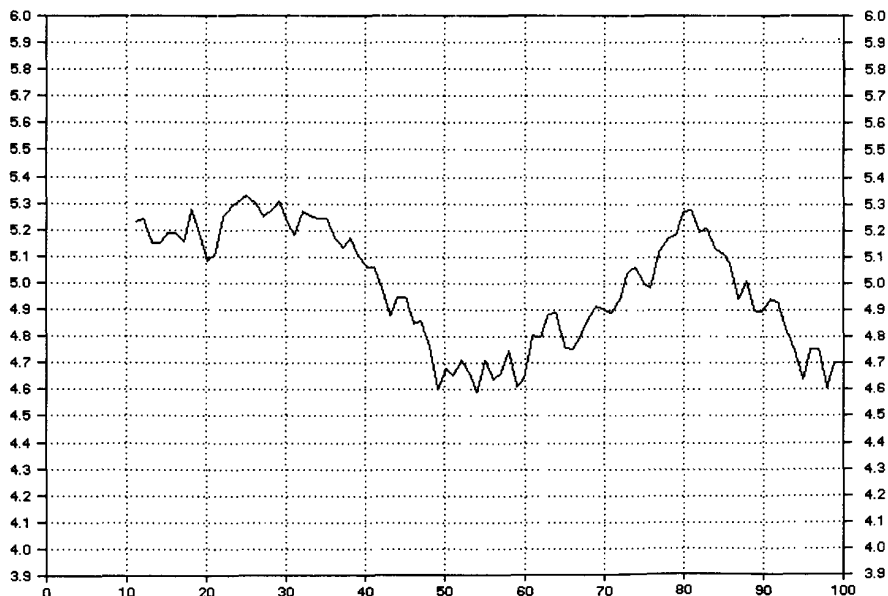
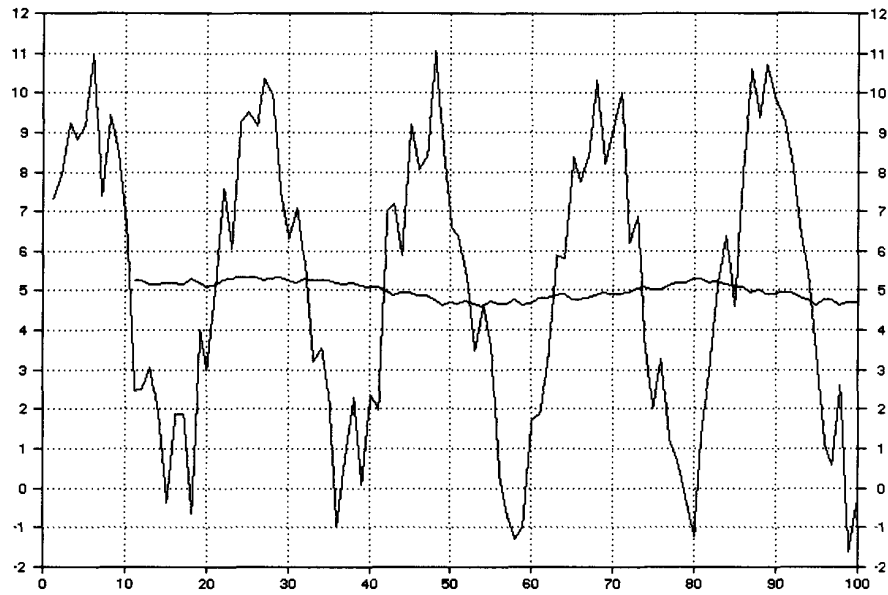


Figure 7.6. The sine wave from Figure 7.2 with random movement added.



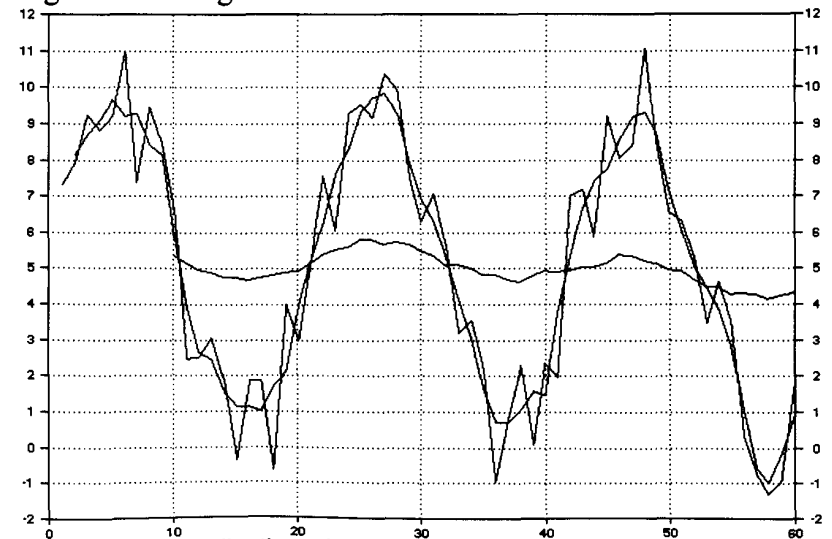
**Figure 7.7.** Upper panel: the result of applying a 21-week average to the data from Figure 7.6. Lower panel: the vertical axis has been expanded to show the random movement more clearly. There is no trace of the 21-week cycle.

## ONE CYCLE PLUS RANDOM MOVEMENT

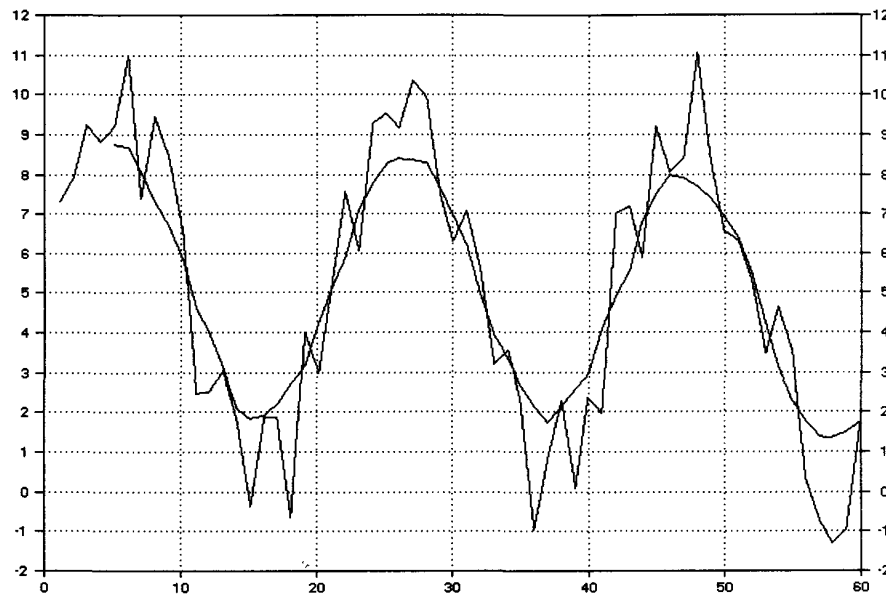
In chapter 5 we showed how, if we took a mixture of cyclic and random movement, we could, by a graphical method, separate each of these components. Now it is necessary to look at the effect of moving averages on data also contains some random movement in order to see if we can achieve the same thing by purely numerical methods. The data for this exercise lies in Figure 7.6, where we have taken the cycle used in Figure 7.2 and added random movement swings from +\$2 to -\$2.

### Isolating the random movement

Since we know that the application of a 21-week average should eliminate the cyclic movement altogether, we are not surprised by the result that is shown in Figure 7.7. The cycle of wavelength 21 weeks has totally disappeared, and what is left is essentially the random movement that was incorporated into the combined complex movement. This can be seen in enlarged form in Figure 7.8.



**Figure 7.8.** The application of 3-week and 19-week moving averages to the data from Figure 7.6. The 3-week average is the line closest in magnitude to the original data. The magnitude of the 19-week average is sharply reduced.



**Figure 7.9.** The application of a moving average of span about half of the wavelength of the cycle gives the cleanest result, as shown for this 9-week average of the noisy 21-week cycle. The penalty is that the magnitude of the result is reduced to around \$7.5 compared with \$10 in the original.

The phrase ‘essentially the random movement’ is used because there will be some obvious differences. First the averaging process will result in the magnitude of the averaged data being less than that of the original random movement, as can be seen in Figure 7.7. Second, if we think more carefully about the averaging process, especially the relationship between the drop point and the next data point added in to the running total, we realize there will be few occasions when these two could be the same. As an example, suppose the current value of the random data is \$1.25 and next week the value will be \$2. This means there will be a positive change of \$0.75. If, however, the drop point 21 weeks ago happened by chance to be \$2, then the running total, and hence the average, will appear as unchanged from this week to next week, even though it should reflect a change of \$0.75.

Quite clearly, because of these considerations, we will never be able to

isolate the random movement by the application of a simple moving average as other than a very good approximation to the original. However, we will soon see that we will be able to do this by another means.

### Isolating the cycle

Our prime aim in using a moving average on this data is to try to isolate the original cyclic movement as far as possible, unencumbered by random movement. The result therefore needs to be close to the original cycle in terms of magnitude and position. As far as retaining the original position is concerned, this can be achieved if we use a span that is less than the wavelength of the cycle and avoid using a span that is greater. We also noted that with such spans the magnitude of the resulting averaged data was reduced as we increased the span.

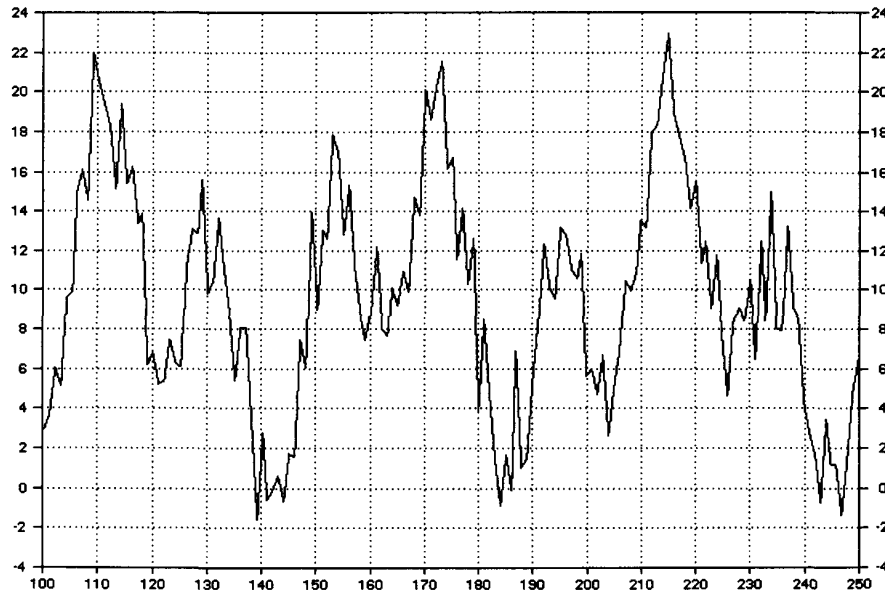
In order to gain some understanding of the effect of the two possible extremes of averages, we show in Figure 7.8 the application of a 3-week average and a 19 week average. Both of these averages remove most of the random movement, leaving a cycle that retains the correct wavelength and position. However, as expected, the 3-week average produces a result that is closest in magnitude to the original sine wave, giving a magnitude of around \$8 compared with the \$10 of the original. On the other hand, as expected, the 19-week average reduces the magnitude sharply, down to only around \$1. Both of these averages suffer from the drawback that there is still a trace of random movement coming through.

Of all the possible odd values of span between 3 and 19, the most successful in removing the random movement is the 9-week average (Figure 7.9). There would be no doubt in the mind of the observer that there is a cycle of wavelength 21 weeks present in the data, but this clarity is obtained at the expense of a good estimate of its magnitude, which is now reduced to about \$7.5.

Quite clearly, in using a moving average to isolate a cycle from a mixture of random and cyclic data, we have to balance the requirement to achieve

a clean result in terms of the shape and position of the cycle that comes through in the smoothed data against the requirement to arrive at a meaningful measurement of the magnitude of this cycle.

We will find that in general, the optimum result in balancing these two requirements is obtained when the span of the average is close to half of the wavelength of the cycle. In the present case of a wavelength of 21 weeks, and bearing in mind the necessity to use an odd value, the optimum span should be either 9 or 11 weeks. As we have seen, the 9 week average is the best in this particular case.



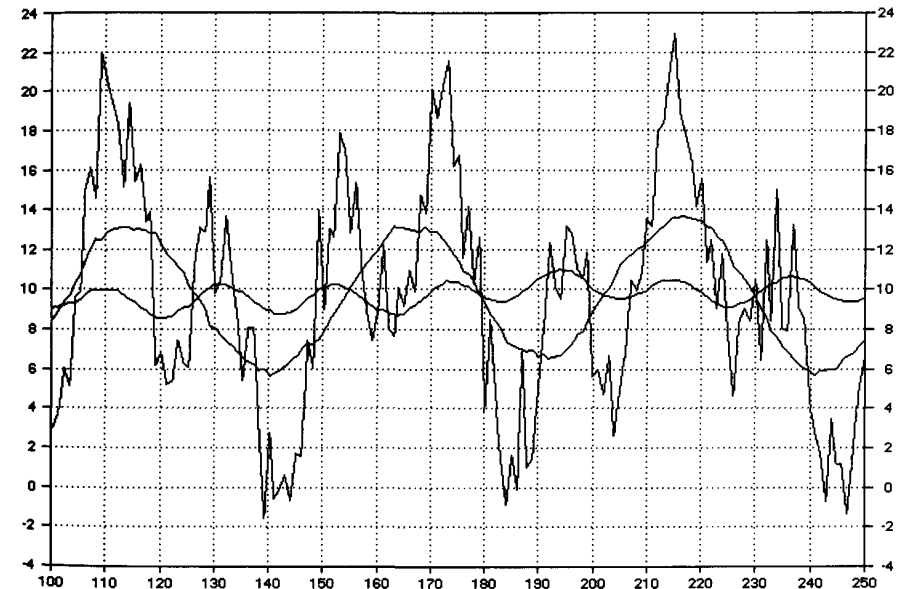
**Figure 7.10.** A combination of random movement with cycles of wavelengths 21 and 52 weeks and magnitudes \$10.

### Two cycles plus random movement

It is now of interest to apply the knowledge we have acquired so far of the properties of moving averages to the complex wave form used in chapter 5 (Figure 5.7), where we combined two cycles, of wavelength 21 weeks and 52 weeks with an amount of random data. Figure 5.7. is re-

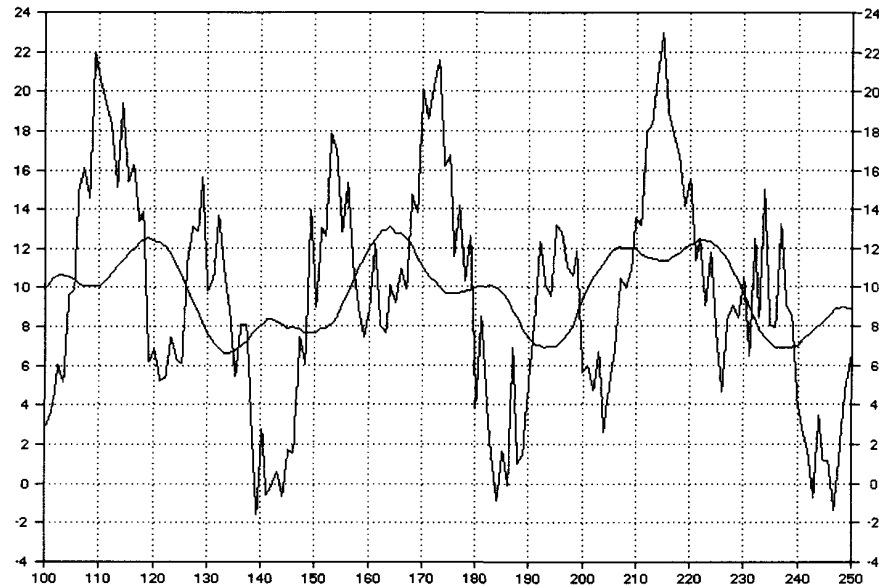
peated here as Figure 7.10.

Since we know that a span equal to or very close to the wavelength of a cycle will essentially remove that cycle, we should try an average of span 21 weeks, and another of 52 weeks. Since, for reasons discussed earlier, we should use an odd span, in the latter case, the most appropriate span would be 51 or 53 weeks.



**Figure 7.11.** Two averages, of spans 21 and 53 weeks are applied to the data from Figure 7.10. The 21-week average has allowed the 52-week cycle to come through, while the 53-week average allows through the 21 week cycle. Each of these still contains traces of the random movement.

In Figure 7.11 we see the result of applying a 21-week average and a 53-week average. As expected, each of these eliminates the cycle of similar wavelength, but allows the other cycle through. In each case a trace of the original random movement remains. From our understanding of the effects of various averages, we expect the 21-week average to leave the position of the 52-week cycle exactly as it was in the original data, since this is an example where the span of the average is less than the 52 week

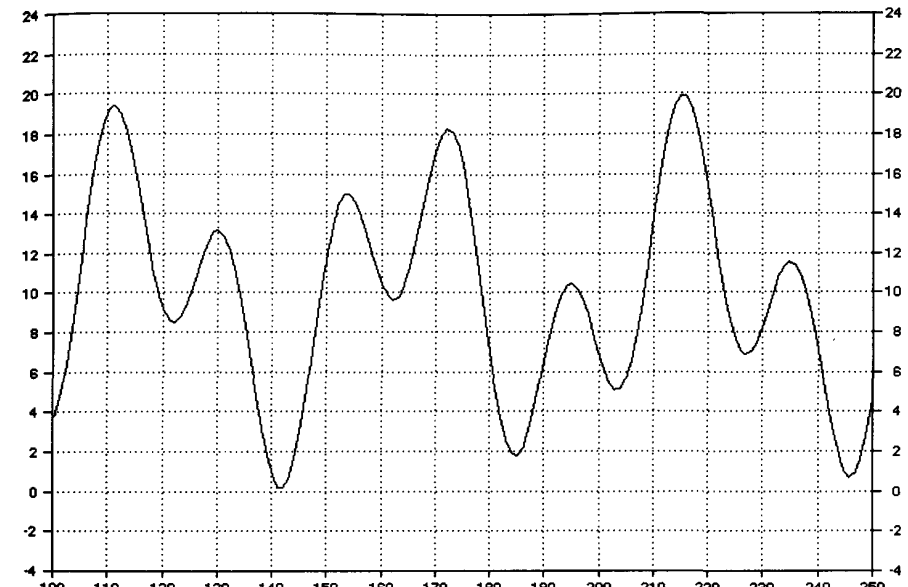


**Figure 7.12.** The effect of applying a 31-week moving average to the data in Figure 7.10. There is a shift in time of either one or both of the cycles.

wavelength. In the other case of the 53-week average as affects the 21 week cycle, we note that the value of 53 lies between  $2 \times 21$  and  $3 \times 21$ , *i.e.* it is a case that will not shift the alignment of the cycle.

The magnitude of the 52 week cycle comes through as about \$7 compared with the original value of \$10, while the magnitude of the 21 week cycle is drastically reduced to about \$1. The main message that comes from applying these two averages to the data in this example is that we can isolate two cycles, of wavelengths 21 weeks and 52 weeks, and an amount of random behavior.

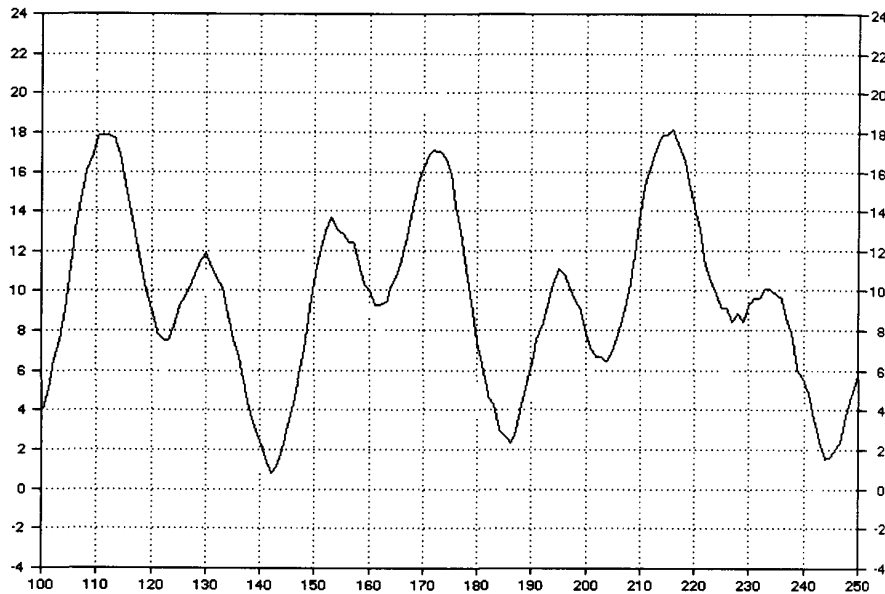
It is useful to see the effect of applying an average that is intermediate in span between the two values of 21 and 53. For this purpose, in Figure 7.12, we show the effect of applying a 31-week moving average to the data. Quite clearly, two cycles are present, and very little trace of random movement exists.



**Figure 7.13.** The original combination of two cycles, minus the random movement is shown here for comparison with the plot of the 31-week average as shown in Figure 7.12.

Since the original combination of two cycles without the addition of random movement is available (Figure 7.13), we can see how efficient a 31-week average is in removing the random movement while leaving the combined cycles to come through the averaging process. There is a considerable loss in the magnitude compared with the original. What is extremely confusing is the total lack of correlation in the position of the cycles in the averaged data in Figure 7.12 compared with their position in the original in Figure 7.13.

The reason for this difficulty is that the 31-week span of the average when compared with the wavelength of the shorter wavelength cycle, 21 weeks, is in the range  $1 \times$  wavelength to  $2 \times$  wavelength, that is one of the ranges where we get a shift in the position of the cycle. This is the reason we stressed earlier that it is imperative to think carefully about the span of average required for a specific purpose.



**Figure 7.14.** The application of a 9-week average to the data from Figure 7.10. The majority of the random movement has now been removed, and the trace is similar to the original two cycles as shown in Figure 7.13. The magnitude is only slightly decreased compared with the original.

Since a 9-week average was the most efficient span for studying the 21-week cycle in a combination of that cycle and random movement, it should be obvious that this would also be a good average to apply to the combined data from Figure 7.10. This is for two reasons—1) first we saw the 9-week average removed the vast majority of the random movement, and 2) second since this span is less than the wavelength of either cycle, we would not run into difficulty with a shift in the position of either cycle in the final output.

The result of applying a 9-week average to the data from Figure 7.10 is in Figure 7.14. Quite obviously, this average has been extremely good in removing the random movement, and has had a minimal effect on the magnitudes of the cycles in the data. The vertical positions of the peaks and troughs are not very different from those in the original in Figure 7.13.

## SMOOTHED AVERAGES

One of the problems we ran into with simple moving averages was a certain amount of the noise came through when these averages were applied to noisy data, *i.e.* the data that had random movement built in. A way of overcoming this is to smooth the average itself by the application of a second average. In other words, the data is smoothed by the first average, and this average is then smoothed by the second average. It is usual to use a smaller span for the second average than for the first.

Of course, there is a bewildering array of combinations available once the span of the first average gets into double figures. Even if we stick to odd values, using a span of 11 for the first average, then we have available spans of 3, 5, 7 and 9 for the second average. The number of second averages available if we stick to odd spans will be  $(n-1)/2 - 1$ , where  $n$  is the span of the first average. In the case of a 201-day average, we can combine this with 99 different second averages. Quite obviously, we have to bring some logic to bear on the situation in order to simplify our selection of the second average. By experimentation, we find the best second average to use is one that is around half of the span of the first average, while still using an odd span. Thus, with a 21-point first average, we could use a 9- or 11-point average as the second one. Either of these will have similar properties.

The way of calculating such a smoothed average is identical to the way the 5-point average was calculated in Table 7.1. Once we have a column of running totals up to the latest point, we use those totals as the input into the second average calculation. There is no point in computing the first average by division of the first column of running totals, since this first average will not be needed. As before, we can use another column as a reminder of which value of the first running total we drop when adding in the next. This process is shown in Table 7.2 for a 11-week average of a 21-week average of the data used to produce Figure 7.10.

Date	Index	Subtract	21-wk total	21-wk average	Subtract	11-wk total	11-wk average
071197	7921.82	X					
071897	7890.46	X					
072597	8113.44	X					
080197	8194.04	X					
080897	8194.04	X					
081597	7871.88	X					
082297	7776.19	X					
082997	7680.26	X					
090597	7680.26	X					
091297	7615.45	X					
091997	7879.56	X					
092697	7913.83	X					
100397	8105.38	X					
101097	8030.23	X					
101797	7876.99	X					
102497	7799.15	X					
103197	7377.74	X					
110797	7577.88	X					
111497	7481.37	X					
112197	7860.18						
112897	7842.03		164682.2	7842.009	X		
120597	8103.87		164864.2	7850.678	X		
121297	7848.99		164822.8	7848.703	X		
121997	7846.50		164555.8	7835.991	X		
122697	7696.75		164058.5	7812.311	X		
010298	7923.94		163788.4	7799.449	X		
010998	7722.16		163638.7	7792.320	X		
011698	7761.02		163623.5	7791.597	X		
012398	7665.36		163608.6	7790.888	X		
013098	7954.83		163883.2	7803.962			
020698	8194.72		164462.5	7831.547		85999.45	7818.132
021398	8340.20		164923.1	7853.482		86010.93	7819.175
022098	8335.72		165345.0	7873.572		86033.82	7821.256
022798	8545.72		165785.4	7894.540		86079.66	7825.424
030698	8569.38		166324.5	7920.214		86163.88	7833.080
031398	8602.52		167050.0	7954.763		86306.33	7846.030
032098	8906.43		168157.3	8007.491		86514.38	7864.943
032798	8826.47		169606.0	8076.478		86798.53	7890.776
040398	8971.20		170999.4	8142.827		87149.76	7922.706
041098	8994.86		172512.9	8214.898		87573.77	7961.252

Table 7.2. The calculation of a 11-week average of a 21-week average for the Dow-Jones Index

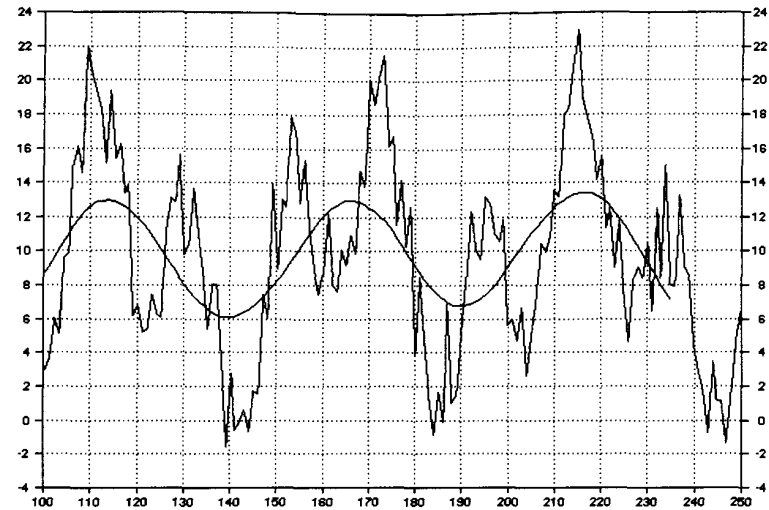


Figure 7.15. A smoothed 21-week average has been applied to the data from Figure 7.10. There is now no trace of the random movement coming through. The averaged data has a wavelength of 52 weeks, but its magnitude of about \$7 is much less than that of the \$10 in the original data. Note that the last plotted averaged point is at week 235, i.e. there is a loss of 15 points at the end of the plot.

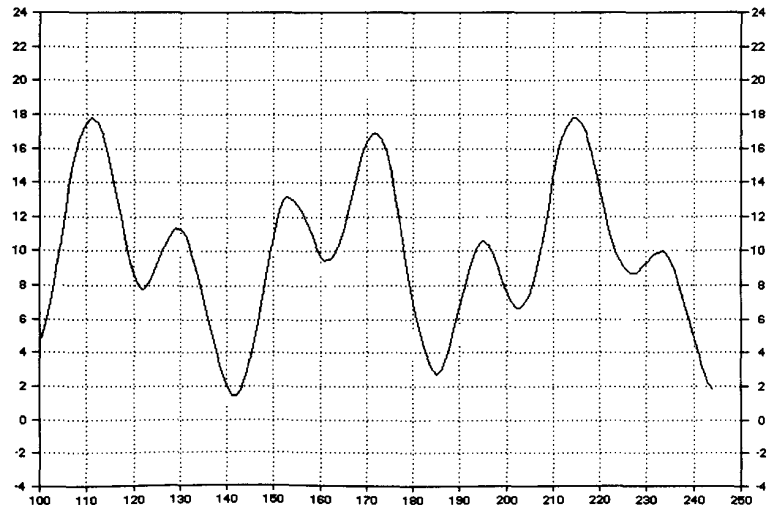


Figure 7.16. The result of applying a smoothed 9-week average to the data in Figure 7.10. Compare this trace with that from obtained from a simple 9-week average as shown in Figure 7.14.

As calculated, the value of the final average points are written at the same point in time as the last data point used in the calculation. In order to plot the correct relationship with the data from which the smoothed average is derived, we have to offset the smoothed average point by two amounts. Each of these follows the formula given previously:

$$\text{shift} = \frac{(\text{span} - 1)}{2}$$

We simply add the two shifts together. For the first 21-week average the shift is 10 weeks back in time, while for the second 11-week average it is 5 weeks back in time. The smoothed average would be plotted 15 weeks back in time. Correspondingly, from the beginning of the data, the first point would be plotted at week 15.

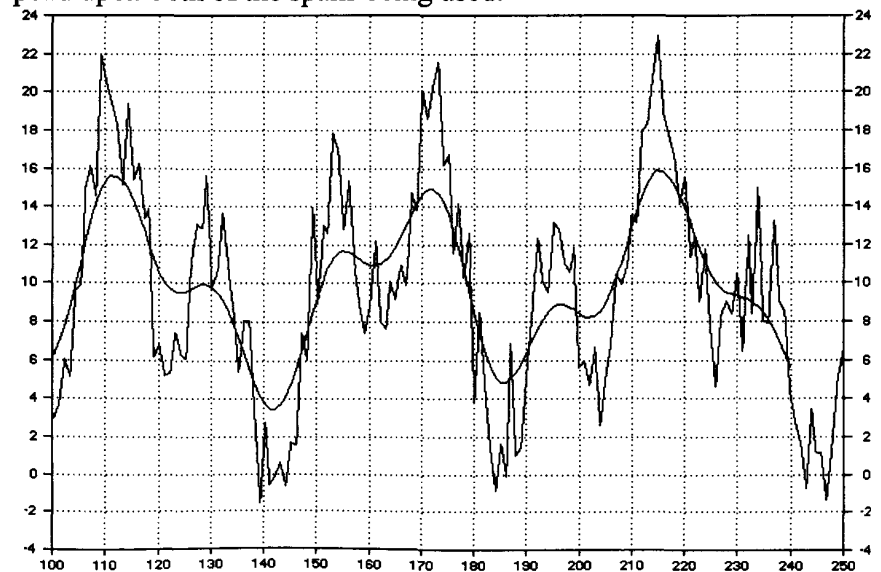
Figure 7.5 presents a plot of this smoothed average. There is a great improvement, in terms of smoothness of the trace compared with the corresponding plot of the simple moving average, as was shown in Figure 7.11. There is no trace now of any random movement coming through. The only difficulty is that the magnitude of the 52-week cycle allowed through is about \$7, compared with the \$10 in the original sine wave. Note that while the data terminates at week 250, the last plotted point of the smoothed average is at week 235, *i.e.* 15 weeks back in time as expected for a 11-week centered average of a 21-week centered average.

The most effective span to use for a simple average in order to remove the random movement was seen to be 9 weeks, as was shown in Figure 7.14. This still suffered from a small amount of random movement coming through. We would expect a 9-week smoothed average would improve the situation considerably. This is indeed the case Figure 7.16 reveals. Now there is no trace of random movement in the result, although the magnitude of the averaged data is somewhat less than in the original. If this result is compared with the original data for the combined cycles in Figure 7.13, the closeness of the smoothed data to the original is very gratifying. However, as will be discussed later, we have the penalty of a

loss of the last 15 points of the averaged data, that will have an implication when we come to the use of smoothed averages as templates for channels.

### Weighted Averages

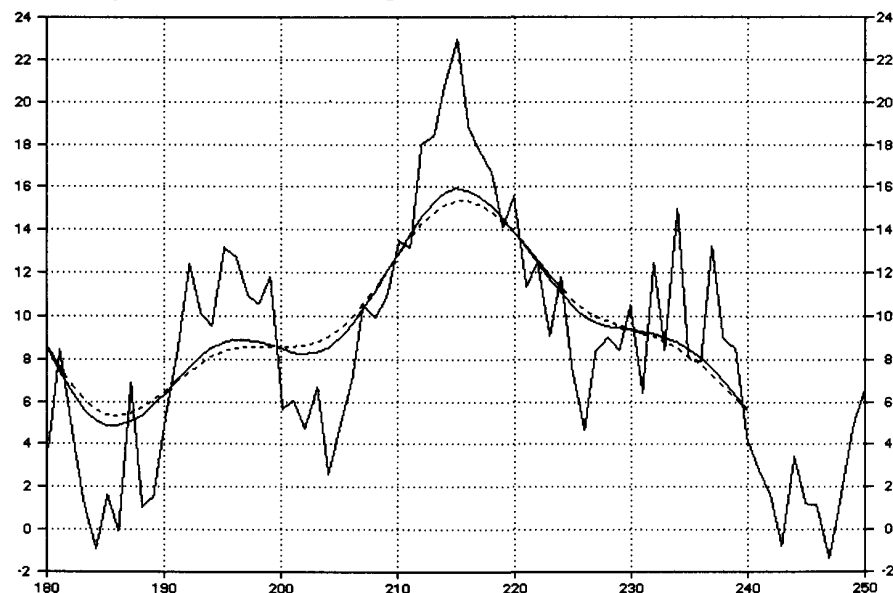
There is another type of average available to us commonly used in computer programs, the weighted average. Unfortunately, it is extremely tedious to calculate, and so only appropriate for those with a computer. It differs from the calculation of a simple average as shown in Table 7.1 by the fact that rather than just adding together each of the  $n$  data points to give a running total, each point has to be multiplied by a fixed value (a 'weight') before the addition. The maximum weight is applied to the central point. A simple average can be viewed as a weighted average whose weights are all 1. Without going into the mathematics, you can see that a smoothed average is a form of weighted average, where the weights depend upon both of the spans being used.



**Figure 7.17.** The effect of applying a weighted 21-week average. Unlike the case of a simple average, the cycle of wavelength 21 weeks is not removed, although there is no trace of the random movement. The average terminates 10 weeks before the last data point.

Because of the weights, the effect of eliminating a cycle of the same wavelength as the span of the average, apparent with simple and smoothed averages, is lost. This can be seen in Figure 7.17, where a 21-week weighted average has been applied. Where the simple average, Figure 7.11, allowed through just the 52-week cycle, with a trace of random movement, the weighted average allows both cycles through, but has eliminated the random movement. As expected, the average cuts off 10 points before the last data point.

The weights used in these examples, require a weighted average of span twice that of the wavelength of a cycle to remove that cycle from the resulting data. A 42-week weighted average would achieve this.



**Figure 7.18.** The application of a 21-week weighted average (solid smooth line) and a 15-week smoothed average (dashed line) to the data from Figure 7.10. Both averages lose the last 10 points. The weighted average is marginally superior because the magnitude of the result is slightly larger and therefore slightly closer to that in the original data.

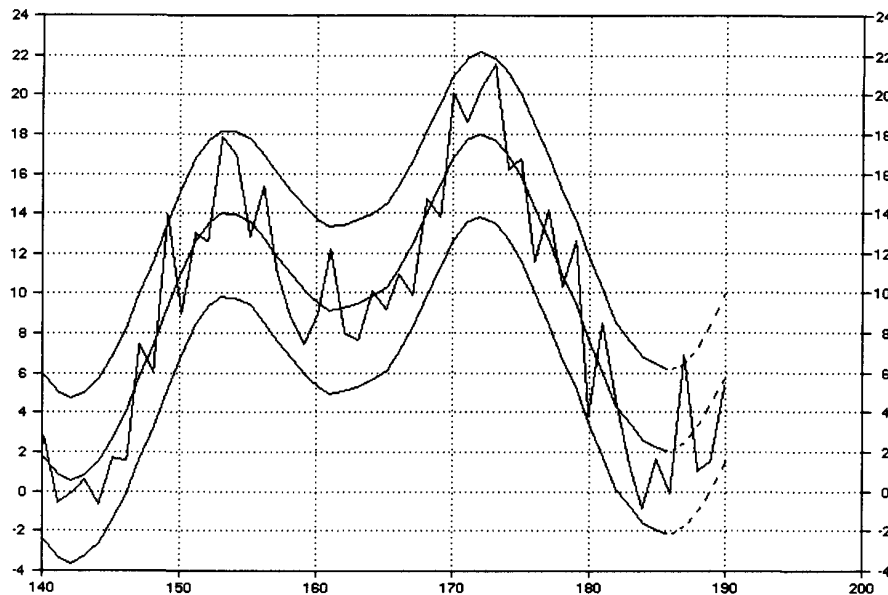
Since smoothed averages are a form of weighted average, and we lose points at the end of the plot in both smoothed and weighted averages, it is

of interest to compare whichever span of smoothed average would cause the same number of points to be lost with the 21-week weighted average. A 15-week smoothed average would also cause the loss of 10 points at the end of the plot. In Figure 7.18 we show the result of applying both a 21-week weighted average and a 15-week smoothed average to the data. Because the two results are so similar, the smoothed average is plotted as a dashed line for clarity. The only apparent difference is that the magnitude of the cycles that come through in the smoothed average are slightly less than those in the weighted average. The weighted average is preferred. What this means, of course, is that the investor without a computer, who calculates a smoothed average is only marginally disadvantaged compared with an investor with a computer who computes and plots weighted averages.

## AVERAGES AS TEMPLATES FOR CHANNELS

We mentioned at the start of this chapter that a trend could be represented by a centered average. We also came to the conclusion in chapter 5 that channels had the same shape as the trends we drew through the center of the data, so it follows that we should be able to draw a channel by using the exact shape of a centered average as a template. The reason we have spent quite a bit of time in this chapter discussing the properties of simple, smoothed and weighted averages is to make sure that when we analyze stock real data we apply logic to the selection of the averages from which channels can be produced. Since we also came to the conclusion that a smoothed average was superior in eliminating random fluctuations and cycles of shorter wavelength than the span of the average, we will use smoothed averages as the templates for drawing channels.

We will start with a consideration of what we called the inner channel in previous chapters. We will choose the lowest span of smoothed average that removes the fluctuations (whether random movement or cycles of shorter wavelength than this span). We will see that when we draw the channel and plot the original data, these fluctuations will be contained in the channel. In the case of our test data from Figure 7.10, our inner chan-



**Figure 7.19.** A 7-week smoothed average is plotted on the data. The two channel boundaries are exact copies of this average, placed at equal distances above and below the original position. The dashed lines are estimates of the position of the average between the last calculated point and the last data point.

nel is the channel that will contain the random movements. We drew such a channel graphically in chapter 5 (see Figure 5.10). The aim is to reproduce this channel by this numerical method as closely as possible. When we come to real data, this selection of the correct span of average for channel production will tend to be by trial and error.

In Figure 7.19, we show a plot of the 7-week smoothed average superimposed on the data. Note of course the average terminates before the last data point. It can also be viewed as a center line, since it runs through the center of the data. The channel is now constructed by duplicating the exact shape of this average twice, plotting one above the original and one below it. These duplicates must always be kept equidistant from the original average in order to preserve the rules of channel analysis. Since they are exact copies, this act of placing them above and below the original will

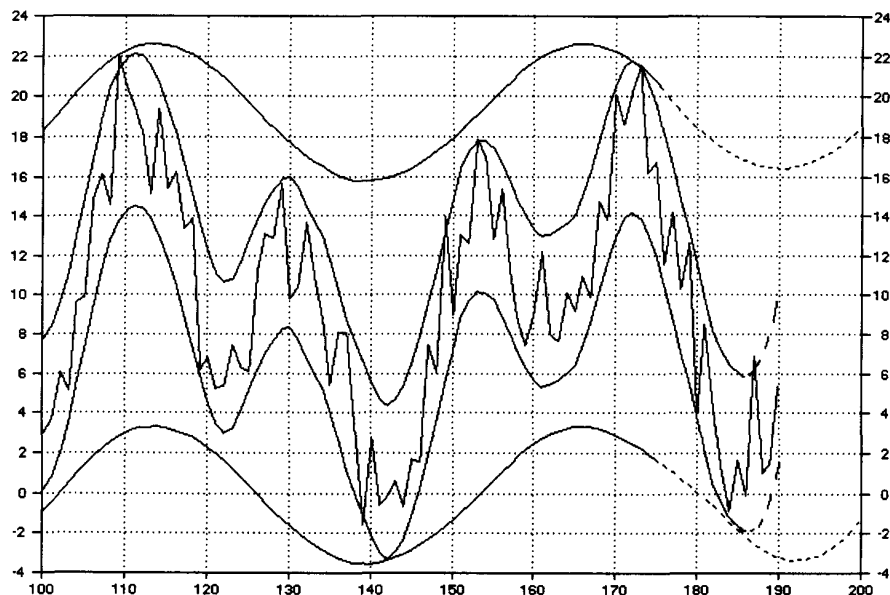
preserve the essential feature of a constant depth. It is now only necessary to move the two duplicates closer to or further from the center line until the acceptable minimum of small violations of these boundaries is reached.

This process is done automatically in a computer program such as **Microvest 5.0™** by storing the distances between each data point and the position of the central average at that point. This gives a distribution of points that will get closer to the theoretical shown in chapter 6 (Figure 6.21) as the number of data points increases. From this distribution it then selects the position of the boundaries to enable a pre-determined number of points to lie outside of the boundaries. Although this number may need to be different in different sets of data, a good starting point is to allow about 3 to 4% of the points to lie outside of the boundaries.

Once the channel has been drawn in this way, it allows us to estimate the magnitude of the random movement. This is of course, the channel depth. The channel contains all of those fluctuations that are of wavelength less than the span used to calculate the average and so construct the channel. As you can see from Figure 7.19, the channel depth is just over \$8, which is in line with the actual magnitude of the random movement as running from +\$2 to -\$2.

Figure 7.19 demonstrates the problem in using the centered average as a template for the channel. We have a gap at the end due to the missing point, and the average and channel terminates 4 points back in time in this case. As we move into the future from the last data point, each new week will bring in a further calculated point for the average, and so the gap will be filled. At a point 4 weeks into the future we will know exactly how the average traversed the gap. At the point we are in Figure 7.19, at week 190, we have to estimate the position of the average over these last four weeks. We are into the same problem addressed in chapter 6, where in the case of real data we will have to examine peaks and troughs in this gap closely in order to provide evidence of what has happened to the channel. In the current example we take into account the large peak at week

187. This forces us to put an upward bend into the channel at the point shown. The estimated positions of the last four points of the average and hence of the channel boundaries are shown as dashed lines.



**Figure 7.20.** An outer channel has been constructed by plotting a smoothed 21-week average on the top of the previous chart and making duplicates of this average as before. The positions of these were adjusted so as to allow the two boundaries just touch the main peaks and troughs in the previous channel. The original 21-week average has been left out for the sake of clarity.

In order to isolate the 52-week cycle we can use a smoothed 21-week average, knowing that this will remove the 21-week cycle and the random data. Now that we know the process we place the channel boundaries as exact duplicates above and below the original position of this average we can leave it out of the plot, Figure 7.20. This channel is superimposed on the channel drawn in Figure 7.19. The boundary positions have been adjusted so that the main peaks and troughs in the inner channel just touch the outer boundaries.

The depth of this second channel is just over \$18. Since the channel represents the 52-week cycle, this means that the channel contains all fluc-

tuations of wavelength of less than 52 weeks, i.e. wavelengths of 21-weeks or less, and they have a combined magnitude of \$18. Since we have established that the random movement is just over \$8 in magnitude, this leaves a difference of \$10, which is our estimate of the magnitude of the 21-week cycle. We know the latter in the original data to have been \$10, so this estimate is excellent.

Although we could draw a third, outer channel by selecting a smoothed average with a span greater than 52 weeks, it is hardly necessary in this case because the outer channel will be running horizontally. The upper boundary would be drawn to touch the two peaks in the second channel just drawn, while the lower boundary is drawn to touch the troughs in this channel. The depth of such a channel is the vertical distance from peak to a trough in the second channel. This is approximately \$26, and is due to all the cycles and random behavior present.

From the way the test data was created in the first place, this total should include \$10 for the magnitude of the 52 week cycle, \$10 for the magnitude of the 21 week cycle and \$8 for the magnitude of the random behavior, i.e. a total of \$28 in all. Thus our estimate of \$26 is quite good. By difference between the two channel depths, we estimate the magnitude of the 52 week cycle as being  $\$26 - \$18 = \$8$ .

The reason for the estimate of this magnitude being slightly low is because of the overall effect of the application of averages in reducing the magnitude of the cycles which the average lets through. We saw this effect in Figure 7.15.

The general strategy in applying centered averages as templates to stock market data is to increase the span until it is obvious there are no more cycles left in the data. In the interests of efficiency, it is sensible to carry out this process quickly by using fairly large increments rather than step through a large number of averages that are very close together.

# CHAPTER 8

## Numerical Analysis—More about Cycles

We saw in the last chapter how moving averages, both simple and smoothed, were able to remove cycles with wavelength equal to the span of the average. We also saw that averages would allow through cycles of wavelength greater than the span of the average, although with reduced magnitude, and would mostly remove cycles of wavelength less than the span of the average. In a mixture of two cycles and random data we were able to isolate the cycle of largest wavelength only by the application of an average span equal to the wavelength of the second cycle. It was not possible to isolate the second cycle simply by applying an average, although channel analysis gave a good indication of the wavelength and magnitude of each cycle, and indeed of the random movement present.

Obviously, if we had three different cycles present in the data, we would not be able to isolate just one of these, because applying an average of the same span as one of the cycles would still leave the combination of the other two cycles coming through. Thus, it is apparent that we cannot use moving averages in the normal way to isolate an individual cycle from a mixture of more than two. With a mixture of two, we are only able to isolate the cycle of largest wavelength.

This chapter shows the use of average differences will overcome some of the problems associated with the isolation of particular cycles. **However, since these calculations will be based on centered averages, they will**

still suffer from the same drawback of loss of data points at the beginning and end of the plotted result. As is the case with averages, we will not be sure what is happening at the present time, and will have to estimate how the calculated data might have unrolled across the gap from the last true calculated point to the present and where desired, into the future.

### SIMPLE AVERAGE DIFFERENCES

We showed in chapter 5 (see Figure 5.3) how the random content of a cycle with added random movement could be extracted by taking the differences between the line drawn through the center of the data and each individual data point. This is simply a manifestation of the general principle of average differences. The fluctuations that have been removed by the averaging process, for example, the random movement when, say a 9-week average has been used, can be recovered by taking the difference between the value of the centered average and the value of the data at each point between the beginning and end of the centered average. The

Date	Index	Subtract	5-week total	5-week average	Centered	Avge Diff
02/06/98	8194.72					
02/13/98	8340.20					
02/20/98	8335.72				8397.148	61.428
02/27/98	8545.72				8478.708	-67.012
03/06/98	8569.38	X	41985.74	8397.148	8591.954	22.574
03/13/98	8602.52	X	42393.54	8478.708	8690.104	87.584
03/20/98	8906.43	X	42959.77	8591.954	8775.200	-131.23
03/27/98	8826.47	X	43450.52	8690.104	8860.296	33.826
04/03/98	8971.20	X	43876.00	8775.200	8973.292	2.092
04/10/98	8994.86	X	44301.48	8860.296	9004.930	10.07
04/17/98	9167.50	X	44866.46	8973.292	9069.050	-98.45
04/24/98	9064.62	X	45024.65	9004.930	9085.840	21.22
05/01/98	9147.07	X	45345.25	9069.050	9106.068	-41.002
05/08/98	9055.15	X	45429.20	9085.840	9095.456	40.306
05/15/98	9096.00	X	45530.34	9106.068	9076.572	-19.428
05/22/98	9114.44	X	45477.28	9095.456	9054.700	-59.74
05/29/98	8970.20	X	45382.86	9076.572	9010.658	40.458
06/05/98	9037.71	X	45273.50	9054.700	8934.032	-103.678
06/12/98	8834.94	X	45053.29	9010.658		
06/19/98	8712.87	X	44670.16	8934.032		

Table 8.1. Calculation of average differences for the Dow-Jones Index

result is known as the average difference. Once the average has been calculated and centered, the process is quite simple, as shown in Table 8.1.

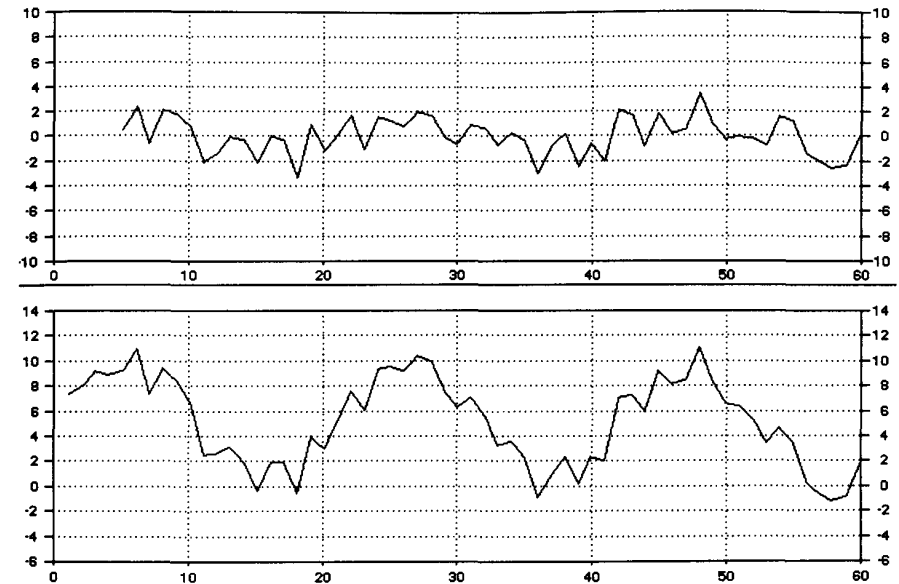
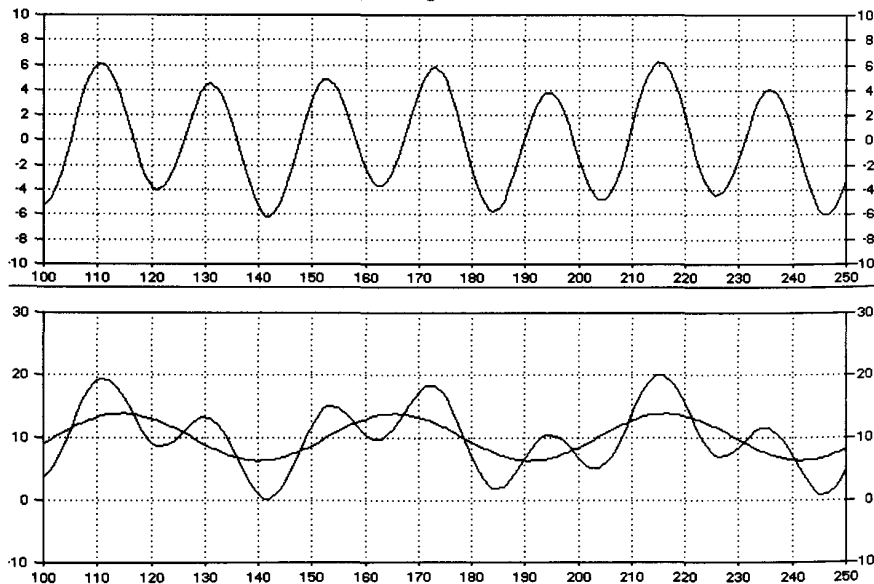


Figure 8.1. Lower panel: a sine wave of wavelength 21 weeks and magnitude \$10 with random movement ranging from -\$4 to +\$4 added. Upper panel: a 9-week average difference plot which just the random movement. Note the loss of 4 calculated points at the beginning of the upper plot because the calculation involves a centered average. A similar cut-off would be seen at the end of the data, terminating at week 1000.

In chapter 7 (Figure 7.9) we showed that the cleanest result was obtained using an average with a span of 9 weeks when applying simple moving averages to the 21-week cycle with added random movement. Now we show the result in Figure 8.1 of taking the 9-week average difference of the same data. The original cycle with its random movement is shown in the lower panel, while in the upper panel you can see that the cycle has been eliminated and only the random movement allowed through. Note the cut-off of the first four calculated points in the upper panel because the calculation is derived from a 9-week centered average. There is not an equivalent at the right hand side of the plot since the display is just the

first section of a much longer set of data that runs to week 1000.

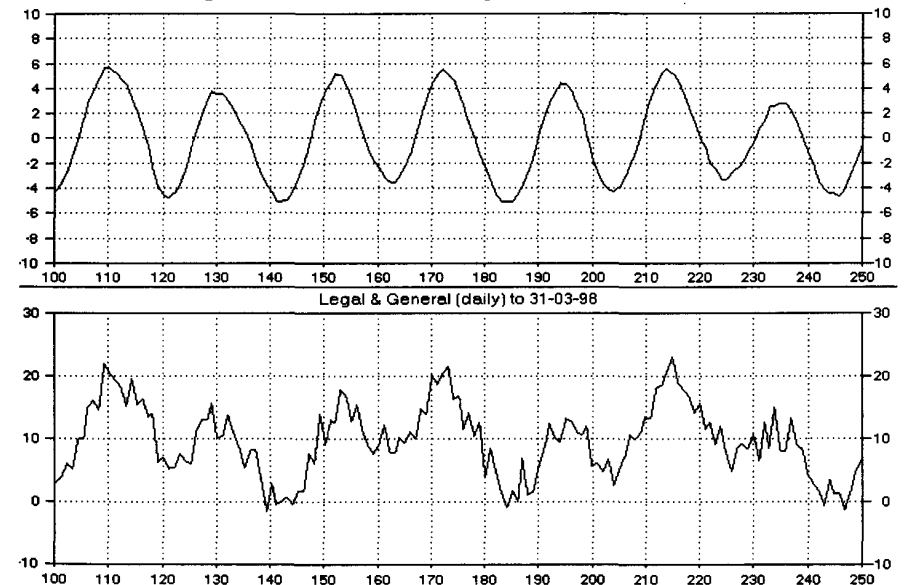
If we apply this same principle to a combination of two cycles, such as the 21-week and 52-week combination used in earlier chapters, we would expect that a 21-week average would highlight the 52-week cycle, since the 21-week cycle would be eliminated. We now expect that a 21-week average difference to show us this 21-week cycle and eliminate the 52-week cycle. This is indeed true, as shown in Figure 8.2. The 21-week average is superimposed on the combination of two cycles in the lower panel, and quite clearly shows the 52-week cycle in isolation. The upper panel shows the 21-week average difference. This is obviously the cycle of wavelength 21 weeks, as the successive peaks and successive troughs are exactly 21 weeks apart. There is a minor fluctuation in the magnitude, and this is due to a trace of the 52-week cycle still coming through. Even so, you can see that by the use of an average and an average difference we can isolate each of the two cycles present in the data.



**Figure 8.2.** Lower panel: the combined 21-week and 52-week cycles. The superimposed 21-week average highlights the 52-week cycle. Upper panel: the 21-week average difference highlights the 21-week cycle. The lost points at either end are not seen because this is a section of a longer set of data.

Because the displayed data is just a central section of a much longer data set that runs to 1000 weeks, we do not see the cut-offs. In this case a 21-week average amounts 10 weeks at either end.

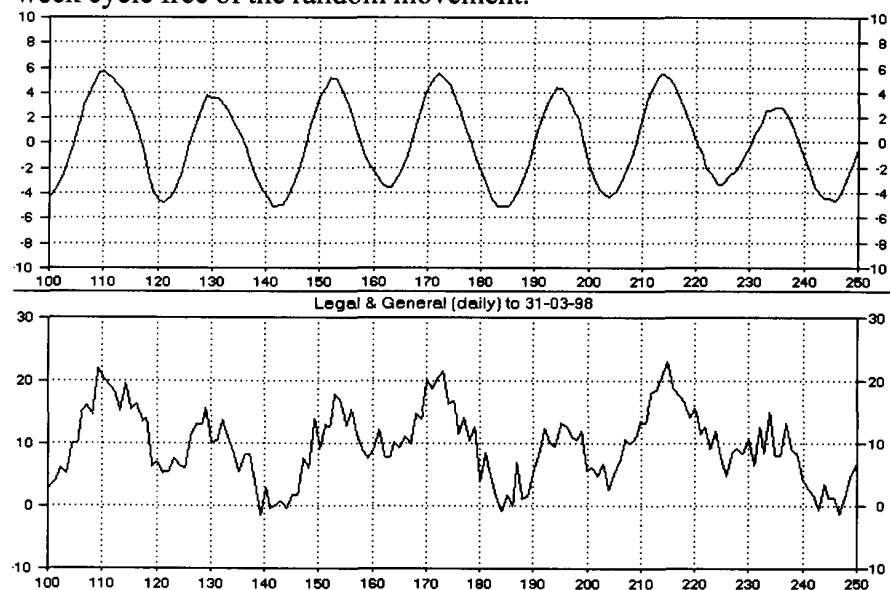
If we turn to the combined cycles with added random movement, we show in Figure 8.3 the effect of applying a 21-week average difference. Although this has the effect of isolating the 21-week cycle, it also allows through the random movement. Another way of looking at it is that we have removed the 52-week cycle from the combined data, leaving the rest of the components to come through.



**Figure 8.3.** Lower panel: the combined 21-week and 52-week cycles with added random movement. Upper panel: the result of applying a 21-week average difference to the data. Both the 21-week cycle and the random movement can be seen, while the 52-week cycle has been removed.

We saw in the last chapter how we could remove the random movement from a combination of a 21-week cycle with random movement by using a 9-week average. We can use this same method again, *i.e.* apply a 9-week centered moving average to the calculated data in Figure 8.3 in order to smooth out the random fluctuations and confirm the presence of

a clean 21-week cycle. The result of doing this is shown in Figure 8.4, where a 9-week centered average has been applied to the 21-week average difference. By doing this, it is quite clear we have isolated the 21-week cycle free of the random movement.



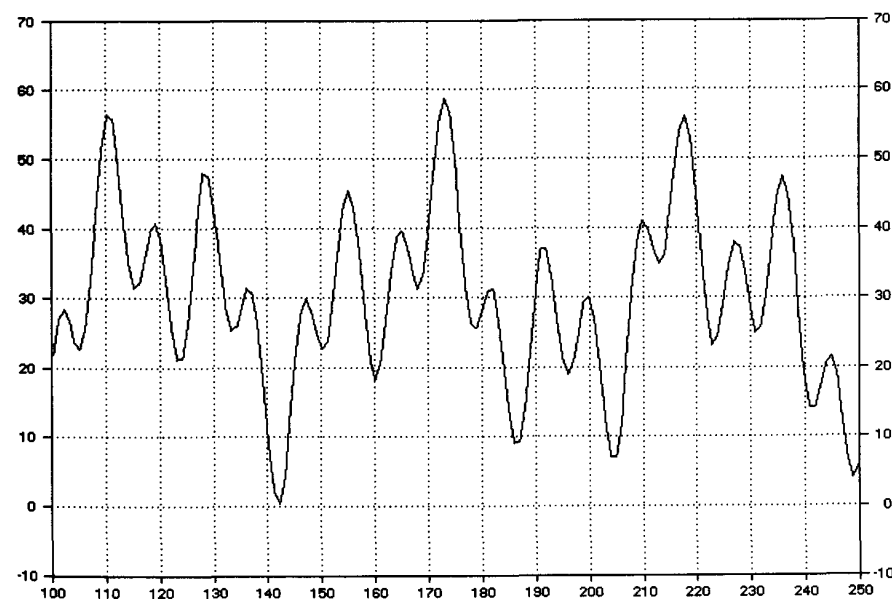
**Figure 8.4.** Lower panel: the combined 21-week and 52-week cycles with added random movement. Upper panel: the 21-week average difference has been smoothed by the application of a 9-week moving average.

What is not obvious, because we are displaying only a central section of the data, is the number of points that are lost at the beginning and end of the final calculation compared with the original data set. We lost ten points at each end by the application of the 21-week average difference, and the use of another 9-week centered average would lose a further four points at each end, giving a loss of fourteen points at each end.

From the next few examples we will be able to see the complementary nature of the two averages. In the case of a complex mixture of many cycles, we will be able to isolate at least two, and possibly more, of the cycles by applying these methods. Of course, as we have seen, the penalty for the sequential application of centered average differences and cen-

tered averages will be the increasing loss of data points. While this is of no consequence at the beginning of the data set, it makes it difficult to determine what is happening, because we must estimate the values of the lost points.

The examples are based on a test mixture of three cycles of wavelengths 9, 21 and 52 weeks respectively. Each has a magnitude of \$20. The combination is shown in Figure 8.5.



**Figure 8.5.** A mixture of three cycles of wavelength 7, 21 and 52 weeks. The magnitude of each cycle is \$10.

### Isolating the largest wavelength cycle

Since, by applying a simple moving average, we allow through those cycles with wavelengths greater than the span used for the average, then the strategy is to use an average whose span lies between the wavelengths of the cycles with the two largest wavelengths. This allows us to isolate the largest wavelength cycle.

### Isolating the shortest wavelength cycle

Since, by applying a moving average difference we allow through all cycles with wavelengths equal to or less than the span used for the average, then the strategy is to use an average difference whose span is equal to this wavelength.

### Other wavelengths

These can be accessed by applying either an average difference and a simple average, or by using two successive averages. A little thought has to go into which of these two combinations should be applied, and which spans should be used. Often there are two routes to isolating an individual cycle from a mixture. The process is analogous to the use of a succession of sieves to separate materials of different diameters.

The problem can be stated as:

*We have a mixture of cycles of wavelengths  $w_1 \dots w_n$ , where the wavelengths are increasing from 1 to  $n$ . The aim is to isolate an individual cycle, say the one with wavelength  $w_5$ .*

#### METHOD 1: BY REMOVING SHORTER WAVELENGTHS FIRST

In this method, we first remove all of the cycles whose wavelengths are less than  $w_5$ . This can be done by applying an average with span equal to  $w_4$ . Wavelength  $w_4$  is thus entirely removed. Traces of the shorter wavelengths may come through.

To this combination of fewer cycles we apply an average difference of span equal to the wavelength we wish to isolate, *i.e.*  $w_5$ . This will isolate  $w_5$  by removing all wavelengths greater than  $w_5$ .

In cases where traces of the shorter wavelengths come through, the application of smoothing average of span equal to the shorter wavelength

will clean up the cycle.

#### METHOD 2: BY REMOVING LONGER WAVELENGTHS FIRST

In this method we first of all remove all of the cycles with wavelengths greater than  $w_5$ . This can be done by applying an average difference with span equal to  $w_5$ . Wavelengths  $w_6 \dots w_n$  are removed.

To this combination of fewer cycles we apply an average of span intermediate between  $w_4$  and  $w_5$ . This will remove all wavelengths of less than the span, leaving  $w_5$  isolated.

We can see that the isolation of the longest and shortest wavelengths from a mixture is simply a special case of these two methods, where the second stage does not need to be applied because only one cycle is present after the first stage.

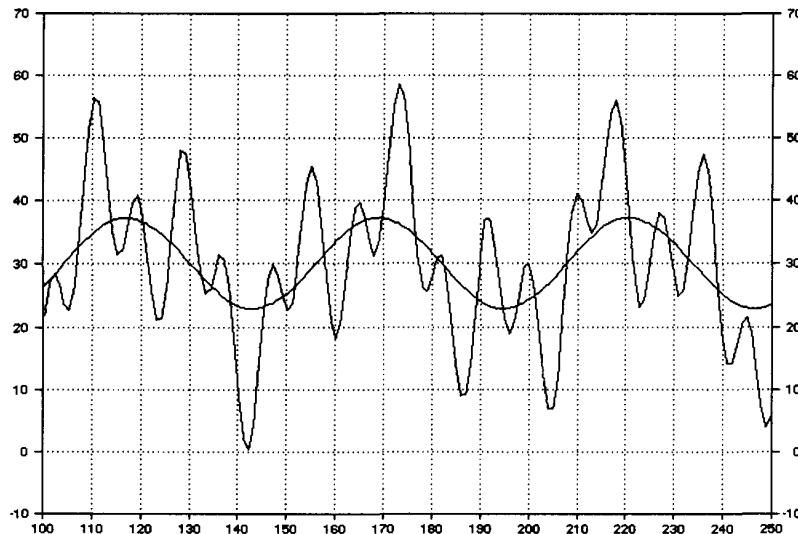
By such a method of attrition, we can isolate any chosen cycle. However, the penalty for this will almost certainly be a reduction in magnitude. Because such a reduction will occur at each of the two (or three if additional smoothing is required) stages.

#### Testing Methods 1 and 2

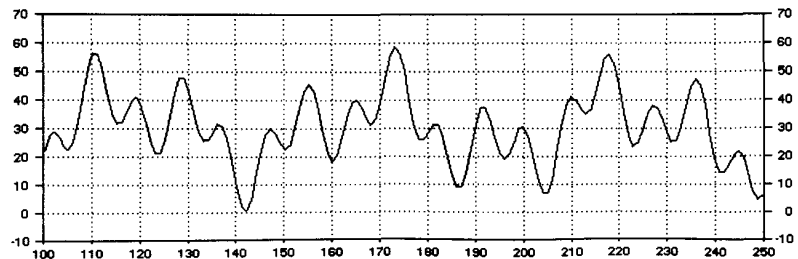
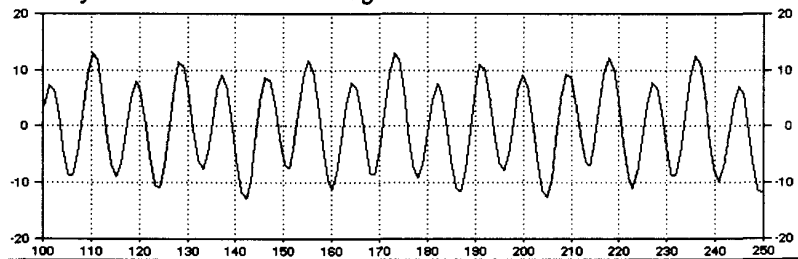
In the test mixture the three cycles have wavelengths of 9, 21 and 52 weeks. Each has a magnitude of \$20. Thus we have  $w_1 = 9$ ,  $w_2 = 21$  and  $w_3 = 52$ .

To isolate the cycle wavelength of 52 weeks, method 1 was applied, using a 21-week average (same as  $w_2$  wavelength). This is a case where there were still traces of the 9-week cycle in the result, so a second average with a span of 9 weeks was used to removed these, giving the clean 52-week cycle shown, superimposed on the original data in Figure 8.6. The magnitude of this cycle is around \$10. About half of the true value. As expected, there has been a considerable amount of attenuation of the

cycle by the two averaging processes.

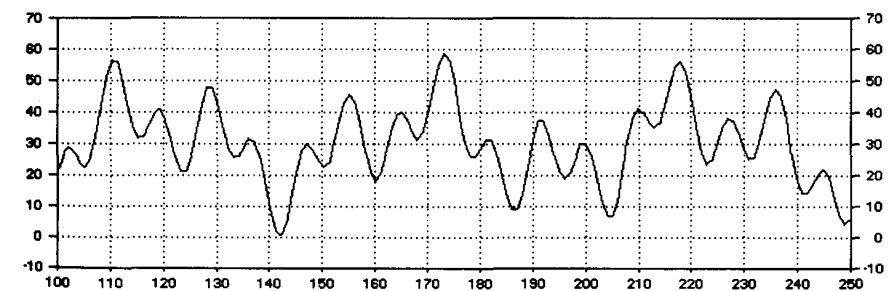
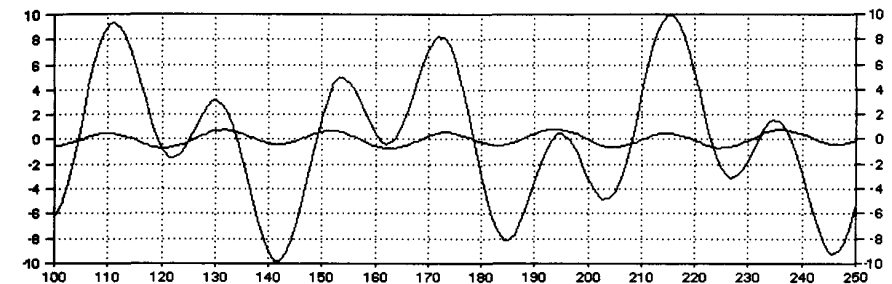


**Figure 8.6.** The application of a 21 week average followed by a 9-week average removes the cycles of wavelengths 21 weeks and 9 weeks, leaving a clean 52 week cycle. The 9-week average was required in order to remove traces of the 9-week cycle from 21-week averaged data.



**Figure 8.7.** Lower panel: the complex mixture of three cycles. Upper panel: the 9-week average difference isolates the 9-week cycle quite cleanly.

To isolate the cycle wavelength of 9 weeks, method 2 was applied, using a 9-week average difference (same as  $w_2$  wavelength). The result is shown in the upper panel of Figure 8.7. In this case it was not necessary to apply any further smoothing average, you can see the magnitude of the cycle is around \$20. There has been very little attenuation by the application of an average difference.



**Figure 8.8.** Lower trace: the original three-cycle combination. Upper trace: The trace with the largest magnitude is the result of applying a 9-week average to the original data. A 21-week average difference is then applied to give the clean 21-week cycle. The magnitude of this is severely reduced to about \$2 from the original \$20.

To isolate the cycle of wavelength 21 weeks, method 1 was applied, using an average of span 9 weeks. The result of applying this average is shown in the upper panel of Figure 8.8.

At this stage there is little loss of magnitude of the combination of 21-week and 52-week cycles that have come through. At the next stage, however, where a 21-week average difference has been applied to re-

move the 52-week cycle, there is a drastic reduction in magnitude, down to about \$2. Even so, it is quite clear we have proved the existence of a cycle with a wavelength of 21 weeks by this method.

As you can see from this last isolated cycle, the difficulty with this sequential method is that sometimes it is difficult to estimate the magnitude of the various cycles present in the mixture of cycles, although we can deduce their wavelengths quite easily.

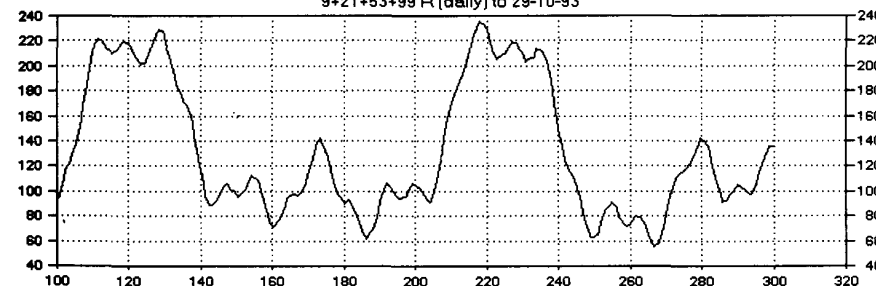
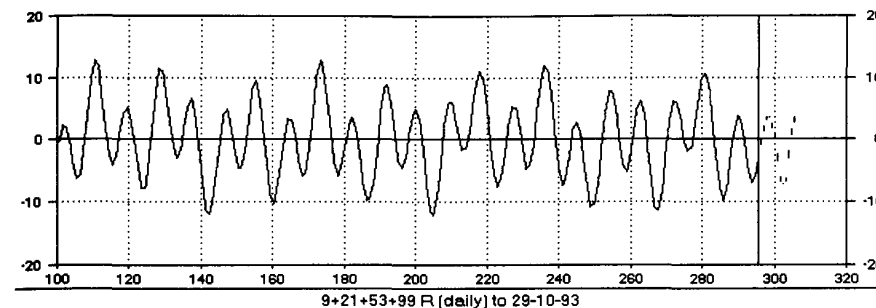
The following method of isolating cycles is far superior because it is only necessary to specify one value, the wavelength of the cycle that the user desires to isolate.

### AVERAGE MINUS AVERAGE

Although this method is also based on average differences, the difference in this case is the difference between two averages, rather than the difference between an average and the original data. For those investors without a computer, the procedure is to take a moving average with span equal to the wavelength of the cycle to be isolated. The average should be centered as in the previous method. A second moving average is calculated with a span half that of the first average, and this is again centered. The next step is simply to take the difference between these two averages.

For those with a computer, the best result is obtained when the second average is a weighted average. This is the method used in the examples that illustrate this approach. In order to have an even more demanding test, a combination of cycles of wavelengths 9, 21, 53 and 99 weeks was calculated. In order to approach more closely the relative magnitudes of cycles in stock market data, the 9-week cycle was given a magnitude of \$20, the 21-week cycle a magnitude of \$40, the 53-week cycle a magnitude of \$80 and the 99-week cycle a magnitude of \$120. There is also a constant amount added to make the lowest point non-zero. The data terminates at week 300, and particular attention will be paid in the examples

to an estimation of the isolated cycles between the last calculated point, which will be half a span back from week 300 and a point some weeks into the future.



**Figure 8.9.** Lower panel, a combination of 4 cycles of wavelengths 9, 21, 53 and 99 weeks, with magnitudes \$20, \$40, \$80 and \$120 respectively. Upper panel: the result of applying a 9/5 week average difference is the presence of a 9-week cycle, and estimated magnitude about \$18. The dashed line is the best estimate of the direction the averaged data would have taken from the last true calculated point, which is 4 weeks in the past (at the vertical solid line) and into the future. The present time is week 300.

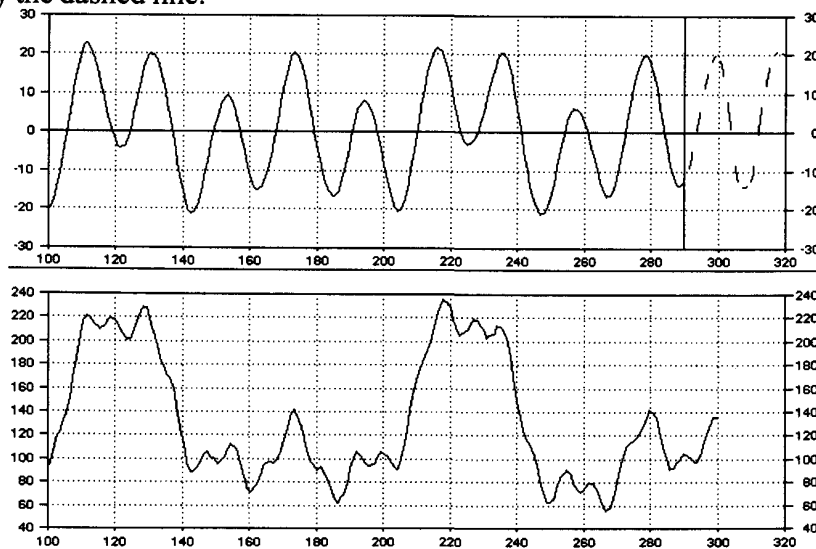
For simplicity, the averages used will be described as a 9/5-week average difference. (The difference between a 9-week and 5-week average has been taken). In Figures 8.9 to 8.12 the combination of cycles is shown in the lower panel so the position of the peaks and troughs in the extracted cycles can be compared with the original trace.

As is the case with centered averages, the difference of the two averages will show a loss of points at the beginning and end of the plot. The average with the largest span determines the number of points lost, as with a

simple average. The last plotted point is marked by a solid vertical line in the top panels of the following figures, and the dashed line shows the estimated position of the plot up to the latest data point and forwards for some time into the future. The estimated position into the future will be used shortly to try to estimate how the data itself will move in to future.

### The 9-week cycle

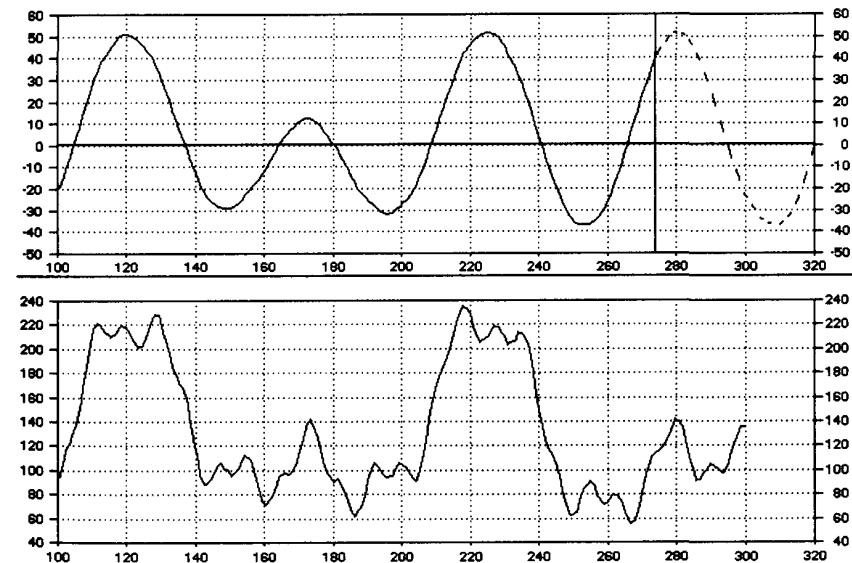
This combined cycle and the result of applying a 9/5-week average difference are shown in Figure 8.9. The lower panel shows the original combination of four cycles, while the upper panel shows quite clearly the 9-week cycle is present in the data with an estimated magnitude of about \$18, close to the original value of \$20. Because the calculation is based on a centered average, the last calculated point is 4 weeks in the past. The estimated course of the average from that point into the future is shown by the dashed line.



**Figure 8.10.** Lower panel, the combination of four cycles of wavelengths 9, 21, 53 and 99 weeks. Upper panel: the result of applying a 21/11 week average difference is to show 21-week cycle, and estimated magnitude about \$35. The dashed line is the best estimate of the direction the averaged data would have taken after the last true calculated point, which is 10 weeks in the past (at the vertical solid line). The present time is week 300.

### The 21-week cycle

To isolate the 21-week cycles requires a 21/11-week average difference, as shown in Figure 8.10. The extracted cycle, while not as close in shape to a sine wave as one would like, nevertheless has a wavelength of 21 weeks and an estimated magnitude of about \$35, compared with the original value of \$40. The estimated course of the average from the last calculated point 10 weeks in the past into the future is shown by the dashed line.

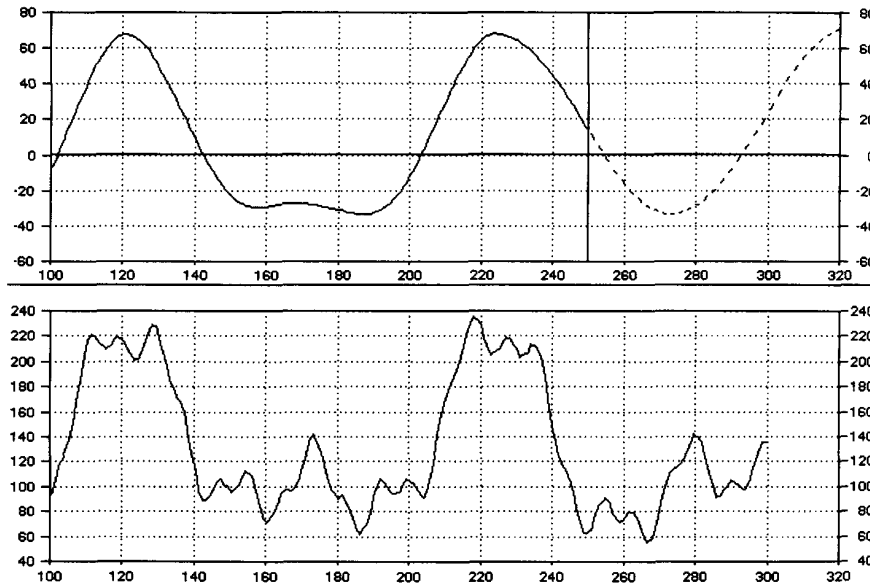


**Figure 8.11.** Lower panel, a combination of 4 cycles of wavelengths 9, 21, 53 and 99 weeks, each of magnitude \$20. Upper panel: the result of applying a 53/27 week average difference is a 53-week cycle, and estimated magnitude about \$18. The dashed line is the best estimate of the direction the averaged data would have taken after the last true calculated point, 26 weeks in the past (at the vertical solid line). The present time is week 300.

### The 53-week cycle

To isolate the 53-week cycles requires a 53/27-week average difference, as shown in Figure 8.11. The extracted cycle shows some variation in the

magnitude, but clearly has a wavelength of 53 weeks. The average magnitude is about \$85, compared with the original value of \$80. The estimated course of the average from last calculated point 26 weeks in the past and into the future is shown by the dashed line.



**Figure 8.12.** Lower panel, a combination of 4 cycles of wavelengths 9, 21, 53 and 99 weeks, each of magnitude \$20. Upper panel: the result of applying a 111/57 week average difference is to show the presence of a 99-week cycle, and estimated magnitude about \$18. The dashed line is the best estimate of the direction the averaged data would have taken after the last true calculated point, or 55 weeks in the past (at the vertical dotted line). The present time is week 300.

### The 99-week cycle

On the basis of the discussion and results so far, we can expect that to isolate the 99-week cycle will require a 99/51-week average difference. However, when this is applied, considerable traces of the 53-week cycle come through, making it difficult to determine the exact wavelength and magnitude. By moving up to a 111/57-week average difference a much better view of this cycle emerge, as shown in the upper panel in Figure

8.12. The estimated course of the average from last calculated point 55 weeks in the past and on into the future is shown by the dashed line.

These examples show that the use of the average-minus-average is an extremely valuable way of investigating a complex mixture for the presence of a particular cycle. It is particularly useful to discover that the magnitude of the extracted cycle is usually only slightly diminished. This will have implications when we apply the method to real stock market data in an endeavor to find out which cycles are present and their influence on the movement of the stock price itself.

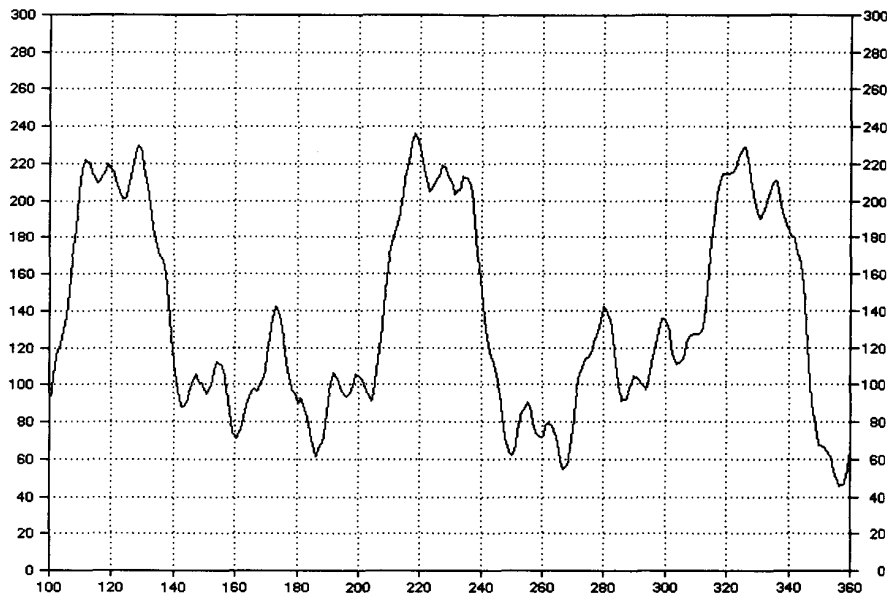
### The current and future status of the cycles

In these examples, we showed the estimated position of the cycles up to and past the present time, or in these examples week 300. The underlying purpose of these exercises in extracting the cycles is to predict what the combined data will be doing in the near future. Once we have established this is possible, even though there may be limitations, we are in possession of a method that can be applied to market data with obvious benefits.

Since the penalty for isolating a particular cycle is the loss of a number of points equal to one less than half a span of the average, (we are isolating cycles with wavelengths similar to the span of the average being used,) then we lose half of a wavelength at the end of the cycle. Even to bring the position up to date, to estimate the current state of the isolated cycles, requires an extrapolation of over half of a wavelength. Gathering together the results from these examples, we find the status of the various cycles as:

- 9-week, falling, estimated magnitude \$18 (actual \$20)
- 21-week, just topping out, estimated magnitude \$35 (actual \$40)
- 53-week, falling, estimated magnitude \$85 (actual \$80)
- 99-week, rising, estimated magnitude \$95 (actual \$120)

Since only the longer term cycle is rising and the other three falling for



**Figure 8.13.** The movement of the complex data up to week 360.

the next few weeks, we can, without applying any arithmetic, we expect the combination of these cycles to fall over the very near future. Figure 8.13, contains a slightly larger section of data and shows that this happens. The original data fell between weeks 300 and 305 before rising slightly, hesitating, and then making a large advance. This large advance finally topped out around week 325.

We need to see now whether, by applying a little more arithmetic, we can deduce that this large advance will happen over the next twenty weeks or so from week 300. One problem is that this time scale of 20 weeks is greater than the wavelength of the shortest 9-week cycle, meaning that it will pass through two peaks or troughs in the time period. The first step is to measure how far past the last turning point, *i.e.* peak or trough, each cycle is, and the current value:

- 9-week, 2 weeks past peak, current value +\$2
- 21-week, just at peak, current value +\$20

- 53-week, 20 weeks past peak, current value -\$23
- 99-week, 25 weeks past trough, current value +\$20

The next step is to deduce how far past a peak or trough the cycle will be in 20 weeks time. Its value can then be estimated by looking at a similar point in the cycle development in the recent past. We will then look at the change this means from the current position and add up all these changes to get an overall change from the current position. This approach is necessary because of the presence of a fixed amount in the complex wave form that was added in order to avoid negative values.

#### *The 9-week cycle*

In 20 weeks time, the 9-week cycle will be 22 weeks past the last true peak, and will have passed through 2 more peaks. In 18 weeks time it will be in the same vertical position as now, so by the time 20 weeks have elapsed, it should be about 4 weeks past a peak, *i.e.* nearly at a trough (half of a wavelength past a peak) and have an approximate value of -\$10.

This gives us a change of -\$12 from its current position. It will rise from this position.

#### *The 21-week cycle*

In 20 weeks, the 21-week cycle will be 20 weeks past the last true peak, or week 300. It will therefore be just one week short of the peak, and should have an approximate value of +\$20. It will start to fall from this position in two weeks time.

The change from the current position is about zero.

#### *The 53-week cycle*

In 20 weeks time this cycle will be 40 weeks past the last true peak. Since

there will have been an intermediate trough at around week 306 (half a wavelength, *i.e.* 26 weeks, past the last true peak, week 280), this puts the cycle 14 weeks past this trough, giving it a further 12 weeks or so before it reaches the peak. It is therefore just short of the mid-point of its climb, with a value just below zero, about -\$5.

The change from the current position is about +\$18. It will continue to climb for 12 weeks.

### *The 99-week cycle*

In 20 weeks time this cycle will be 45 weeks past its trough. It will be 10 weeks short of a peak (half wavelength is 55 weeks). Its estimated value is therefore about \$40.

The change from the current position is about +\$20. It should top out around week 330 as this 99-week cycle has the greatest magnitude of the three.

From these changes of -\$12, zero, +\$18 and +\$20, we expect a total change of +\$26. From Figure 8.13, we can see the change between week 300 and week 320 was approximately \$80. Thus, (**very importantly!**), we have deduced the direction of the change correctly with the estimated amount less than half of the actual change. This is easily explained on the basis of the loss of magnitude when the cycles were extracted using the difference between the two averages.

In summary, we were able to deduce correctly from this study of the individual cycles in the data that the complex data would:

- fall over the following few weeks from week 300
- make a considerable rise by week 320
- probably top out around week 330

Now that we have seen the power of these methods, it is of interest to

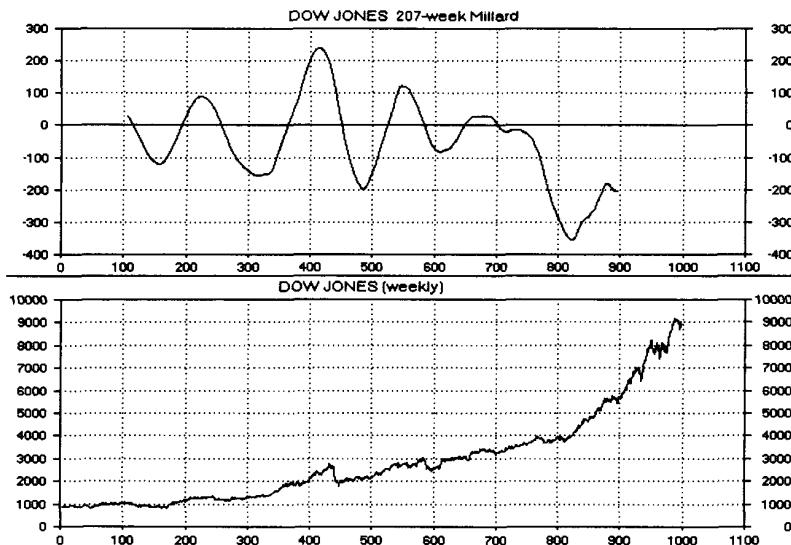
apply them to some real market data to give us a flavor of what is possible.

## CYCLES IN THE MARKET

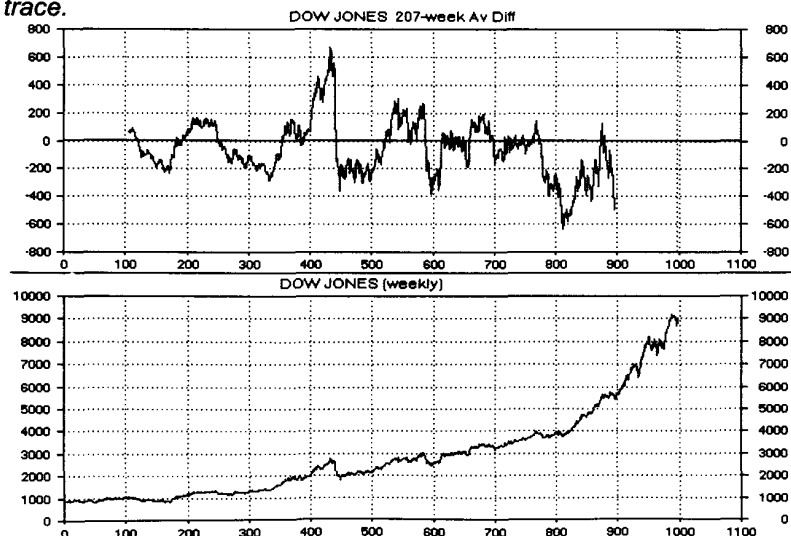
The discussion in chapter 6 showed there are cycles present in stocks, currencies, etc. These cycles vary from very short term, with wavelengths less than 10 days up to long term cycles with wavelengths of two years or longer. What was not discussed was whether cycles are present in a market index such as the Dow-Jones Index. This index is derived from its 30 constituent companies. If we accept the existence of a four year business cycle, when we consider cycles of shorter wave length, our inclination is to think that each stock is subject to its own individual cyclic movement. Because of this, we expect the cyclic movements of less than 4 years wavelength to have been smoothed out by the averaging effect of the 30 composite stocks. Thus, on the basis of this argument, the only cycle we would expect to see to any great extent in the movements of the Dow-Jones Index would be one with a wavelength of around four years.

In order to view this cycle, a plot of the 207-week (*i.e.* four years) average-minus-average is shown in Figure 8.14. The lower panel shows the Dow-Jones Index from May 1979 to May 1998. The upper panel is the result of the calculation, and is cut off for the last 103 weeks because the calculation is based on a centered average.

The interesting point is that while the four year cycle was fairly regular during the 1980s, it became very distorted around week 700, in 1992. It is now going through a highly unpredictable phase. It could be argued that at the present time (June 1998) the cycle has disappeared. It will return to a regular state some time in the future, but that time is not predictable. During its regular phase it reached a maximum magnitude of around 450 points.



**Figure 8.14.** Lower panel: A plot of the weekly closing values of the Dow Jones Index from May 1979 to May 1998. The time axis is marked in weeks to simplify the measurement of wavelengths. Upper panel: the 207-week average-minus-average isolates the four year cycle. The last 103 weeks are lost from the trace.

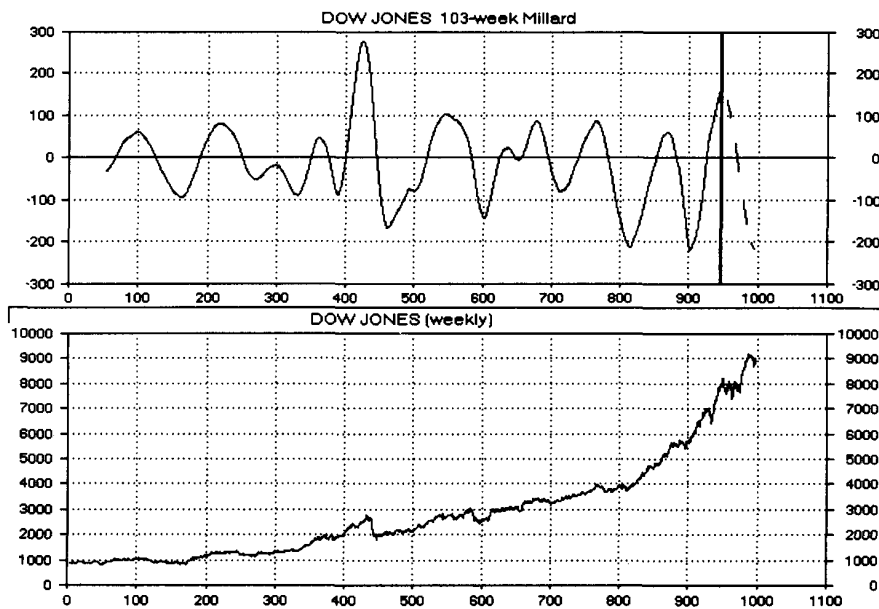


**Figure 8.15.** A plot of the 207-week average difference shows the sum of all of the cycles of less than four years wavelength present in the Dow-Jones Index. A number of major peaks about 100 weeks apart can be discerned.

One laborious way of analyzing for the presence of shorter term cycles would be to use the moving average minus moving average method, running through all the values from say five weeks up to four years. However, we can take a look at the total picture for all cycles of wavelength less than four years by using the four year average difference. If we use weekly data, this means an average difference such as 207 weeks. The result of applying this is shown in the upper panel of Figure 8.15.

A study of this average difference should then tell us if our view that there are no cycles other than four year cycles in the Dow Jones Index is correct. At first sight the plot in Figure 8.15 seems to be meaningless, other than the fact that the sum of all of these movements has made a contribution that has varied from +650 points to -650 points. The time scale has been marked in weeks rather than with dates so the distance between important peaks and troughs can be readily estimated. We note that important peaks occur at approximately 560, 660, 770 and 870 weeks. The differences between these peaks are 100, 100, 110 and 110 weeks. Since this is around two years, we can deduce that there could be a cycle of two year wavelength present in the Dow Jones weekly closes.

This can now be checked by using the average minus average method, using a span of say 103 weeks for the longest span, and 51 weeks for the shortest span (the value of 51 is not critical, similar results will be obtained with 53 or 55). This should isolate cycles of wavelength around 103 weeks if they are present. The result is shown in Figure 8.16. Quite clearly, in the upper panel we see a cycle whose wavelength is a nominal 103 weeks, *i.e.* two years. As expected for real data, we do not have a pure sine wave, but a wave whose wavelength and magnitude are subject to a variation due to the effect of random forces. There is, for example a slight distortion around week 650 due to the presence of a temporary cycle of shorter wavelength. The magnitude has varied from about 250 points to a maximum of about 400 points in 1987. At the most recent calculated point, it is about 350 points. There is a loss of 51 points at the end of the calculation because it is based on a 103-week centered average. Since the cycle is now quite regular, it is possible to estimate how it

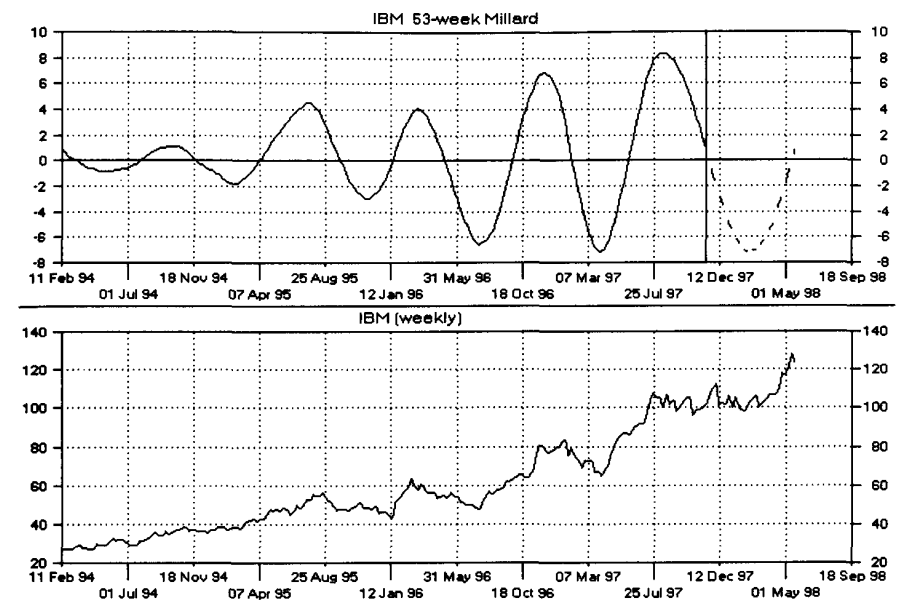


**Figure 8.16.** By using a 103-week average-minus-average calculation the presence of a two year cycle in the Dow Jones Index is clearly demonstrated. As expected from real market data, the cycle is subject to a variation in wavelength and magnitude. Since there is a loss of 51 points at the end of the trace from the position of the solid line, the last section (dashed line) of the plot is an estimate. The latest magnitude is about 350 points.

may have moved over this period, as shown by the dashed line in Figure 8.16.

Many other cycles can be found in the weekly closing of the Dow-Jones Index by this method. In most cases you will find that major peaks and troughs in the cycles in the Dow will be mirrored by peaks and troughs in those stocks containing cycles of similar wavelength. This is the principle of commonality referred to by Hurst.

In the case of individual stocks, we can take **IBM** as an example. The plot of **IBM** weekly closings since February 1994 is shown in Figure 8.17. For anyone skeptical about the presence of cycles in stock market data, this provides an excellent example of the extraction of a clean, 53-



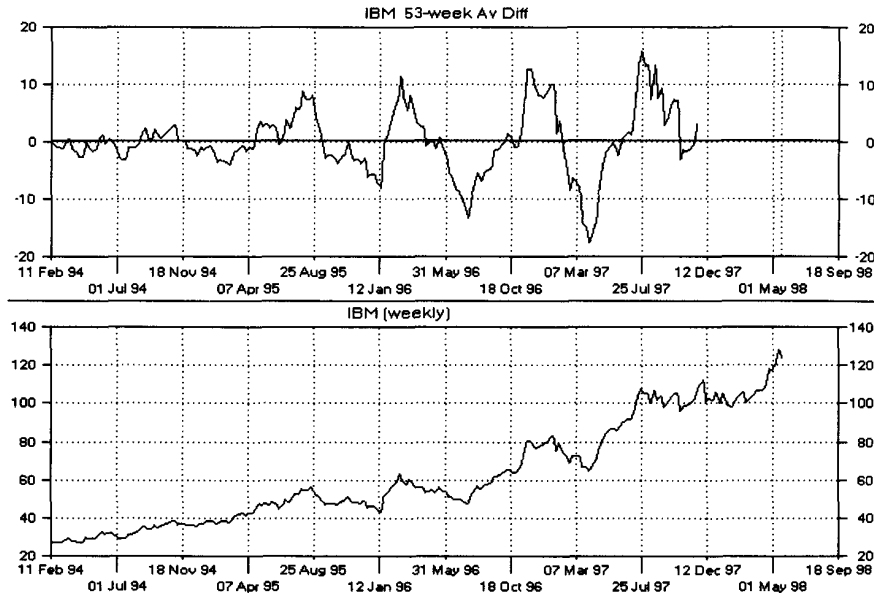
**Figure 8.17.** Lower panel: a plot of the weekly closing of IBM since early 1994. Upper panel: the 53-week (one year) cycle extracted by using a 53-week average-minus-average calculation. Since there is a loss of 26 points at the end of the trace from the position of the solid line, the last section (dashed line) of the plot is an estimate. This is an excellent example of the variation in magnitude of cycles in the stock market.

week (one year) cycle by the use of the average-minus-average method.

The magnitude is steadily increasing over the period. This is an illustration of the principle of variation that operates on cycles in real market data. You can also see a correlation between troughs and peaks in this cycle and the start and end of upward legs in the stock price movement.

The latest magnitude of this cycle can be estimated as \$15. Since by the method used there is an attenuation of the magnitude, the real contribution to the most recent upward movement in the stock price will be greater than this. By inspection of the original data, the trough in the stock price occurred on April 4, 1997, with the stock at \$64<sup>5</sup>/<sub>8</sub>, and by July 25 the price had reached \$107. While not all of this rise is attributable to the 53-

week cycle, and shorter wavelength cycles will have made a contribution, this does suggest that the estimated magnitude of the 53-week cycle is much too low.



**Figure 8.18.** The 53-week average difference of the weekly closing values of **IBM** show all those cycles with wavelengths of 53 weeks and less.

An appreciation of the contribution made by all cycles of 53-week or shorter wavelength can be made by the use of a 53-week average difference. This is shown in Figure 8.18. You can now see that this complex sum of cycles was responsible for a rise of at least \$32 from the low point on April 4, 1997.

Cycles can only be used in a predictive sense when they are going through a regular phase. Thus, the four year cycle in the Dow-Jones Index, Figure 8.14 is useless from this point of view. The 53-week cycle in **IBM** is a different matter. Because it is still sinusoidal in shape, we can, extrapolate it to the present time and on into the near future (Figure 8.17). Since we have seen the magnitude increasing, we expect it to peak out at a value of around \$10. The time of this peak should be about 53 weeks

from the last peak, on August 15, 1997. This gives us August 21, 1998 as the probable maximum of this 53-week cycle. Since at the last data point, on May 22, 1998 the stock was at \$123<sup>5</sup>/<sub>8</sub>, and the value of the cycle was around zero, we would anticipate a rise of at least \$10 in the stock price by late August unless shorter term cycles are already falling and acting in the opposite direction. Similar methods would have to be applied to isolate shorter term cycles before action could be taken. As shown in the next chapter, this method is used together with channel analysis so that investment decisions are taken when the two methods are consistent with each other.

These few examples serve to show how, by a simple, if tedious, set of calculations, important information about the status of various cycles in market data can be determined. The calculations can readily be carried out with a spreadsheet, or a number of investment software packages. We can either look at the total contribution made by a group of cycles, as was shown in the **IBM** case, or that made by a specific cycle, again illustrated by **IBM**. By this means we can find out if that particular cycle is going through a regular phase when its contribution to the overall movement can be estimated, or through a disordered phase when its contribution cannot be quantified.

# CHAPTER 9

## Applications of Numerical Analysis

In this chapter we apply the methods discussed in chapters 7 and 8 to real market data. For each of the examples we will display channels that are based on templates derived from a smoothed moving average calculation, showing how the particular spans were chosen. The channels will be constructed at points of interest on the historical chart to see how they would have predicted the movement from that point in time. At the same point in time an analysis of the status of important cycles will also be investigated in order to act as confirmation or otherwise of the message being given by channel analysis. Rather than repeating the term '*average-minus-average*' calculation, giving the span of both centered averages, we will use the term '*cycle highlighter*' to mean the same thing, specifying the span of the largest of the two averages, for example *53-week cycle highlighter*.

As in chapter 6, the stepwise approach of using weekly and then daily data is most efficient. Some of the examples used here were also analyzed in chapter 6 by the graphical method. We will see that the channels produced by calculation will be quite similar. Since centered averages produce channels that terminate half a span back in time from the last data point, a computer program such as **Microvest 5.0™** (see Appendix) uses a quadratic curve fitting routine based on the last few calculated points to extrapolate the channels to the present and into the future. Such a program also adjusts the vertical position of the channels to achieve the permitted number of points to lie outside the channel boundaries. If these extrapolated channels are violated by the price,

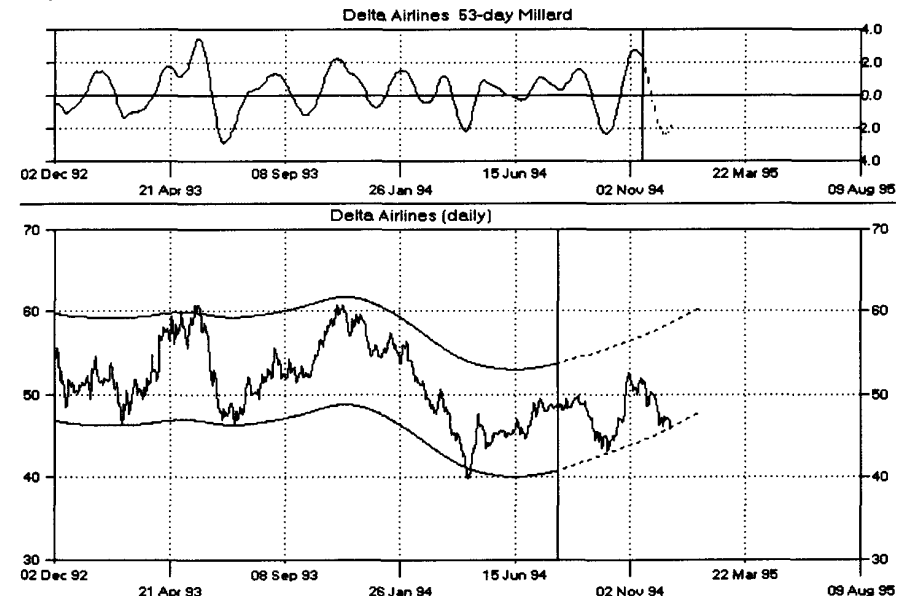
then they have to be bent in one direction or another to remove the violation. To do this, exactly the same logic has to be applied as in the graphical method. A more detailed look is taken in chapter 10 at such turning points in channels.

### DELTA AIRLINES IN DECEMBER 1994

The position for **Delta Airlines** with daily data on December 22, 1994 is shown in Figure 9.1. The stock had fallen each day from December 19 when it closed at  $\$47\frac{1}{8}$  and close of  $\$45\frac{3}{4}$  on the 22nd before jumping the next day to  $\$49\frac{5}{8}$ . Channel analysis by the graphical method in chapter 6 indicated the stock was near a rising lower boundary and therefore could be bought. The channel calculated from a centered moving average span 201 days is shown in the lower panel. This span was chosen because a 200-day unlagged average is typically chosen by chartists as a sign that the long term trend is rising. The dotted lines show where the boundaries are estimated to lie between the last calculated point (100 days ago) and the current time. Quite clearly the channel is well past its turning point and has been rising for some time. The daily falls in price from December 19 took the stock down to the estimated position of the lower boundary on December 22. The investor could not buy at this point because the price was still falling, and a trough has to be formed to confirm the position of the lower boundary. Thus, as discussed in chapter 6, the investor would be forced to wait until the 23rd. A rise during the early part of the 23rd would have given the investor some indication the stock would close higher, thereby forming the required trough. It is of interest to see if the use of cycle analysis could have anticipated the jump in price by the close on December 23, so the investor could have gotten into the stock a day earlier.

We can see in the lower panel of Figure 9.1 a previous occasion when there was a trough in the data that bounced up from the boundary since the boundary changed direction. This point is October 6, 1994, and is 54 days back from December 22. Since on December 22 we are expecting a bounce up from the boundary within a day or so. This means we would have two troughs about 54 days apart, signifying a cycle with a wavelength of 54 days. We can use a 53-day cycle highlighter to check the status of this cycle. This is shown

in the upper panel of Figure 9.1, with the estimated movement of the cycle since the last calculated point 26 days ago shown as a dashed line. We see that the cycle is about to bottom out, and its magnitude is just over \$4. Allowing for the loss in magnitude by the process of isolating the cycle, we might expect the true magnitude to be around \$6.

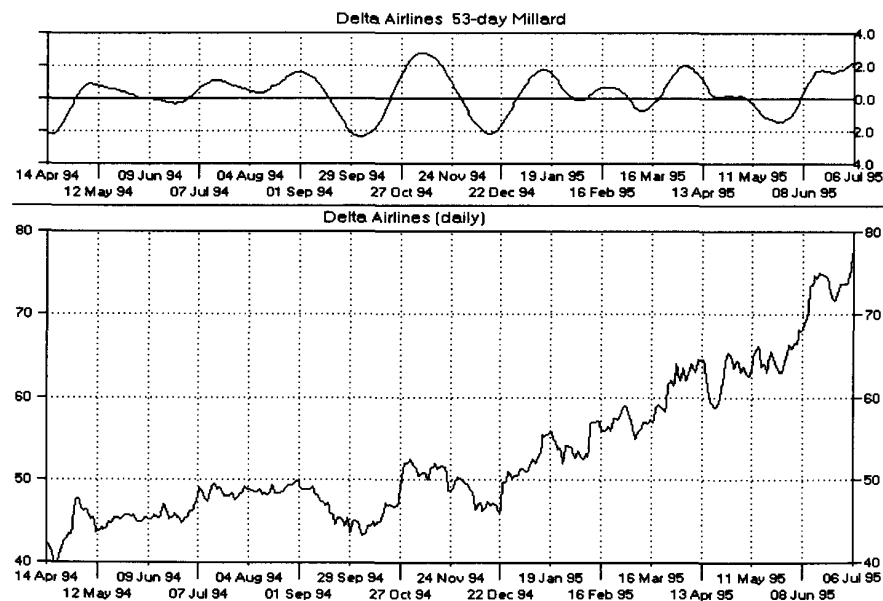


**Figure 9.1.** Lower panel: plot of daily closing prices of Delta Airlines December 22, 1994. The channel is derived from a calculation of a centered 201-day average. The estimated portion of the channel is shown by the dashed boundaries. Upper panel: cycle analysis using 53-day cycle highlighter. The last calculated point is indicated by the vertical solid line. The dashed line is the estimation of the cycle from that point in time.

From this evidence we come to the conclusion that a short term up trend will soon begin, or has perhaps just started, this should take the price up by at least \$6 over the next half cycle, 26 days. Since the channel is also rising, and rose nearly \$2 during 26 days, this rise will be added in. The expectation is for a rise of nearly \$8 from the current level of  $\$45\frac{3}{4}$  over the next 26 days when the 53-day cycle will reach its peak. This gives us a short term target level of around \$54. We are comfortable that, on the morning of December 23, with the price rising from the opening of the market, it is correct to buy **Delta**

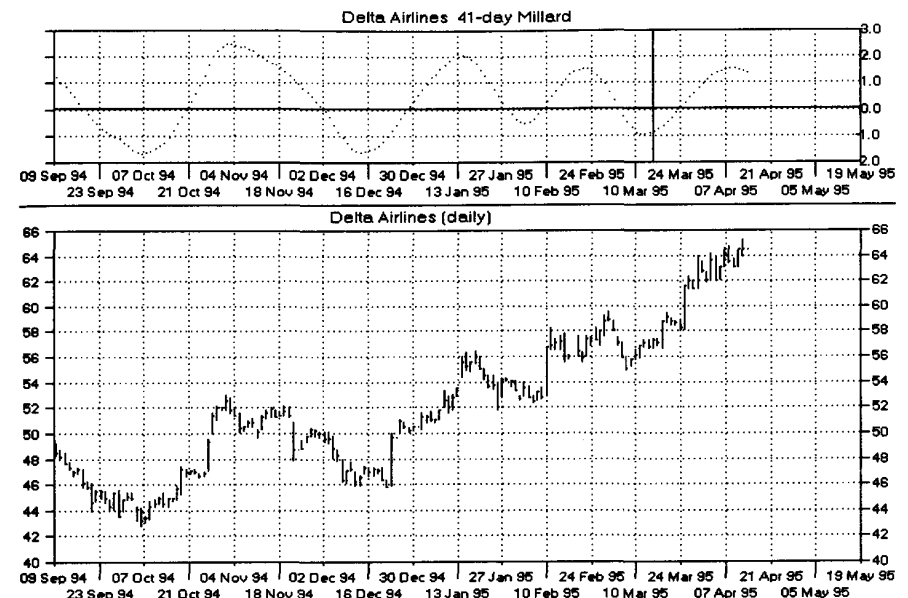
**Airlines**, at a price of around \$50 to \$50<sup>1</sup>/<sub>8</sub>.

The price rose quite steadily from this point, and it is interesting to see if there was any indication of the topping out of the 53-day trend around 26 days on from December 22. There was such an indication, because the price reached \$56 some 20 days on from December 22, compared with the prediction for a rise to \$54 in this time.



**Figure 9.2.** Lower panel: daily closing prices of **Delta Airlines**. Upper panel: the cycle analysis using 53-day cycle highlighter. The 53-day cycle becomes distorted from January 1995.

Figure 9.2 shows that after a small dip, the price rose quite steadily over the next few months. The upper panel shows the 53-day cycle over the next few months. While it still existed over the months following the decision to buy in late December, you can see it became distorted by interference from cycles of shorter wavelength. We were only able to use this cycle in December as an aid to our decision to buy because it became symmetrical and therefore predictable. It is vital that decisions are not taken when a cycle is distorted, because any extrapolation to the current time from the cut-off point will be subject to considerable error.

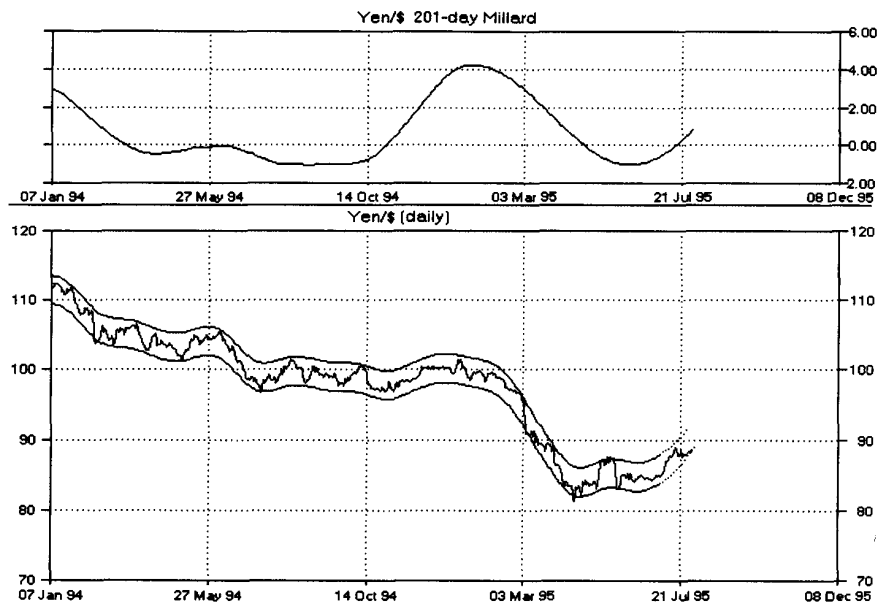


**Figure 9.3.** Lower panel: daily ranges in **Delta Airlines** up to April 1995. Upper panel: the 41-day cycle highlighter shows a regular 41-day cycle that is just topping out in April. The cycle is estimated from the last calculated point, the position of the vertical solid line.

Figure 9.3, shows the daily ranges in **Delta Airlines** up to April 1995. The upper panel shows the result of applying the 41-day cycle highlighter. In this case this short term cycle was quite regular during the period following the buying decision in December.

### Japanese Yen in 1995

A channel drawn for the Yen/US\$ ratio in August 1995 is shown in the lower panel of Figure 9.4. Only one channel is drawn, because the main point to be made from this chart is the similarity in shape between the 201-day cycle extracted by the highlighter and this channel. The cycle had an estimated magnitude of around 5.1 during 1994/95, but the true value would have been higher.



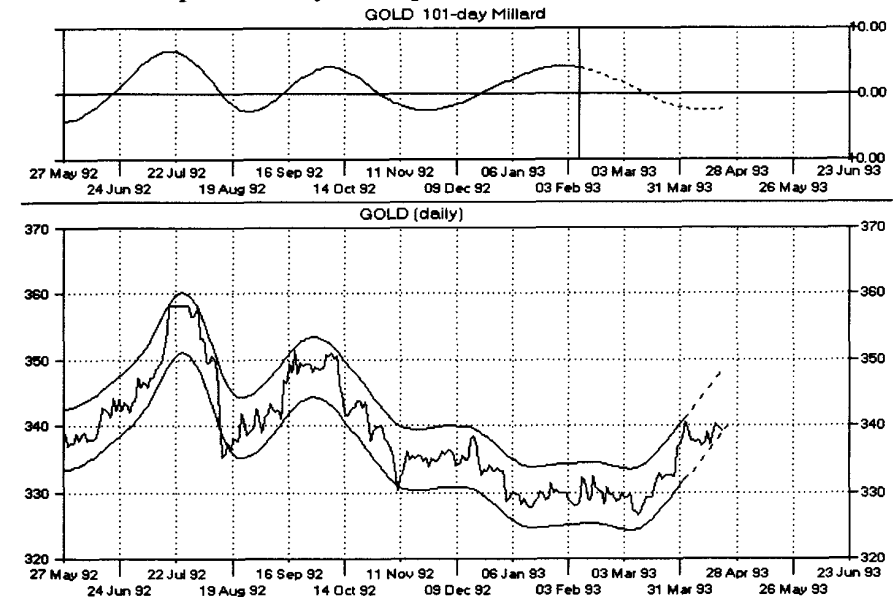
**Figure 9.4.** Lower panel: A single channel drawn for the Yen/US\$ ratio. Upper panel: the 201-day cycle highlighter shows the 201 day cycle is very similar in shape. This leads us to expect a considerable rise in the channel, therefore carrying the price higher.

Because of similarity in shape, the investor, when viewing the situation at this point in time, would feel the channel is due for a rise. On the basis of symmetry, you could expect the channel to rise back to the 100 level. Since the cycle would be expected to reach its next peak around September/October 1995, it can be anticipated that the channel would top out at the same time at a ratio of about 100. The ratio of 88.305 on the August 2, as discussed in chapter 6, has placed the ratio at a point close to the rising boundary, so that the investor could now take a decision.

In this instance, the medium term cycle has performed the same function as a second, outer channel in giving a target where the ratio should move. The ratio rose more rapidly than anticipated, reaching 104 within six weeks of the decision point on August 2.

## GOLD IN 1993

The chart of the gold price to April 21, 1993 is shown in Figure 9.5. A channel has been calculated and drawn by using a 35-day centered average as a template. The gap of 26 days has been estimated and is shown as a dashed line. The two peaks in July and September 1992 in the channel,

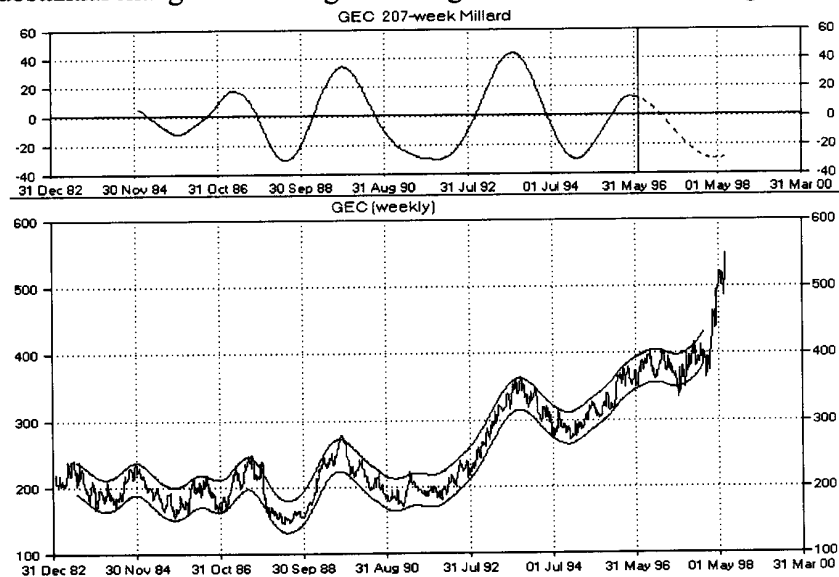


**Figure 9.5.** Lower panel: a chart of the gold price to April 21, 1993. The channel drawn is similar to the inner channel in Figure 6.15 (chapter 6). Upper panel: the 101-day cycle has probably just bottomed out and will give an impetus to the upward movement of the channel.

and the trough in August 1992 were obviously due to a cycle with large magnitude. The separating two peaks is about 52 days, with the trough at midway. This means that a cycle of wavelength 52 days was present at that section of the chart, but unfortunately, this cycle subsequently diminished to a very low magnitude, so it cannot be used for predicting future movement. When a 101-day cycle was tested by the highlighter, the trace given in the upper panel was obtained. This shows that this medium term cycle had just passed its bottom and therefore will be available to give additional impetus to the gold price (already in a channel that has been rising for some 25 days.)

## GEC

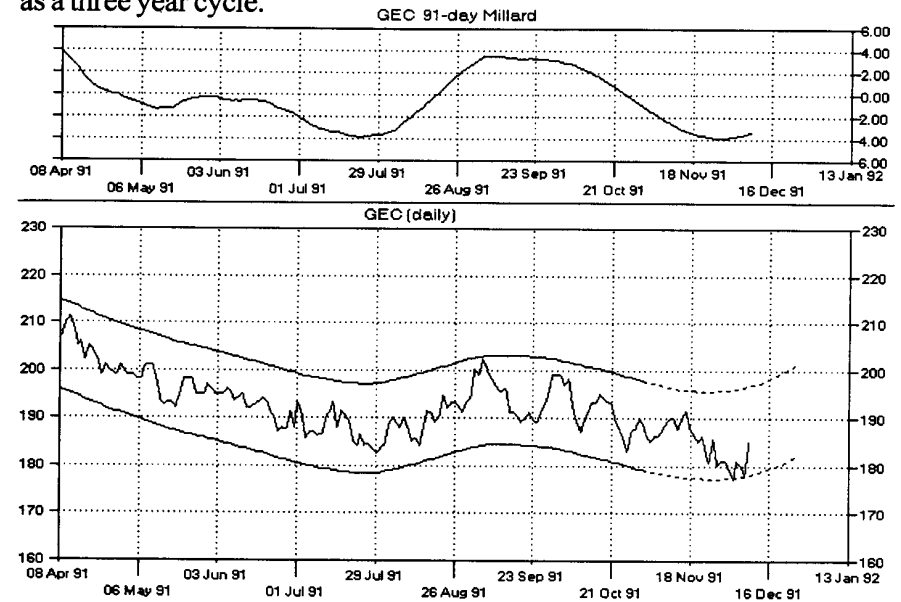
A GEC channel was given in chapter 6 as an example of gradually increasing wavelength and magnitude, and is shown again in the lower panel of Figure 9.6 with just a single channel drawn. When a 207-week highlighter was used to extract the four year cycle, the trace shown in the upper panel was obtained. You can see the nominal four year cycle appears to be responsible for the major peaks and troughs in the channel, but this cycle is subject to a substantial change in wavelength and magnitude. Since the vertical gridlines



**Figure 9.6.** Lower panel: a channel calculated for GEC, a good example of the principle of variation in wavelength and magnitude. Upper panel: the 207-week (four year) cycle produced by the cycle highlighter shows that this nominal cycle was mainly responsible for the peaks and troughs in the channel.

are 100 weeks apart, it is possible to get an appreciation of the wavelength changes by the horizontal distance between successive peaks and troughs. These are 65, 69, 94 and 67 weeks, so the wavelength, being double, passes through the values 130, 138, 188 and 134 weeks. This means the average wavelength of the cycle was closer to three years than four. Since a three year cycle is quite unusual in the UK stocks, the apparent wavelength of three

years is due to a mixture of a four year and a two year cycle which can appear as a three year cycle.

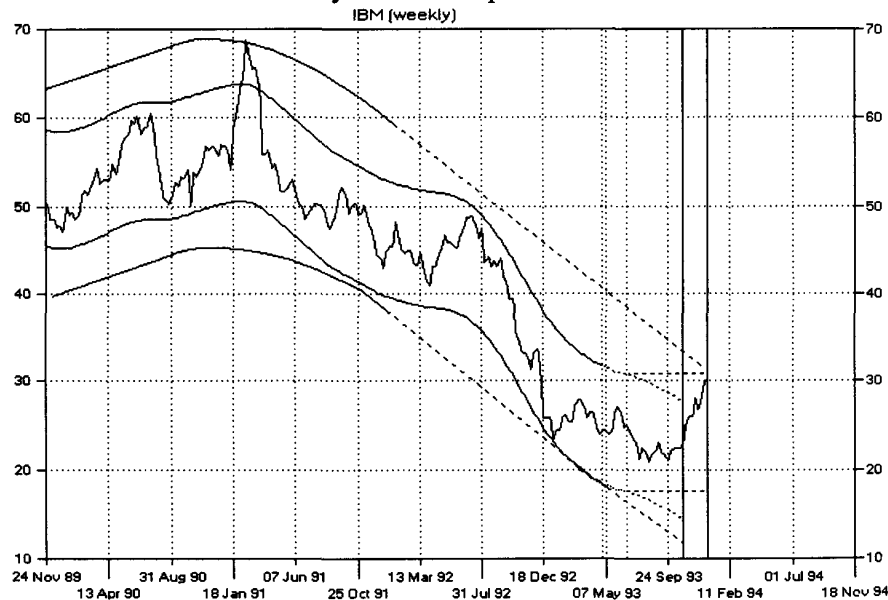


**Figure 9.7.** Lower panel: the position in GEC on December 9, 1991. This point is prior to a very large rise in the stock that almost tripled its price in less than two years. The single channel drawn is now headed up the price having bounced up from the lower boundary. Upper panel: The two major troughs in the channel are about 90 weeks apart. This suggests a 91-week cycle highlighter should be applied as shown. The major cycle is just past the bottom. Its effect should be to boost the rise in the channel.

Figure 9.7 shows the position in GEC on December 9, 1991, a point chosen because the price made a very large advance from that point. The channel has been rising for a few weeks after turning up in early November, and the price has bounced up from the lower boundary that ran through the two closely spaced troughs in the price movement. The two major troughs in the channel itself are some 90 days apart, and therefore suggests that a cycle of this wavelength is becoming important. Because of this the cycle highlighter was used with a span of 91 days, with the result shown in the upper panel. This cycle has just past its low point, and therefore could be expected to make a further contribution to the upward direction of the channel. This confirms that the investor could have bought the stock at that time. \

## IBM IN DECEMBER 1993

This stock and this time period have been chosen because just after a major turning point in **IBM**, the stock rose from a low of around \$20 in August 1993 to over \$100 in a few years. It is important to demonstrate that



**Figure 9.8.** The weekly closing prices of **IBM**. The inner channel is based on a 53-week centered average, and the outer on a longer span. The solid vertical lines show the position at two points in time, October 29, 1993 and December 23, 1993. In October, the extrapolation of the inner channel shows it still falling, by December, the rise in price to just under \$30 forces the channel to run horizontally. The investor would now be interested in the stock.

channel analysis can deal with such turning points, getting the investor into a stock in as short a time as possible after the turn while capturing a large percentage of the rise.

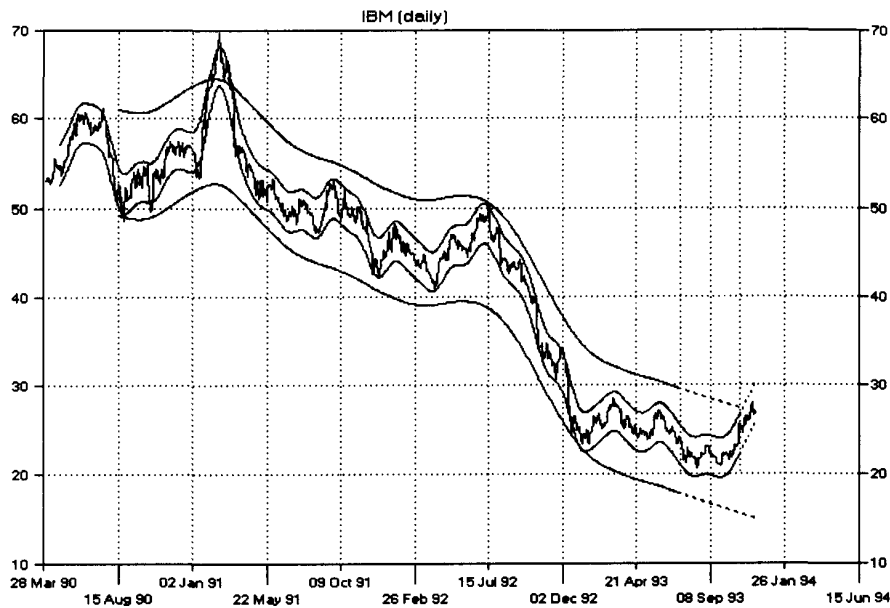
A chart of the weekly closing prices is shown in Figure 9.8. There are two vertical lines on the chart, one at the last data point, on December 24, 1993 and the other two months before on October 29, 1993. The reason for showing these is to emphasize the change that will have occurred in a calculation of

the channel at these two points. The inner channel is produced from a centered 53-week average, and the outer channel by a similar calculation using a longer term average.

On October 29, the stock closed at \$23. This was a rise of almost \$3 from its lowest point on August 13. The inner channel boundaries produced by the channel extrapolation on October 29, are the falling dashed lines. The extrapolation of the outer channel also shows the boundaries as the more or less straight, dashed, lines. This outer channel is also falling on October 29 and is expected to continue at least a few weeks. At this point the investor comes to the conclusion that because the extrapolated outer and inner channels are both falling, there is no opportunity to invest at this point. The investor can also see the stock price is nearing the falling upper boundary of the inner channel. Thus, at this time all the signs are negative.

By December 24, the inner channel can be extrapolated as running more or less horizontally. The main reason for this is the price had risen consistently from its value of \$23 in late October to  $\$29\frac{7}{8}$  by the close on the 24th. If the boundary was still drawn as continuing in the same direction as it was in late October, then this price level would be considerably above the upper boundary. The only way to avoid this violation of the upper boundary of the inner channel by the price is to force the channel to run horizontally. If the following week's closing price rises even higher, then this would force the channel to an even higher position, so it would then be rising, rather than progressing horizontally. This would be a very positive signal to consider buying the stock.

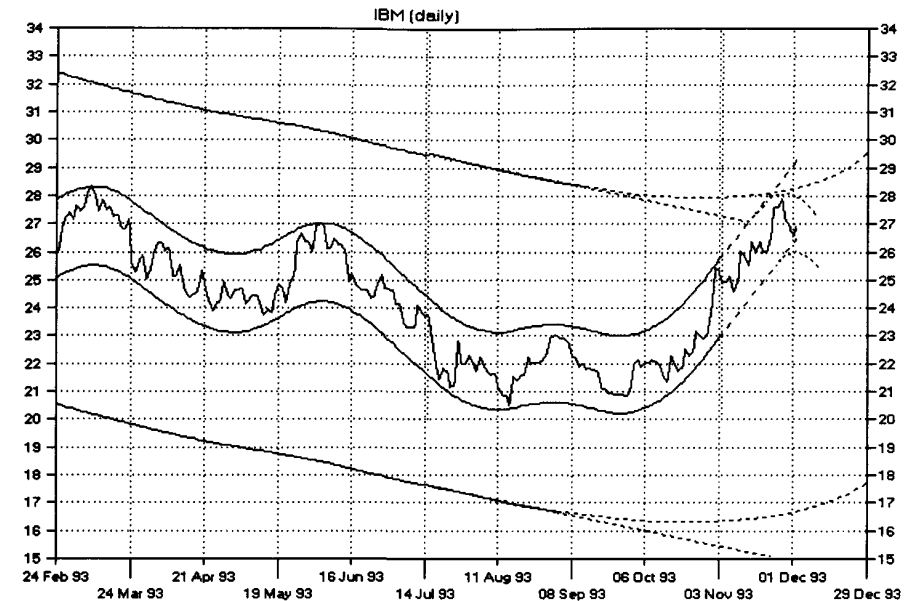
Since the investor would have been aware in early December that the rate of descent of the 53-week channel had slowed down rapidly, and it would be expected to reverse direction in the near future. It would have been prudent to look at daily data from the beginning of December onward so that changes in the daily channels could be analyzed for early indication of a change in climate for **IBM**.



**Figure 9.9.** IBM daily closing prices on December 3, 1993. The outer channel is a 210-day channel and the inner a 41-day channel. Each channel has been extrapolated by curve fitting, these sections being shown as dashed lines.

The position on December 3, 1993 is shown in Figure 9.9. The two channels that have been drawn are based on a 210-day average and a 41-day average. The reason for using a 201-day average has been commented on previously, and is that this, or rather the 200-day version of it, is widely used by technical analysts. The 41-day average is used to show up short term trends because it represents two months of trading days. The averages are extended by curve fitting technique. You can see that this type of extrapolation causes two problems. First, the outer boundary will pass below the level of the most recent prices and second, the rising upper boundary of the inner channel will clash with the falling upper boundary of the outer channel. Obviously the position of the boundaries must be changed.

In our rules for extrapolating channels, it was stated we should work from the outer channels inwards. The first step is to recognize that we must bend the



**Figure 9.10.** An enlarged section of the plot from Figure 9.9. The original extrapolation of the channels are the straight dashed lines. The curved lines for the outer channel are the result of bending the channel to avoid the peak in November 1993. The curved lines for the inner channel are because it now has to bounce back from the upper boundary of the outer channel.

outer channel up to an extent that at the very least will pass through the recent high point of \$27.875 on November 26. Then we must make the inner channel bounce back down from this. These changes are shown in the expanded plot in Figure 9.10. The original extrapolations are shown as almost straight dashed lines. The new, minimum position of the outer channel to clear the peak of November 26 can be seen as a curved dashed line, and the inner channel is now made to bounce back down. These new positions crystallize the view that the peak on November 26 is the highest to be expected for the immediate future, and that the price will now fall to the rising lower boundary in a period of days. Applying the principle of symmetry to the inner channel at its bending point in late November 1993, we expect the fall to last for perhaps seven or eight weeks. This is how long the inner channel took to rise from its last trough in late September. Since we would not contemplate an investment

until we are sure the price has just rebounded from a lower rising boundary, this would mean a wait of perhaps six weeks from the present.

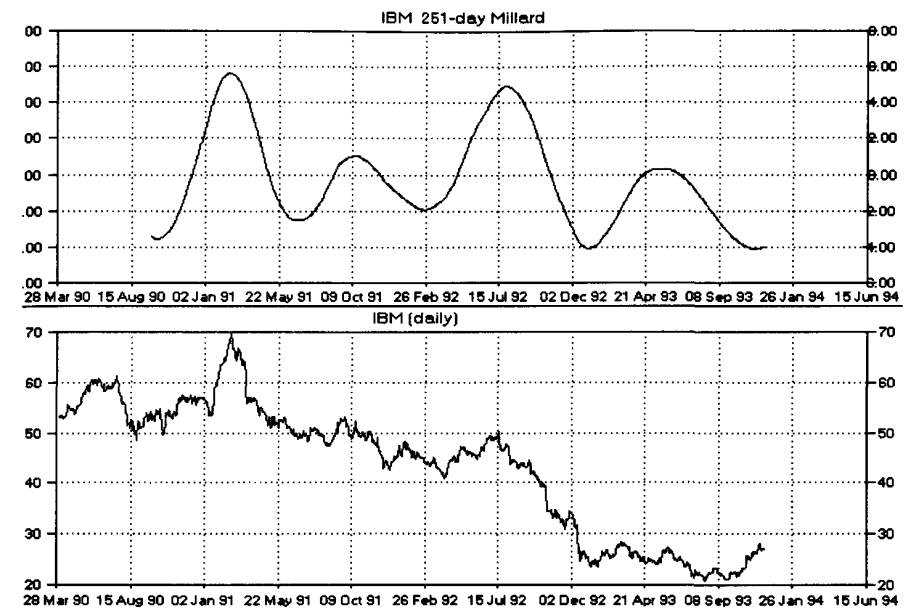
Note that this new position for the outer channel is the lowest in a vertical sense commensurate with avoiding the November peak. The channel might well have risen at a greater rate than that depicted in Figure 9.10, but we have no evidence from the channels or price data that that might be the case.

It is important to realize the **outer channel**, being based on a 201-day centered average, **is the result of the combination of all cycles that are present in the data whose wavelengths are greater than 201 days.** In order to confirm we are correct in drawing this channel as rising from a turning point around November 1993, we need to establish the present and near future status of the important cycles of longer wavelengths.

Of the known cycles in market data, the most appropriate to isolate would be the one year cycle, since it is closest in wavelength to 201 days. There are other reasons why it is a good choice: first, there will be less cut off data than with longer wavelengths, so we have less of a gap across to extrapolate to the present, and second its effect will be more immediate than cycles of longer wavelength if we establish that this cycle is just coming off its low point.

This cycle is shown in the upper panel of Figure 9.11. The extrapolation of the cycle to the present shows its probable position to be past the bottom and about to rise substantially over the next half cycle, *i.e.* six months. Since the message from this is in total agreement with the estimation of the 201-day channel, we now have a very positive climate for the medium term future movement of **IBM** stock. However, the short term climate is quite different. We should never invest in a stock that is near to our estimation of the position of an upper boundary. This is exactly the position with **IBM** on December 3.

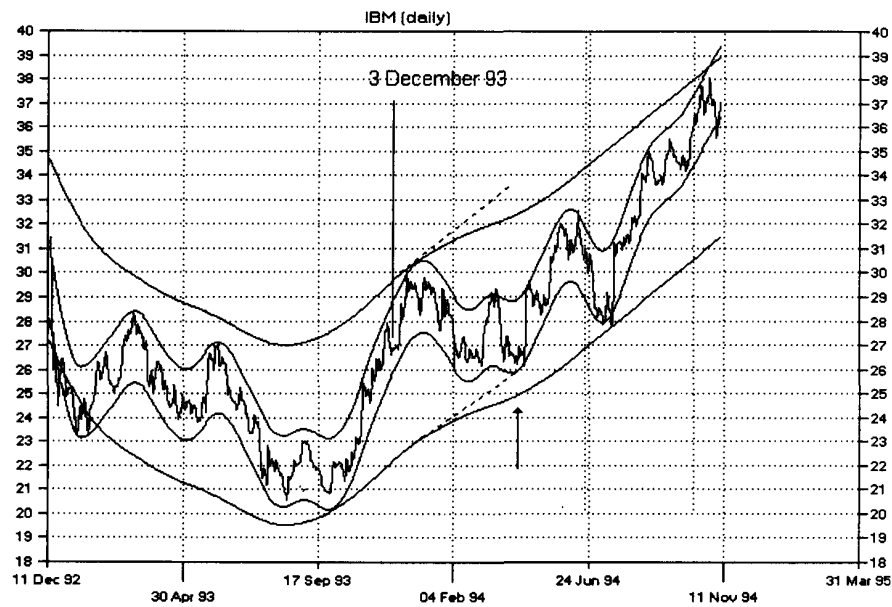
Our expectation is that the inner channel will soon move downwards, taking the price with it, so we now need to wait until the inner channel is close to the lower boundary of the outer channel and ready to bounce upwards.



**Figure 9.11.** Lower panel: **IBM** daily closing prices on December 3, 1993. Upper panel: the 251-day cycle highlighter shows that the one year cycle has probably just passed its bottom.

This position is reached in April 1994, as shown in Figure 9.12. The figure shows the channels as calculated in November 1994, so the position of the channels in December 1993 and April 1994 is the real position, these two points in time being well before the last calculated data point in the outer channel. You can see the estimation that the price was near the top of the outer channel was not far off the mark, the price was three-quarters of the way up from the lower boundary. The arrow marks the point in April 1994 it would be considered the time for buying **IBM**. The inner channel had fallen from the top boundary, and the dashed line shows the estimate of the position of the outer channel at that time. Clearly, the inner channel would be estimated as having bounced up from the lower boundary and the time to buy had arrived.

In retrospect, this was an excellent decision. It is interesting to point out the difference between the estimated position of the lower boundary in April, shown by the dashed line, and the real position, showed by the solid channel.



**Figure 9.12.** The subsequent movement of **IBM** stock. The channels are now calculated through to November 1994, their actual position on December 3, 1993. Our estimate that the price was near the upper boundary and that it would be premature to buy can now be seen to be correct. The arrow indicates the point (April 1994) where the stock would be bought, since the dashed line shows the estimated position of the outer boundary at that time.

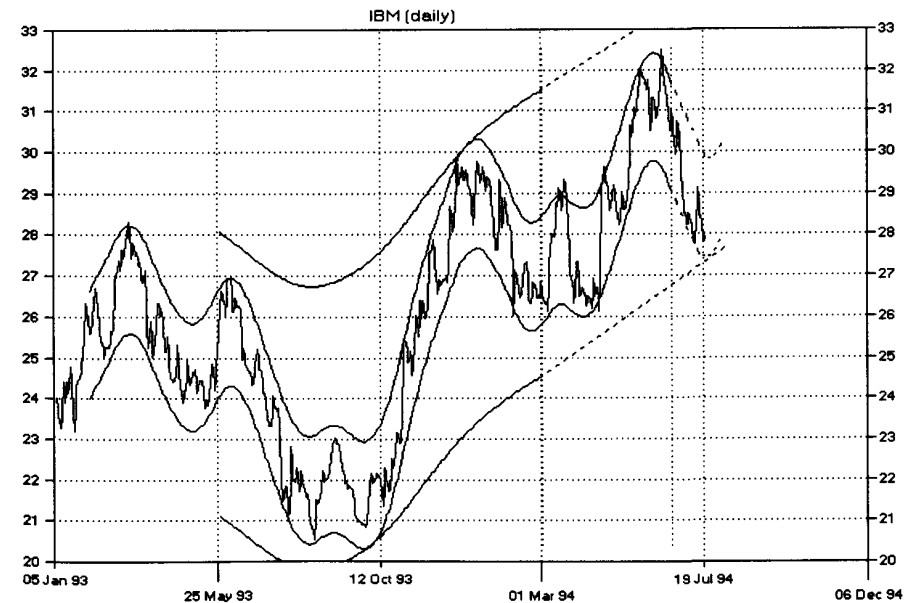
The estimate of the channel position was high by about \$1, but the inner channel never quite reached this low. The inner channel therefore changed direction at the estimated position of the outer channel and not the real position! However, the estimated position still represented a low risk area at the time, and therefore an investment was justified.

If the dashed lines are extended into the future, they give an indication of the target area into which the stock could be expected to move once bought in April 1994. This would be around the \$35 to \$37 level. As each day went by, the estimate of the channel boundaries would have been updated, and by late May, the estimate of the upper boundary would have been much lower, than the estimate made in April. Thus, when the price reached \$32, it would have been quite close to the upper boundary and the investor would be looking for

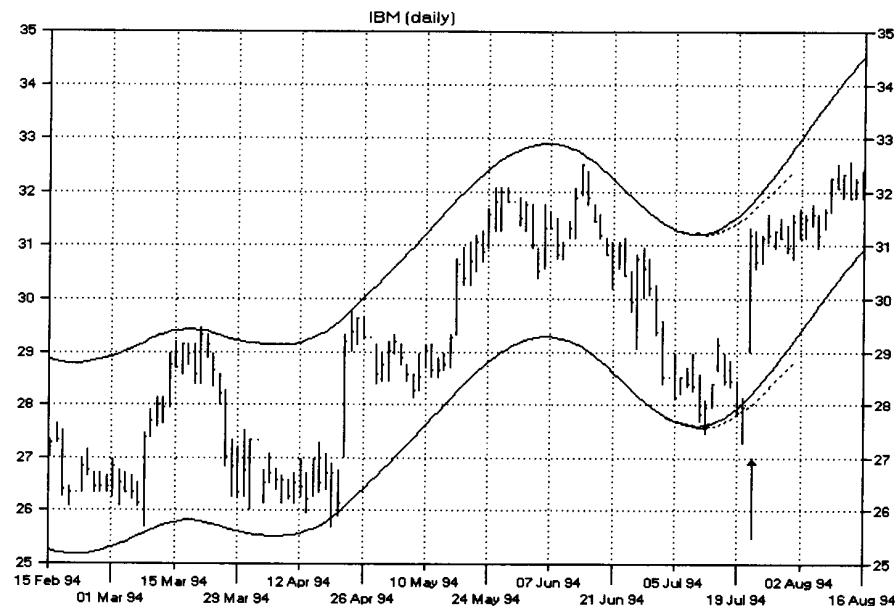
a selling signal.

## IBM IN JULY 1994

The chart in Figure 9.12 shows there was another buying opportunity in **IBM** in July 1994 when the inner channel approached the lower boundary of the outer channel. The position on July 19, with the estimated position of both channels is shown in Figure 9.13. The price at the close was  $\$27\frac{3}{4}$ . The investor is now waiting for a rise from this point so as to form a trough in the price at the lower boundary. The price closed on the 20th just below \$28. The trough was formed by this rise, and the investor would be looking for the best opportunity to buy on the July 21.

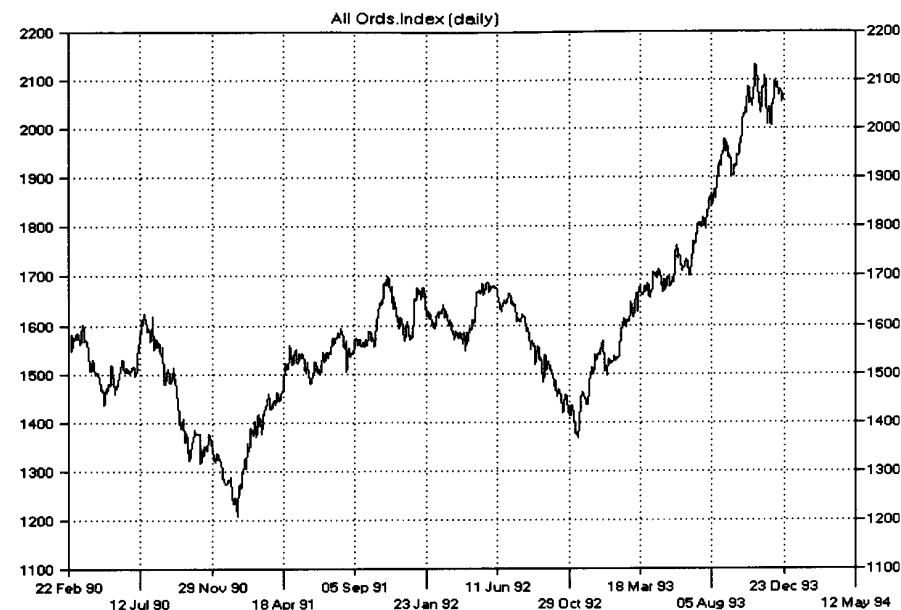


**Figure 9.13.** The position in **IBM** on July 19, 1994. The estimated channels are shown as dashed lines. The inner channel is expected to bounce off the lower boundary of the rising outer channel a matter of days. The investor would watch closely for a price rise from the boundary.



**Figure 9.14.** The daily ranges in IBM. The solid line channel is the actual channel drawn from data that lies in the future. The dashed lines are the estimates of the boundaries made after the close on July 20, 1994 to allow the closing price of just below \$28 to lie on the boundary. Note how good the estimate was. The arrow marks July 21.

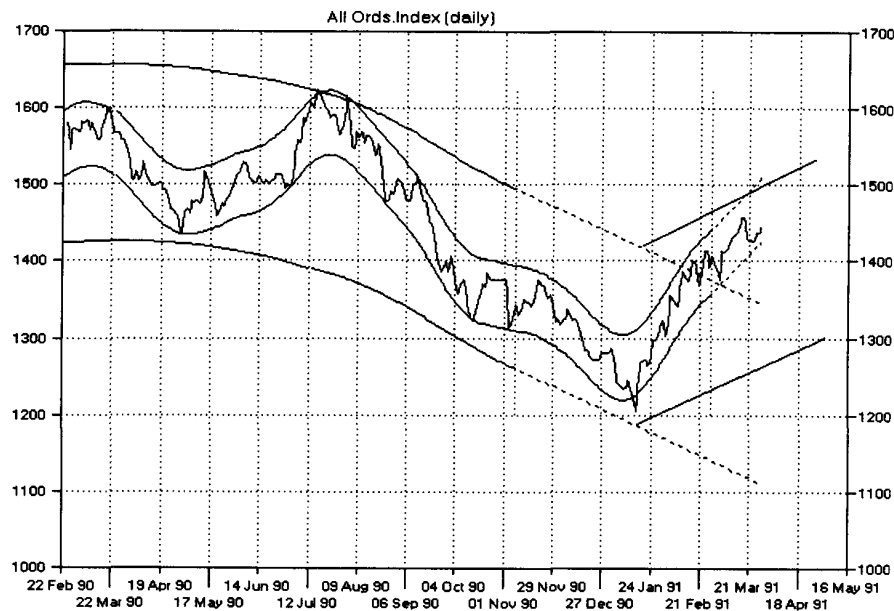
A new estimate could be made of the position of the inner channel boundaries after the close on the 20th by making the trough formed by this small rise to lie on the estimated boundary. This is shown in Figure 9.14, that also shows the actual channels as calculated some time in the future. These show how excellent an estimation of the boundary was obtained by this approach. The arrow marks the day of July 21. The price opened at  $\$29\frac{3}{4}$  before falling back to \$29. This opening was a long way above the estimated lower boundary, and the investor was now convinced that IBM is bouncing upwards at a rapid rate. The careful investor would note that the price fell back from the opening, and, in line with our rule not to buy while the price is falling, would hold off until the price rose from the low point of \$29. The investor should have been able to get below \$30, and would have been pleased by a close at just over \$31. The stock moves sideways for a few days more before resuming a rapid upward rise.



**Figure 9.15.** The Sydney All-Ordinary Index showing two major lows during the period. Since they are about two years apart, this suggests that a strong two-year cycle is in being at this time.

## AUSTRALIAN STOCK EXCHANGE

In common with stock exchanges across the world, the Sydney exchange suffered a fall at the onset of the Gulf crisis due to the potential threat to world oil supplies. In retrospect, the fall was not as severe as on other stock markets, you can see from the chart of the Australian All-Ordinary Index in Figure 9.15. You can see that in addition to the sustained 400 point fall during the second half of 1990, a loss of almost similar proportions occurred from mid-1992. These falls created two major troughs at 1204.5 on January 16, 1991 and 1365.1 on November 17, 1992. Since these are just two months short of being two years apart, they could be considered the successive low points of a two year cycle. We will look at both of these interesting points on the chart to see how channel and cycle analysis dealt with the climb back from these falls.



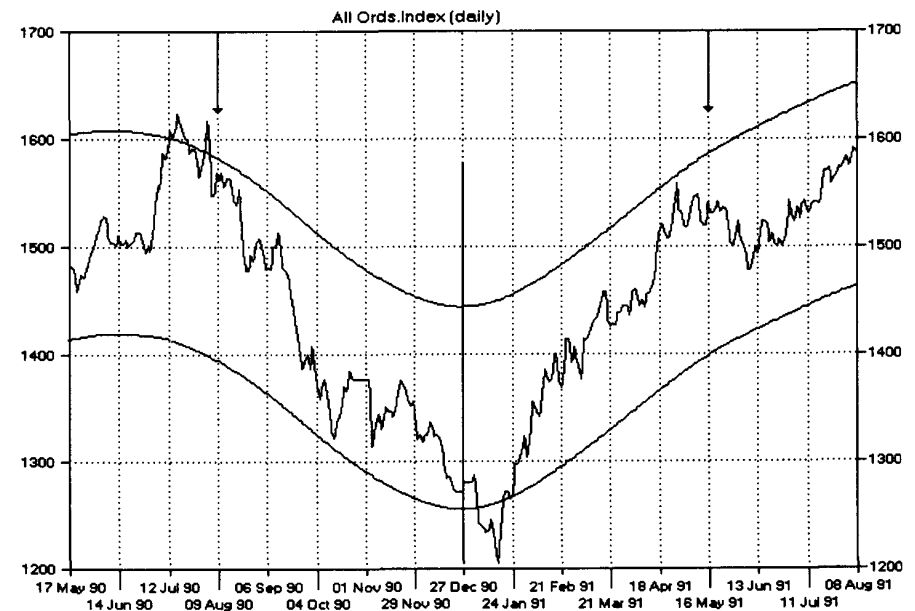
**Figure 9.16.** *The Australian All-Ordinary Index. The channels as they would be extrapolated in March 1991 would obviously run well below the last month of data. By re-drawing the channels to form a symmetrical turning point as shown, the data is kept within the channel. As now drawn, a rebound of the Index downwards should occur soon.*

### Turning point in January 1991

The first major trough in early 1991 is shown on an enlarged scale in Figure 9.16. The extrapolation of the outer 201-day channels by the software curve fit routine (or by eye) results in more or less straight parallel boundaries. The obvious problem is that the level of the Index at the time the channels are drawn is much higher than the upper boundary. As in other examples, the only way to avoid this is to put a bend in the channel to take the upper boundary to at least the level of the highest recent point, which in this example is the latest point.

Since the extrapolated channels are such straight lines, a quick way of gaining an impression of the probable direction of the channels is to invoke the principle of symmetry around the turning point and draw a new channel with bound-

aries running up at the same slope they were running down to the turning point. The best initial estimate of the position of the turning point in the channel is the major low point on January 16, so this can be made the junction of the two opposing channels. By doing this, the upper boundary then clears quite comfortably the recent peak of 1456.5 on March 19. As drawn, there is no great expectation for a significant rise in the All-Ordinary at this point, since the inner channel, produced by a 41-day centered average, is getting closer to this upper boundary, a bounce down should occur within a few weeks.



**Figure 9.17.** *The turning point on January 16, 1991 in the Australian All-Ordinary Index. The 201-day channel is an excellent example of almost perfect symmetry between the two points marked with arrows.*

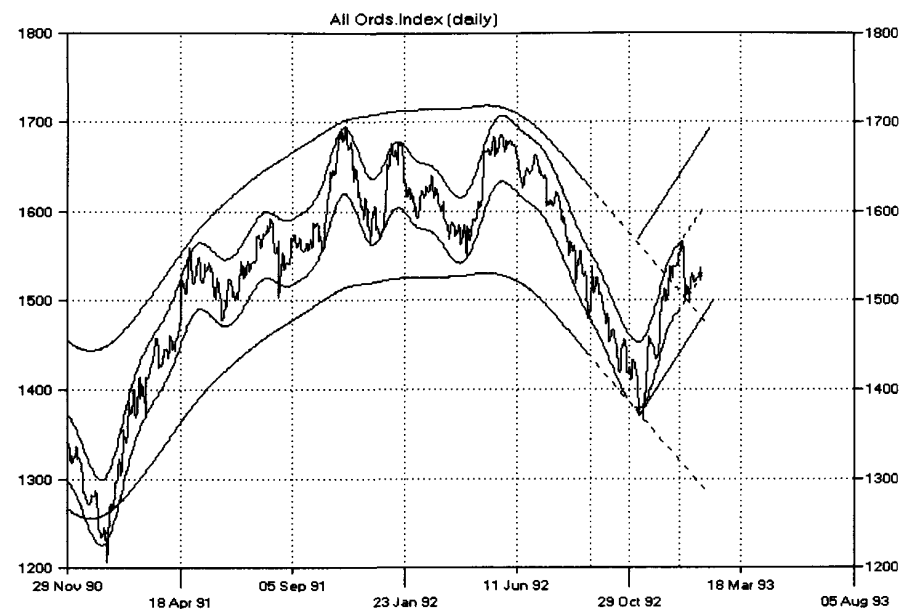
The interesting point about this exercise in symmetry is that this turning point in the Australian Index is one of the most symmetrical to be found. This is shown in Figure 9.17, where the actual channels are shown. These are real because they were calculated from a point much further into the future. The center point of the turn is shown by the solid vertical line, and the almost perfect symmetry extends out to the arrows on either side. As can be seen, the vertical positions of the boundaries at the positions of these arrows are virtually

identical. The position of the boundaries as drawn by the method shown in Figure 9.15 is excellent. The only major difference is that the actual turning point in the channel doesn't exactly coincide with the low point in the Index itself, but this is a frequent feature of channel analysis. It happens because as was stated in an earlier chapter, two components decide the exact turning point—the change between the current data point and the next one, and the change between the first data point in the span, which is due to be dropped from the total and the next one in the data set. This will be discussed in the next chapter.

The reason for this high degree of symmetry is because of the dominance, over this period of time, of the two year cycle which is just reaching its low point on January 16. There is little interference by one year cycles that might have caused distortion. It can also be seen from Figure 9.17 how good an estimate of the upper boundary position were the lines drawn in Figure 9.16. The peak on March 19 is now seen to be comfortably below the upper boundary of the channel.

### Turning point in November 1992

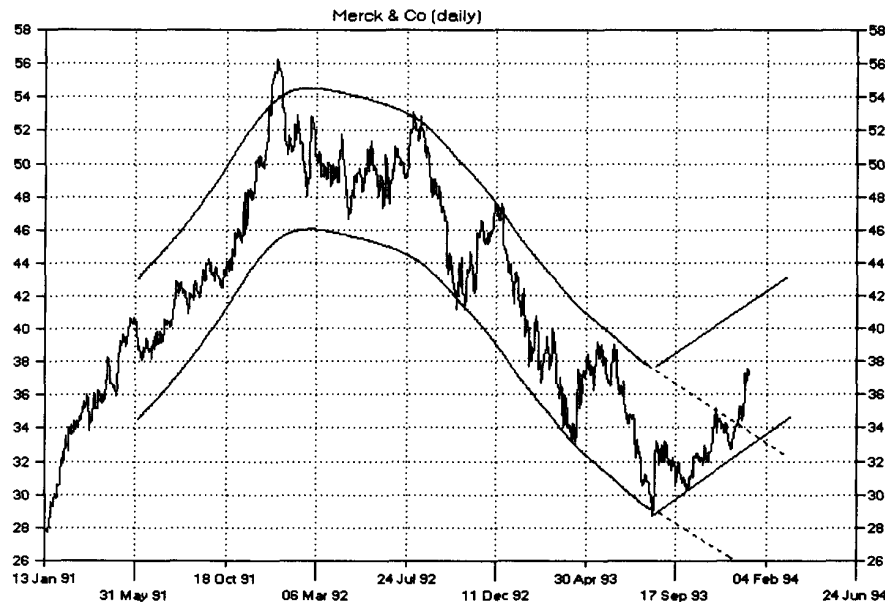
The position in the Australian All-Ordinary Index on January 29, 1993 is shown in Figure 9.18. The turning point on November 17, 1992 can be considered to have the same characteristics as the one in 1991, because an extrapolation of outer channel by the end of January 1993 has it falling in almost a straight line. Because of this it is clear that the rise from the major low point takes the Index above the initial estimate of the position of the upper boundary. The first minor peak on December 14, at 1512.4 is just about on the estimated boundary, but the next minor peak on December 21 at 1537 takes the Index slightly above the boundary, while the latest peak of 1464 on January 5 is well above the boundary. This means that quite a major adjustment is called for, and in view of the straight line nature of the extrapolated channel, the same construction can be employed as previously. This is shown in Figure 9.18, where the change of direction is taken to be the low point on November 17, 1992. By doing this, the recent peaks in the data are kept below the new



**Figure 9.18.** The November 1992 turning point in the Australian All-Ordinary Index. The channels. The outer channel as it would be extrapolated in January 1993 (dashed lines) would obviously run well below the last month of data. The channels have been re-drawn so as to form a symmetrical turning point as shown, keeping the data within the channel.

estimate of the upper boundary position. The fact that the peaks are now short of the boundary means that a reversal of direction of the inner channel should occur in the not too distant future.

Although not shown, this second turning point in the 201-day channel is also very symmetrical, the symmetry extending out to about 60 days either side of the minimum point in the channel. The channel low point was again slightly offset from the low point in the data, occurring on November 9, some six business days before the Index low on the 17.



**Figure 9.19.** The position in **Merck** on January 11, 1994. The 201-day channel is shown. A few weeks previously the channel would be extrapolated as the dashed lines. The rapid rise over the last few weeks would force a change in direction of the channel, the last section of which would be drawn as shown by the solid lines.

## MERCK & CO

This is an interesting example of a false dawn, where the prediction of a turning point in the stock price, predicted by channel analysis turned out to be rather premature, although not disastrously so.

The position on January 11, 1994 is shown in Figure 9.19, with the stock at  $\$37\frac{1}{8}$ . A few weeks earlier, the stocks had made a peak at  $\$35\frac{1}{8}$  on November 19. The extrapolated 201-day channel at that point in time, appeared to be running downwards in almost a straight line, as shown by the dashed line. The investor would think the channel was more or less in the correct position, because the peak on the 19th just touched this upper boundary. The investor would have nodded happily as the unrolling price moved downwards in line with the expectation of a reversal from the upper boundary. After a few weeks the price had fallen to  $\$32\frac{5}{8}$  by December 14 before a very short

term trend reversed direction again and the price was drawn toward the upper boundary of the channel. A very minor peak was formed on December 27 at  $\$35\frac{1}{4}$ . To prevent this minor peak violating the upper boundary would have required an adjustment to the upper boundary. Since this peak is marginally higher than the peak of  $\$35\frac{1}{8}$  on November 19, the adjustment would mean the upper boundary, and hence the channel, would have to rise at a very shallow angle.

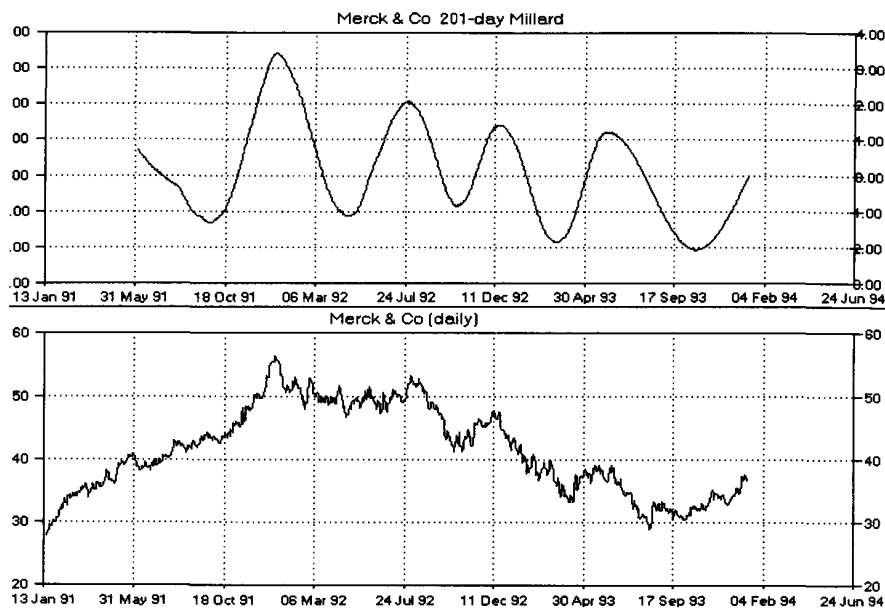
A problem was then caused by the very rapid rise in price of the stock over the next few days at the beginning of January, since the price reached the  $\$37\frac{1}{8}$  level, as shown by Figure 9.19. This meant a rapid reappraisal of the channel boundary, that would now have to rise at quite a rapid rate to accommodate this new price level. This in turn meant we must have had a major turning point in the channel if it is now apparently rising as fast as it was falling just a few weeks earlier.

If the same procedure is adopted as in the previous example, then the construction of a new channel direction would give a channel similar to the latest section drawn with solid boundaries. This will place the current price level of just over  $\$37$  about half way up the channel, so that a further short term rise is to be anticipated. The medium term outlook is also positive since the channel can now be seen to have changed direction only recently.

The careful investor seeks to check this view of the medium term prospects for **Merck** by looking at the position of the 201-day cycle in the stock. By applying a 201-day cycle highlighter, the chart shown in Figure 9.20 was obtained. The best estimate of the status of the 201-day cycle was that it had passed its low point some days ago, and was about halfway up its climb. This means it had about 50 days left before peaking again.

It must be stressed that the investor should not have bought any **Merck** stock at this time because the price was not in the position of having just rebounded off the lower boundary, but was at least half-way up the channel if not higher.

The investor should wait for the next bounce up from the lower boundary to

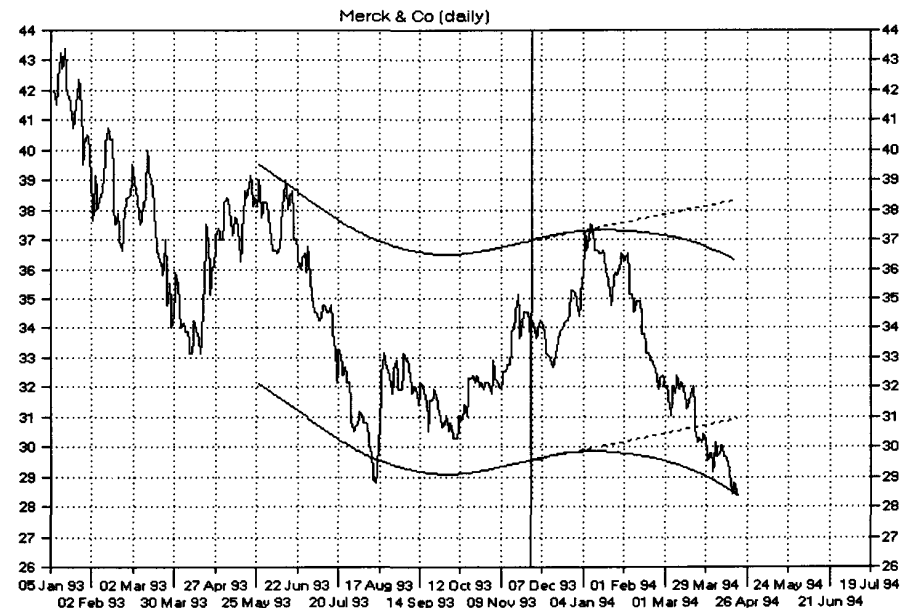


**Figure 9.20.** The 201-day cycle highlighter has been applied to the Merck price on January 11, 1994. The cycles are fairly regular in wavelength although there is a variation in magnitude. The best estimate of this cycle is that it is halfway up to its peak, some 50 days in the future.

occur before taking action. The other negative factor to consider is the fact that the 201-day cycle would peak about 50 days on from this point in January, and would then be falling. The investor would hope the price would arrive again at the lower boundary just as the cycle was about to rise again, indicating a wait of perhaps 150 days.

Things did not go quite as anticipated over the next few months, since the price never reached the estimated position of the upper boundary. Instead, it fell back initially to just under \$35, rose again slightly to  $36\frac{1}{2}$  before falling steadily. A hesitation in early March saw the price rebound from the \$31 level on March 4 to just over \$32. At that point the investor could have argued that the trough formed at \$31 was on the estimated position of the lower boundary. The fact that another trough at a slightly higher level was formed a few days later by a rise to \$32 on March 21 would have been a signal to buy the stock, although there would have been some slight unease due to the fact that

the 201-day cycle was probably about to fall. The view that the channel had formed a major turning point and therefore should be on course for a sustained rise would have outweighed this uneasiness and the investor would be looking for a good price the next day.

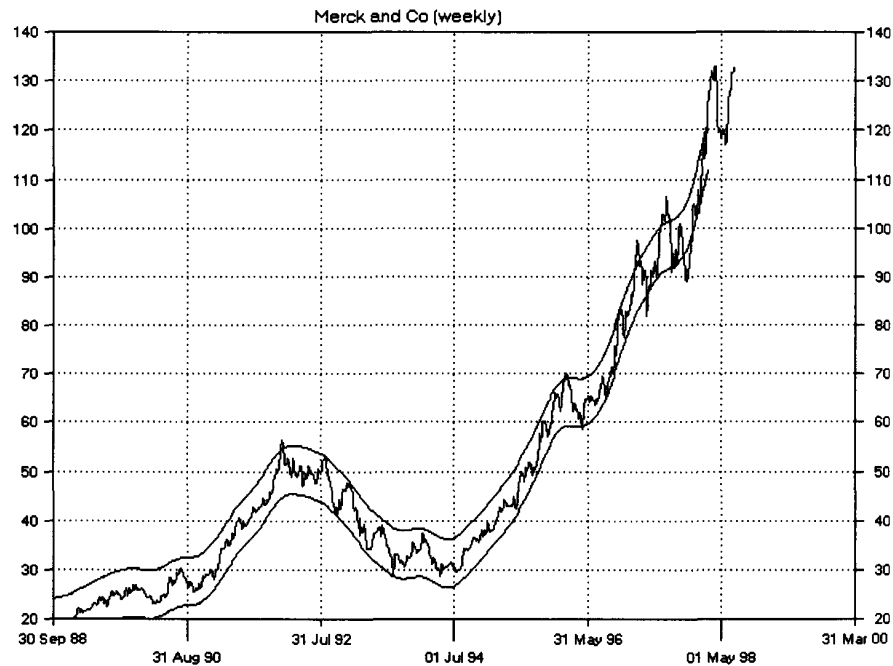


**Figure 9.21.** The channel in Merck on April 15, 1994. The vertical line is the last true calculated position. The dashed line is the extrapolation by the curve-fitting process. The curved, solid channel shows how the fall in price has forced a bend in the channel.

Once the stock had been bought, the feeling of optimism would not have persisted for long, since the stock fell back once more. By April 15, the price was down at  $28\frac{3}{8}$  and the position was as shown in Figure 9.21.

The problem at this point was the price had penetrated the rising lower boundary of the channel. This necessitated a change in the estimated position of the channel so that the channel would be forced lower. The only way this could be done while still avoiding a penetration of the upper boundary by the previous high in January would be to put a bend in the channel as shown in Figure 9.21. Thus, the turn up in the channel that was deduced from the data in January has

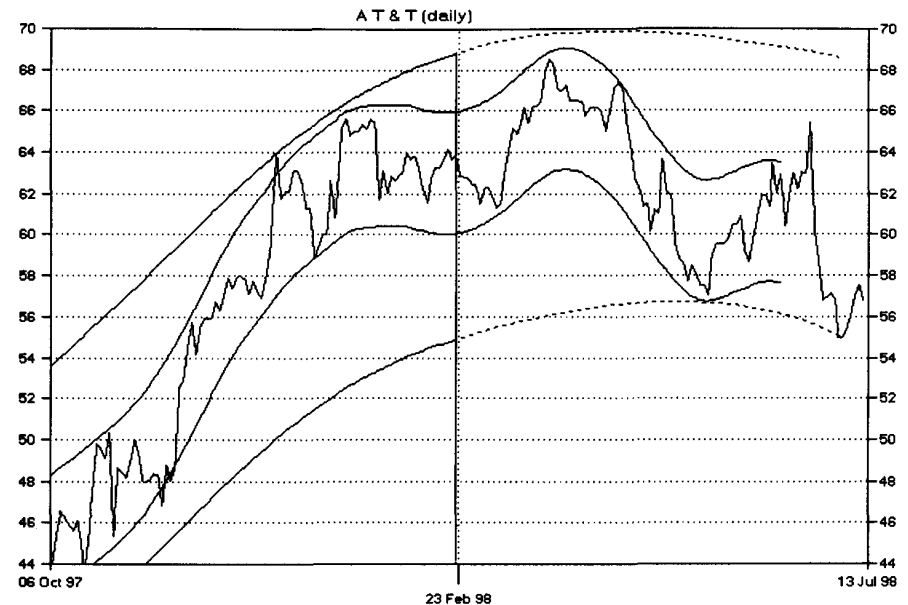
now become a turn down in the channel now that the additional data to April had become available.



**Figure 9.22.** Weekly closing for *Merck*. The 41-week channel is equivalent to the 201-day channel used in previous charts. You can see the reversal in the channel direction in early 1994 was very temporary, and caused by a double bottom formation.

The fall in the channel did not last long. It turned out the price on April 15 was the lowest point reached, and a sustained rise was made from that point forwards. In order to cover as large a span of data as possible, the chart in Figure 9.22 shows weekly closings for *Merck*. The 41-week channel is shown as being the equivalent of the 201-day channel in daily data. You can see the reason for the short term change in the channel direction was the fact that a double bottom formation had occurred. At the time this appeared to be quite a strong deformation of the channel, whereas in retrospect, you can see from Figure 9.22, it is hardly more than a blip. The investor who entered the stock in March 1994 and was worried by the fall of a few dollars by April would soon have been feeling very relaxed indeed as the long term trend powered

the stock up through \$50, \$100 and then \$130.



**Figure 9.23.** Channels drawn for *AT&T* on July 10, 1998. The outer is a 201-day channel while the inner is a 41-day channel. The last calculated point for the outer channel is shown by the solid vertical line. The outer channel has to be bent as shown in order to avoid penetration of the lower boundary.

## AT&T

So far we have concentrated on positive turning points in channels that have provided buying opportunities. In this example we will look at negative turning points, *i.e.* the topping out of channels, that will interest the short seller. *AT&T* is an excellent example of a stock that made a very large advance over a few years and then, at the time of writing, appears to be topping out and on its way down for the immediate future.

Figure 9.23 is shows the position in *AT&T* on July 10, 1998. Two channels have been drawn on the daily data, the 201-day outer and the 41-day inner. The vertical line shows the position of the last calculated point of the outer

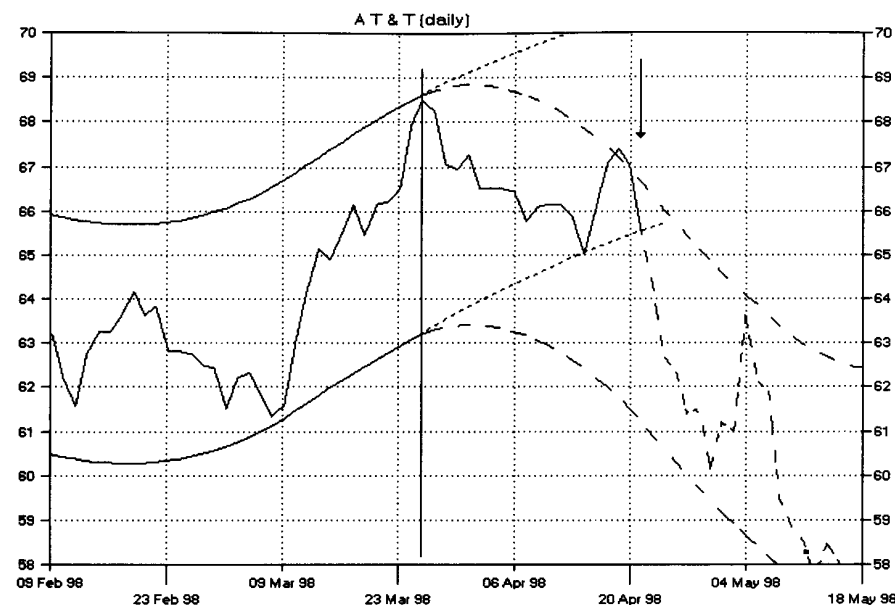
channel. The extrapolation of the outer channel to the present time is shown by the dashed lines.

Obviously, as the channel boundaries are extrapolated from the position of the last calculated point, an increasing amount of bend must be applied to the channel in order to allow the trough on May 19 (at just over \$57) to be accommodated on or near the boundary. As the extrapolation continues, the even lower trough formed on July 2 by a fall to just under \$55 forces an even tighter radius to the bend that by this point is clearly falling. As drawn, you can see the channel has topped out a little later than the peak price in the data, the latter being on March 25, 1998 at  $\$68\frac{1}{4}$ .

As far as the inner channel is concerned, the major feature in the last few weeks was the rapid fall from the peak of over \$65 reached on June 23. The price fell in a matter of three days to  $\$56\frac{3}{4}$ . This forced a bend in the inner channel so that it has now fallen rapidly to the lower boundary of the outer channel and has probably just begun to bounce up again.

Since by July 10, the stock had fallen to  $\$56\frac{3}{4}$  from  $68\frac{1}{2}$  on March 25, a loss of 17%, the question arises, how soon after the peak price should the investor be aware of things going wrong with the stock, so avoiding action could have been taken. The position in AT&T on April 21, 1998 is shown by the arrow in Figure 9.24. The calculated 41-day channel terminates at the position given by the vertical line, and the extrapolation to the point given by the arrow is shown by the dashed line.

At this point, the trough formed at a price level of \$65 on April 14 fell quite neatly on the estimated position of the lower boundary. The investor now expected a short term rise to the top of this inner channel, giving a target area of at least \$70. There appeared to be no cause for alarm when the price, having reached over  $\$67\frac{3}{8}$  on April 17, fell back to \$67 on April 2. The investor would expect the stock to resume its climb to the upper boundary within a few days. However, the stock fell yet again the next day, April 21 to  $\$65\frac{3}{8}$ . It was now exactly at the estimated position of the lower boundary, and the investor would have been waiting anxiously for a bounce upwards to



**Figure 9.24.** The position in AT&T on April 21, 1998 is shown by the arrow. The vertical line is the last calculated point for the 41-day channel. The extrapolation of the channel from the last calculated point to April 21 is shown by the short dashed lines. The price has now fallen below the estimated position of the lower boundary, and is a strong indication of a fall in the near term. Future movement of the stock price and the channel is shown by the long dashed lines, showing that the prediction was correct.

form a trough that would lie on this boundary. This did not happen, since the stock fell yet again on April 22 to  $\$64\frac{1}{4}$ . The stock was then well below the lower boundary, and the conclusion would have been the channel must have changed direction so it was now falling. The investor should have been convinced that AT&T was due for a further fall and that it was time to exit the stock, and/or instigate a short sale. A price level of around \$64 could have been obtained early the next morning.

The long dashed lines in Figure 9.24 indicates that we took the correct course of action based on the evidence available at the time. The price had fallen to around \$57 by July 10. Thus the investor had saved some \$7 by this careful analysis using a short term channel.

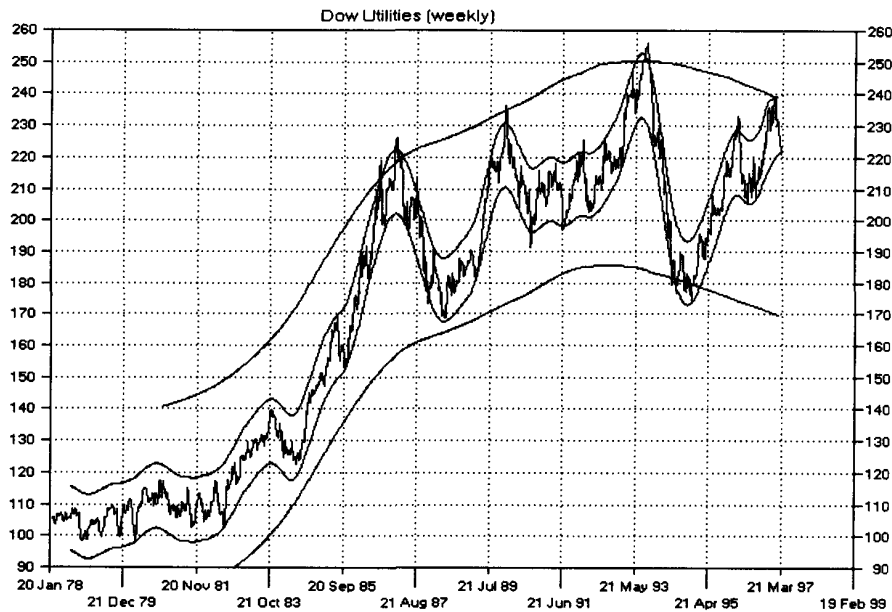


Figure 9.25. The Dow-Jones Utilities Index weekly closings since January 1978.

### DOW JONES UTILITIES

Figure 9.25 shows a plot of the Dow-Jones Utilities Index since 1978. The data is weekly, and with such a long run it is possible to draw a long term 401-week outer channel, *i.e.* a channel that is the result of cycles of wavelengths longer than eight years. The outer channel itself of course contains the sum total of all cycles with wavelengths eight years or less.

The inner channel is based on a 41-week average. It is interesting that the most prominent of the outer cycles is a three year cycle, with two major peaks in January 1987 and December 1989. The cycle then dies away so that shorter wavelengths take over for a few years, but it then reappears with a major peak in September 1993. The next peak would have appeared in September 1996 but for the intervention of a shorter wavelength cycle that split the peak into two peaks, in February 1996 and January 1997.

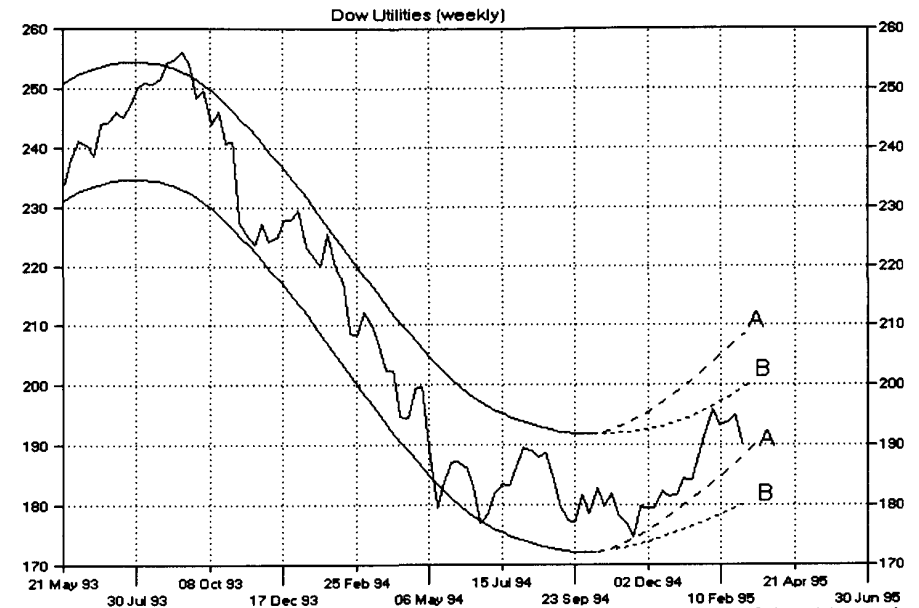


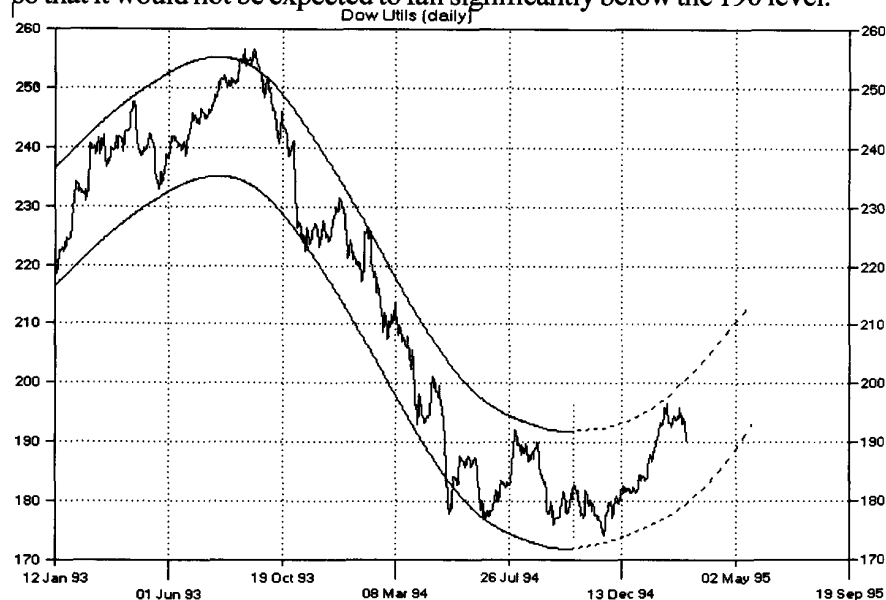
Figure 9.26. There are two alternative extrapolations, A and B, of the 41-week channel for the Dow-Jones Utilities Index on March 3, 1995. Either the trough on November 18, 1994 or the peak on February 3, 1995 can be at a boundary, but not both.

Of particular interest is the quite sharp turning point shown in December 1994 in the 41-week channel, the emphasis being on how soon after the turn the investor could be relatively sure the one year downtrend had come to an end. The previous peak in the channel was in September 1993, so that the channel had been falling for over a year before reaching the lower boundary of the long term outer channel. A better idea of the turning point is given by the enlarged section shown in Figure 9.26 for the situation on March 3, 1995. Only the inner 41-week channel is shown, the outer long term channel is omitted since it is not needed in the analysis of the data at this point. The solid boundaries represent the actual calculated channel, while the two sets of dashed lines are estimates of the boundaries.

The reason for the two alternative estimates for the channel boundaries is the relative position of the two recent features, the trough at 174.47 on November 18, 1994 and the peak on February 3, 1995 at 195.62. Obviously, the

presence of the peak on February 3, is the crucial factor that determines the channel must have changed direction and is now headed upwards. The difficulty is that unless the channel is distorted badly, a smooth extension of the channel can either have the November trough on the lower boundary (channel A) or the February peak on the upper boundary (channel B) but cannot accommodate both of these features on the boundaries.

Although of course the prime objective of the analysis was to determine that the channel had changed direction, a decision between the two alternative channels would be useful since it would give an indication of the probable movement of the Index in the immediate future. In the case of channel B, the probability is that the Index will fall further, since the lower boundary is considerably lower than the current value for the Index. The target area for this movement would be around the 185 mark. If channel A is accepted, then the probability is that the Index will stop falling and bounce upwards very soon, so that it would not be expected to fall significantly below the 190 level.

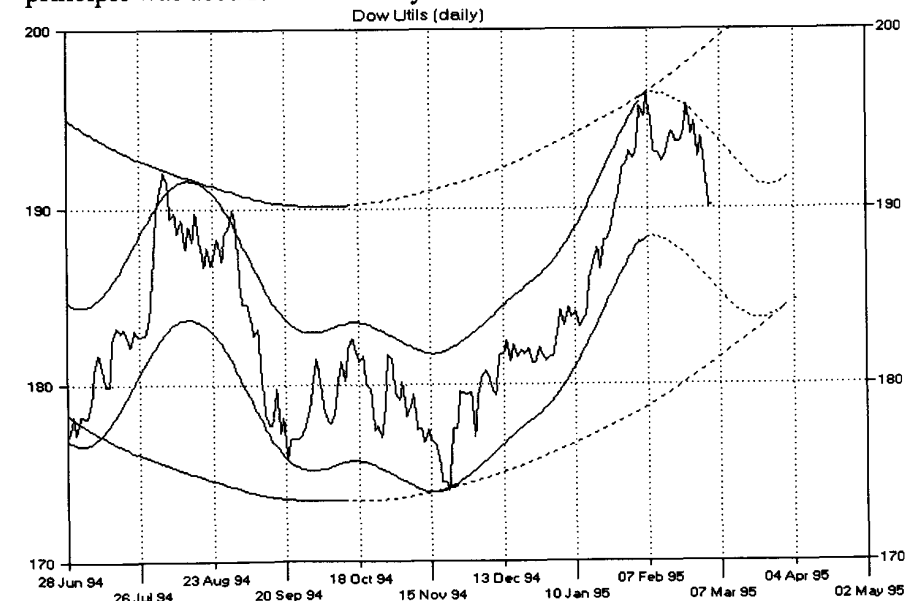


**Figure 9.27.** The 201-day channel in the Dow-Jones Utilities Index on March 3, 1995. The estimated boundaries are shown as dashed lines, using the principle of symmetry around the turning point. This shows that a further fall can be expected in the Index over the short term.

The only criterion that might be used to decide between these two alternatives is the principle of symmetry. It appears to hold on about 80% of occasions where a channel changes direction, and as discussed earlier, a major turning point in the Australian All-Ordinary Index was an excellent example.

In the present case, the channel that is closest to being a mirror image of the actual channel with the turning point as the line of symmetry is channel B. This means we expect the Index to fall somewhat further before hitting the rising lower boundary.

The situation was resolved further by using daily data, as shown in Figure 9.27. In this case, the 201-day channel was used to preserve the close similarity with the 41-week channel used for weekly data. Since it was decided from weekly data that the best channel was the symmetrical one, the same principle was used for the 201-day channel.



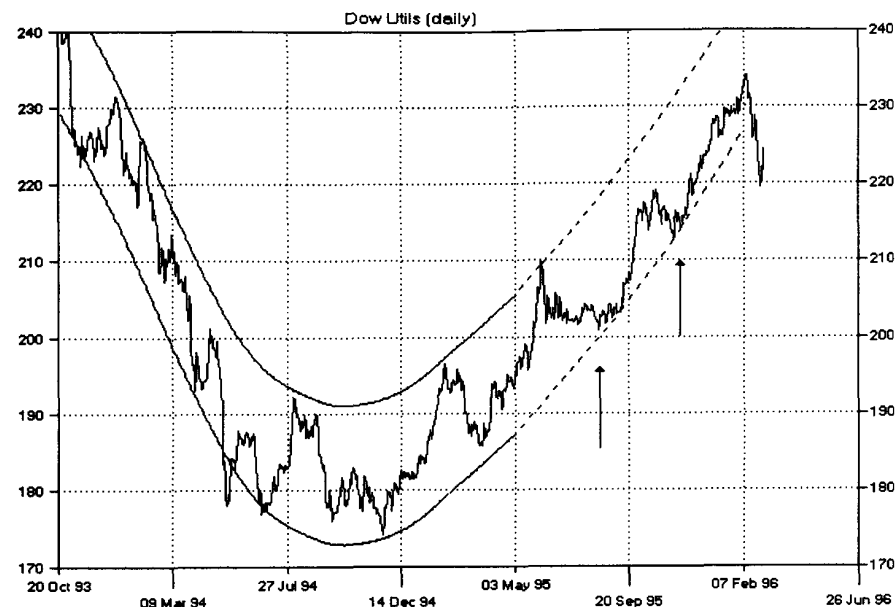
**Figure 9.28.** The Dow-Jones Utilities Index on March 3, 1995. An inner 41-day channel has now been added to the 201-day channel. Both have been extrapolated according to the dashed lines. The indication is for a fall in the value of the Index to around 185 from late March onwards and then a rise to over 200 some weeks past the last date on the chart.

In order to predict more easily the movement of the Index in the immediate short term, it is necessary to view an inner channel so that its relationship with the 201-day channel can be deduced. In Figure 9.28 a 41-day inner channel has been added. The extrapolation of this channel is shown as a dashed line, as is the extrapolation of the 201-day channel. Now that the estimate for the 201-day channel boundaries has been put in place, these boundaries now limit the excursions of the 41-day channel. Thus, it has to be made to bounce downwards in early February, and made to continue its journey down to the rising lower boundary of the 201-day channel. It can be estimated as reaching that point in late March, from where it should rise again. Although off the right hand side of the chart, the inner channel should meet the upper 201-day channel boundary in late May at the soonest, and could be delayed much longer. The longer this arrival at the upper boundary takes, obviously the high will the Index rise. If it reaches the boundary in June, then a target of around 210 is likely.

The Index behaved perfectly, hitting the upper boundary at 196.35 on February 2, and as predicted, fell from its value of 190.09 on March 3 to 185.61 on March 21. This is the point when it bounced up again, and rose steadily until it reached a temporary peak of 209 on June 5, 1995. You can see from the extrapolations in Figure 9.28, the estimation of the channel positions, and hence the value of the Index, in the near future was extremely accurate.

In retrospect, you can see this was another example of where to apply symmetry as an aid in determining the channel position correctly, and predicting future movement.

The examples so far have concentrated on turning points in channels, since a knowledge of when a trend has changed, or is about to change, direction is essential if consistent profits are to be made. If we move on slightly in time in this example of the Dow-Jones Utilities, we can see a situation where the prediction is not for a turn, but for the channel to continue forwards in more or less the same direction. This is shown in Figure 9.29 where the extrapolation of the 201-day channels as calculated in September 1995 is shown. The indication is that the channel will continue to rise, carrying the Index with it. The



**Figure 9.29.** The 201-day channel as estimated on September 8, 1995 (indicated by the left hand arrow). The extrapolation takes the channel into the future. The channel was accurate enough to predict the bounce for the lower boundary in late November 1995 (right hand arrow).

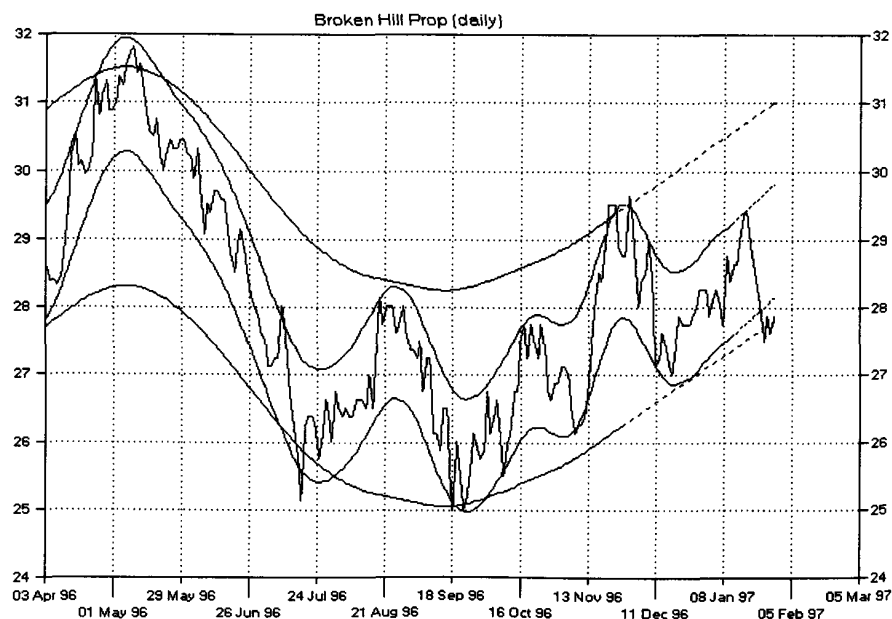
future movement of the Index is also shown, so you can see the estimate of the channel into the future was correct. The validity of the lower boundary was confirmed by the bounce upwards of the Index in late November 1995. A series of troughs on November 14 (212.5), November 22 (214.08) and November 30 (215.79) all fell exactly on this extrapolated boundary.

### OCCASIONAL FAILURE OF CHANNEL ANALYSIS

The examples discussed so far in this chapter have been ones where channel analysis has been vital in deciding what course of action should be followed. Obviously, since there is a large amount of random behavior in the stock market, predictions made in this way can turn out to be incorrect. Occasionally, a stock can fall so rapidly down through a lower channel boundary that a considerable loss has accrued before remedial action can be taken. However,

in the majority of cases where a prediction is incorrect, the initial penetration of a boundary occurs to only a limited extent so a decision can be taken in good time. The only reason for a larger loss to be made in such circumstances is the psychological one of an investor being convinced that the move in the wrong direction is a limited one, and things will change for the better within a few days. The investor then holds on for too long until what would have been a small, acceptable loss, becomes a large, unacceptable one. The only way to avoid this mistake is to sell immediately. It is obvious the price has not stopped at a lower boundary but has continued down through it.

An example that demonstrates this approach is that of **Broken Hill** in January 1997. The channels drawn for this stock are shown in Figure 9.30. The outer channel is based on a 101-day average while the inner is based on a 25-day average. At the last calculated point for the outer channel the extrapolation of the gently rising curve was a very smooth extension with a curve of slowly increasing



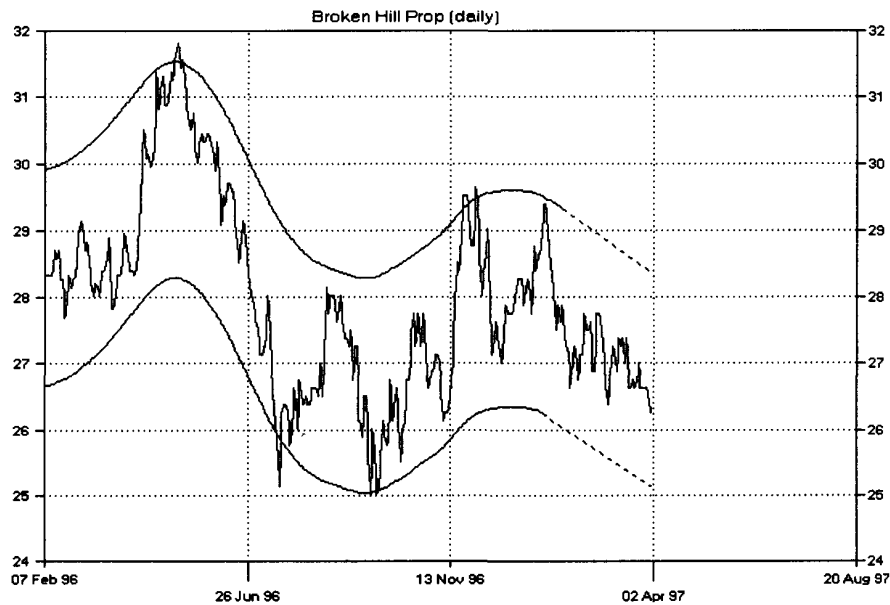
**Figure 9.30.** Channels drawn on the daily closings of **Broken Hill** on January 29, 1997. The estimated channels are drawn as dashed lines. The outer is based on a centered 101-day average and the inner on a centered 5-day average.

slope. The peak on November 28 at  $\$29\frac{1}{2}$  occurred before the cut-off, so the slight penetration of the upper boundary had to be accepted. This meant the peak close to it, at  $\$29\frac{5}{8}$  on November 29, although after the cutoff, also had to be left penetrating the extrapolated upper boundary, since to do otherwise would have meant a major distortion of the channel.

The stock dropped quite rapidly from that point to the trough at  $\$27$  on December 18, but this trough was still above the lower boundary of the outer channel, since again, to force the lower boundary to touch this trough would have meant an extreme upward bend in the outer channel. From that point **Broken Hill** rose in a series of small peaks and troughs to a peak of  $\$29\frac{3}{8}$  on January 17, 1997 before falling rapidly to  $\$27\frac{1}{2}$  on January 24. This fall took the stock just a fraction of a dollar below the estimated boundary, but this level was well within tolerance. The stock rose, fell and rose again from over three days until January 29 where it hovered above the boundary, as shown in Figure 9.30. At this point, at a level of  $\$27\frac{7}{8}$ , there was nothing to suggest the estimated channel was not in the correct position. The investor would be contemplating buying the stock with a useful rise to well over  $\$30$  in prospect.

An investor, buying at this level, would find that this was the best price reached by **Broken Hill** for some time, since it fell the very next day. The movement over the next few months is shown in Figure 9.31. By April 1, the stock was down to  $\$26\frac{1}{4}$  and still falling. More importantly, a calculation of the outer 101-day channel on this date showed that the channel had changed direction around December 24 - 27, 1996 and was already on its way down before any extrapolation was made.

The extrapolation of the channel from the last calculated point is difficult because it can be seen that the peaks and trough following the major peak on December 17 are all bunched within a narrow vertical band, and therefore we are not in the position of having any features that will define the upper and lower boundaries. In the absence of these features the principle of symmetry has to be applied as giving the best estimation on the available evidence of the channel direction.



**Figure 9.31.** The outer channel drawn for **Broken Hill** on April 2, 1997 shows that path of the channel as estimated on January 29, was totally incorrect. Rather than continuing to rise, the channel had turned at a point between the peaks on November 29, 1996 and the lower peak on January 17, 1997.

The result is shown by the dashed boundaries in Figure 9.31, and this places the stock just below the mid-channel position and moving down. With the short term trend in the stock now clearly headed downwards and the medium term 101-day channel also falling, the stock is a definite loser for the immediate future. The confirmation of this view of the prospects for **Broken Hill** is a low of just above \$15 was reached in June 1998.

This example shows why it is imperative to sell a stock as soon as it violates the estimated position of a lower boundary. In this case the fall through the boundary was of limited extent, and there was a limited recovery so the loss would have been quite small. Failure to take action would have increased the eventual loss to an unacceptable 45%.

There are several ways in which a stock can fall through a lower boundary:

1. Limited fall below boundary with recovery to a point above the boundary
2. Limited fall below boundary with partial recovery to a point below the boundary or sideways hesitation
3. Limited fall below boundary with further fall after one time period
4. Large fall below boundary

The investor should exit the stock in each of these cases at the first instance of penetration of the lower boundary, although case 1 might cause some indecision. This is because in this circumstance the channel could continue upwards after this one-off penetration of the boundary, but cannot be guaranteed. The investor could stay with the stock while recognizing there is an increased level of risk, these situations where the penetration is only temporary are not common. In most cases a turn down in the channel direction is being signaled.

Cases 2 and 3 are the ones that the investor should give thanks for, since it enables a dignified exit to be made from the stock at a small loss, as long as this exit is made immediately, as was the case with **Broken Hill**.

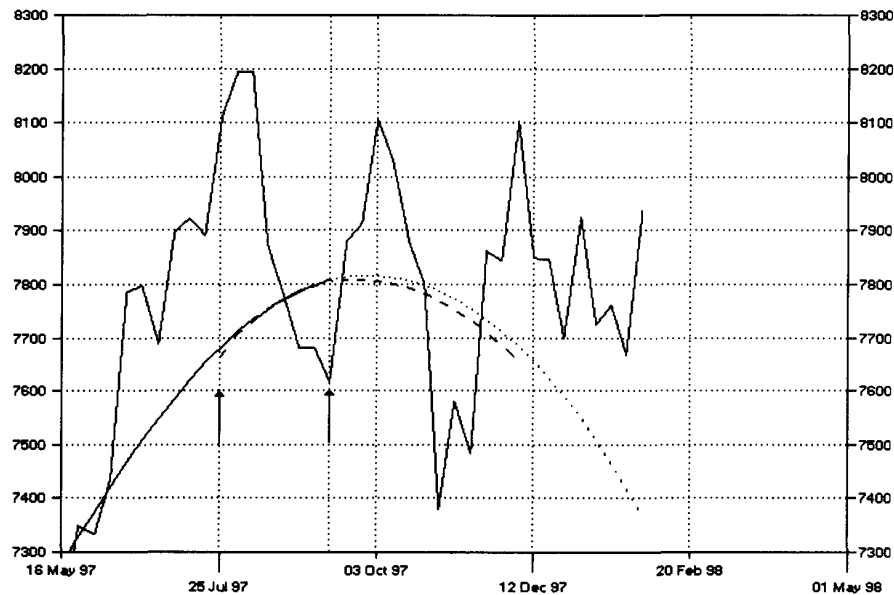
The effect of case 4 is to cause a very large and unavoidable loss, and it is not uncommon to see a loss of 20% upwards in a day. Since such a movement is totally unpredictable, the investor has only two decisions to make: either to sell or to hold. To hold evidences faith that the stock will experience a short term recovery. During the holding period, the best case is that the loss will not increase, and the worst that a further drop will increase the loss. The best advice is to sell and seek an opportunity to recover the loss in another better-positioned issue..

# CHAPTER 10

## Channel Turning Points

In the last chapter most of the examples were concerned with determining if a channel had changed direction. The point was made that knowing that a channel, and hence a trend, had changed direction was the most important piece of information that could be derived from a study of channels. In this chapter we will look more closely at the issue in an effort to improve on the excellent results obtained in the last chapter. The main improvement would be a reduction in the time lag between the actual turn in the channel and the point where it becomes obvious that the turn has occurred. The time lag is due to the unavoidable property of centered moving averages that the last calculated (*i.e.* the true) point, and hence the last real position of the calculated channel, derived from it, terminates half a span in the past. We try to estimate what has happened to the average between the last calculated point and the present. From this we can also guess what the average will do in the future.

The first step, if carried out by the simple graphical method, is to project the channel forwards from the last true point by drawing the smoothest and most obvious continuation of the last few points in the calculated channel boundaries. If done by a computer, the procedure is to use a curve-fitting routine, such as a quadratic or cubic fit, to the last few points of the calculated average to decide how it might have crossed the gap between the last true point and the present time. A small mathematical adjustment has to be applied so the value estimated by the routine at the position of the last true point coincides with the true value. If this is not



**Figure 10.1.** The extrapolation of a 41-week average. The last calculated point is at the position of the right hand arrow. A quadratic fit is calculated using the average points that lie between the two arrows. This is plotted as the dashed line. It is then adjusted so that it coincides with the actual average at the positions of the two arrows before being calculated and plotted up to date as the dotted line.

done, then the extrapolation starts out being in error from the first. The process is shown in Figure 10.1. The right hand vertical arrow shows the position of the last calculated point of a 41-week average. The left hand arrow shows the point eight weeks before this. These last eight points of the actual centered average are used to calculate a least squares quadratic fit. This is plotted as the dashed line. Although not easy to see, this line does not coincide with the actual calculated average at either the first arrow or the second arrow. It is then adjusted so that it does coincide at both of these points, and its adjusted position is shown by the dotted line.

A computer program such as **Microvest 5.0™** does this calculation and adjustment before using the calculation as a template for the channel boundaries, allowing the specified number of points to lie outside of the boundaries. With a small amount of practice, a graphical estimation of how the

centered average crosses the gap from the last calculated point to the present time will be quite close to this curve-fitted version. This can then be used as a template for the channel boundaries.

In a great many cases, this graphical or computational exercise is all that needs to be done to produce a channel accurate in terms of containing all of the price movement across the gap until the present time, and that will also be valid into the near future.

## TURNING POINT DELAY

There is almost inevitably a delay between a trough or peak in the data and the corresponding change in the direction of an average. The delay gets larger as the span of the average increases. The reason for the delay is found in the way averages are calculated, with the next data point being added in and the drop point, *i.e.* the data point a complete span back in time, being subtracted from the running total. With, for example, a falling average, the running total will only become larger than its previous value if the next data point is larger in value than the drop point.

### Minimum delay

The minimum delay between a peak or trough in the data and a change in the direction of the average is obviously one point, *i.e.* a day for daily data and a week for weekly data. The probability of an average changing by the time the next data point comes in decreases rapidly as the span of the average increases. The further back we go from the peak or trough in the data, the larger the gap between the value at that point in time and the value at the peak or trough. In order to cause the average to change direction as the next data point after the trough comes in we need a larger and larger change between this next datapoint and the peak or trough datapoint.

For averages of small spans, this required change, while large, may still be within the range of changes that have occurred historically (see sec-

tion on probability in chapter 3). As the span increases, the change necessary between the peak or trough and the next data point becomes so large that it becomes larger than any previous known change, and therefore it becomes highly improbable that it will occur. Occasionally, a five point average will change direction after this minimum delay, but the probability of averages with the spans we have been using in previous examples, such as 41 and 201, changing direction with this minimum delay is so low it is extremely unlikely to happen.

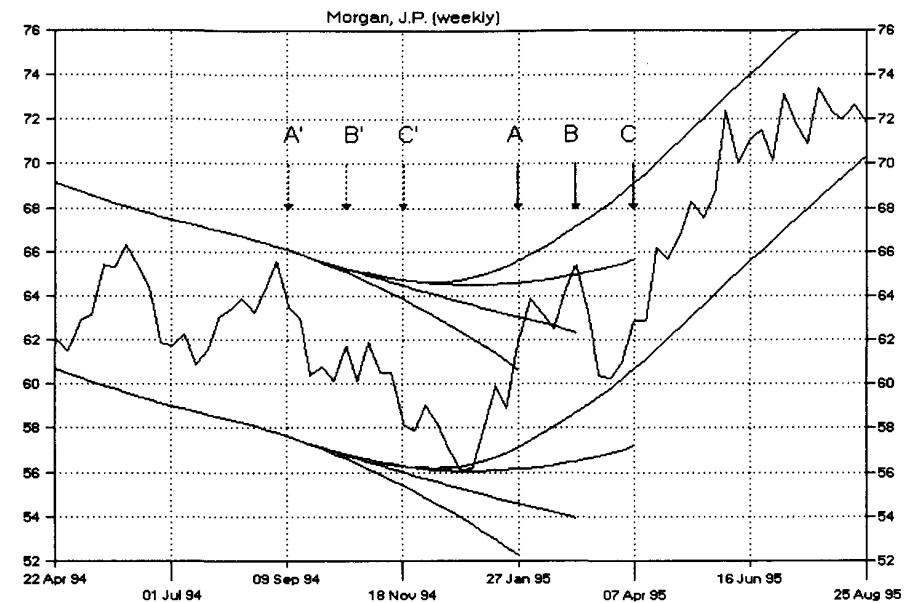
### Maximum delay

The maximum delay between a peak or trough in the data, a change in direction of the average is one point less than the span of the average. For example, 200 days for a 201-day average, or 40 weeks for a 41-week average. This will only happen in the special case that the change between the peak or trough and the point previous to it is so large that this price level is not reached until another  $n$  points have elapsed, where  $n$  is the span of the average.

### Typical delay

We have seen the delay between a peak or trough in the data and a turning average ranges between 1 point and  $n - 1$  points, where  $n$  is the span of the average. If a large number of average turning points is studied, you can see the delays form a flattened distribution, with limits of 1 and  $n - 1$ . The most frequently occurring delay is one of half of the span of the average. Although this means the most likely delay is one of half a span of the average, because the distribution is flattened, delays of up to a few points more or less than the half span are also quite common. The exact delay that occurs for an average depends solely upon the scatter of the data around the peak or trough, and is not predictable in advance for any specific average.

The delays in a 41-week average as the point of calculation moves past the trough in the data is illustrated by the example of the turning point in



**Figure 10.2.** The effect of delays in calculating 41-week channels. The continuous channel running from left to right is the actual channel, calculated some time in the future. The minimum in the channel occurred on December 2, 1994. The channel was calculated successively at points A (January 27, 1995), B (March 3, 1995) and C (April 7, 1995), with the extrapolations from the last true points at A, B and C being shown. The first indication of a turn in the channel was on March 10, 1995. By point C the turn was now obviously well established although the extrapolation is still not very close to the true channel.

the **J. P. Morgan** stock price in late 1994/ early 1995 as shown in Figure 10.2. The actual 41-week channel, as calculated some time in the future is shown, as are three successive calculations of the channel based of course on the 41-week centered average. The turning point in the actual channel, as calculated in the future, occurred on December 2, 1994.

The first calculation of the channel, at point A on January 27, 1995, gave the extrapolation from point A, with the channel apparently headed downwards at an ever increasing rate. The next calculation, at point B on March 3, gave the extrapolation from point B, with the channel still headed downwards, but at a more or less constant rate or fall. By the time the calculation was carried out on April 7, the extrapolation from point C

now gave a channel that had begun to rise, even though comparison with the true channel shows its positioning was not all that good.

Not shown is the point where the first indication that the channel had stopped falling might be about to turn up. That was given on March 3, 1995, some thirteen weeks after the actual turn. The penalty to the investor of this unavoidable delay in the channel changing direction is of course lost profit, since the price may have risen considerably from its low point by the time the change in the channel direction becomes apparent.

Although in this exercise the channels have been extrapolated by the computer from the calculated centered average, the investor who drew the extrapolation by eye across the gap from the last calculated point to the present time would end up with very similar channel boundaries.

At this point, it should be noted that no account has been taken of the violation of these channel boundaries by peaks or troughs in the data and any bending or change in direction of these features might force on the channel.

### FACTORS THAT FORCE A CHANGE IN CHANNEL DIRECTION

Although some of these have been illustrated in the many examples in previous chapters, it is useful to restate these and add some additional ones before examining them in greater depth.

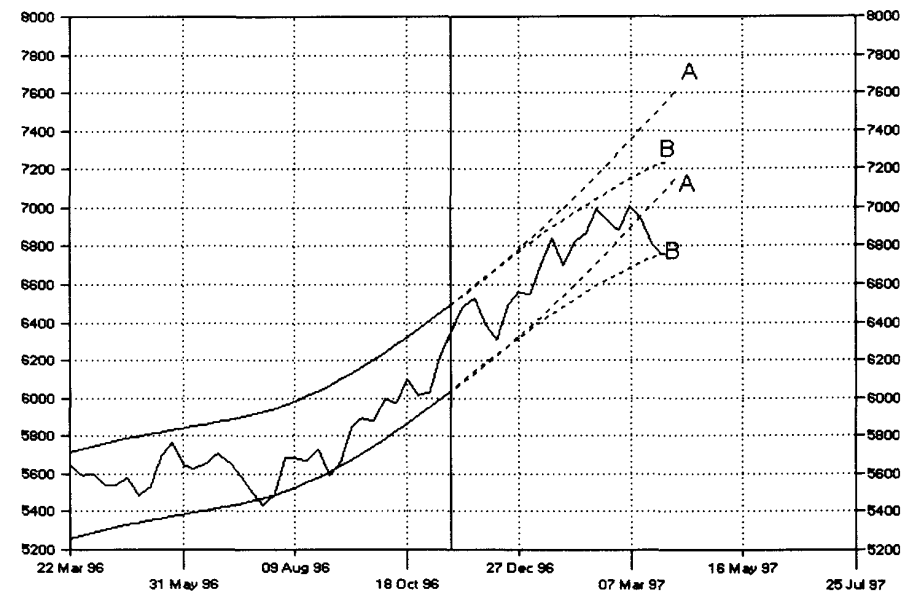
#### Moderate changes in direction

Once the boundaries have been extrapolated by either of the methods just discussed, then there are three factors that will cause a minor adjustment. The first is the penetration of either the upper boundary by a peak or the lower boundary by a trough (but not both) formed in the gap between the last calculated point and the latest data point. The second is the penetration of the boundary by an unexpected or unusually large movement in

the most recent data where a peak or trough has not yet formed. The third is an unexpected or unusually large movement in the data around the section that is one complete span back in time (the drop point, see chapter 7).

#### Boundary penetration by a peak or trough

A minor violation of either the upper boundary by a peak or the lower boundary by a trough is acceptable, since a tolerance will have been allowed over the complete history of the channel. The prime aim though is to allow troughs and peaks to lie on the boundary rather than outside of it. If the penetration appears to be larger than is acceptable, then the channel has to be bent enough to accommodate the peak or trough causing the violation.



**Figure 10.3.** A modest adjustment has to be made from the original extrapolated boundaries (A) to the new boundaries (B) because of the latest fall in the value of the data. The boundary can only stay in position B if the next data point is higher than the latest, thus forming a trough that can lie on the boundary, otherwise the boundary will have to be adjusted downwards again.

### Boundary penetration by most recent data

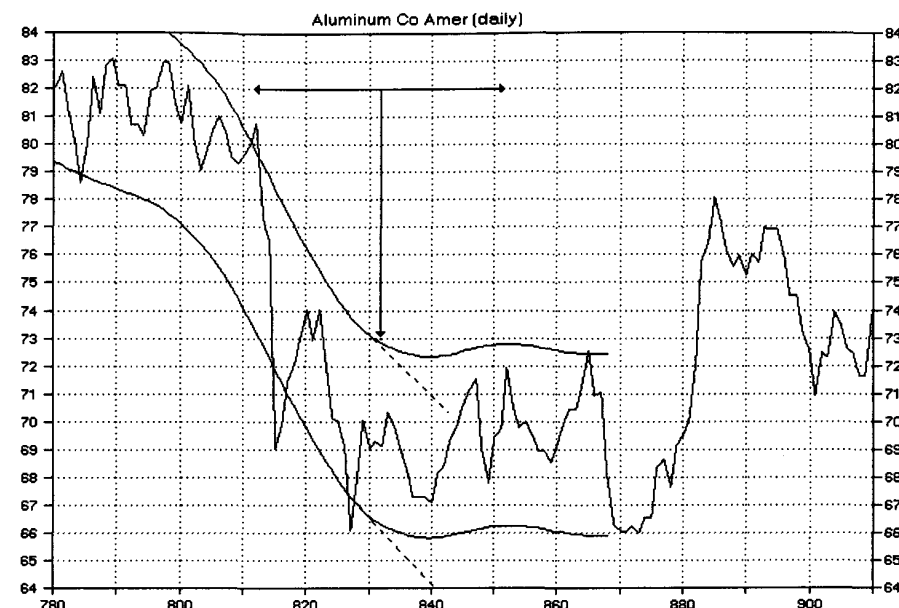
The situation when the latest data point is penetrating a boundary is rather different. Although the only adjustment that can be made is to move the boundary to allow the data point to lie on it, it is only if the next data point, yet to occur, makes this latest point a peak or a trough that this estimated position for the boundary will be correct. If the next data point continues the move in the same direction, then the boundary will have to be adjusted yet again. Thus, today's adjustment of the boundary must be seen as only temporary until the next data point shows otherwise. In such circumstances with adjustments being made each time new data becomes available, the investor should not take action. To take action is to predict the current short term trend has finally changed direction when there is no evidence to support this belief. This scenario is shown in Figure 10.3.

The original estimation of the boundaries before any adjustment is made is shown as channel A. The recent fall in the value of the data requires the boundary to be moved down to position B. The adjustment at this time is not large enough to cause a reversal in the channel direction, but simply a falling off in the rate of the rising channel.

### Unusual movement a complete span in the past

The comment was made early in chapter 7 that the change in the value of an average is brought about not only by the value of the next data point being added into the running total, but also by the value of the point, in the past, which is being subtracted.

Taking a rising average as an example, the rate at which it rises will slow down if the difference between the data point being added in and the point being dropped becomes smaller than it was at the time of the previous point. In the extreme, of course, if the data point being added in is less than the point being dropped, then the calculated value of the average will be less than it was at the previous data point and the average will reverse direction.



**Figure 10.4.** There are 41 points between the ends of the double headed arrow. These produce the averaged point at the position of the vertical arrow. The normal extrapolation of the average would give the dashed line. There is an abnormally large fall between points 812 and 815, while the changes between points 843 and 846 are more normal. This imbalance accounts for the decrease in the rate of descent of the channel, shown as the solid line from the vertical arrow forward.

If therefore we examine the section of the data around one whole span of the average in the past and find unusually large rises, then we must expect the rate of increase of the average to start to slow down. This is because we will be dropping larger values of the data and replacing them with smaller, more normal values. This concept is illustrated in Figure 10.4. The average of the 41 points starting from point 812 is shown by the vertical arrow. The extrapolation of the channel from the mid-point of this set of data follows the dashed line. The next few points from 812 to 815 show an abnormally large fall, while at the other end of the section, between points 843 and 846, the changes are more normal. When these two ends of the range of points used for the calculation are taken into account, the rate of descent of the channel decreases rapidly. Once these

abnormal falls pass out of the calculation, the average moves more or less sideways because the values of the points being added in are very similar to those being dropped.

### Reversal of Direction

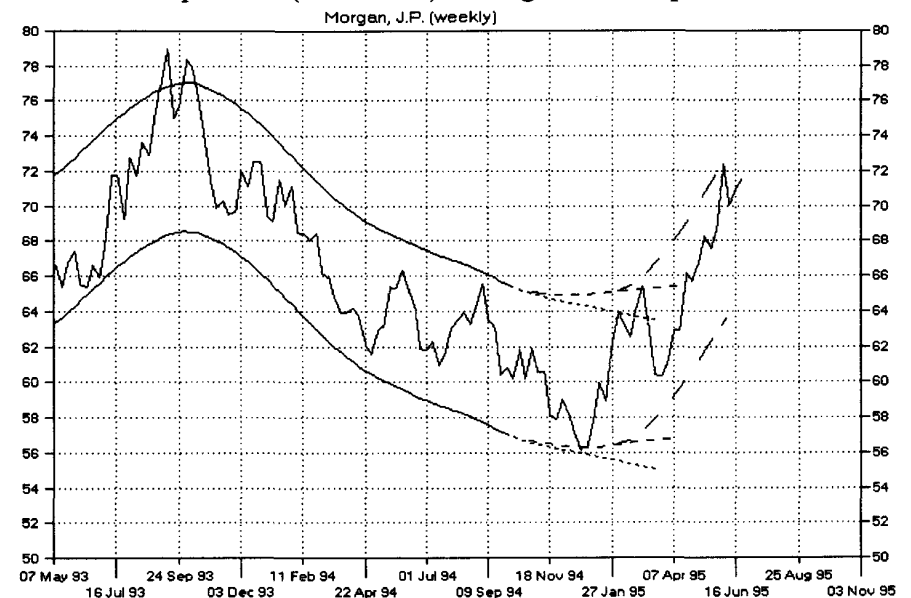
There are three factors that will cause a total reversal of the direction of a channel. The first is the penetration of both the upper boundary by a peak and the lower boundary by a trough formed in the gap between the last calculated point and the latest data point. The second is the penetration of the boundary by an unexpected or unusually large up or down movement in the most recent data where a peak or trough has not yet formed, but where a previous trough or peak forces a reversal rather than a minor adjustment. The third is where a channel will collide with an outer channel calculated from an average of longer span unless the inner channel is made to change direction.

In all of these cases, unless there are a considerable number of peaks and troughs to establish the boundaries with a high degree of validity, the principle of symmetry can be employed in order to help decide on the new position for the channel.

### Boundary penetration by both a peak and a trough

In the case of moderate changes in direction, it was only necessary to bend the channel to accommodate whichever feature was penetrating the boundary. Where we have both a peak and trough, we find that bending the channel one way to accommodate one of the features will make the penetration by the other feature even worse. The only solution will be to bend the channel to reverse direction. Obviously the bend will be somewhere between the last calculated point the latest feature that would otherwise penetrate a boundary. In the absence of other information, the bending point has to be taken as the position of the first feature that would penetrate the boundary.

This exercise was carried out in nearly all of the examples in the last chapter, but one more example is given here for completeness. The 41-week channel is shown for **J.P Morgan** in Figure 10.5. On February 10, 1995 the stock had fallen from a level of  $\$63\frac{3}{8}$  the previous week, forming a peak on February 3. The extrapolated channel, falling in a more or less straight line, allows this peak to sit on the upper boundary while also keeping the trough of  $\$56$  on December 23, 1994 within the channel, so that the extrapolation (dotted line) looks good at this point in time.



**Figure 10.5.** The extrapolated boundaries of a 41-week channel have to be adjusted twice to accommodate the two peaks in the stock price at March 3, 1995 ( $\$65\frac{3}{8}$ ) and June 2, 1995 ( $\$72\frac{3}{8}$ ) while keeping the trough at December 23, 1994 ( $\$56$ ) on or within the lower boundary.

However, within another four weeks another peak had formed at  $\$65\frac{3}{8}$  on March 3. This peak can only be kept within the channel if the fall in the channel is brought to an end and a slight rise is built in. The lower boundary of this adjusted channel passes just through the December trough, but still allows the peak of March 3 to also lie on the upper boundary, so that again, the newly estimated channel appears to be in a reasonable position.

Before long, another adjustment of the channel was called for, since the price rose to form a peak of  $\$72\frac{3}{8}$  on June 2. This calls for a definite upward bend in the channel, otherwise this peak would penetrate well above the current estimated position of the channel. In this particular case this high peak means the level of symmetry around the turning point is quite low. The channel is now rising at a much faster rate.

### PROBABILITY METHODS

The recently developed Sigma-p algorithms (see Appendix) offer a considerable improvement on the way that turning points in channels are estimated. One algorithm (Sigma-p A) calculates a better channel across the gap between the last true average point to the current time than the curve-fit method. The other (Sigma-p B) calculates a window where the channel should change direction, although it does not, however give any indication of a price level at which the turn will occur; this has to be deduced from a consideration of where the channel boundaries are likely to be at that point in time. The interesting point about Sigma-p B is that it can calculate the position of the next turning point well into the future, sometimes more than a year ahead.

A predictability score is given for the calculation, so that action is not taken by the investor in those situations where the predictability is low. Predictability is highest when weekly closing prices are used, and varies according to the span being used as the basis of the channel calculation.

The percentage predictability for each of the Dow 30 constituent companies is shown in Table 10.1 for both 41-week and 53-week channels. Often there can be a wide variation between the two channels for the same company. For example in the case of the **Aluminum Company**, where it changes from 80.1% for the 41-week channel to 38.7% for the 53-week channel. The most predictable 41-week channels in July 1998 are those for the **Aluminum Company** and **Woolworth**, while the least predictable are **Du Pont** and **Merck**. For 53-week channels, the most predictable are **AT & T** and **3M**, while the least are the **Aluminum Com-**

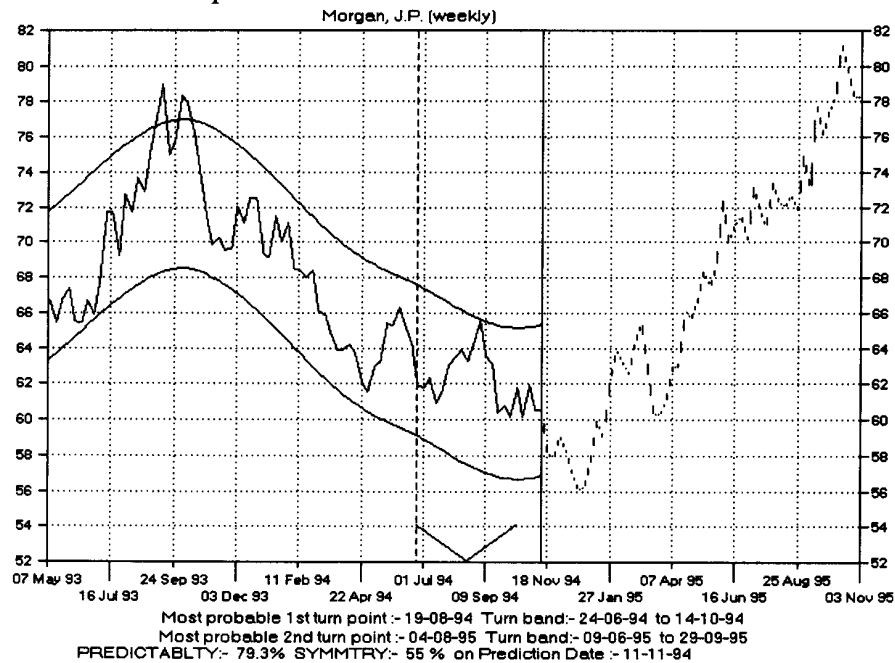
pany and Caterpillar.

Stocks	41-week predictability	53-week predictability
AT&T	72.8	78.3
Allied Signal	55.3	72.9
Aluminum Co	80.1	38.7
American Express	65.2	64.5
Bethlehem Steel	73.9	67.2
Boeing Company	70.3	75.3
Caterpillar Inc.	75.8	32.8
Chevron Corp	63.5	58.1
Coca Cola	62.9	49.2
Disney	66.4	68.8
Du Pont	42.9	75.1
Eastman Kodak	75.1	64.8
Exxon	71.1	58.6
General Electric	58.5	71.4
General Motors	77.3	53.5
Goodyear Tire	70.5	64.2
IBM	50.5	56.5
Internl Paper Co	63.7	71.8
J P Morgan	78.0	73.1
MacDonalds	62.3	71.2
Merck & Co	41.5	54.7
Minnesota M M	71.3	78.2
Philip Morris	75.2	63.4
Proctor & Gamble	61.9	52.6
Sears Roebuck	68.3	75.8
Texaco Inc	51.1	46.4
Union Carbide	75.0	71.3
United Technols	62.5	71.0
Westinghouse	78.2	65.2
Woolworth Corp	82.9	59.8

Table 10.1

Predictability for a channel turn normally lies within the range of 35 to 85%. The investor should only work with stocks whose predictability lies above 70%.

A few examples serve to show the advantage of these methods over the traditional extrapolation of channel boundaries.



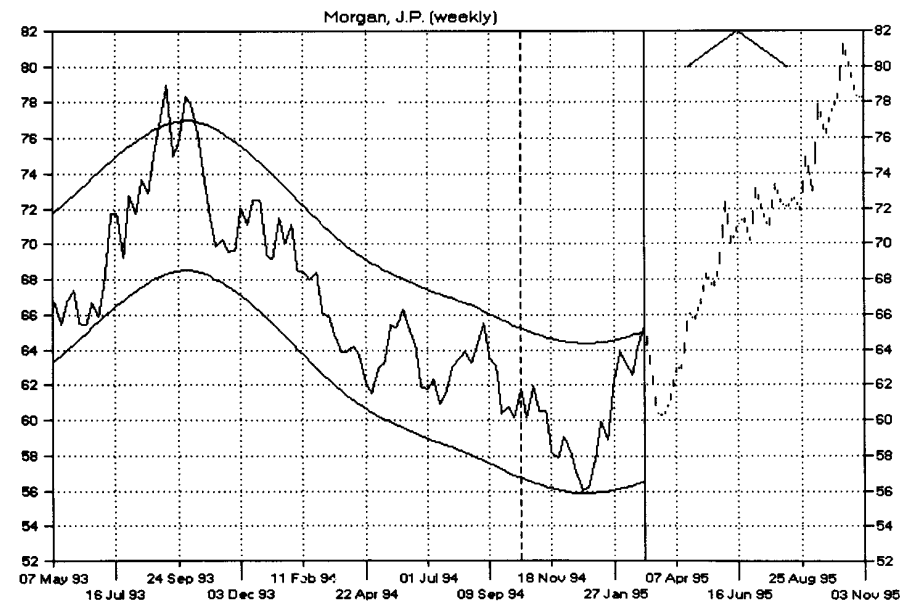
**Figure 10.6.** Prediction of the 41-week channel turning point for J.P Morgan on November 11, 1994. The dashed vertical line is the last true channel position. The channel boundaries between the latter and the time that the prediction is made (solid vertical line) are estimated by a probability algorithm, while the downward pointing chevron is a different calculation of the most likely turning point window. Future movement of the stock is shown by the broken line. (Note: dates are European style)

### J. P. Morgan

A chart produced for J.P Morgan on November 11, 1994 is shown in Figure 10.6. This should be compared with Figure 10.5. You can see that the channel turning upwards only became apparent after the peak was

formed on June 2, 1995. Now we can see that Sigma-p A produced a 41-week channel some six months earlier that had obviously changed direction even though the major trough on December 23, had not yet been formed. Sigma-p B confirmed this prospect of a newly rising channel by estimating that the most likely turning point was on August 19, 1994, *i.e.* in the gap between the last true channel position and the current time. This would have allowed the investor in early enough to take full advantage of the ensuing rise that took the stock up to over \$80 by the following October.

By March 3, 1995, with the stock having risen to \$65 <sup>3</sup>/<sub>8</sub>, Sigma-p B has now calculated that the turning point in the 41-week channel is real, so that it calculates the next probable turn, that now lies in the future. The estimation is for a turn between June and July of that year. It can be seen from Figure 10.7 that by June the progress of the stock had flattened out, so that it appeared that the up trend was coming to an end. However, the

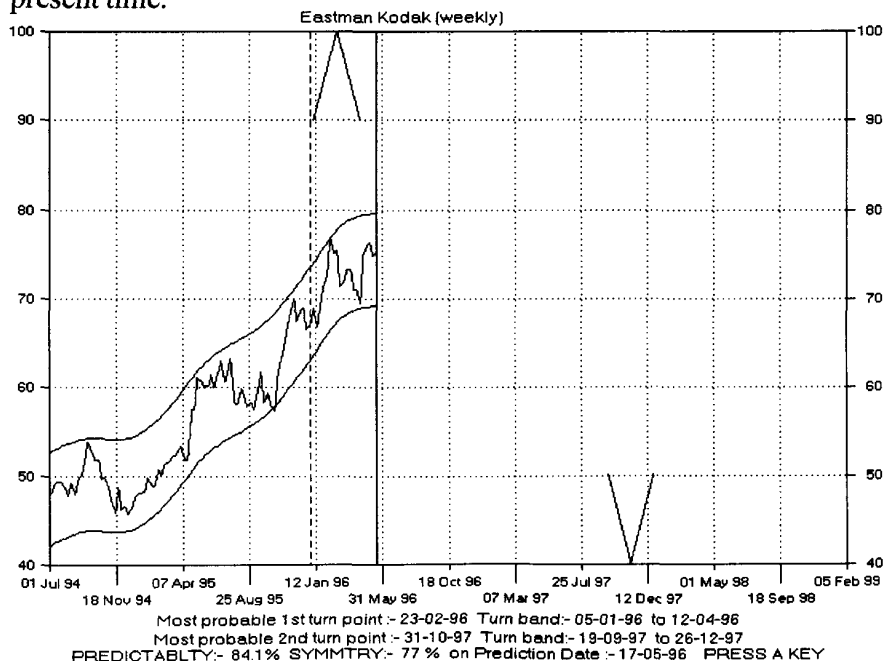


**Figure 10.7.** By March 3, 1995 the chevron has disappeared from the gap between the last true channel point (vertical dashed line) and the current time (solid vertical line) and is now estimating a down turn in the channel in June 1995.

investor would have been waiting for a signal based on the position in June, at which time the prediction of the time of the turning point had moved further into the future, allowing the investor to continue to take advantage of the rise that took the stock even higher over the next few months.

**Eastman Kodak (May 1998)**

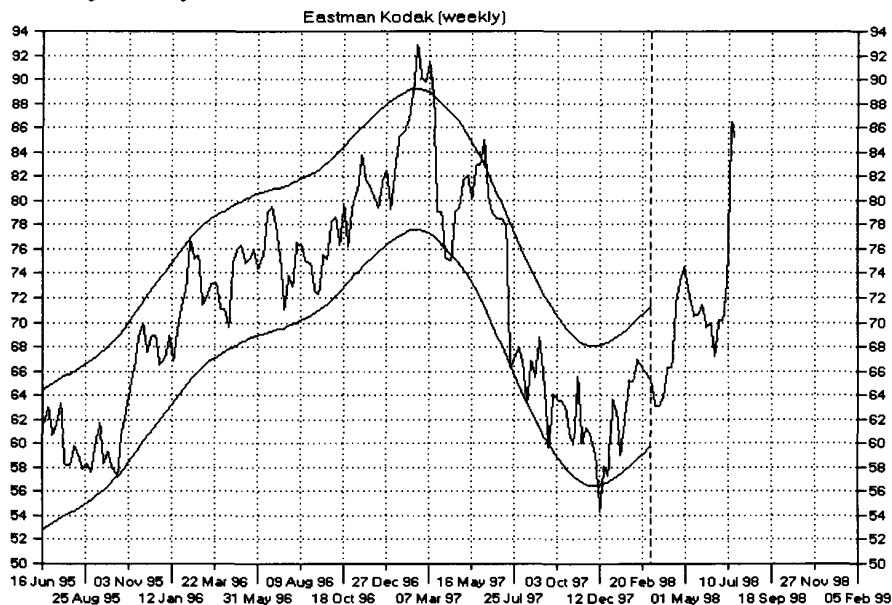
The position on May 17, 1996 for **Eastman Kodak** is shown in Figure 10.8. This example is chosen because at the time the predictability at 84.1% was extremely high. The channel direction, estimated by Sigma-p can be seen to have probably topped out. This is confirmed by the estimation of the most likely turning point having been on February 23, many weeks somewhere in the gap between the last true channel point and the present time.



**Figure 10.8.** The Sigma-p prediction for **Eastman Kodak** on May 17, 1996 is for the 41-week channel to have already turned down on the previous February, and for a fall to continue until October 1997 where the channel should begin to rise again.

It is interesting to see that the prediction of the most likely point for the next turn, made on May 17, 1996, was in late October 1997, some 76 weeks into the future!

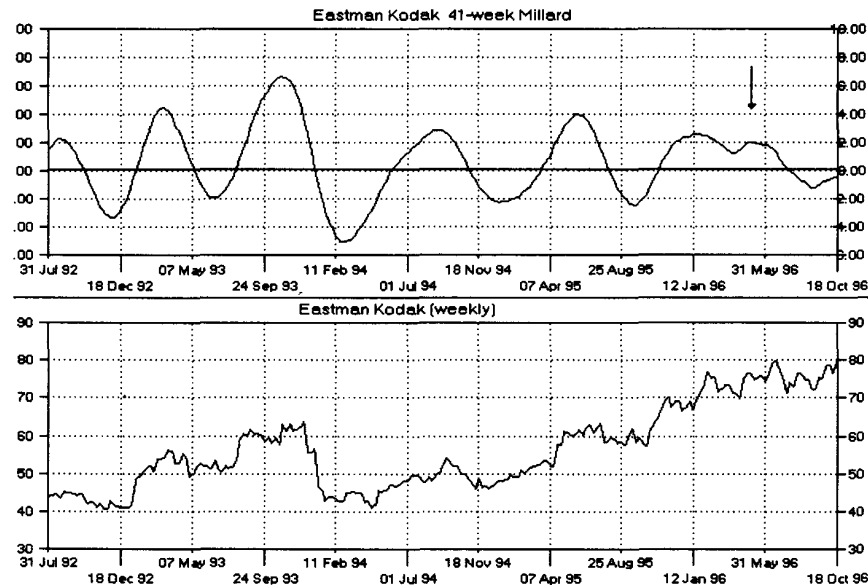
The astonishing accuracy of this prediction can be seen from Figure 9.9, where the 41-week channel has been calculated at the time of writing of this chapter, July 24, 1998. The calculated channel terminates some 20 weeks prior to this, but the turning point occurs prior to this cut-off and is therefore the true turning point. This turn was on December 5, 1997, only five weeks later than the prediction made more than 19 months previously in May 1996!



**Figure 10.9.** The recent history of **Eastman Kodak** on July 24, 1998. The calculated 41-week channel terminates 20 weeks back at the position of the dashed line. This shows that the turning point occurred on December 5, 1997. The estimation for this turn, made in May 1996, 19 months earlier, was only 5 weeks out!

One point the reader will have noticed when comparing Figure 10.9 with Figure 10.8 is the fact that the original turn down in the channel was predicted, on May 17, 1996, as having occurred in February 1996. The

subsequent channel movement right up until October 1996 remained in line with this prediction, but a shorter wavelength cycle then became prominent, taking the price level higher for around six more months. The kink in the channel from May 1996 forward can be seen quite clearly in Figure 10.9.



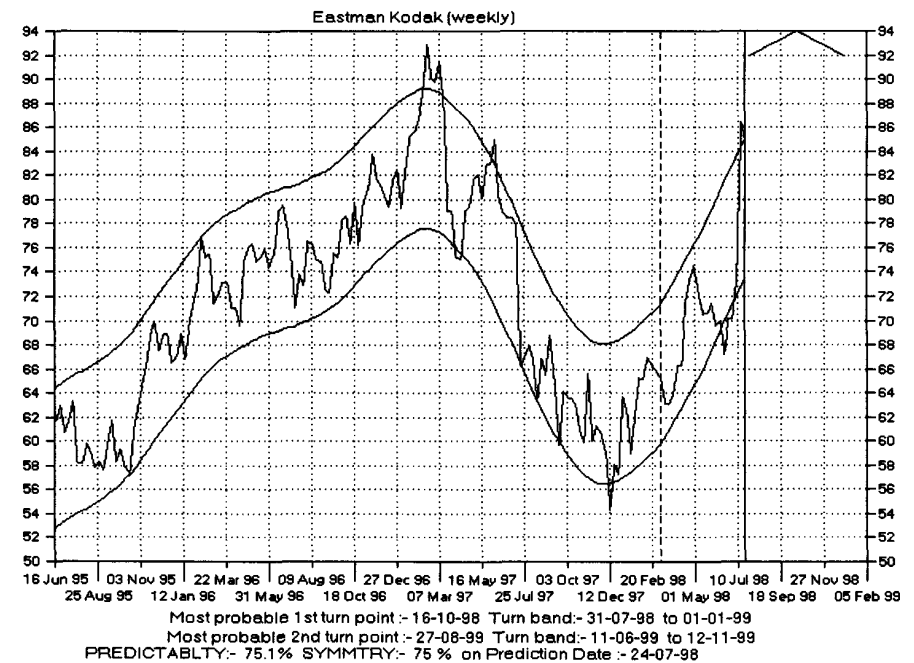
**Figure 10.10.** The plot of the 41-week cycle for *Eastman Kodak* (upper panel) shows a distortion due to interference by a shorter wavelength cycle at the point in May 1996 indicated by the arrow. This is the reason the predicted turning point in February 1996 was delayed.

The interference by another cycle is confirmed by the plot of the 41-week cycle, isolated by the cycle highlighter, shown in Figure 10.10. You can see there was indeed another, short wavelength cycle distorting the normal shape of the cycle at this point. It was this unpredictable cycle that was responsible for the delay in the turn down of the 41-week channel.

Finally, since the later part of this chapter has been concerned with the prediction of channel turning points, it is necessary for this author to stick his neck out and make a prediction on the day before the electronic manu-

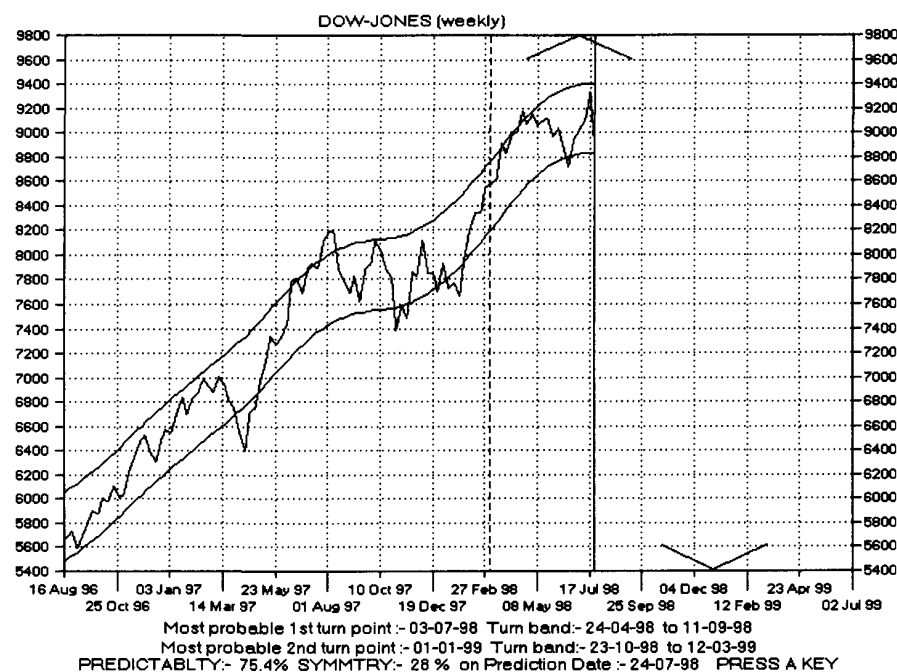
script is sent to the publisher! Since at the time of writing, **Eastman Kodak** has a high predictability rating, it is sensible to stay with this one, although, due to the interference by the shorter wavelength cycle in May 1996, the predictability has now fallen to 75.1%. The fact that the predictability is not forecast as being 100% will be my get out if my forecast turns out to be slightly in error!

Figure 10.11 shows the prediction for the channel turning point as July 24, 1998. The turning band lies between July 31, 1998 and January 1, 1999, *i.e.* a turn can be expected at any time in this window, with the most likely turning point (downwards) being October 18, 1998.



**Figure 10.11.** The prediction for the turning point in the 41-week channel for *Eastman Kodak* made on July 24, 1998. The turn is predicted to occur between July 24, 1998 and January 1, 1999 with the most probably point being October 16, 1998.

As far as the Dow is concerned (Figure 10.12), Sigma-p shows that the



**Figure 10.12.** The prediction made for the turning point in the 41-week channel for the Dow Jones Index, made on July 24, 1998. The turn is predicted between April 24, 1998 and September 11, 1998 with the most probable point as July 3, 1998. It is likely that the Dow has already topped out for the time being.

41-week channel has probably turned, with the turning band predicted as lying between April 24 and September 11, 1998. The most probable turning point is July 3, 1998, with the predictability, at 75.4, being reasonably high. A cautionary note is sounded by the fact that the symmetry estimate of channel turning points is very low at 28%. Although it is likely the Dow has already topped out for the time being, the turning point may be significantly distorted.

It has to be remembered that these turning point estimations by Sigma-p gives no indication as to the amount that the channel will subsequently fall. It sometimes happens in retrospect, a predicted turning point can be seen to appear as a slight inflection in the channel because a shorter wavelength cycle then becomes dominant and the channel continues forwards

in the same direction. Such a case can be seen for the Dow in Figure 10.12 around October 1997. Prior to that point Sigma-p predicted a turn in October 1997, but while a turn did begin, the sharp rise in the Dow in early 1998 reversed this process.

## **APPENDIX**

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"The work of J.M. Hurst is highly regarded by technical analysts interested in the cyclical approach. Those who want a thorough education on this topic should avail themselves of the opportunity to acquire his full length course, which has been unavailable for many years until recently. The principles it teaches are just as valid today as they were 25 years ago."

—Tim Slater, President, Dow Jones Telerate Seminars

In the world of channels, bands, and envelopes, J.M. Hurst stands out as a primary source. (*THE PROFIT MAGIN OF STOCK TRANSACTION TIMING* constitutes the earlier stock-market citation for envelopes I have found.) So it is with great pleasure, and not a little excitement, that I greet 'lost' material from this venerable source. Long out of print and known to but a few, Hurst's course should prove to be an invaluable asset to the research-oriented technical analyst."

—John Bollinger, CFA, CMT

"My copy of "The Profit Magic of Stock Transaction Timing," by J. M. Hurst was only \$5.95, when purchased in March of 1979; it remains one of few treasured and frequently referenced volumes. Being an engineer, it is gratifying to find a book that is not full of hocus-pocus and magical methods. Hurst's tome clarifies cycles, channels, and brings a host of believable and useful methods for price analysis. Ed Dobson should be 'publisher of the decade' for uncovering and producing a course written by such a major contributor to market analytics. If you have not read his book, you need this course. If you have read his book, you have probably already ordered the course."

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"Jim Hurst's original cycle work laid the foundation for most of the cycle analysis being done in today's futures and stock markets. The cycle concepts and forecasting techniques are as valid today as they were then. His book and course should be read and studied by all serious students of the markets."

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"Every since I read about Hurst's method of "phasing," I have looked forward to learning more about his work. His apparently pragmatic approach to technical analysis is very appealing and should adapt well to the more advanced tools now in our hands."

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"I am delighted that Ed Dobson is preserving the Hurst Cycles Course for posterity. It is superb material and should be in the library of every serious technician. I have relied heavily on this material in my own cyclical analysis and in my writings on the subject."

—John J. Murphy, Noted technical analyst, Author of *Technical Analysis of the Futures Market and Inhermarket Technical Analysis*

"Anyone interested in stock or commodity cycles should be enlightened by the work of James Hurst. His pioneering into the cyclical nature of stocks and commodities is the background of modern cyclic theory. Hurst's entry and exit methods are by themselves worth the price of the course."

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"After studying technical analysis for several years my perspective was changed forever by reading Hurst's book on cycles and studying his course in the early 1970s. This was the first true explanation of the rhythm in chart formations and has been a valuable tool to this day. It adds tremendously to an understanding of the markets."

—Jim Tillman, Publisher of *Cycle trend Market Letter*

"When Ed Dobson told me he had located the workbooks and audio tapes of J. M. Hurst's course on market cycles, I felt as if a past market master had been resurrected from the dead. Hurst was such a brilliant original thinker that I can't imagine anyone who is serious about technical and cycle analysis would be without this material if given the opportunity to acquire it. Hurst's original book written in the late 1960s was the genesis of my career in cycles and contributed to a significant degree to any success I have enjoyed in this business."

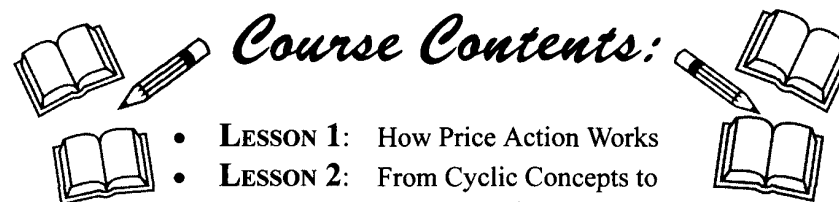
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"...carefully researched work on cycles and envelopes, backed up by solid and verifiable facts... brilliant application of mathematical analysis to the stock market... he developed a simple technique, which we now call channel analysis, which could easily be applied by the pencil and paper investor." ... man whose work must be considered a landmark in the field of investment."

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